PETRO-CANADA LUBRICANTS HANDBOOK 2017

Industry-leading products for improved business performance

PETRO-CANADA™
LUBRICANTS

Beyond today's standards.™

PETRO-CANADA LUBRICANTS: GOING BEYOND TODAY'S STANDARDS™

For more than 40 years, Petro-Canada has researched, developed and produced more than 350 world-class, advanced lubricants, specialty fluids and greases. Our products serve a diverse range of industries around the globe including transportation, mining, construction, the food industry, general manufacturing, industrial, power generation, plastics processing, forestry, and agriculture.

Petro-Canada's base oils are manufactured using the HT Purity Process resulting in crystal-clear base oils that are 99.9% pure – some of the purest in the world. Then we add a unique combination of additives to produce lubricants with exceptional performance and advanced protection. Our focus on delivering products that last longer translates into a performance edge for our customers, through increased productivity and reduced operating costs.

We invite you to get started by leveraging the comprehensive product information in this Handbook. Please note, this Handbook is current as of the time of publication; however, Petro-Canada is constantly innovating and improving its products to meet the ever-changing demands of the marketplace, so the information contained herein is subject to change. This Handbook is also available on www.lubricants.petro-canada.com. The products throughout are available in a wide range of package sizes and are stocked at many strategic locations around the world either by Petro-Canada or one of our many global distributors.

To help our customers select the right lubricant for the job, request a copy of our LubeSource Product Catalogue, LUB 2097. It's an informative guide that narrows your lubricant choices to a primary recommendation.

Petro-Canada Lubricants Inc.
Mississauga, Ontario, Canada

MAXIMUM PERFORMANCE • PERFORMANCE MAXIMALE • HT

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PETRO-CANADA QUALITY AND ENVIRONMENT STATEMENT

At Petro-Canada, we take quality very seriously. We are in constant, relentless pursuit of quality excellence in our products, our processes and our people.

Petro-Canada Lubricants maintains ISO 9001 and ISO/TS 16949 registrations to demonstrate to customers our commitment to quality. In 1993, Petro-Canada Lubricants became the first lubricants manufacturer in North America to be ISO 9001 registered.

Subsequently in 2002, Petro-Canada Lubricants became the first Lubricants manufacturer in the world to be registered to ISO/TS 16949 designed for suppliers to the automotive industry.

Petro-Canada Lubricants also maintains an ISO 14001 registration. Our vision and values drive our commitment to the environment.

We are guided in our day-to-day business activities by our Management System Vision. In order to achieve recognition as a first quartile supplier of choice for quality lubricants, specialty fluids, greases and related services, Petro-Canada will:

- Demonstrate our commitments by maintaining our ISO 9001, ISO 14001 and ISO/TS 16949 registrations.
- Ensure our operations comply with customer requirements, government legislation, corporate policy and applicable industry standards.
- Work towards the reduction of pollution by determining, evaluating and mitigating the environmental impacts of our business during the start-up, normal operation and shutdown of our facilities, as well as during project planning and implementation through to decommissioning.
- Ensure all employees and others working on our behalf are informed, trained and authorized to meet our quality and environmental performance requirements.
- Continually improve our products through design, manufacturing, delivery and service processes. This will be achieved through ongoing improvement of the effectiveness of our Quality and Environmental Management Systems.
- Establish quality and environmental objectives and targets and periodically review performance through the Management Review Process.

Our No-nonsense Lubricants Warranty.

"We will repair damaged equipment, or replace damaged equipment parts resulting from a failure due to defects of the Petro-Canada lubricant, as long as the lubricant is used in accordance with your equipment manufacturer's and our recommendations"

It's more than just a warranty. It's a commitment.

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INTRODUCTION

This Lubricants Handbook is a comprehensive reference guide designed to provide users with broad knowledge of Petro-Canada's many lubricant products. We have indexed the contents by product brand name, by product application and by subject. We have included a reference guide with current and former names where products have undergone name changes. We have also included a section with valuable general lubricant and industry information.

This Handbook is divided into nine (9) sections:

1. Indexes
2. The HT Purity Process (Base Oils)
3. Automotive Lubricants
4. Industrial Lubricants
5. Greases
6. Food Grade Lubricants
7. Specialty Base and Process Fluids
8. Fuels and Refinery Products
9. Glossary of Terms, Conversion Charts and Tables

Each Product Group is comprised of subsections that begin with a general description of the product and its applications. This includes the certifications and approvals granted by various specification writing bodies and technical organizations. This is followed by the typical characteristics for each of the various grades of the product.

More comprehensive technical data for each lubricant can be sourced from our extensive TechData series, available from your Petro-Canada Representative or one of our many global distributors. TechDatas are also available on our global website, lubricants.petro-canada.com

You can request additional information through one of the Petro-Canada contact points listed on the outside back cover of this Handbook.

LUBRICANTS HANDLING & STORAGE

Petro-Canada's lubricating oils and greases are the result of considerable research and development work; they are carefully manufactured and delivered, and are as good for their intended use as we can make them. During storage it is important to guard against contamination, which can drastically impact the performance and life of a lubricant. Numerous studies have shown that both water and dirt can decrease the life of bearings and other components. Preventing contamination during storage has a direct pay-back in terms of ensuring optimum lubricant performance, longer lubricant life and reduced maintenance costs.

INSIDE STORAGE

Lubricants should preferably be stored inside. However, even then there are certain precautions that should be followed:

- The temperature of the storage area should remain moderate and not be subject to wide fluctuations.
- The storage area should be located away from industrial contamination, such as fumes or dust.
- The storage area and dispensing equipment should be clean and be part of a regular cleaning schedule.
- Labels, stencils, markings on containers and dispensing equipment should be kept legible to avoid cross-contamination or incorrect application.
- All oils should use separate dispensing equipment.
- The oldest dated product that is required should be used first (First IN First OUT)

OUTSIDE STORAGE

If outside storage is unavoidable, then the following additional precautions should be followed:

- Ensure that the bungs on drums are screwed in tight.
- Store drums horizontally, with bungs below the oil level (i.e. at 3 o'clock and 9 o'clock). This prevents the seals from drying out and leaking.
- Drums stored on their sides should be clear of the ground and preferably rest on wooden or steel beams. They may be stacked three high if wedged properly to prevent movement.
- Stacking often results in the bottom drums never being used, so the use of a rack is preferred.
- Do not store drums on end with the bungs on top. Rain water collects on the drum head and is drawn into the oil when the drum breathes during temperature cycles. If drums must be stored this way, they should be tilted first by standing on edge (say on a 2 x 4 piece of lumber) with the bungs parallel to the tilt. When oil is drawn from the drum, the head should be wiped clean first.
- Drums should preferably be covered with a tarpaulin to protect them from the elements.
- To minimize contamination and the effects of weathering, time spent in outdoor storage should be kept to a minimum.
- Outdoor storage locations should be away from dusty areas such as quarries or unpaved roads. Opening drums in such conditions will contaminate the contents.

- Smaller package sizes (e.g. pails) and larger package sizes (e.g. Intermediate Bulk Containers (IBCs)) should be properly stored, covered, examined regularly and kept to a minimum to provide a quick turnover.
- For product delivered in plastic IBCs, they must be stored out of direct sunlight. These packages have minimal UV protective qualities, and exposure to direct sunlight may cause discolouration of the oil.

HANDLING

Lubricating oils and greases are a relatively harmless class of material. Nevertheless, care should be taken to avoid skin contact and inhalation of oil mists. Petro-Canada provides Safety Data Sheets (SDS) on all of its products and these are available from your Sales Representative, Customer Order Management Representative (COMR) or can be accessed on our website, lubricants.petro-canada.com.

Some general guidelines for handling lubricating oils and greases are as follows:

- Use personal protective equipment to avoid skin contact. This may also include the use of a barrier cream to reduce direct contact.
- Quickly remove any product that does get on the skin.
- Do not use gasoline, kerosene or similar solvents to remove lubricants from the skin as they take the natural oils from the skin and cause dryness.
- Use only mild soap and warm water or a recommended hand cleaner to remove lubricating oil and grease from the skin. Dry the skin using clean hand towels.
- Wash hands and arms at the end of the working day and before eating.
- Remove any contaminated clothing and clean thoroughly before re-use.
- Avoid breathing in oil mists.
- Clean-up lubricating oil and grease spills immediately and dispose of them according to environmental guidelines.
- Obtain medical advice concerning any potential health problems.
- Take special consideration to prevent any injection into the skin (hydraulics, pneumatics, pressurized delivery equipment, etc.)

Always refer to product SDS for specific safety and handling requirements.

PRODUCT SHELF LIFE – LUBRICATING OILS

Depending on their composition, the performance properties and stability of liquid lubricants (oils) will remain intact for a number of years provided they are in their unopened, original sealed containers and have been in protected storage that prevented exposure to UV light or severe high/low temperature cycles.

Industry performance standards and lubrication formulations can change.A lubricant which is near its expiry date may still perform to its original design, but it may not meet the latest requirements and specifications of newer equipment. It is always advised to consult the OEM manual.

The shelf life of Petro-Canada's lubricating oils is as follows:

**Protected conditions: indoor or covered storage with no freeze/thaw cycles.*

Indefinite Storage Life

• Base Oils and Process Oils

These may be stored indefinitely under protected conditions without any significant deterioration in performance. Slight changes in appearance / colour may occur. If they are used as part of a manufacturing process or application, the product properties should be reconfirmed if over 5 years old.

5 Year Shelf Life

- Hydraulic oils (except HYDREX Extreme)
- Engine oils (diesel, gasoline, locomotive, natural gas) with the exception of SENTRON Ashless 40
- PRODURO products (meeting Caterpillar TO-4 and FD-1)
- R&O and turbine oils
- Tackified products such as way oils, chain oils, rock drill oils, saw guide oils
- ENDURATEX and HARNEX industrial gear oils
- PURITY FG Silicone Spray, Penetrating Spray and MICROL MAX Spray.

3 Year Shelf Life

- White Mineral Oils USP (North America) with Vitamin E
- Automotive Gear Oils
- Automatic Transmission Fluids
- HYDREX Extreme hydraulic fluid
- UTF/THF/UTTO fluids (DURATAN)
- SYNDURO SHB multifunctional synthetic lubricants
- SENTRON Ashless 40 natural gas engine oil
- PURITY FG Hydraulic Fluids, Gear Fluids, Compressor Fluids, Chain Fluids
- PURITY FG Multipurpose Spray
- Air and natural gas compressor fluids
- VULTREX Gearshield NC

2 Year Shelf Life

- PURITY™ FG AW Hydraulic Fluids with MICROL™
- Neat metalworking/cutting fluids
- White Mineral Oil DAB (Europe), without Vitamin E

1 Year Shelf Life

- PURITY™ FG Trolley Fluid
- PURITY™ FG Corrcut-E Fluid 15
- PURITY™ FG Synthetic Roll Clean Fluid
- Water soluble metalworking/cutting fluids

Storage under unprotected conditions can result in water ingress. Water is detrimental to the appearance of the lubricant (hazy and milky) but more importantly, it affects the additive system and greatly reduces the performance level of the lubricant. It can also cause rust formation/corrosion in metal containers.

PRODUCT SHELF LIFE – GREASE

The shelf life of a grease is affected by the type and amount of thickener used, consistency of the grease, manufacturing method employed and the formulation complexity. Generally, lithium, lithium complex and calcium sulfonate complex greases remain stable for a long time. Some thickeners may have a tendency to set and harden over long storage periods (such as aluminum complex), while others may soften on aging (such as barium greases).

The shelf life of Petro-Canada Lubricants' greases of NLGI grade 1 or higher is five (5) years.

Petro-Canada Lubricants' greases of a NLGI grade of 0 of softer (#0, 00 or 000) generally have a shelf life of three (3) years. The list includes, but may not be limited to:

- PEERLESS™ OG0
- PRECISION™ XL EP00, PRECISION™ XL EP000, PRECISION™ XL 5 Moly EP0
- PRECISION™ Synthetic EP00
- PURITY™ FG00
- VULTREX™ Rock Drill EP000
- VULTREX™ MPG Synthetic Arctic
- VULTREX™ ▼OGL Heavy 6200 and OGL Synthetic 2200.
- VULTREX™ EGF 1000

The only exceptions are the following greases which have a shelf life of two (2) years :
- VULTREX™ OGL Synthetic All Season 680
- VULTREX™ OGL Synthetic Arctic

For specialty or niche products not listed, please consult your Petro-Canada Representative.

PRODUCT FILL DATES

Product fill dates appear on all our packaging and indicate the date that the particular package was filled. The shelf life of our products begins with these fill dates.

Here is a summary of where the package fill dates can be located on the package and how to read them.

This information applies only to fill dates for products packaged at Petro-Canada Lubricants' Mississauga, Canada, manufacturing plant (Lubeplex). For all others, please contact your Sales Representative.

1L Bottle and 4L Jug: Labelled Front and Back

- Coding on back (Ink Jet):
150305LX indicates the fill date March 5th 2015 and LX is for Lubeplex
- 1L & 4L Case:
150305LX indicates the fill date March 5th 2015 and LX is for Lubeplex

Pails: On the side (below the barcode) coded with ink jet (sticker on grease pails)

150305LX indicates the fill date March 5th 2015 and LX is for Lubeplex

Kegs: Side Label

2015/03/05LX indicates the fill date March 5th 2015 and LX is for Lubeplex

Drums: Top & Side Labels

2015/03/05LX indicates the fill date March 5th 2015 and LX is for Lubeplex

IBC/Totes: Two Labels on Opposite Sides

2015/03/05LX indicates the fill date March 5th 2015 and LX is for Lubeplex

Greases:

- Tubes:
2015/03/05LX indicates the fill date March 5th 2015 and LX is for Lubeplex
- Inner Pack (10 Tube Pack): on side of the pack
15.03.05 indicates the fill date March 5th 2015
- Case: on top of the case
2015/03/05 indicates the fill date March 5th 2015

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HARMONY/PREMIUM ARCTIC 15	HYDREX™ MV ARCTIC 15	2001
HARMONY/PREMIUM HVI 22,	HYDREX™ MV 22	2001
HARMONY/PREMIUM HVI 36, 60	HYDREX™ MV 32, 68	2015
HARMONY/PREMIUM PLUS	HYDREX™ XV ALL SEASON	2001
HEAVY DUTY DIESEL ENGINE OILS		
DURON-E	DURON HP	
DURON-E XL	DURON SHP	
DURON-E SYNTHETIC	DURON UHP	
DURON-E UHP	DURON UHP	
DURON	DURON HP	
DURON XL	DURON SHP	
DURON SYNTHETIC	DURON UHP	
DURON UHP 10W-40	DURON UHP E6 10W-40	
COMPRESSOR FLUIDS		
PURITY™ FG SYNTHETIC COMPRESSOR	PURITY™ FG SYNTHETIC FLUID 46	2010
HEAT TRANSFER FLUIDS		
CALFLO™ FG	PURITY™ FG HEAT TRANSFER FLUID	2004
CALFLO™ SYNTHETIC ARCTIC	CALFLO™ SYNTHETIC	2011
SMALL ENGINE OIL		
SNOWMOBILE MOTOR OIL	SUPREME SYNTHETIC BLEND 2-STROKE SMALL ENGINE OIL	2014
TWO CYCLE MOTOR OIL	SUPREME SYNTHETIC BLEND 2-STROKE SMALL ENGINE OIL	2014
STATIONARY GAS ENGINE OILS		
SENTRON™ 541C	SENTRON™ ASHLESS 40	2014
SENTRON™ 445, 470	SENTRON™ LD 3000	2014
SENTRON™ FLEET 10W-40	SENTRON™ VTP 10W-40,	2014
SENTRON™ FLEET 0W-30	SENTRON™ VTP 0W-30	2014
SENTRON™ 840	SENTRON™ MID ASH 40	2014
INDUSTRIAL GEAR OILS		
ULTIMA SYNTHETIC	ENDURATEX™ SYNTHETIC EP	2006
ULTIMA EP	ENDURATEX™ EP	2006
ULTIMA PLUS	ENDURATEX™ XL SYNTHETIC BLEND 68/220	2006
ULTIMA EP 68/150	ENDURATEX™ XL SYNTHETIC BLEND 68/150	2006
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SENATE	ENDURATEX ™ MILD WG	2006

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PRECISION™ GOLD	PRECISION™ SYNTHETIC	2005
PRECISION™ GOLD HEAVY	PRECISION™ SYNTHETIC HEAVY 460	2005
PRECISION™ SYNTHETIC HEAVY	PRECISION™ SYNTHETIC HEAVY 460	2011
PRECISION™ GOLD MOLY	PRECISION™ SYNTHETIC MOLY	2005
PRECISION™ EP1, EP2	PRECISION™ XL EP1, EP2	2005
PRECISION™ EP00	PRECISION™ XL EP00	2005
PRECISION™ EMB	PRECISION™ XL EMB	2005
PRECISION™ MOLY EP1, EP2	PRECISION™ XL 3 MOLY EP1, EP2	2005
MULTIPURPOSE EP1, EP2	PRECISION™ GENERAL PURPOSE EP1, EP2	2005
MULTIFLEX MOLY EP2	PRECISION™ GENERAL PURPOSE MOLY EP2	2005
MULTIFLEX MOLY SPECIAL	PRECISION™ XL 3 MOLY ARCTIC	2005
GREASE OG-0, OG-1, OG-2 OG-2 (RED), OG-PLUS	PEERLESS™ OG0, OG1, OG2 PEERLESS™ OG2 RED; PEERLESS™ OG PLUS	2005
VULCAN SYNTHETIC ALL SEASON	VULTREX™ OGL SYNTHETIC ALL SEASON 680	2008
VULCAN SYNTHETIC ARCTIC	VULTREX™ OGL SYNTHETIC ARCTIC	2005
VULCAN EGF 1000	VULTREX™ EGF 1000	2005
VULTREX OGL HEAVY 3600	VULTREX™ OGL HEAVY 6200	2012

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PETRO-CANADA AND THE HT PURITY PROCESS

BASE OIL MANUFACTURE

Lubricant base oils are produced in a series of steps which are designed to enhance certain desirable properties. For paraffinic oils, these include viscosity index, oxidation resistance, thermal stability and low temperature fluidity.

Starting from petroleum crude oil, the typical process for making a base oil is as follows:

- Separation of lighter boiling materials, such as gasoline, diesel, etc.
- Distillation to isolate desired base oil viscosity grades
- Selective removal of impurities, such as aromatics and polar compounds
- Dewaxing to improve low temperature fluidity
- Finishing to improve oxidation resistance and heat stability

In general, both Solvent Refined and Hydrotreated base oils are manufactured this way, but differ in the type and severity of processes used.

BASE OIL CLASSIFICATION

Before reviewing how base oil is manufactured, the American Petroleum Institute's (API) Base Oil Classification system should be explained. As shown below, the API system classifies base oils into five major groups. While these groups were originally intended to be used for formulation of engine oils, their definition is widely understood and usage has expanded beyond this area.

	Base Oil Characteristics			
API Group	**Sulphur Wt, %**	**Saturates Wt, %**	**Viscosity Index VI**	**Manufacturing Method**
I	>0,03	<90	80-119	Solvent Refined
II	<0,03	>90	80-119	Hydroprocessed
III	<0,03	>90	120+	Severely Hydroprocessed
IV		Polyalpha Olefins (PAOs)		Oligomerization
V		Other Base Oils		Various

Although not officially recognized by the API, the following additional terms are often used in the industry.

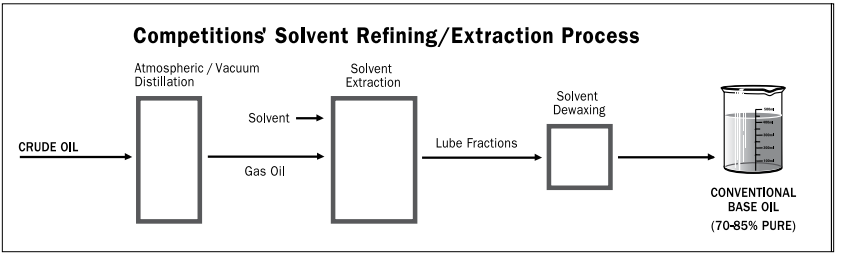
	Base Oil Characteristics			
API Group	**Sulphur Wt, %**	**Saturates Wt, %**	**Viscosity Index VI**	**Manufacturing Method**
II+	<0,03	>90	110-119	Hydroprocessed
III+	<0,03	>90	130+	Severely Hydroprocessed

Group I, or conventional base oils manufactured by Solvent Refining, make up most of the base oil produced in the world today. Containing more than 0.03 wt % Sulphur and/or less than 90 wt % Saturates, they are less pure than Hydroprocessed or Synthetic base oils.

Group II and III base oils are manufactured by what the API calls Hydroprocessing or Severe Hydroprocessing. With Sulphur content of less than 0.03 wt % and Saturates content of more than 90 wt %, they are more pure than Group I base oils. Petro-Canada uses a special high severity version of Hydroprocessing, called HT Severe Hydrotreating, to produce Group II, II+ and III base oils. It's also known as the HT Purity Process.

SOLVENT REFINING PROCESS

Initially, lighter products such as gasoline, diesel, etc., are separated from crude oil by atmospheric distillation. The heavier material is then charged to a vacuum distillation tower, where lubricant fractions of specific viscosity ranges are taken off. These fractions are then treated individually in a solvent extraction tower. A solvent such as furfural is mixed with the fractions and extracts about 70-85% of the aromatic material present. The solvent extracted lube fraction is then dewaxed by chilling to a low temperature, which removes much of the wax. This improves the low temperature fluidity of the product. Finally, the dewaxed lube fractions can be finished to improve their colour and stability, depending on the application requirements. One common method of finishing is mild hydrofinishing. This step should not be confused with Petro-Canada's HT Purity Process, as conditions of temperature and pressure in hydrofinishing are mild and therefore less effective at removing impurities. The API classifies the products of Solvent Refining as Group I base oils.



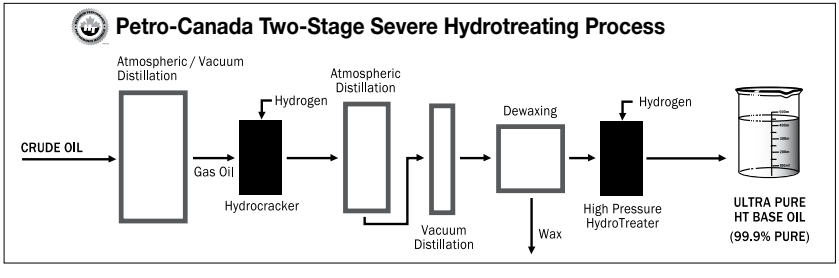
PETRO-CANADA'S HT SEVERE HYDROTREATING PROCESS

In Petro-Canada's HT Severe Hydrotreating process (also known as the HT Purity Process), the elimination of aromatics and polar compounds is achieved by reacting the feedstock with hydrogen, in the presence of a catalyst at high temperatures and pressures.

Several different reactions occur in this process, the principal ones being:
- Removal of polar compounds containing sulphur, nitrogen and oxygen
- Conversion of aromatic hydrocarbons to saturated cyclic hydrocarbons
- Breaking up of heavy polycyclo-paraffins into lighter, saturated hydrocarbons

These reactions take place at temperatures as high as 400°C/752°F, pressures around 3000 psi and in the presence of a catalyst. The hydrocarbon molecules that are formed are very stable and this makes them ideal for base oils used for lubricant blending. They are classified by the API as Group II base oils.

There are two stages in the Petro-Canada HT Severe Hydrotreating process. The first stage removes unwanted polar compounds and converts the aromatic components to saturated hydrocarbons. After separation into desired viscosity grades by vacuum distillation, batches of waxy lube base oil are chilled and dewaxed. These are then passed through a second stage high pressure hydro-treater for additional saturation. This final step maximizes stability by removing the last traces of aromatic and polar molecules, producing a water-white and 99.9% pure base oil.



HT SEVERE HYDROTREATING/ HYDROISOMERIZATION

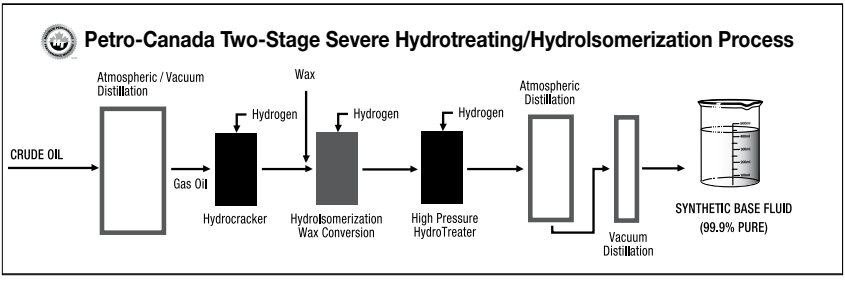
Petro-Canada operates a second base oil manufacturing unit that runs in parallel with the HT Severe Hydrotreating plant. This unit utilizes the HT Severe Hydrotreating process, but replaces the conventional dewaxing step with Hydroisomerization.

The Hydroisomerization process employs a specialized catalyst to selectively isomerize wax (*n*-paraffin mixture) to high VI, low pour point, isoparaffinic base oil. The process yields base oils with higher VIs and improved yields, compared to previous conventional dewaxing techniques. The process is capable of producing 130 VI base fluids. More often, it is set up to produce high viscosity index (Group II+ and III) base fluids with VIs ranging from 115 to 127. A further process feature is the flexibility it offers to produce base oils with pour points lower than -25°C.

Petro-Canada employs Hydroisomerization in conjunction with HT Severe Hydrotreating and as a result its base oils have the following attractive features:

- High Viscosity Index
- Low Volatility
- Excellent Oxidation Resistance
- High Thermal Stability
- Excellent Low Temperature Fluidity
- Low Toxicity

These features give performance characteristics very similar to lubricants formulated with poly-alpha-olefin (PAO), the most common type of synthetic.



COMPARISON OF THE PRODUCTS OF THE HT PURITY PROCESS AND SOLVENT REFINING

• BASE OILS

There are significant differences in performance between HT Severely Hydrotreated and Solvent Refined base oils. The main reason for the difference lies in the virtual elimination of aromatic molecules (typically less than 0.1%) in the HT Purity Process. In comparison, the aromatic content of Solvent Refined base oils is typically between 10-30%. Solvent Refined base oils are considerably less pure than HT Severely Hydrotreated base oils.

Characteristic	Significant Difference
COLOUR	HT Severely Hydrotreated base oils are clear and colourless.
VISCOSITY INDEX	HT Severely Hydrotreated base oils have high VIs so they 'thin-out' less at high temperatures.
OXIDATION RESISTANCE	HT Severely Hydrotreated base oils respond very well to anti-oxidants and so have excellent resistance to oxidation and long lubricant life in finished products.
THERMAL STABILITY	HT Severely Hydrotreated base oils have very good resistance to heat.
CARBON RESIDUE	HT Severely Hydrotreated base oils produce low amounts of residue.
DEMULSIBILITY	HT Severely Hydrotreated base oils separate readily from water.
LOW TOXICITY	HT Severely Hydrotreated base oils have low toxicity, due to a virtual absence of impurities. Petro-Canada White Oils are pure enough to be used in cosmetics and pharmaceuticals.
BIODEGRADABILITY	HT Severely Hydrotreated base oils have good biodegradability characteristics.

2

• FINISHED LUBRICANTS

Finished lubricants blended from Petro-Canada HT Severely Hydrotreated base oils exhibit superior performance in many key properties versus Solvent Refined base oils. These include:

- Viscosity Retention
- Oxidation Resistance
- Thermal Stability
- Reduced Environmental Impact

• VISCOSITY RETENTION

In service, lubricants based on Petro-Canada HT Severely Hydrotreated base oils do not 'thicken-up' (increase in viscosity), or thin-out as much as many Solvent Refined lubricants. This is especially valuable for automatic transmission fluids, where consistent shift characteristics depend on viscosity stability. This feature also contributes to greater fuel efficiency in motor oils and reduced power consumption from industrial lubricants.

• OXIDATION RESISTANCE

Finished lubricants based on Petro-Canada HT Severely Hydrotreated base oils have shown the ability for superior resistance to oxidation compared to Solvent Refined lubricants. This allows them to be used at higher temperatures or for longer time periods than Solvent Refined lubricants. Petro-Canada's unique line of products, such as *COMPRO™ XL-S Compressor Fluid* and *TURBOFLO™ XL Turbine Fluid*, are based upon this valuable property.

• THERMAL STABILITY

Petro-Canada HT Severely Hydrotreated base oils demonstrate excellent thermal stability. This leads to reduced deposits and cleaner equipment internals, compared to many Solvent Refined lubricants. Petro-Canada product lines that leverage this feature include *CALFLO™ Heat Transfer Fluid, COMPRO™ XL-S Compressor Fluid,* and *DEXRON®-VI Automatic Transmission Fluids.*

• REDUCED ENVIRONMENTAL IMPACT

Petro-Canada HT Severely Hydrotreated base oils have very low toxicity and can biodegrade faster than many Solvent Refined lubricants of comparable viscosity, due to a virtual absence of impurities. When carefully formulated with selected additives, these features are preserved in finished lubricants. Product lines where these features may be found include: *PURITY™ FG Food Grade Lubricants, ENVIRON™ AW and MV Hydraulic Oils, PARAFLEX™ HT Fluids,* and *SEPRO™ XL Paper Machine Oils*.

PETRO-CANADA INTEGRATED MANAGEMENT SYSTEM

Petro-Canada Lubricants has implemented the Operational Excellence Management System (OEMS). OEMS provides the framework for a single way to do business across all standards including ISO 9001, ISO/TS 16949, ISO 14001 and OSHA 18000 to deliver consistent, reliable, repeatable and sustainable processes and manage business risks. The ISO family of International Standards, provides a consistent set of operating guidelines.

ISO 9001 AND ISO/TS 16949 REGISTRATION

Petro-Canada Lubricants Inc. maintains the ISO 9001 and ISO/TS 16949 registrations to demonstrate to customers its commitment to quality.

ISO 9001 is an international standard that emphasizes the importance of a process approach when developing, implementing and improving the quality management system in order to enhance customer satisfaction by meeting customer requirements.

In 1993 Petro-Canada Lubricants earned the distinction of being the first lubricants manufacturer in North America to be ISO 9001 registered. Stringent audits are conducted to ensure detailed procedures are rigidly adhered to and all products are manufactured consistently in accordance with established standards.

ISO/TS 16949 was prepared by the International Automotive Task Force (IATF). This Technical Specification covers the entire ISO 9001 standard elements and has automotive industry supplemental requirements.

In October 2002, Petro-Canada Lubricants opened the door to the global market by being the first lubricants manufacturer in the world to be registered to ISO/TS 16949.

ISO 14001

Petro-Canada Lubricants has chosen ISO 14001 as the foundation for its Environmental Management System due to its wide recognition and global acceptance. ISO 14001 is an internationally recognized approach to Environmental Management. It is a disciplined approach to identification, prioritization, and management of environmental impacts resulting from business operations.

ISO 14001 differs fundamentally from ISO/TS 16949 and ISO 9001. ISO/TS 16949 and ISO 9001 provide guidelines to address customer needs and expectations in terms of quality of product/service. ISO 14001 improves and sustains environmental regulatory compliance and focuses on continual improvement in environmental performance.


MAXIMUM PERFORMANCE
PERFORMANCE MAXIMALE
TM/MC

AUTOMOTIVE LUBRICANTS

Automotive equipment is the largest user of lubricants and the steady improvement of this equipment can only be maintained with the continued close association with leading lubricant manufacturers, such as Petro-Canada. Operators of automotive equipment have come to expect high quality and reliable performance from today's automotive lubricants.

Petro-Canada is committed to maintaining its leadership in automotive lubricant quality, by continued R&D effort to develop new and improved products. Researchers at our Lubricants Centre are continually working on products in the lab and in the field with commercial equipment. Petro-Canada keeps in close contact with all the car, truck, engine and other equipment manufacturers as well as with our customers. Our goal is to meet the ever changing needs of the market.

ENGINE OIL FUNCTIONS

Modern engine oil has been carefully developed by engineers and chemists to perform several important functions. The efficient operation of an engine depends on the oil to:

- Permit easy starting
- Disperse soot
- Lubricate engine parts and prevent wear
- Reduce friction
- Protect against rust and corrosion
- Help prevent sludge and varnish formation
- Prevent combustion chamber deposits
- Cool engine parts
- Seal combustion pressures
- Resist foaming
- Provide fuel efficiency

• Permit Easy Starting

The ease of starting an engine depends not only on the condition of the battery, ignition and fuel quality, but also on the flow properties of the engine oil. If the oil is too viscous or heavy at starting temperatures, it will impose enough drag on the moving parts that the engine cannot be cranked fast enough to start promptly and keep running.

Since cold temperatures thicken all oils, an oil for winter use must be thin enough to permit adequate cranking speeds at the lowest anticipated temperature. It must also be fluid enough to quickly flow to the bearings to prevent wear. In addition, the oil must be thick enough, when the engine reaches normal operating temperatures, to provide adequate protection.

Viscosity is an important characteristic of an oil which is defined as the oil's resistance to flow. It can be measured in many ways, but a critical one for engine oil is referred to as the cold cranking temperature. It evaluates the ease with which the engine crankshaft can rotate at the specified temperature. This resistance, or fluid friction, keeps the oil from being squeezed out from between engine surfaces when they are moving under load or pressure. Resistance to motion or flow is a function of the molecular structure of the oil. Since it is this internal fluid friction that

is responsible for most of the drag put on the starter during cranking, it is important to use an oil with viscosity characteristics that ensure ease of cranking, proper oil circulation, and high temperature protection.

The effect of temperature on viscosity varies widely with different types of oil. For this reason, a calculation has been developed to quantify the amount of viscosity change with temperature, which is known as the Viscosity Index (VI). An oil with a high viscosity index is one that shows less change in viscosity with temperature variation. Today, through the use of enhanced refining methods and special chemical additives, many high viscosity index engine oils are light enough to enable easy cranking at low temperatures and yet will still be viscous enough to protect satisfactorily at high temperatures.

These oils with high viscosity indexes are known as “multi-grade” oils. Often they are also called by names that imply all-season usage since they perform satisfactorily in both winter and summer. Multi-grade oils are most often recommended by vehicle manufacturers.

• Lubricate Engine Parts and Prevent Wear

Once an engine is started, the oil must circulate promptly and lubricate all moving surfaces to prevent the metal-to-metal contact that would result in wear, scoring, or seizure of engine parts. Oil films on bearings and cylinder walls are sensitive to movement, pressure and oil supply. These films must be continually replenished by adequate flow and proper oil distribution.

As mentioned earlier, the viscosity of an oil must be low enough at the starting temperature to permit rapid cranking and starting, and high enough at peak operating temperatures to ensure adequate separation of moving parts for guaranteed engine protection.

Once the oil reaches the moving parts its function is to lubricate and prevent wear of the surfaces. Lubrication specialists describe several classes of lubrication.

Full-film or elasto-hydrodynamic lubrication occurs when the moving surfaces are continuously separated by a film of oil. The determining factor in keeping these parts separated is the viscosity of the oil at its operating temperature. The viscosity must remain high enough to prevent metal-to-metal contact. Since the metals do not make contact in full-film lubrication, wear is negligible unless the separated parts are scratched by particles larger or of equal size than the thickness of the oil film itself. Bearings on crankshafts, connecting rods, and camshafts normally operate with full-film lubrication.

Under some conditions, it is impossible to maintain a continuous oil film between moving parts and there is intermittent metal-to-metal contact between the high spots (asperities) on sliding surfaces. Lubrication specialists call this mixed film lubrication. Under these circumstances, the load is only partially supported by the oil film. The oil film is ruptured resulting in significant metal-to-metal contact. When this occurs, the friction generated between the surfaces can produce enough heat to cause one or both of the metals in contact to melt and weld together. Unless counteracted by proper additive treatment, the result is either immediate seizure or the tearing apart and roughening of the surfaces.

Boundary lubrication conditions exist during engine start-up and often during the operation of a new or rebuilt engine. Boundary lubrication is also found

around the top piston ring where oil supply is limited, temperatures are high, and a reversal of piston motion occurs.

• Reduce Friction

Under full-film lubrication conditions, a thick film of oil prevents metal-to-metal contact between moving engine parts. Relative movement of these lubricated parts requires enough force to overcome the fluid friction of the lubricant. The viscosity of the oil should be high enough to maintain an unbroken film, but should not be higher than necessary, since this increases the amount of force required to overcome this fluid friction.

Car manufacturers specify proper oil viscosity ranges according to expected ambient temperatures. This is to ensure that the lubricant will provide adequate, but not excessive, viscosity at normal operating conditions. When oil becomes contaminated, its viscosity changes. With soot, dirt, oxidation, or sludge, viscosity increases; with fuel dilution it decreases. Both directions of viscosity change are potentially harmful to the engine. For this reason, contaminant levels in engine oil must be kept low. This can be best accomplished by changing the oil and filter at proper intervals. If an engine oil does not disperse contaminants properly, the oil filter will plug and go into bypass allowing the contaminants to cause damage to the internal parts of the engine.

The amount and type of chemical additives is important for reducing friction under the extreme pressure conditions of boundary lubrication. The proper balance of the total additive system in a modern engine oil is critical if all lubrication conditions of an engine are to be satisfied. The oil formulator can achieve this balance of motor oil compounding only through much research, with emphasis on proof-testing in actual engines, both in the laboratory and in field service.

• Protect Against Rust and Corrosion

For each gallon of fuel burned in an engine, more than one gallon of water is formed. Although most of this water is in vapour form and goes out the exhaust, some condenses on the cylinder walls or escapes past the piston rings and is trapped, at least temporarily, in the crankcase. This occurs most frequently in cold weather before the engine has warmed up.

In addition to water and the by-products from incomplete combustion of the fuel, other corrosive combustion gases also get past the rings and are condensed or dissolved in the engine oil. Add to this the acids formed by the normal oxidation of oil and the potential for rust and corrosive engine deposits becomes significant.

The life of engine parts depends in part on the ability of the motor oil to neutralize these corrosive substances. Thanks to much research, effective oil-soluble chemical compounds have been developed. These are added to engine oils during manufacture to provide vital protection to engine parts.

• Help Prevent Sludge and Varnish

In formulating today's high quality motor oils, a basic objective is not only to keep engine parts clean, but also to prevent sludge and varnish deposits from interfering with proper engine operation.

Engine sludge formation is generally a problem of low engine temperature

operation. Engine sludge deposits are formed by combinations of water from condensation, dirt and the products of oil deterioration and incomplete combustion. Sludge-forming materials are often so small initially that no oil filter can remove them. They are much smaller than the thickness of the oil film on engine parts and therefore cause no wear or damage so long as they remain small and well-dispersed. However, as their levels increase in the oil during use, they tend to join together to form larger masses and oil flow can be restricted.

Sludge formation is aggravated by water vapour which condenses in the crankcase in cold engine operation. The rate at which sludge-forming materials accumulate in the crankcase oil is related to several factors of engine operation. Factors such as, rich air-fuel mixtures which occur during starting or when a choke is sticking; operating with dirty air cleaners; or cases of ignition misfiring, increase the rate of sludge accumulation in the oil.

Straight mineral oils have only a very limited ability to keep these contaminants from coagulating and forming masses of sludge within the engine. This is the job of the detergent/dispersant additives that are blended into modern engine oils. These additives keep vital engine parts clean and oil contaminants suspended in such a fine form that they can be removed by regular oil and filter changes.

Detergent/dispersants are also very effective in preventing varnish deposits within an engine. Varnish-forming materials react chemically or combine with oxygen in the crankcase to form complex chemical compounds. These compounds continue to react with each other and with oxygen on the hotter parts of the engine, especially EGR valves and oxygen sensors and are baked by engine heat into a hard coating on the hotter parts of the engine. The hydraulic lifters, piston rings, and bearings are particularly sensitive to varnish deposits. If varnish-forming materials are allowed to accumulate in these areas, engine operation is impaired.

Engines cannot tolerate excessive amounts of sludge and varnish on sensitive parts. Sludge deposits collect on oil pump screens, limiting the flow of oil to vital engine parts and resulting in rapid and destructive wear. Piston rings which are stuck or sluggish because of varnish accumulation prevent the engine from developing full power. Sludged or plugged oil-control rings prevent removal of excess lubricant from the cylinder walls and result in excessive oil consumption.

• Disperse Soot

Soot is a by-product of diesel and some direct injection gasoline engine combustion. It is black carbonaceous particulate matter, which does not dissolve in lubricating oil, but can be suspended by the oil and removed during an oil change. If soot is not well dispersed it will cause the oil to thicken up from its original SAE viscosity grade. In addition, soot can agglomerate to form particles large enough to initiate abrasive wear and when the soot load of an oil gets too high, it settles out and forms sludge. Agglomerated soot and/or highly thickened oil can result in high pressure at the oil filter inlet. This can cause the filter by-pass to open and allow unfiltered oil into the engine.

Engine oils formulated to fight soot are able to disperse large amounts of soot without thickening up. Good soot dispersal stops large particles agglomerating, reduces abrasive wear developing and inhibits the formation of sludge.

For many years the U.S. Environmental Protection Agency (EPA) has set stringent limits on nitrogen oxide (NOx) and particulate matter (PM) emissions from on-road trucks and buses. Through a combination of engine redesign, ultra-low-sulphur diesel (ULSD) fuel and new engine oil technology, these new vehicles cut harmful emissions by 98 percent. In addition, the regulation required a 97 percent reduction in the sulphur content of on-road diesel fuel – from 500 parts per million (ppm) to 15 ppm – so the fuel won't damage the new exhaust aftertreatment devices, specifically Diesel Particulate Filters (DPFs) that trap and further reduce soot emissions.

Engine manufacturers have been developing engines that not only utilize DPFs but also run on pollution-reducing ULSD fuel and utilize cooled exhaust gas recirculation (EGR) devices to redirect some of the exhaust gases normally emitted by the vehicle back into the engine, thus lowering NOx production but creating more internal soot.

Effective with the 2010 model year, limits for nitrogen oxide (NOx) emissions were further reduced. Most OEMs implemented the use of Selective Catalytic Reduction (SCR) devices in order to meet the 2010 emission levels. The 2010 implementation of lower emissions limits did not require any changes to the lubricants specifications.

• Reduce Combustion Chamber Deposits

In performing its lubrication function, some oil must reach the area of the top piston ring in order to lubricate and seal the rings and the cylinder walls. This oil is then exposed to the heat and flame of burning fuel and part of it actually burns off.

Modern refining techniques have produced oils that burn cleanly under these conditions, leaving little or no carbon residue. The detergent/dispersant additives in modern motor oils keep the piston rings free in their grooves, thereby maintaining compression pressures and minimizing the amount of oil reaching the combustion chamber. This not only reduces oil consumption, but more importantly, keeps combustion chamber deposits to a minimum.

Excessive combustion chamber deposits adversely affect engine operation. Deposits that form on spark plugs may cause the plugs to foul. Excessive deposit build-up causes pinging, knocking, or other combustion irregularities that reduce the efficiency and economy of the engine. Because these deposits act as heat barriers, pistons, rings, spark plugs, and valves are not properly cooled. This can result in damage or even failure of the parts necessitating premature replacement/ overhaul.

In preventing excessive combustion chamber deposits, it is important that a motor oil accomplish two things:

- The oil must keep the piston rings free so that they can minimize the amount of oil reaching the combustion chamber.
- That portion of the oil reaching the combustion chamber should burn as cleanly as possible.

• Cool Engine Parts

Many people assume that engine cooling is accomplished only through the action of the fluid in the cooling system. This in fact does only about 60 percent of the cooling job. It cools the upper part of the engine only – the cylinder heads, cylinder walls, and the valves. The crankshaft, the main and connecting rod bearings, the camshaft and its bearings, the timing gears, the pistons, and

many other components in the lower part of the engine are directly dependent on the motor oil for necessary cooling. All these parts have defined operating temperature limits which must not be exceeded. Some can tolerate fairly high temperatures while others, such as the main and connecting rod bearings, must run relatively cool to avoid failure. Circulating oil picks up heat and carries it to the crankcase or oil cooler. Afterwards, cooler fluid or surrounding air removes the excess heat.

To keep this cooling process working, large volumes of oil must be constantly circulated to the bearings and other engine parts before eventually returning to the oil pan to cool and be recirculated again. If the oil supply is interrupted, these parts heat up rapidly from increased friction and combustion temperatures. A bearing failure is often referred to as a “burned-out bearing” because temperatures rose high enough to actually melt the bearing metal.

While only a small quantity of oil is required at any one time and place to provide lubrication, the oil pump must circulate many litres/gallons of oil per minute. Chemical additives and the physical properties of the oil have little effect on its ability to provide adequate cooling. What is critical is the continuous circulation of large quantities of oil throughout the engine and over hot engine parts. This is made possible through the use of large-capacity oil pumps and oil passages adequate to handle the required volume of oil. These oil passages cannot do the job properly if they are allowed to become partially or completely clogged with deposits. When this happens, the oil cannot circulate or cool properly and early engine failure may result. This is another reason for changing the oil and filter before the contaminant level becomes too high. Proper cooling also requires that the oil level in the crankcase never be permitted to remain below the “add oil” line on the dipstick. This to ensure sufficient retention time of the oil in the crankcase.

• Seal Combustion Pressures

The surfaces of the piston rings, ring grooves, and cylinder walls are not completely smooth. If examined under a microscope, these surfaces would show minute hills and valleys. For this reason, the rings by themselves can never completely prevent high combustion and compression pressures from escaping into the low pressure area of the crankcase, as a consequence reduction in engine power and efficiency. Engine oil fills in these hills and valleys on ring surfaces and cylinder walls and helps to seal in compression and combustion pressures. Because the oil film at these points is rather thin – generally less than 0.025 mm thick – it cannot compensate for existing excessive wear of rings, ring grooves, or cylinder walls. Where such conditions already exist, oil consumption may be high. It may also be high in a new or rebuilt engine until the hills and valleys on these surfaces have smoothed out enough to allow the oil to form the right seal.

• Be Non-Foaming

Because of the many rapidly moving parts in an engine, air in the crankcase is constantly being whipped into the oil. This produces foam, which is simply a lot of air bubbles which may or may not readily collapse. These air bubbles normally rise to the surface and break, but water and certain other contaminants slow down the rate at which this occurs, and the result is foam.

Foam is not a good conductor of heat, so if the amount of foam is excessive,

engine cooling will be impaired because the heat will not be dissipated. Foam also does not have much ability to carry a load and has an adverse effect on the operation of hydraulic valve lifters and bearings. This is because it contains air and air is easily compressible. On the other hand, oil which is free of air is virtually incompressible.

Many engines have variable timing units, fuel injectors, valve control solenoids, and many other units that require high pressure oil to make them operate properly. Foam or air entrainment in the oil causes failure modes and shuts the engine down.

ADDITIVES

In summary, an engine oil has to perform ten basic functions. To carry out these functions, the base oil must be refined to a very high level and then compounded with specially selected chemical additives. Skillful selection of additives, blended together with Petro-Canada's HT Severely Hydrotreated base oils results in engine oils of outstanding performance.

• DETERGENTS

These chemicals, usually metallo-organic based, are designed to control deposits and keep engine components clean. They are able to clean up existing deposits in the engine, as well as disperse insoluble matter into the oil. Detergents control contamination resulting from high temperature operation. Over-based detergents also neutralize acidic contaminants from fuel sulfur, engine exhaust, oil oxidation and/or nitration.

• DISPERSANTS

These are usually ashless organic chemicals, which control contamination from low temperature operation. Both detergents and dispersants attach themselves to contaminant particles, such as soot or varnish and hold them in suspension, preventing sludge and deposit formation. The suspended particles, together with their additive carrier, are so small that they can pass harmlessly between moving surfaces and through oil filters. This contamination is removed from the engine when the oil is changed.

• OXIDATION INHIBITORS

These agents reduce oxygen attack on the lubricant base oil to a minimum. Petro-Canada's HT Severely Hydrotreated base oils have a superior response to these additives compared to Solvent Refined base oils. This results in an engine oil with high resistance to oil thickening and the build-up of corrosive acids, hence maintaining good oil flow properties and resistance to bearing corrosion.

• CORROSION AND RUST INHIBITORS

Acids are produced by the combustion process and when an engine oil degrades with use. Unless rendered harmless by the engine oil, these acids can cause rapid deterioration of engine components. Corrosion inhibitors protect non-ferrous metals by coating them and forming a barrier between the parts and their environment. Rust Inhibitors protect iron/steel surfaces from oxygen attack, by forming a similar protective screen as mentioned

above. Parts such as hydraulic lifters, push rods, etc. are prone to this type of corrosion.

• ANTI-WEAR AGENTS

These agents prevent wear due to seizure or scuffing of rubbing surfaces. Compounds such as zinc dialkyl-dithiophosphate (ZDDP) break down at microscopic hot spots and form a chemical film which eliminates metal-to-metal contact before it grows. Thus scuffing, galling and seizure are prevented.

• FOAM DEPRESSANTS

Detergent and dispersant additives can facilitate aeration of an oil, which leads to foaming. This can reduce the lubricating ability of an oil and even interfere with oil pumping. Incorporation of a foam depressant controls this tendency by reducing surface tension to speed up the collapse of foam.

• VISCOSITY INDEX (VI) IMPROVERS

VI improvers are long chain polymers that can coil and uncoil in response to changes in temperature. They improve an oil's ability to resist changes in viscosity with temperature (i.e. improve its viscosity index). At low temperatures they coil up into tight balls which do not significantly increase the oil's resistance to flow (viscosity). However, at high temperatures, they uncoil into long chains which interweave and increase the oil's viscosity. VI improvers must resist breakdown due to shear and high temperatures to ensure a long lasting effect.

• POUR POINT DEPRESSANTS

Base oils in API Groups I, II and III contain hydrocarbons that tend to crystallize into waxy materials at low temperatures. Incorporation of a chemical which reduces the size/rate of wax crystal formation can give an oil better low temperature fluidity, hence a lower pour point. Petro-Canada's HT Severely Hydrotreated base oils have a minimum of waxy materials, so they have superior response to these additives compared to Solvent Refined base oils.

• FRICTION MODIFIERS

Some oils contain friction-modifying chemicals, which can reduce the fuel consumption of an engine. These chemicals form a chemical or physically bonded film that reduces the friction between the lubricated engine parts.

OIL CLASSIFICATION SYSTEMS

In selecting a proper engine oil, the vehicle operator must consider both the oil viscosity and the lubricant service requirements for his vehicle. To enable the operator to identify a proper oil, the engine manufacturers and the petroleum industry utilize two complementary classification systems that are described below:

SAE ENGINE OIL VISCOSITY CLASSIFICATION

The earliest attempts to classify and identify motor oils were made when the first automobiles appeared. Even then, the physical property viscosity was known to be one of the most important characteristics of an oil and oils were classified as light, medium, or heavy, depending on their viscosity. When calibrated instruments became available to accurately measure viscosity, the Society of Automotive Engineers (SAE) developed a classification system based on viscosity measurements. This system (Engine Oil Viscosity Classification – SAE J300), which has been modified over the years, establishes fourteen distinct motor oil viscosity classifications or grades, as shown in the Table below.

SAE VISCOSITY GRADES FOR ENGINE OILS (SAE J300 JAN. 15)

SAE Viscosity Grade	Low-Temperature (°C) Cranking Viscosity[3], mPa·s Max	Low-Temperature (°C) Pumping Viscosity[4], mPa·s Max with No Yield Stress [4]	Low-Shear-Rate Kinematic Viscosity[5] (mm^2/s) at 100 °C Min	Low-Shear-Rate Kinematic Viscosity[5] (mm^2/s) at 100 °C Max	High-Shear-Rate Viscosity[6] (mPa·s) at 150 °C Min
0W	6 200 at -35	60 000 at -40	3.8	-	-
5W	6 600 at -30	60 000 at -35	3.8	-	-
10W	7 000 at -25	60 000 at -30	4.1	-	-
15W	7 000 at -20	60 000 at -25	5.6	-	-
20W	9 500 at -15	60 000 at -20	5.6	-	-
25W	13 000 at -10	60 000 at -15	9.3	-	-
8	-	-	4.0	<6.1	1.7
12	-	-	5.0	<7.1	2.0
16	-	-	6.1	<8.2	2.3
20	-	-	6.9	<9.3	2.6
30	-	-	9.3	<12.5	2.9
40	-	-	12.5	<16.3	3.5 (0W-40, 5W-40, and 10W-40 grades)
40	-	-	12.5	<16.3	3.7 (15W-40, 20W-40, 25W-40, 40 grades)
50	-	-	16.3	<21.9	3.7
60	-	-	21 .9	<26.1	3.7

1. Notes - 1 mPa·s = 1cP; 1 mm^2/s = 1 cSt
2. All values, with the exception of the low-temperature cranking viscosity, are critical specifications as defined by ASTM D3244
3. ASTM D5293: Cranking viscosity - The non-critical specification protocol in ASTM D3244 shall be applied with a P value of 0.95.
4. ASTM D4684: Note that the presence of any yield stress detectable by this method constitutes a failure regardless of viscosity.
5. ASTM D445
6. ASTM D4683, ASTM D4741, ASTM D5481, or CEC L-36-90.

The “W” following the SAE viscosity grade stands for “winter” and indicates that an oil is suitable for use in colder temperatures. Oils carrying the “W” designation must have the proper viscosity value when measured at appropriate low temperatures. Those SAE classifications which do not include the “W” define oil grades for use at higher temperatures. The viscosity of these oils – SAE 8, 12, 16, 20, 30, 40, 50 and 60 – must have the proper value when measured at 100°C and under high shear conditions at 150°C.

As noted earlier, the development of viscosity index improvers made the manufacture of multi-graded motor oil possible. Many of these oils - SAE 0W-20, 0W-30, 0W-40, 5W-20, 5W-30, 5W-40, 10W-30, 10W-40, 15W-40 and 20W-50 - have been marketed for decades in North America. The new high temperature viscosity grades (SAE XW-8, XW-12, XW-16) will become more popular in the near future as the engine manufacturers modify their engines to utilize them to maximize fuel economy.

Multigrade motor oils are widely used because they are light enough for easy cranking at low temperatures, but heavy enough to perform satisfactorily at high temperatures as well.

The engine manufacturers' recommendations for oil viscosity remain the primary references, particularly if warranty coverages are in force. However, a basic guide prepared from owners' manuals is shown in the table below:

GUIDE TO SAE GRADES OF ENGINE OIL

Ambient Temperature Range °C	SAE Multi-Grades °F	SAE Grade
–40°C to +40°C	–40°F to +104°F	0W-8 and 0W-16
–40°C to +40°C	–40°F to +104°F	0W-20 and 0W-30
–35°C to +40°C	–31°F to +104°F	5W-20 and 5W-30
–30°C to excess of +40°C	–22°F to excess of +104°F	10W-30 and 10W-40
–25°C to excess of +40°C	–13°F to excess of +104°F	15W-40
–20°C to excess of +40°C	–4°F to excess of +104°F	20W-50
	SAE Single Grades	
–30°C to +20°C	–22°F to +70°F	10W
–20°C to +30°C	–4°F to +86°F	20W
0°C to excess of +40°C	+32°F to excess of +104°F	30
+5°C to excess of +40°C	+40°F to excess of +104°F	40
+10°C to excess of +40°C	+50°F to excess of +104°F	50

Footnotes

i) The lowest ambient temperatures quoted above are for equipment with no starting aids. Starting aids, such as block coolant heaters, oil sump heaters and battery warmers will further reduce the minimum starting temperature.

ii) The ambient temperatures quoted above should only be taken as a guide. For the exact SAE grade required, consult the owner's manual.

It is important to understand that the SAE viscosity grade classification system identifies only viscosity and indicates nothing else about the type or quality of an oil or the service for which it is intended.

API ENGINE SERVICE CLASSIFICATION

Since 1970, the American Petroleum Institute, the American Society for Testing and Materials, and the Society of Automotive Engineers have cooperated in maintaining the API Engine Service Classification System. This system enables engine oils to be defined and selected on the basis of their performance characteristics and the type of service for which they are intended.

It should be emphasized that the API Engine Service Classification System has no connection with the SAE Engine Oil Viscosity Classification System. The latter is used to indicate only the SAE viscosities of oils. Both are necessary to adequately define an engine oil's characteristics insofar as customer selection of the proper product to meet the engine's need is concerned.

The API Engine Service Classification System presently includes twenty-five classes of service (current and obsolete) which are summarized in the chart below:

Letter	Designation API Service	Oil Description
SA	Utility gasoline and diesel engine service. (OBSOLETE)	Oil without additive.
SB	Minimum duty gasoline engine service. (OBSOLETE)	Some antioxidant and anti- scuff properties.
SC	1964 gasoline engine warranty requirements. (OBSOLETE)	Meets 1964-67 requirements of automotive manufacturers.
SD	1968 gasoline engine warranty requirements. (OBSOLETE)	Meets 1968-71 requirements of automotive manufacturers.
SE	1972 gasoline engine warranty requirements. (OBSOLETE)	Meets 1972-79 requirements of automotive manufacturers.
SF	1980 gasoline engine warranty requirements (OBSOLETE)	Meets 1980-88 requirements of automotive manufacturers.
SG	1989 gasoline engine warranty requirements (OBSOLETE)	Meets 1989-93 requirements of automotive manufacturers.
SH	1994 gasoline engine warranty requirements (OBSOLETE)	Meets 1994-96 requirements of automotive manufacturers.
SJ	1997 gasoline engine warranty requirements	Meets 1997-2000 requirements of automotive manufacturers.
SL	2001 gasoline engine warranty requirements	Meets 2001-2004 requirements of automotive manufacturers.
SM	2004 gasoline engine warranty requirements	Meets 2004 onwards requirements of automotive manufacturers
SN	2011 gasoline engine warranty requirements	Meets 2011 onwards requirements of automotive manufacturers
CA	Light duty service on high quality fuels. (OBSOLETE)	Meets Military requirement MIL-L-2104A (1954).
CB	Moderate duty service on lower quality fuels. (OBSOLETE)	Meets Military requirement I MIL-L-2104A, but test run on high sulphur fuel (Suppl. 1).
CC	Moderate to severe duty diesel and gasoline service. (OBSOLETE)	Meets Military requirement MIL-L-2104B (1964).
CD	Severe duty diesel service. (OBSOLETE)	Provides moderately super charged diesel performance. Meets requirements of MIL-L-2104C and Caterpillar Series 3 lubricants.
CD-II	Severe duty 2-stroke cycle diesel engine service. (OBSOLETE)	Meets requirements for API CD service, plus Detroit Diesel 6V53T approval.
CE	Turbo-charged and Super-charged heavy-duty diesel engines, manufactured since 1983. (OBSOLETE)	Meets the requirements for API CD service, plus those for Mack E0-K/2 and Cummins NTC-400 approvals.

Letter	Designation API Service	Oil Description
CF	Off-road indirect injected diesel engines and other diesel engines using a broad range of fuel types including high sulphur (>0.5%) fuel. (OBSOLETE)	Provides effective control of piston deposits, wear and corrosion in naturally aspirated turbocharged or supercharged diesel engines. Can be used to replace CD oils.
CF-2	Severe duty 2-stroke cycle diesel engine service. (OBSOLETE)	Service typical of 1994 severeduty two-stroke cycle diesel engines requiring highly effective control over deposits and wear. Can be used to replace CD-II oils.
CF-4	Severe duty turbocharged 4-stroke cycle diesel engines, especially late model (since 1988) lower emission engines. (OBSOLETE)	Meets requirements of Caterpillar 1-K spec, plus those for Mack EO-K/2 and Cummins NTC-400 approvals.
CG-4	Severe duty service in 4-stroke cycle diesel engines designed to meet 1994 emission standards using low sulphur-fuel (<0.05% to <0.5%). (OBSOLETE)	Provides effective control over high temperature piston deposits, wear, corrosion,foaming, oxidation stability and soot accumulation. Canbe used to replace CD, CE and CF-4 oils.
CH-4	For high-speed, 4-stroke cycle diesel engines, designed to meet 1998 emission standards, using low sulphur fuel (<0.05% to <0.5%).	Provides superior control overhigh temperature piston deposits, wear, corrosion,foaming, oxidation stability and soot accumulation. Canbe used to replace CF-4 and CG-4 oils.
CI-4 (CI-4 Plus)	Represents a performance boost over CH-4. For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications where fuel sulphur contents range from less than 0.05% by weight. Designed to meet 2002 emission standards and to meet increased engine severity caused by Exhaust Gas Recirculation (EGR).	Provides enhanced performance over that provided by CH-4, in terms of viscosity control, soot accumulation, oxidation stability and piston deposits. May be used to replace CF-4, CG-4, and CH-4 oils. Some CI-4 oils may also qualify for the CI-4 Plus designation which represents even better protection against wear, improved soot handling and shear stability.
CJ-4	For use in high-speed four-stroke cycle diesel engines designed to meet 2007 and 2010 model year on-highway exhaust emission standards as well as for previous model years. These oils are suitable for use in all applications with diesel fuels ranging in sulphur content up to 500 ppm (0.05% by weight). This category is designed to cope with stringent environmental emissions legislation and increased engine severity caused by Exhaust Gas Recirculation (EGR).	Oils designated for this service are currently available from Petro-Canada and may also be used where API CH-4 and CI-4 / CI-4 Plus oils are required.

Letter	Designation API Service	Oil Description
CK-4	API Service Category CK-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway and Tier 4 off-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after treatment system durability and/or oil drain interval.	API CK-4 oils exceed the performance criteria and are backwards compatible to API CJ-4,CI-4 PLUS, CI-4, and CH-4 API Service Categories. When using CK-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval recommendations.
FA-4	API Service Category FA-4 describes certain XW-30 oils specifically formulated for use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. These oils are formulated for use in on-highway applications with diesel fuel sulfur content up to 15 ppm (0.0015% by weight). Refer to individual engine manufacturer recommendations regarding compatibility with API FA-4 oils.	API FA-4 oils are not interchangeable or backward compatible with API CK-4, CJ-4, CI-4 PLUS, CI-4, and CH-4 oils. Refer to engine manufacturer recommendations to determine if API FA-4 oils are suitable for use. API FA-4 oils are not recommended for use with fuels having greater than 15 ppm sulfur. For fuels with sulfur content greater the 15 ppm, refer to engine manufacturer recommendations.

The following are more detailed descriptions of the API Service Classification. They are a guide to the proper selection of engine oils for significantly different engine service operations.

API "S" ("Service") CATEGORIES (Gasoline, Propane, CNG)

Standards SA to SH have been removed as they are considered obsolete. The current standard is backservicable to these standards.

"S" category oils are generally associated with spark ignition engines.

SJ FOR 1997 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, sport utility vehicles, vans and light trucks beginning with 1997 model year, operating under manufacturers' recommended maintenance procedures. Oils meeting API Service Classification SJ may be used where API Service Classifications SH and earlier have been recommended.

SL FOR 2001 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, sport utility vehicles, vans and light trucks effective July 1, 2001. In addition to a general improvement in quality, this new standard aims specifically to improve oil volatility, oil life, fuel economy and emissions system compatibility. Oils meeting API Service Classification SL may be used where API Service Classifications SJ and earlier have been recommended.

SM FOR 2004 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, sport utility vehicles, vans and light trucks effective December 2004. In addition to a general improvement in quality, this new standard aims specifically to improve oil volatility, oil life, fuel economy and emissions system compatibility. Oils meeting API Service Classification SM may be used where API Service Classifications SL and earlier have been recommended.

SN FOR 2011 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

API Service Category SN was adopted in October 2010 for use in describing engine oils available in 2011. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures. Vehicle owners and operators should follow their vehicle manufacturer's recommendations on engine oil viscosity and performance standard. API SN aims generally to improve oil robustness and seal compatibility over API SM. When combined with Resource Conserving (see below), SN oils help improve fuel economy, protect emissions systems, protect turbochargers and protect engines when ethanol-containing fuels up to E85 are used. Engine oils that meet the API Service Category SN designation may be used where API Service Category SM and earlier S categories have been recommended.

PASSENGER CAR, SPORT UTILITY VEHICLE, VAN AND LIGHT TRUCK RESOURCE CONSERVING OIL CLASSIFICATION

The Resource Conserving classification for gasoline-powered passenger cars, sport utility vehicles, vans and light trucks is a supplementary classification for engine oils. Resource Conserving oils have been formulated to help improve fuel economy, protect emissions system components, protect turbochargers from deposits and help protect engines when operating on ethanol-containing fuels up to E85. The performance requirements for this supplementary classification are technically described in API 1509, Technical Bulletin 1, June 17, 2010.

Resource Conserving in Conjunction with API Service Category SN

API Service SN engine oils designated as Resource Conserving are formulated to help improve fuel economy and protect vehicle emission system components in passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines. These oils have demonstrated a fuel economy improvement (FEI) in the Sequence VID test at the percentages listed in the following table when compared with a baseline oil (BL) used in the Sequence VID test. Additionally, these oils have demonstrated in the tests listed that they provide greater emission system and turbocharger protection and help protect engines when operating on ethanol-containing fuels up to E85.

Many previous S-categories made reference to “Energy Conserving”, but this reflected an emphasis on fuel-economy performance alone. Resource Conserving in conjunction with API SN focuses on fuel economy, emission system and turbocharger protection, and compatibility with ethanol-containing fuel up to E85. Oils that have passed the tests at the limits shown and are properly licensed by API may display “Resource Conserving” in the lower portion of the API Service Symbol in conjunction with API Service SN in the upper portion. The fuel economy and other resource conserving benefits obtained by individual vehicle operators using engine oils labeled Resource Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits.

Resource Conserving Primary Performance Criteria with API Service Category SN

PERFORMANCE TEST	PERFORMANCE CRITERIA	
SEQUENCE VID(ASTM D7589)[a]		
Viscosity Grade	FEI SUM	FEI2 minimum after 100 hours aging
XW-20	2.6%	1.2%
XW-30	1.9%	0.9%
10W-30 and all other viscosity grades not listed above	1.5%	0.6%
Sequence IIIGB (ASTM D7320)	79% phosphorus retention min	
Emulsion Retention (ASTM D7563)	No water separation	
High Temperature Deposits TEOST; 33C (ASTM D6335), Total Deposit Weight, mg		
SAE 0W-20	Not Required	
All other viscosity grades	30 Max	

[a]Viscosity grades are limited to 0W, 5W and 10W multi-grade oils.

API "C" ("COMMERCIAL") CATEGORIES (DIESEL)

"C" category oils are generally associated with diesel (aka heavy-duty) engines.

CA FOR DIESEL ENGINE SERVICE

Service typical of diesel engines operated in mild to moderate duty with high quality fuels and occasionally has included gasoline engines in mild service. They were widely used in the late 1940's and 1950's. (Obsolete)

CB FOR DIESEL ENGINE SERVICE

Service typical of diesel engines operated in mild to moderate duty, but with lower quality fuels which necessitate more protection from wear and deposits. Oils designed for this service were introduced in 1949. (Obsolete)

CC FOR DIESEL ENGINE SERVICE

Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines operated in moderate to severe duty service and certain heavy-duty gasoline engines. Oils designed for this service provide protection from high temperature deposits and bearing corrosion in these diesel engines and also from rust, corrosion and low-temperature deposits in gasoline engines. These oils were introduced in 1961. (Obsolete)

CD FOR DIESEL ENGINE SERVICE

Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines where highly effective control of wear and deposits is vital, or when using fuels of a wide quality range including high sulphur fuels. Oils designed for this service were introduced in 1955 and provide protection from bearing corrosion and from high-temperature deposits in these diesel engines. (Obsolete)

CD-II FOR SEVERE DUTY 2-STROKE CYCLE DIESEL ENGINE SERVICE

Service typical of 2-stroke cycle diesel engines requiring highly effective control over wear and deposits. Oils designed for this service also meet all performance requirements of API Service Category CD. (Obsolete)

CE FOR 1983 DIESEL ENGINE SERVICE

Service typical of certain turbocharged or supercharged heavy-duty diesel engines manufactured since 1983 and operated under both low speed high load and high speed high load conditions. Oils designed for this service must also meet the requirements of the API Engine Service Categories CC and CD. (Obsolete)

CF FOR 1994 OFF-ROAD INDIRECT INJECTED DIESEL ENGINE SERVICE

API Service Category CF denotes service typical of off-road indirect injected diesel engines and other diesel engines that use a broad range of fuel types including those using fuel with higher sulphur content, for example, over 0.5% wt. Effective control of piston deposits, wear and corrosion of copper-containing bearings is essential for these engines which may be naturally aspirated, turbocharged or supercharged. Oils designated for this service may also be used when API Service Category CD is recommended. (Obsolete)

CF-2 FOR 1994 SEVERE DUTY 2-STROKE CYCLE DIESEL ENGINE SERVICE

API Service Category CF-2 denotes service typical of two-stroke cycle engines requiring highly effective control over cylinder and ring-face scuffing and deposits. Oils designated for this service have been in existence since 1994 and may also be used when API Service Category CD-II is recommended. These oils do not necessarily meet the requirements of CF or CF-4 unless the oils have specifically met the performance requirements of these categories. (Obsolete)

CF-4 FOR 1991 DIESEL ENGINE SERVICE

Service typical of severe duty turbocharged, 4-stroke cycle diesel engines, particularly late models designed to give lower emissions. These engines are usually found in on-highway, heavy duty truck applications. API CF-4 oils exceed the requirements of CE category oils and can be used in place of earlier CC, CD and CE oils. (Obsolete)

CG-4 FOR 1994 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications where the fuel sulphur may vary from less than 0.05

percent to less than 0.5 percent by weight. CG-4 oils provide effective control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulation. These oils are especially effective in engines designed to meet 1994 emission standards and may also be used in engines requiring API Service Categories CD, CE and CF-4. (Obsolete)

CH-4 FOR 1999 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications, where the fuel contents range from less than 0.05% to less than 0.5% by weight. CH-4 oils provide superior control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulation. These oils have been specifically formulated for engines designed to meet November 1998 EPA emission standards and may be used where API CD, CE, CF-4 and CG-4 oils are required. Oils designated for this service have been available since 1999.

CI-4 (CI-4 PLUS) FOR 2002 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications where fuel sulphur contents range from less than 0.05% to less than 0.5% by weight. This new category is designed to cope with stringent environmental emissions legislation and increased engine severity caused by Exhaust Gas Recirculation (EGR). Oils designated for this service are currently available from Petro-Canada and may also be used where API CD, CE, CF-4, CG-4 and CH-4 oils are required.

CJ-4 FOR 2007 and 2010 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high-speed four-stroke cycle diesel engines designed to meet 2007 and 2010 model year on-highway exhaust emission standards as well as for previous model years. These oils are compounded for use in all applications with diesel fuels ranging in sulphur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulphur fuel may impact exhaust after treatment system durability and/or oil drain interval.

CK-4—For 2017 HEAVY-DUTY DIESEL ENGINE SERVICE

For use in high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after treatment system durability and/or oil drain interval.

FA-4—For 2017 HEAVY-DUTY DIESEL ENGINE SERVICE

For use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. These oils are formulated for use in on-highway applications with diesel fuel sulfur content up to 15 ppm (0.0015% by weight). Refer to

individual engine manufacturer recommendations regarding compatibility with API FA-4 oils.

OTHER DIESEL ENGINE OIL SPECIFICATIONS

Some diesel engine manufacturers have engine oil requirements that are not completely covered by API classifications.

CATERPILLAR ECF-1

A specification introduced in 2003, designed for the ACERT (Advanced Combustion Emission Reduction Technology) engines. This requires oils to be either CI-4/CH-4 and <1.3% sulphated ash and 1 pass of CAT 1P test or to be CI-4/CH-4 and 1.3-1.5% sulphated ash and 2 passes of CAT 1P test.

CATERPILLAR ECF-1-a

A specification introduced in 2007, to replace ECF-1, designed for all 2006 and older Caterpillar on-highway diesel engines, Caterpillar 3500 Series and smaller commercial and machine diesel ACERT (Advanced Combustion Emission Reduction Technology) engines. This requires oils to be either CH-4 and <1.3% sulphated ash and 1 pass of CAT 1P test or to be CH-4 and 1.3-1.5% sulphated ash and 2 passes of CAT 1P test.

CATERPILLAR ECF-2

A specification introduced in 2007, designed for all 2006 and older Cat on-highway diesel engines, Cat 3500 Series and smaller commercial and machine diesel ACERT (Advanced Combustion Emission Reduction Technology) engines. This requires oils to be either CI-4/CI-4 Plus and ≤1.5% sulphated ash.

CATERPILLAR ECF-3

This specification is equivalent to API CJ-4 and the chief recommendation by Caterpillar for their 2007 compliant engines equipped with diesel particulate filters (DPFs). It is also recommended in legacy on-road equipment when used with diesel fuel up to 500 ppm of sulphur.

CUMMINS 20071

The Cummins 20071 specification defines the premium quality engine oil that must be used in Cummins 1997 year engines, operating in North America with extended oil drain intervals. Cummins 20071 oils must pass the Cummins M-11 engine test at 200 hours, together with a matrix of other diesel engine tests (Mack, Caterpillar and GM).

CUMMINS 20072

The Cummins 20072 specification defines the premium quality engine oil that must be used in Cummins 1997 engines, operating globally with poor fuel quality and inferior engine maintenance practices.

Cummins 20072 oils must pass the Cummins M-11 engine test at 200 hours, a matrix of other diesel engine tests (Mack, Caterpillar and GM) and meet the ACEA E3 requirements for a diesel engine oil.

CUMMINS 20076

The Cummins 20076 specification defines the premium quality engine oil that must be used in Cummins 1999 year engines, operating in North America with extended oil drain intervals. Cummins 20076 oils must pass the Cummins M-11 engine test at 300 hours, together with a matrix of other diesel engine tests with tightened limits, compared to the earlier 20071 specification.

CUMMINS 20078

Cummins 20078 is also defined around the increased performance embodied in the CI-4 tests and limits.

CUMMINS 20081

A premium specification for Cummins 2007 and 2010 compliant engines equipped with diesel particulate filters (DPFs). It contains no new tests beyond API CJ-4 requirements, however it has tighter pass limits on some of the engine tests. Can be used with diesel fuel containing up to 500 ppm of sulphur.

CUMMINS 20086

A premium specification for Cummins 2017 compliant engines equipped with diesel particulate filters (DPFs). It contains no new tests beyond API CK-4 requirements, however it has tighter pass limits on some of the engine tests. Can be used with diesel fuel containing up to 15 ppm of sulphur.

CUMMINS 20087

This specification describes the requirements for premium quality engine oils for use in Cummins engines that require an API FA-4 oil, and are equipped with exhaust gas recirculation (EGR) and exhaust aftertreatment. The requirements in the Cummins Engine Standard are more strenuous or equivalent to API FA-4 category oils. Can be used with diesel fuel containing up to 15 ppm of sulphur.

DETROIT DIESEL DFS 93K218

This specification defines the requirements for Detroit Diesel engines designed to meet the EPA 2007 and 2010 on-road emission requirements. These engine emission systems are equipped with cooled EGR and diesel particulate filters (DPFs). 93K218 is a premium oil specification and it exceeds API CJ-4 with higher pass limits on several of the key engine tests of the CJ-4 test program. 93K218 surpasses the requirements of previous DD specifications and therefore the oils are considered to be back serviceable in older engines. Preferred fuel for this application is Ultra Low Sulphur Diesel (ULSD; 15 ppm Sulphur). In applications where Low Sulphur Diesel (500 ppm) is used, drain intervals may be slightly shortened relative to ULSD.

Detroit Diesel Corporation 2-stroke cycle engines require SAE 40 or 30 oils of CF-2 quality and with a sulphated ash level of no more than 1.0% weight. SAE 15W-40 oils of API CF-2 quality and having a High Temperature-High Shear (HTHS) Viscosity of at least 3.7 cP are permitted as a third choice in Detroit Diesel Model 53, 71, and 92 engines (must meet 1.0% wt ash limit). SAE 15W-40 and SAE 30 oils are not permitted at all in the large Model 149 engines. Note that Detroit Diesel Corporation no longer manufacturers 2-cycle engines for the commercial market.

DETROIT DIESEL DFS 93K222

This specification describes the type of engine lubricants preferred for use in DDC engines meeting EPA 2007, EPA 2010, GHG 2014, and GHG 2017 exhaust emission regulations, particularly those equipped with cooled EGR, Diesel Particulate Filters (DPF) and Selective Catalytic Reaction (SCR), including DD5, DD8, DD13, DD15, DD16, MBE 900, MBE 4000, Series 50, and Series 60 engines. To meet emission design criteria, these engines must burn ≤15 ppm Ultra Low Sulfur Fuels and use the lubricants meeting this specification.

These lubricants are also recommended for all four-cycle Detroit Diesel engines including with and without an after treatment system.

DFS93K222 is a premium oil specification that exceeds API CK-4 with higher pass limits on several of the key engine tests as well requires additional testing requirements.

DETROIT DIESEL DFS 93K223

This specification describes the type of engine lubricants recommended for use in DDC engines meeting EPA2010 and GHG 2017 exhaust emission regulations, particularly those equipped with cooled EGR, Diesel Particulate Filters (DPF) and Selective Catalytic Reaction (SCR), including DD5, DD8, DD13, DD15, and DD16. To meet emission design criteria, these engines must burn ≤15 ppm Ultra Low Sulfur Fuels and use the lubricants meeting this specification.

DFS93K223 is a premium oil specification that exceeds API FA-4 with higher pass limits on several of the key engine as well requires additional testing requirements. Further information regarding the application and use of oils meeting this specification is available in the DDC Service Brochure Publication DDC-SVC-BRO-0001.

MACK EO-M PLUS

The MACK EO-M Plus specification was introduced in 1999. Use of MACK EO-M Plus oils is mandatory in all MACK 1999 year engines, where oil drain intervals are as long as 50,000 miles or 80,000 km.

MACK EO-M Plus oils must be multigraded, meet the requirements of API CH-4 and pass the following engine tests: Mack T-8E & Mack T-9 with tightened limits and the Cummins M-11 extended to 300 hours.

MACK EO-N PLUS

This specification defines a premium oil performance above and beyond the stringent CI-4 tests, and consequently beyond the MACK EO-N specification.

MACK EO-N PREMIUM PLUS ’03

This specification is required for the Mack ASET family of engines, which utilize exhaust gas recirculation (EGR) and also highly recommended for all other Mack engine models, regardless of vintage. MACK EO-N Premium Plus ’03 engine oils exceed both the API CI-4 and previous EO-N performance specifications.

MACK EO-O PREMIUM PLUS '07 / VOLVO VDS-4 / RENAULT VI RLD-3

These specifications define the requirements for Mack, Volvo, and Renault engines designed to meet the EPA 2007 and 2010 on-road emission requirements. The new engines are equipped with diesel particulate filters (DPFs). As premium specifications, they exceed API CJ-4 with tighter pass limits in the Mack T-12, Cummins ISM and Cummins ISB engine tests plus the addition of the Volvo D12D test. EO-O Premium Plus surpasses the requirements of previous Mack specifications and therefore the oils are considered to be backward serviceable in older engines. Can be used with diesel fuel containing up to 500 ppm of sulphur.

MACK EOS-4.5 / VOLVO VDS-4.5 / RENAULT RLD-4

These specifications define the requirements for Mack, Volvo, and Renault engines designed to meet the EPA 2017 and GHG 2017 on-road emission requirements. The new engines are equipped with diesel particulate filters (DPFs) and SCR. As premium specifications, they exceed API CK-4 with tighter pass limits in the Mack T-12 and T-13, Cummins ISM and Cummins ISB engine tests plus the addition of the Volvo D12D test. EOS-4.5 surpasses the requirements of previous Mack specifications and therefore the oils are considered to be backward serviceable in older engines.

API SERVICE CLASSIFICATION SYMBOL

API's Lubricants Subcommittee established the symbol illustrated below to provide uniform identification and an improved means for the general public to identify appropriate engine oils according to the manufacturer's recommendation for the needs of a particular vehicle. The symbol is used to display the appropriate API service category or categories (upper part of the symbol), the SAE viscosity grade (center of the symbol), and, if applicable, Resource Conserving features of an oil (bottom part of the symbol). Resource Conserving is not applicable for heavy-duty diesel engines. The symbol clearly provides all the pertinent information a customer needs in one convenient location.

ILSAC CERTIFICATION SYMBOL

The ILSAC (International Lubricants Standardization and Approval Committee) certification mark, commonly referred to as "the Starburst", is shown below.

This symbol enables the general public to identify oils which meet the warranty requirements of Chrysler, Ford and the Japanese automakers. General Motors currently recommends "dexos1" product for their more recent gasoline engines. Consult the owner's manual to determine whether the engine should use GF-5/API SN or dexos1.

The latest ILSAC specification (October 2010) is identified as ILSAC GF-5. The API "Starburst" symbol only applies to 0W-XX, 5W-XX and 10W-XX viscosity oils that not only meet the GF-5 specification, but also meet API SN and the Resource Conserving classification.

The "Starburst" symbol must be displayed on the front of a motor oil container.

USED OIL ANALYSIS

Used Oil Analysis programs for engine oils, such as Petro-Canada's "LUBRI-TEST" program, which is offered in Canada, provides several customer benefits:

- Reduce unscheduled vehicle downtime
- Improve vehicle reliability
- Help organize effective maintenance schedules
- Extend engine life
- Optimize oil change intervals
- Reduce cost of vehicle maintenance

Used engine oil analyses are carried out principally to determine the overall condition of the oil and the engine. Monitoring an oil's condition at successive intervals, over a relatively long time period, can be used to establish:

- Presence of Undesirable Contaminants, such as:
  - Excess Wear Metals
  - Gasoline or Diesel Fuel
  - Coolant
  - Road Salt
  - Dirt, Sand or Dust
- Optimum Oil Change Interval

The following items are tested to determine the condition of an engine oil:

- **Viscosity** - is the measure of an oil's resistance to flow. An oil can "thicken-up" due to oxidation, the presence of contaminants, or evaporation of light components. It can "thin-down" due to oil shearing or fuel dilution. Reported as cSt @ 40°C and cSt @ 100°C
- **Coolant** - ethylene glycol is the major component of antifreeze coolant systems, so the presence of glycol is determined. A positive test result indicates a defective gasket or a cracked head/block. Detection of glycol requires immediate attention, as it reacts quickly in a hot engine to become acidic and form varnish and sludge.
- **Water** - presence due to condensation from low temperature engine operation or from a leak in the cooling system.
- **Dilution** - the amount of gasoline or diesel present in an oil.
- **Acid Number** - expresses the quantity of base required to neutralize all the acidic constituents present in the oil. Often an indicator of how oxidized an oil has become.
- **Base Number** - measures the reserve alkalinity of an oil, which is the ability of an alkali to neutralize the effect of acid formation.
- **Wear Metals or Additive Elements** - The presence of the following elements is usually determined by Inductively Coupled Plasma Emission Spectroscopy: Aluminum, Barium, Boron, Calcium, Chromium, Copper, Iron, Magnesium, Phosphorus, Sodium, Tin and Zinc.
- **Degradation by-product** - includes oxidation, nitration and sulphation as determined by the FTIR method. Elevated results, above normal trends, generally indicate excessive stress of the oil due to extended oil service or other combustion related issues.
- **Soot** - The fine black particles, chiefly composed of carbon, produced by incomplete combustion of the fuel.

USED OIL ANALYSIS TESTS

CONTAMINANT WARNING LEVELS

TEST	WARNING LIMIT
Viscosity	
- cSt @ 40°C	25% change versus the new oil viscosity
- cSt @ 100°C	15% change versus the new oil viscosity
Coolant	Any positive identification
Water	Greater than 0.1%
Fuel Dilution	Greater than 5%
Acid Number	More than 5 units (engine oil) or 1 unit (industrial oil)
Base Number	No lower than 3 to 4 units
Soot	Greater than 5%*
Oxidation	Greater than 30 A/cm (above baseline)

* Confirm OEM recommended limits

AUTOMOTIVE WEAR METALS WARNING LEVELS

ELEMENT	WARNING LIMITS	COMMENTS
Iron (Fe)	Greater than 100 ppm	High levels indicate worn crankshafts, valves, cylinder-liner, bearings
Chromium (Cr)	Greater than 10 ppm	High levels indicate worn piston rings, bearings or contamination by antifreeze
Copper (Cu)	Greater than 20 ppm	High levels indicate worn bearings and bushings
Tin (Sn)	Greater than 10 ppm	High levels indicate worn bearings and bushings
Aluminum (Al)	Greater than 20 ppm (>80 ppm Aluminum Block Engines)	High levels indicate worn pistons or engine block
Lead (Pb)	Greater than 25 ppm	High levels indicate worn bearings. Where leaded gasoline used, results are meaningless
Boron (B)	Greater than 20 ppm	High levels indicate radiator fluid leak. Some engine oils contain a boron dispersant additive. Check sample of new oil
Silicon (Si)	Greater than 20 ppm	High levels indicate presence of dust or sand. May also be due to high level of silicone anti-foam. Check sample of new oil. Radiator fluids contain silicates that show up as Silicon in sample.
Magnesium (Mg), Calcium (Ca) Barium (Ba), Sodium (Na) Phosphorus (P), Zinc (Zn) Potassium (K)		These elements may be part of the additive package. They remain in the oil and do not deplete. The presence of Na and K can indicate a leak of radiator fluid.

ppm = parts per million

PASSENGER CAR MOTOR OILS

Passenger cars are delivering more power and performance than ever before. Engine power outputs, in horsepower per litre, have increased tremendously over the past decade or so. Current smaller, higher powered passenger car engines not only run hotter, but also work harder than ever before. As a result, engines are much more demanding on motor oils for their lubrication. The very close tolerances of rapidly moving engine parts together with pressures for lower oil consumption, reduced engine emissions, increased equipment durability and fuel economy, place heavy demands on today's passenger car motor oils. Petro-Canada's complete line of passenger car motor oils, formulated using the latest in lubricant technology, is ready and able to meet these new challenges.

PETRO-CANADA SUPREME™ - MULTIGRADE MOTOR OIL

PETRO-CANADA SUPREME™ is a superior passenger car motor oil formulated using a high performance additive system. It exceeds the latest service requirements for most gasoline powered engines found in North American and Asian passenger cars and light trucks.

PETRO-CANADA SUPREME™ 5W-20, 5W-30 and 10W-30 give excellent year-round performance in today's passenger car engines, equipped with the latest emission controls and turbochargers. Meeting API SN, these oils demonstrate superior control of ring-zone deposits in small high-output engines. PETRO-CANADA SUPREME™ 5W-20, 5W-30 and 10W-30 are all friction modified to save fuel and meet the latest API Resource Conserving standard as well as the ILSAC GF-5 specification for motor oil.

PETRO-CANADA SUPREME™ 10W-40 and 20W-50 are specialty grades, designed for older North American cars, or for engines operating under high ambient temperatures.

PETRO-CANADA SUPREME™ is recommended for use in all passenger car, propane and compressed natural gas (CNG) powered engines.

PETRO-CANADA SUPREME™ Multigrade Motor Oil is available in five SAE Grades: 5W-20, 5W-30, 10W-30, 10W-40 and 20W-50.

Typical characteristics are shown below:

		PETRO-CANADA SUPREME™				
SAE Grade		5W-20	5W-30	10W-30	10W-40	20W-50
Viscosity	**cSt @ 40°C**	46.2	61.5	67.7	105	159
	cSt @ 100°C	8.3	10.7	10.4	15.4	17.9
Viscosity Index		158	166	141	154	124
Flash Point, COC, °C/°F		229/444	229/444	237/459	247/477	267/513
Cold Crank Viscosity, cP @ °C		3,800@-30	4,300@-30	5,190@-25	5,510@-25	7,590@-15
Borderline Pumping Viscosity, cP @ °C		10,700@-35	16,960@-35	16,140@-30	24,360@-30	22,500@-20
Sulphated Ash, % Wt		1.04	0.99	0.91	0.86	0.93
Base Number (D2896), mg KOH/g		9.1	9.1	7.7	7.7	7.7
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C		2.6	3.1	3.1	3.9	4.6

Meet: API SN, Resource Conserving (only 5W-20, 5W-30, 10W-30), ILSAC GF-5 (only 5W-20, 5W-30,10W-30), GM 6094M (5W-20, 5W-30 and 10W-30), Ford WSS-M2C945-A (5W-20 only), Ford WSS-M2C946-A (5W-30 only), Chrysler MS-6395 (5W-20, 5W-30 and 10W-30 only), Honda, Hyundai, Kia, and Mazda Service Fill (5W-20, 5W-30, and 10W-30 only).

PETRO-CANADA SUPREME™ SYNTHETIC BLEND XL MOTOR OILS

PETRO-CANADA SUPREME™ Synthetic Blend XL 5W-20 and 5W-30 are premium quality synthetic blend motor oils for passenger cars, vans, CUVs, SUVs and light duty trucks. They are formulated to provide excellent year-round protection and benefits such as outstanding protection against wear, rust and corrosion, superior aeration control for improved oil and engine performance, excellent low temperature performance for faster unaided cold weather engine starts, and cleaner running engine leading to reduced engine deposit formation. PETRO-CANADA SUPREME™ Synthetic Blend XL also contributes to improved fuel economy, low oil consumption through less evaporation and enhanced emission control system protection.

PETRO-CANADA SUPREME™ Synthetic Blend XL 5W-20 and 5W-30 meet the service fill requirements of Ford WSS-M2C945-A (5W-30), Ford WSS-M2C946-A (5W-20), Chrysler MS-6395, & most Asian OEMs where SAE 5W-20 or 5W-30 are specified.

	PETRO-CANADA SUPREME™ Synthetic Blend XL	SYNTHETIC BLEND XL
SAE Grade	5W-20	5W-30
Viscosity cSt @ 40°C	48.6	65.6
cSt @ 100°C	8.5	11.0
Viscosity Index	152	161
Flash Point, COC, °C/°F	239/462	235/455
Cold Crank Viscosity, cP @ °C	5,140@-30	5,670@-30
Borderline Pumping Viscosity, cP @ °C	13,270@-35	19,500@-35
Sulphated Ash, % Wt	0.99	0.96
Base Number (D2896), mg KOH/g	9.0	8.9
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	2.7	3.3

Meet: API SN, Resource Conserving, ILSAC GF-5

PETRO-CANADA SUPREME™ SYNTHETIC MOTOR OILS

PETRO-CANADA SUPREME™ Synthetic 0W-20, 0W-30, 5W-20, 5W-30, and 10W-30 are our top-of-the-line passenger car motor oils. Specially formulated with Petro-Canada's Very High Viscosity Index (VHVI) Synthetic Base Fluids and a unique additive chemistry, they help deliver consistent, superior performance under the toughest driving conditions.

PETRO-CANADA SUPREME™ Synthetic motor oils have outstanding resistance to thermal breakdown and provide exceptional wear protection under both low and high temperature situations. PETRO-CANADA SUPREME™ Synthetic 0W-30 and 0W-20 help protect against the extremes of Canadian winter, and their exceptional fluidity facilitates starting down to -40°C.

PETRO-CANADA SUPREME™ Synthetic motor oils exceed most North American and Asian passenger car and light truck manufacturers' warranty requirements for gasoline fuelled vehicles. They also exceed API Service Category SN with Resource Conserving and the ILSAC GF-5 standard.

PETRO-CANADA SUPREME™ Synthetic 0W-20 and 5W-30 are also fully approved against the GM dexos1® specification.

Typical characteristics are shown below:

	PETRO-CANADA SUPREME™ Synthetic				
SAE Grade	0W-20	0W-30	5W-20	5W-30	10W-30
Viscosity cSt @ 40°C	44.1	58.3	44.9	63.9	64.3
cSt @ 100°C	8.3	10.6	8.3	11.0	10.5
Viscosity Index	166	175	162	165	153
Flash Point, COC, °C/°F	231/448	227/441	233/451	230/446	237/459
Cold Crank Viscosity, cP @ °C	5,800@-35	5,650@-35	3,570@-30	4,850@-30	3,730@-25
Borderline Pumping Viscosity, cP @ °C	16,400@-40	22,900@-40	9,100@-35	15,700@-35	10,300@-30
Sulphated Ash, % Wt	0.92	0.92	0.92	0.92	0.92
Base Number (D2896), mg KOH/g	9.1	7.7	7.9	7.9	7.9
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	2.6	3.1	2.7	3.2	3.2

Meet: API SN, Resource Conserving, ILSAC GF-5, GM 6094M* (0W-30, 5W-30, 10W-30 and 5W-20), GM dexos1® (0W-20 & 5W-30), Ford WSS-M2C946A (5W-30), Ford WSS-M2C945A (5W-20), Ford WSS-M2C947-A (0W-20) & Chrysler MS-6395.

The dexos® specification and trademark are exclusive to General Motors, LLC.

*dexos1 supercedes GM6094M and GM4718M

PC SYNTHETIC 5W-40 MOTOR OIL
(AVAILABLE ONLY IN EUROPE AND OTHER SELECT GEOGRAPHIES)

PC SYNTHETIC 5W-40 is a fuel saving synthetic motor oil that is produced with high quality synthetic base oils and an advanced additive system. This full synthetic motor oil provides excellent low temperature fluidity, excellent resistance to high temperature lubricant breakdown, longer oil life, lower oil consumption and outstanding wear protection.

It exceeds the ACEA C3 requirements for gasoline and light duty diesel engines.

PC SYNTHETIC 5W-40 is fully approved under VW standard 502 00, 505 00 and 505 01. It also meets the requirements of Mercedes-Benz 229.51, BMW LL-04, Porsche A40 and Ford M2C917-A.

	PC SYNTHETIC 5W-40
SAE Grade	5W-40
Viscosity cSt @ 40°C	82.8
cSt @ 100°C	14.0
Viscosity Index	172
Flash Point, COC, °C/°F	233/451
Cold Crank Viscosity, cP @ °C	5,050@-30
Borderline Pumping Viscosity, cP @ °C	33,270@-35
Sulphated Ash, % Wt	0.8
Base Number (D2896), mg KOH/g	7.7
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.6

PC SYNTHETIC 5W-40 is only available for sale in Europe and other select geographies.

PETRO-CANADA SUPREME™ SYNTHETIC BLEND XL 5W-40 MOTOR OIL (AVAILABLE ONLY IN CHINA)

PETRO-CANADA SUPREME™ SYNTHETIC Blend XL 5W-40 is a premium synthetic blend motor oil designed to help provide long engine life by lubricating critical parts effectively. It also provides enhanced protection for the latest emission control systems and turbochargers.

PETRO-CANADA SUPREME™ SYNTHETIC Blend XL 5W-40 motor oil is formulated to meet the API SN Service Classification for gasoline service.

		PETRO-CANADA SUPREME™ SYNTHETIC BLEND XL 5W-40
SAE Grade		5W-40
Viscosity	**cSt @ 40°C**	91.4
	cSt @ 100°C	14.8
Viscosity Index		169
Flash Point, COC, °C/°F		235/455
Cold Crank Viscosity, cP @ °C		<6000 @ -30
Borderline Pumping Viscosity, cP @ °C		38252 @ -35
Sulphated Ash, % Wt		1.06
Base Number (D2896), mg KOH/g		8.3
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C		3.8

PETRO-CANADA SUPREME™ SYNTHETIC 5W-40 MOTOR OIL (AVAILABLE ONLY IN CHINA)

PETRO-CANADA SUPREME™ SYNTHETIC 5W-40 is a premium advanced synthetic motor oil designed to lubricate the engines of today's gasoline and ethanol (up to E85) fuelled passenger cars, vans, CUVs, SUVs and light duty trucks. It provides exceptional resistance to high temperature thermal breakdown, extended engine life, outstanding low temperature fluidity, reduced oil consumption and protection of exhaust emission control systems.

PETRO-CANADA SUPREME™ SYNTHETIC 5W-40 is suitable for use when API SN is recommended.

		PETRO-CANADA SUPREME™ SYNTHETIC 5W-40
SAE Grade		5W-40
Viscosity	**cSt @ 40°C**	92.3
	cSt @ 100°C	14.7
Viscosity Index		167
Flash Point, COC, °C/°F		240/464
Cold Crank Viscosity, cP @ °C		5,980 @ -30
Borderline Pumping Viscosity, cP @ °C		25,120 @ -35
Sulphated Ash, % Wt		0.95
Base Number (D2896), mg KOH/g		7.9
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C		3.8

PETRO-CANADA SUPREME™ SYNTHETIC BLEND XL 5W-40 and PETRO-CANADA SUPREME™ SYNTHETIC 5W-40 are only available for sale in China.

PC EUROPE SYNTHETIC 5W-30 MOTOR OIL (AVAILABLE ONLY IN CHINA)

PC EUROPE SYNTHETIC 5W-30 motor oil is designed to lubricate gasoline and light duty diesel engines without after-treatment devices (DPF-diesel particular filters). This fully synthetic motor oil is formulated for European passenger cars, sport utility vehicles, vans and light duty trucks.

With today's high-powered engines, PC EUROPE SYNTHETIC 5W-30 motor oil can provide long engine life through enhanced lubrication and protection of critical engine parts. It is specially formulated to achieve a minimum HTHS (High-Temperature High-Shear) viscosity of 3.5 cP. HTHS is an indicator of the oil film thickness that will protect the engine from wear at high temperature in the narrow confines between fast moving parts in an engine. PC EUROPE SYNTHETIC 5W-30 offers better wear protection under severe high-speed operations.

	PC EUROPE SYNTHETIC 5W-30
SAE Grade	5W-30
Viscosity cSt @ 40°C	73.9
cSt @ 100°C	12.2
Viscosity Index	162
Flash Point, COC, °C/°F	236/457
Cold Crank Viscosity, cP @ °C	6,400@-30
Borderline Pumping Viscosity, cP @ °C	21,800@-35
Sulphated Ash, % Wt	1.0
Total Base No. (TBN), mgKOH/g	10.0
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.5

PC EUROPE SYNTHETIC 5W-30 is only available for sale in China.

HEAVY DUTY DIESEL ENGINE OILS

Commercial and Industrial requirements for heavy duty engine oils continue to stress higher levels of turbocharging and power outputs, and demand the use of ultra low sulphur diesel fuel for highway fleet operations. U.S. EPA regulations require heavy duty diesel engine manufacturers to reduce NOx emissions via modification of their engine designs. This has resulted in a considerable increase in the soot loading of engine oils. 2007 EPA compliant low emission engines have adopted advanced exhaust after-treatment devices such as diesel particulate filters (DPF) with or without diesel oxidation catalysts (DOC), and increased rates of Exhaust Gas Recirculation (EGR). In addition to these technologies, the 2010 EPA compliant low emissions engines now include emissions systems using Selective Catalytic Reduction (SCR) or increased EGR. Petro-Canada has responded to these developments by again improving the quality and performance of its commercial engine oils, using its HT Severely Hydrotreated base oils and high performance additives.

DURON™ ENGINE OILS

The DURON™ next generation line of premium quality, Heavy Duty Diesel Engine Oils are designed to improve engine reliability and reduce operating costs through its better engine protection, fuel economy potential and extended drain capabilities. The DURON™ product line is formulated to meet the challenges of current low emission engines (API CK-4 and FA-4) including the latest EPA standards. DURON™ multigrades exceed API CK-4 standards required in many on-road and off-road engines and is fully back serviceable to the previous categories (CJ-4, CI-4 etc), while the monogrades are suitable where former API categories CF or CF-2 are recommended.

DURON™ Heavy Duty Diesel Engine Oils may be used in engines fueled by diesel, gasoline, and propane, and in some natural gas (CNG) applications. This allows the selection of one engine oil for a mixed-fuel fleet, which meets most manufacturers' warranty requirements.

DURON™ Heavy Duty Diesel Engine Oils are suitable for use in engines powered by both ultra low and low sulphur diesel. DURON next generation is formulated from one of the purest base oils in the world; the result of our HT purity process to produce 99.9% pure base oils. DURON next generation is formulated to the highest API diesel and gasoline performance standards for 4-Stroke engine oils and is suitable for use in extended oil drain service.

DURON™ ENGINE OILS (API CK-4)

Petro-Canada DURON™ next generation multigrade engine oils are premium heavy duty diesel engine oils that exceed the requirements of API CK-4 and is back serviceable to the previous categories (API CJ-4, CI-4 etc) and are suitable for use in current EPA compliant low emission engines which employ advanced exhaust aftertreatment devices such as diesel particulate filters (DPF), diesel oxidation catalysts (DOC), Selective Catalytic Reductions (SCR) and increased rates of Exhaust Gas Recirculation (EGR).

DURON™ is available in multiple performance offerings as shown below. These engine oils have undergone rigorous engine testing and have demonstrated extended drain capabilities in severe service field trials in both new and older engine designs. DURON™ is formulated to meet the

latest OEM specifications for current low emission engines equipped with advanced exhaust aftertreatment devices.

DURON™ HP 15W-40 High Performance heavy duty diesel engine oil that delivers all weather engine protection including dependable cold start up and exceptional shear stability.

DURON™ SHP 15W-40 Super High Performance synthetic blend heavy duty diesel engine oil that delivers exceptional performance and outstanding shear stability that helps deliver comprehensive protection to vital engine parts over a wide range of operating conditions.

DURON™ SHP 10W-30 Super High Performance synthetic blend heavy duty diesel engine oil that delivers advanced engine protection and all-weather performance. It provides optimal engine durability and can deliver up to 1%* fuel economy improvements.

DURON™ UHP 10W-40 Ultra High Performance full synthetic all-weather heavy duty diesel engine oil. It is designed to provide exceptional protection against engine wear and extended drain performance (exceeding OEM standard intervals)† even in the harshest operating conditions and maximum allowable load conditions.

DURON™ UHP 5W-30 Ultra High Performance heavy duty diesel engine oil is formulated with synthetic base oils and high performance additives designed to deliver up to 2x** better wear protection and up to 4%*** better fuel economy.

DURON™ UHP 0W-40 Ultra High Performance heavy duty diesel engine oil specially formulated with a unique high performance additive system in combination with high quality synthetic base oils to deliver ultimate protection in extreme temperature conditions.

DURON™ UHP 5W-40 Ultra High Performance full synthetic heavy duty diesel engine oil that provides excellent protection and performance, especially in extreme temperature environments.

DURON™ UHP 0W-30 Ultra High Performance heavy duty diesel engine oils with unique additives and high quality synthetic base oils to deliver ultimate protection in extreme temperature conditions.

* Comparing 15W-40 with 4.1cP HTHS vs 10W-30 with 3.5cP HTHS.
** Based on results from the Daimler OM 646 LA industry recognized test.
*** Fuel economy results are based on the generally accepted and industry recognized SAE J1321 Type II fuel consumption test. Comparison of fuel economy is relative to DURON™-E 15W-40, and in combination with TRAXON™ Synthetic 75W-90 (relative to a TRAXON™ 85W-140) gear oil. Actual results are dependent on external factors including, but not limited to: driving terrain, weather conditions, tire pressure and severity of operating conditions.
† Extending drain intervals should always be undertaken in conjunction with an oil analysis program.

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	DURON™		
	HP	**SHP**	**SHP**
SAE Grade	**15W-40**	**15W-40**	**10W-30**
Viscosity cSt @ 40°C	118	114	80.1
cSt @ 100°C	15.6	15.4	12.0
Viscosity Index	139	142	145
Flash Point, COC, °C/°F	228/442	226/439	220/428
High Temp/High Shear Viscosity, cP @ 150ºC	4.1	4.1	3.5
Cold Crank Viscosity, cP @°C/°F	5540 (-20 / -4)	5000 (-20 / -4)	5570 (-25 / -13)
Pour Point, °C/°F	-36 / -33	-36 / -33	-42 / -44
Borderline Pumping Viscosity, cP @°C/°F	21350 (-25 / -13)	19880 (-25 / -13)	18160 (-30 / -22)
Sulphated Ash, % Wt	1.0	1.0	1.0
Base Number (D2896), mg KOH/g	9.8	9.8	10.0

	DURON™				
	UHP	**UHP**	**UHP**	**UHP**	**UHP**
SAE Grade	**10W-40**	**5W-30**	**5W-40**	**0W-40**	**0W-30**
Viscosity cSt @ 40°C	107	67.3	95.1	82	65.2
cSt @ 100°C	15.5	11.4	14.3	14.5	11.5
Viscosity Index	155	165	169	180	173
Flash Point, COC, °C/°F	244/471	231/448	235/450	224/435	220/428
High Temp/High Shear Viscosity, cP @ 150ºC	4.1	3.5	3.8	3.9	3.4
Cold Crank Viscosity, cP @°C/°F	5720 (-25 / -13)	5875 (-30 / -22)	5900 (-30 / -22)	5900 (-35 / -31)	5400 (-35 / -31)
Pour Point, °C/°F	-42 / -44	-45 / -49	-45 / -49	-45 / -49	-45 / -49
Borderline Pumping Viscosity, cP @°C/°F	25600 (-30 / -22)	16000 (-35 / -31)	34200 (-35 / -31)	28300 (-40/ -40)	19600 (-40 / -40)
Sulphated Ash, % Wt	1.0	< 1.0	< 1.0	1.0	1.0
Base Number (D2896), mg KOH/g	10.0	9.6	11	9.5	9.7

For DURON™ Performance Specifications, Refer to Table (see page 72)

DURON™ ADVANCED DIESEL ENGINE OIL (API FA-4)

DURON™ ADVANCED next generation premium performance synthetic blend diesel engine oil delivers industry leading protection against increased wear and is formulated to exceed API FA-4 requirements. It is suitable for use in 2017 and future engines which specify the use of an API FA-4 oil.

DURON™ ADVANCED (and all API FA-4 oils) have limited backwards compatibility with older engines as these oils are specifically engineered for newer engines designed to meet new legislation around emissions and fuel economy. They will operate at a lower high temperature high shear (HTHS) viscosity, meaning less friction and viscous drag in the engine and enable reduced fuel consumption, while still offering increased levels of wear protection. DURON ADVANCED provides additional fuel savings over CK-4 of the same grade, up to 1%*.

Typical characteristics are shown below:

		DURON™ ADVANCED
SAE Grade		**10W-30**
Viscosity **cSt @ 40°C**		66.2
cSt @ 100°C		10.3
Viscosity Index		143
Flash Point, COC, °C/°F		227/440
Pour Point, °C/°F		-42 / -44
High Temp/High Shear		
Viscosity, cP@150°C / 302°F		3.1
Cold Crank Viscosity	**cP @ °C**	4900 (-25 / -13)
Borderline Pumping Viscosity	**cP @ °C/ °F**	13100 (-30 / -22)
Sulphated Ash, % Wt		1.0
Base Number (D2896), mg KOH/g		10.0

For DURON™ Performance Specifications, Refer to Table (see page 72)

* Comparing an SAE 10W-30 with 3.5cP HTHS vs a 10W-30 with 3.1cP HTHS.

DURON™ MONOGRADE ENGINE OILS

Petro-Canada DURON™ Monograde Engine Oils meet the performance requirements of the former API categories CF and CF-2. They can be used in older diesel or gasoline engines that require a single viscosity grade engine oil that specifies API CF or CF-2 level of performance. They may also be used in many stationary and marine applications , where automotive diesel fuel is used.

DURON™ Monograde Engine Oils are available in four SAE grades: 10W, 30, 40 and 50.

Typical characteristics are shown below:

	DURON™ Monograde			
SAE Grade	**10W**	**30**	**40**	**50**
Viscosity cSt @ 40°C	40.4	91.6	133	206
cSt @ 100°C	6.7	11.2	14.4	19.1
Viscosity Index	124	110	107	105
Flash Point, COC, °C/°F	211/412	249/480	223/433	259/498
Pour Point, °C/°F	-33/-27	-30/-22	-27/-16	-21/-6
Cold Crank Viscosity, cP @ °C	3640@-25	–	–	–
Borderline Pumping Viscosity, cP@ °C		–		–
Phosphorus, % Wt	0.12	0.12	0.12	0.12
Sulfur, % Wt	<0.35	<0.35	<0.35	<0.35
Sulphated Ash, % Wt	1.0	1.0	1.0	1.0
Base Number (D2896), mg KOH/g	8.6	8.0	8.4	8.7

For DURON™ Monograde Performance Specifications, Refer to Table (see page 72)

- DURON™ Monogrades can be used in transmissions, where a motor oil is specified.
- DURON™ Monogrades are excellent hydraulic fluids for mobile equipment, where a motor oil is specified.
- DURON™ 30 & 40 are suitable for use in the following medium and high-speed marine engines, fueled by diesel or gasoline (where water separation is not required): Allis-Chalmers, B&W/Alpha, Buda, Caterpillar, Chrysler, Cummins, Daihatsu, John Deere, Detroit Diesel 2-stroke engines, Deutz, Dorman, English Electric, Fairbanks-Morse, Ford, Gardener, Hatz, Intrepid, Isuzu, Mack, MAN, Mitsubishi, Moteurs Baudouin, MTU, Murphy, Nissan, Nohab, Onan, Paxman, Ruston, Stork/Werkspoor, Volvo, Wartsilla/ Wichman, Waukesha/Scania, White, Yanmar.
- DURON™ 30 is also approved for use with Simplex seals from ThyssenKrupp.

DURON™ UHP E6 10W-40 ENGINE OIL
(AVAILABLE ONLY IN EUROPE)

DURON™ UHP E6 10W-40 Heavy Duty Engine Oil delivers superior engine protection and operational efficiency. Made with base oils that are 99.9% pure, DURON™ UHP E6 10W-40 outperforms ACEA requirements and demanding OEM specifications to provide tangible benefits such as longer engine life, extended drains*, better all weather performance and better efficiency resulting in increased productivity.

DURON™ UHP E6 10W-40 is a superior quality heavy duty, low SAPS (Sulphated Ash, Phosphorous, Sulphur), diesel engine oil specifically designed to exceed ACEA E6 performance requirements. It is an Ultra High Performance Diesel (UHPD) engine oil with extended drain capability and excellent all weather performance. DURON™ UHP E6 10W-40 is approved for use with leading OEMs.

*Extending drain intervals should always be undertaken in conjunction with a regular oil analysis program.

Typical characteristics are shown below:

	DURON™ UHP E6 10W-40
Viscosity, cSt @ 40ºC	92.8
cSt @ 100ºC	14.2
Viscosity Index	157
Pour Point, ºC	-39
High Temp/High Shear Viscosity, cP @ 150ºC	4.1
Flash Point, COC, ºC	237
Cold Cranking Viscosity, cP @ -25ºC	5,750
Borderline Pumping Viscosity, cP @ -30ºC	17,320
Base Number (D2896), mg KOH/g	9.5
Sulphated Ash, % Wt	1.0

PETRO-CANADA HDEO RECOMMENDED APPLICATIONS	H Approved I Suitable For Use 3 Meets Specifications	
ACEA	3	E6, E7, E9
API	3	CI-4
DAF	3	Standard Drain
Deutz	H	DQC III-10 LA
Mack	H	EO-N
MAN	H	3477, 3275-1
Mercedes-Benz	H	228.51
MTU	H	Type 3.1
Renault	H	RLD-2
Scania	I	LA*
Volvo	H	VDS-3

* Meets Scania low ash requirements

DURON™ CLASSIC (ONLY AVAILABLE IN SELECT GEOGRAPHIES*)

DURON™ CLASSIC engine oils are premium multigrade heavy duty engine oils recommended for engines fueled by diesel, gasoline, propane, or compressed natural gas (CNG), where applications specify API CH-4 / SJ, operating on-highway or off highway in transportation, mining, forestry, construction, farm and marine applications.

DURON™ CLASSIC 15W-40 is licensed with API as CH-4/SJ.

DURON™ CLASSIC 20W-50 is suitable for use in diesel powered engines in some smaller vehicles, including cars and light trucks where this viscosity grade and API CH-4, CG-4, or earlier specifications are required.

Typical characteristics are shown below:

	DURON™ CLASSIC	
	15W-40	**20W-50**
Viscosity, cSt @ 40ºC	110	171
cSt @ 100ºC	15.4	19.2
Viscosity Index	149	128
Pour Point, ºC/ºF	-42/-44	-36/-33
High Temp/High Shear Viscosity, cP @ 150ºC	4.1	5.0
Flash Point, COC, ºC/ºF	240/464	258/496
Cold Cranking Viscosity,		
cP @ -20ºC/-4ºF	6,000	
cP @ -15ºC/5ºF		6,860
Base Number (D2896), mg KOH/g	9.0	9.0

* Check with a Petro-Canada Sales Account Manager for availability.

DURON™ EXTRA (ONLY AVAILABLE IN SELECT GEOGRAPHIES*)

DURON™ EXTRA is formulated to exceed API CJ-4/SN requirements and provides excellent engine protection. It is fully back-serviceable where CI-4, CH-4 and previous categories are required. It also demonstrates excellent all-weather performance including dependable cold start-up performance and exceptional shear stability, minimizes engine wear and oil consumption. It has demonstrated extended drain capabilities (exceeding OEM standard intervals)* while subjected to tough service conditions. DURON™ EXTRA 15W-40 is API CJ-4/SN licensed.

Typical characteristics are shown below:

	DURON™ EXTRA	
	15W-40	**20W-50**
Viscosity, cSt @ 40ºC	118	173
cSt @ 100ºC	15.6	19.7
Viscosity Index	139	131
Pour Point, ºC/ºF	-36/-33	-33/-27
High Temp/High Shear Viscosity, cP @ 150ºC	4.1	5.0
Flash Point, COC, ºC/ºF	228/442	231/448
Cold Cranking Viscosity,		
cP @ -20ºC/-4ºF	5,540	
cP @ -15ºC/5ºF		6,400
Base Number (D2896), mg KOH/g	9.8	9.8

* Extending drain intervals should always be undertaken in conjunction with an oil analysis program.

PETRO-CANADA HDEO RECOMMENDED APPLICATIONS

H Approved | I Suitable For Use | 3 Meets Specifications

Approvals	DURON HP 15W-40	DURON SHP 15W-40	DURON SHP 10W-30	DURON UHP 10W-40	DURON UHP 5W-30	DURON UHP 5W-40	DURON UHP 0W-40	DURON UHP 0W-30	DURON ADVANCED 10W-30
ACEA	3 E7, E9	3 E7, E9	3 E7, E9	3 E7, E9	3 E6, E7, E9				
API	H CK-4 / SN	H CK-4 / SN	H CK-4 I SN*	H CK-4 / SN	H CJ-4 / SN	H CK-4 / SN	I CK-4 / SN	H CK-4 / SN	H FA-4
CAT®	I ECF-3, TO-2	I ECF-3, TO-2	I ECF-3, TO-2	I ECF-3, TO-2	I ECF-3	I ECF-3, TO-2	I ECF-3, TO-2	I ECF-3, TO-2	
Cummins	H CES 20086	H CES 20086	H CES 20086	H CES 20086	H CES 20081	H CES 20086	I CES 20086	I CES 20086	H CES 20087
DAF					3 Standard and Extended Drain				
Detroit Diesel	H DFS 93K222	H DFS 93K222	H DFS 93K222	H DFS 93K222	H DFS 93K222	H DFS 93K222			H DFS 93K223
DEUTZ				H DQC III-10 LA**	H DQC IV-10 LA				
Ford	H WSS-M2C171-F1	H WSS-M2C171-F1	H WSS-M2C171-F1	H WSS-M2C171-F1		H WSS-M2C171-F1			
GM		I 9985930	I 9985930	I 9985930					
JASO	I MA, MA2	I MA, MA2, DH-1	I MA, MA2, DH-1	I MA, MA2, DH-1	I DH-1		I MA, MA2	I MA, MA2	
MACK	H EOS-4.5	H EOS-4.5	H EOS-4.5	H EOS-4.5	H EO-O PP '07	H EOS-4.5			
MAN	H 3575, 3275-1	H 3575, 3275-1			I 3477, 3677**				
Mercedes-Benz	H 228.31	H 228.31	H 228.31		H 228.51				
mtu	H Type 2.1	H Type 2.1			H Type 3.1				
Renault Trucks	H RLD-4	H RLD-4	H RLD-4	H RLD-4	H RLD-3	H RLD-4			
SCANIA					I LA**				
VOLVO	H VDS-4.5	H VDS-4.5	H VDS-4.5	H VDS-4.5	H VDS-4	H VDS-4.5			

* Use of a diesel engine oil for gasoline applications may compromise the life of the emissions device. Please refer to the owner's manual to ensure proper oil is used.

** Approval pending with proven technology

DURON™ GEO LD 15W-40

DURON™ GEO Long Drain (LD) 15W-40 natural gas mobile engine oil delivers superior engine protection and extended drain* capabilities for Compressed Natural Gas/Liquefied Natural Gas (CNG/LNG) engines in mobile applications.

Specifically designed for extended drain intervals up to 1200 hours while protecting critical engine parts, DURON™ GEO LD 15W-40 can help minimize downtime and service costs by keeping fleets on the road longer.

DURON™ GEO LD 15W-40 is approved for use in engines requiring Cummins CES 20085 or Detroit Diesel DFS 93K216 specifications.

*Extending drain intervals should always be undertaken in conjunction with an oil analysis program. Refer to owner's manual or operations and maintenance manual for complete information.

Typical characteristics are shown below:

		DURON™ GEO LD 15W-40
Viscosity,	**cSt @ 40°C**	114
	cSt @ 100°C	15.4
Flash Point, COC, °C / °F		242/468
Pour Point, °C / °F		-33/-27
Sulphated Ash, % Wt		0.80

RALUBE™ – LOCOMOTIVE DIESEL ENGINE OIL

RALUBE™ oils are designed to lubricate large medium-speed diesel engines driving railroad locomotives, marine vessels and electric-power generators.

RALUBE™ oils incorporate chlorine-free additive chemistry. RALUBE™ oils help provide strong oxidation resistance, wear protection and deposit control.

RALUBE™ diesel engine oils are designed to provide exceptional deposit control necessary for severe railroad service. In addition, by minimizing engine deposits, they allow maximum oil drain intervals to be achieved without compromising engine durability.

RALUBE™ oils are zinc-free for compatibility with silver plated or silver alloy engine components. RALUBE™ oils have been tested and approved in railroad service, in close co-operation with the major locomotive engine builders such as Electro-Motive Diesel and General Electric. Electro-Motive Diesel and General Electric list these oils as approved for use in their equipment.

RALUBE™ 940 CF is an SAE 20W-40, 9 Base Number railway diesel engine oil designed to address EPA Tier 4 emission standards and is suitable for use with current and late model EMD and GE units operating on Ultra Low Sulphur Diesel.

RALUBE™ 40 CFS is an SAE 40 grade, 13 Base Number premium quality crankcase oil, formulated for severe service in diesel locomotive engines, driving railroad locomotives, marine vessels and electric power generators. RALUBE™ 40 CFS is suitable for use in Caterpillar 3600 series engines.

Typical characteristics are shown below:

		RALUBE™	
		940 CF	**40 CFS**
SAE Grade		20W-40	40
Viscosity	**cSt @ 40°C**	136	142
	cSt @ 100°C	14.3	14.8
Viscosity Index		107	104
Flash Point, COC, °C/°F		271/520	267/513
Pour Point, °C/°F		-27/-17	-27/-17
Sulphated Ash, % Wt		1.0	1.5
Base Number (D2896), mg KOH/g		9.0	14

AUTOMATIC TRANSMISSION FLUIDS

Automatic Transmission Fluids (ATFs) are among the most complex lubricants on the market today. Containing many additive components, ATFs represent a careful balance of properties needed to meet the unique requirements of automatic transmissions. They may be described as viscometrically similar to SAE 0W-20 grade oils, but with exceptionally good low temperature properties. ATFs contain some of the same additives as engine oils, but have additional components to give special frictional properties and exceptional oxidation resistance. Their excellent low temperature fluidity and antiwear properties enable ATFs to perform well as hydraulic fluids in industrial equipment and air compressors, provided that water separation is not required.

These fluids perform five basic functions:

- Transmit hydrodynamic energy in the torque converter.
- Transmit hydrostatic energy in hydraulic logic control circuits and servomechanisms.
- Lubricate shaft bearings, thrust bearings, and gears.
- Transmit sliding friction energy in bands and clutches.
- Act as a heat transfer medium controlling automatic transmission operating temperatures.

Automatic transmission fluid specifications are in a state of flux and now there are several types of fluids specified for North American automatic transmissions. The most widely marketed fluid is DEXRON®-III/ MERCON® type ATF, a friction modified fluid, recommended for transmission top-up or refill by many automobile manufacturers for late model vehicles (prior to 2006). For General Motors' transmissions of 2006 model year and onward, the required fluid is DEXRON®-VI or DEXRON®-HP. Ford Motor Company requires all its automatic transmissions to be serviced with MERCON® V, MERCON® SP or MERCON® LV fluid. General Motors and Ford Motor Company are now recommending Ultra Low Viscosity (ULV) ATF in select vehicle models containing their jointly developed 10 speed (and in some cases their 9 speed) automatic transmissions. The shift towards lower viscosity fluids, such as DEXRON®-VI, MERCON® LV and now ULV ATF is intended to gain improvements in fuel economy. Ford Type F, a non friction-modified fluid, is still used for 1979 and earlier Ford or other older import cars. FCA US LLC (formerly Chrysler Group LLC) recommends ATF+4® fluid be used in most of their transmissions for all model years. This market fragmentation has led to the increasing acceptance of multi-vehicle service fill ATFs. We recommend consulting a Petro-Canada representative for an official ATF recommendation.

PETRO-CANADA ATF D3M

Petro-Canada ATF D3M demonstrates outstanding oxidative and thermal stability, giving extremely long service life under severe operating conditions. The fluid's operating range is between -40°C/-40°F and 160°C/320°F. ATF D3M is fully qualified for use in transmissions where a fluid meeting the former DEXRON®-III(H), -III(G), -II(E), or MERCON® specification is recommended. This would include where the legacy General Motors specification 6297M and Ford specifications M2C166-H or M2C185-A are recommended.

Petro-Canada ATF D3M is designed to meet the severe requirements of the Allison C-4 and V-730D specifications for transmission/torque converter fluids. It is approved against the Allison TES-389 specification. Petro-Canada's ATF D3M is suitable for use when Caterpillar TO-2 and MB 236.1/.5/.6/.7 specifications are recommended. It is also suitable for use in Clark Powershift Transmissions down to -30°C/-22°F as well as transmissions manufactured by Renke.

Petro-Canada ATF D3M also acts as an excellent hydraulic fluid and it surpasses the performance of most top quality antiwear hydraulic fluids or motor oils. It is suitable for use with Sundstrand, Bosch-Rexroth, Vickers and Denison (except certain axial piston) hydraulic pumps.

Petro-Canada ATF D3M is superior to 10W motor oils commonly used in mobile equipment hydraulic systems, because it has a better cold starting performance, superior materials compatibility and a greater resistance to oxidation. It may be used in power steering units specifying a DEXRON®-III or II type fluid. It is dyed red for easy identification.

PETRO-CANADA DURADRIVE™ MV SYNTHETIC ATF

Petro-Canada DURADRIVE™ MV Synthetic ATF is Petro-Canada's high viscosity multi-vehicle ATF. This full synthetic formulation offers true multi-vehicle performance, outstanding wear protection, and exceptional fluid life.

DURADRIVE™ MV Synthetic provides the frictional properties, wear protection and viscometrics needed by most major North American, Asian, and European automatic transmissions. It is specially formulated to provide consistent shift feel and transmission protection over a long fluid life. DURADRIVE™ MV Synthetic's benefits include excellent oxidation and shear stability, outstanding wear protection, and exceptional low temperature fluidity. It also provides industry leading anti-shudder durability (ASD) and frictional stability, exceeding the performance of many genuine OEM fluids.

DURADRIVE™ MV Synthetic is approved for Ford MERCON® V (M5080701) and exceeds JASO 1A requirements. It is fully suitable for use in a wide range of North American, Asian and European automatic transmissions where the following OEM specifications are recommended:

Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle[1]
Passenger Car - North American OEM	Ford MERCON® V **approved (M5080701)**	
	Ford MERCON®	
	Chrysler ATF+3®, MOPAR ASRC	
	Ford FNR5	
	GM DEXRON® II (IID, IIE) III (IIIF, IIIG, IIIH)	
	Saturn T-IV Fluid	
Passenger Car - Asian OEM	Aisin Warner JWS 3309 (T-IV)[2]	Aisin Warner JWS 3324 (WS)[1], AW-1[1]
	Honda ATF Z1	Honda DW-1[1]
	Hyundai/Kia SP-II, SP-III, JWS 3314, JWS 3317	Hyundai/Kia SP-IV[1], SPH-IV[1], SP-IV RR[1], SPIV-M[1] / SP4-M[1]
		Hyundai NWS-9638[1]
	JASO 1A	JASO 1A-LV[1]
	Kia Red-1	
	Mazda ATF F-1, ATF M-III, ATF M-V	
	Mitsubishi Diaqueen J2	Mitsubishi Diaqueen J3[1] / Diaqueen ATF PA[1]
	Mitsubishi SP-II, SP-III	Mitsubishi SP-IV[1]
	Nissan 402, Nissan Matic D, J, K	Nissan Matic S[1], W[1]
	Subaru ATF, ATF-HP	
	Suzuki 3314, 3317	
	Toyota T, T-II, T-III, T-IV[2]	Toyota WS (JWS 3324)[1]
Passenger Car - European OEM	Audi G 052 162, G 052 990, G 055 025	Audi G 055 005[1], G 055 162[1]
	BMW 7045E (3 Series), 8072B (BMW 5 Series), LA 2634, LT 71141	BMW 83 22 0 142 516[1]
	Mercedes-Benz MB 236.10 (NAG 1 / Shell 3403), MB 236.1, 236.2, 236.3, 236.5, 236.6, 236.7, 236.9, 236.11, 236.81	Mercedes-Benz 236.12[1], 236.14[1], 236.15[1], 236.41[1]
	Renault DP-0	
	Saab 3309	Saab 93 165 147[1]
	Volvo 4 speed (P/N 1161621), Volvo P/N 1161540/1161640[2]	Volvo 6 speed MY 2011-2013 (P/N 31256774 or 31256675)[1]
	VW G 052 162, G 052 990, G 055 025	VW G 052 540[1], G 055 005[1], G 055 162[1]
	ZF TE-ML 09, 11 (3/4/5 speed)	ZF 6 speed (S671 090 255)[1]

DURADRIVE™ MV Synthetic is not recommended for DCT and CVT transmissions or where a non-friction modified fluid is recommended (e.g. Ford Type F). Always consult the vehicle's owner manual for specific transmission fluid recommendations.

For a full listing of suitable for use applications including transfer case and power steering applications, please consult Tech Data IM-8043E or a Petro-Canada Technical Service Advisor.

[1] DURADRIVE™ MV Synthetic ATF is a high viscosity formulation and does not meet the viscosity profiles of these low viscosity specifications. Field testing results have demonstrated proof of no harm but product will not provide the potential fuel economy benefits of the low viscosity genuine oils.
[2] Except AWTF80-SC transmissions or MY 2008-2010 V70

PETRO-CANADA ATF TYPE F

As noted earlier, this fluid differs from ATF D3M in its frictional properties, as they relate to the design of pre-1980, Ford automatic transmissions. ATF Type F meets the requirements of the obsolete Ford specification ESW-M2C33-F. It can also be used where Ford ESP-M2C33-G is specified. ATF Type F is sometimes specified by other equipment OEMs who want a non-friction modified fluid. Petro-Canada ATF Type F is not recommended in applications that require DEXRON® or any MERCON® type fluids, which are friction modified fluids.

AUTOMATIC TRANSMISSION FLUID TYPICAL CHARACTERISTICS

Typical characteristics of Petro-Canada DURADRIVE™ MV Synthetic ATF, ATF D3M and ATF Type F are shown below:

		DURADRIVE™ MV Synthetic ATF	Petro-Canada ATF D3M	Petro-Canada ATF Type F
Viscosity	**cSt @ 40°C**	36.1	34.3	40.8
	cSt @ 100°C	7.4	7.7	8.2
Viscosity Index		178	210	180
Brookfield Viscosity,	**cP @ - 18°C**		–	970
	cP @ - 20°C	1,210	1,140	–
	cP @ -30°C	2,697	3,160	–
	cP @ - 40°C	11,538	12,060	23,260
Pour Point, °C/°F		-54/-65	-51/-60	-48/-54
Flash Point, COC, °C/°F		206/403	185/365	204/399
Colour		Red	Red	Red

VEHICLE APPLICATIONS

DEXRON®-III/MERCON®

Petro-Canada ATF D3M is approved for use in General Motors (prior to 2006) and Ford (1980 to 1996) vehicles. It also meets or exceeds the requirements of the following manufacturers where a DEXRON®-III/ MERCON® type fluid is recommended.

Alfa Romeo
American Motors
Audi
BMW
Daewoo
Datsun/Nissan
Fiat
Geo
Infiniti
Jaguar*
Lexus
Mazda
Merkur
Mercedes-Benz
Mitsubishi
Peugeot
Porsche
Renault
Rover
Saturn
Saab (4-speed)
Sterling
Suzuki
Subaru
Toyota (except 4-speed 1981-83)
Volkswagen
Volvo (1984 onwards)

*Except Borg-Warner transmissions

Type F Fluid

Petro-Canada ATF D3M Automatic Transmission Fluid is not recommended for the vehicles listed below. They require Petro-Canada ATF Type F Fluid.

Ford (1978 & earlier models where Type F fluid is specified)
Jaguar (Borg-Warner)
Mazda (1981-85)
Saab (3-speed)
Toyota (4-speed 1981-83)
Volvo (1984 BW55 & 1981-83)

(The above listings are only a guide. Always consult the vehicle's owner manual and a Petro-Canada Representative for specific recommendations.)

PETRO-CANADA DEXRON®-VI ATF AUTOMATIC TRANSMISSION FLUID

Petro-Canada DEXRON®-VI is an exceptional automatic transmission fluid approved by General Motors for use in vehicles with GM automatic transmissions. This unique fluid is specially formulated to provide twice the service life of a DEXRON®-III (H) ATF and offers enhanced performance for both new and older transmissions. It is designed to protect automatic transmissions through improved oxidation resistance, friction durability, shear stability and wear protection to help meet warranty protection requirements in late model vehicles. Designed to provide responsive shift feel throughout the life of the oil, Petro-Canada DEXRON®-VI ATF consistently protects vehicle transmissions longer than all previous DEXRON® type fluids.

Petro-Canada DEXRON®-VI ATF was developed in conjunction with General Motors fluid design criteria for all 2006 and beyond model year vehicles with automatic transmissions requiring the use of fluid meeting the GMW16444 specification. General Motors recommends the use of DEXRON®-VI for many automatic transmissions including those prior to 2006 model year. It is fully back serviceable where the former DEXRON®-III(H), -III(G) and -II(E) specifications were recommended. Petro-Canada DEXRON®-VI is also approved against the Mercedez-Benz 236.41 specification. Petro-Canada DEXRON®-VI ATF is Voith Transmission approved for the 36,000 mile standard drain interval (H55.6335.xx DIWA Service Bulletin 013 and 118, formerly G1363).

Petro-Canada DEXRON®-VI is suitable for use where Volvo specification 97342 is mandated. It is also suitable where Chrysler/Dodge/Jeep vehicles call for Part Number 68043742AA. Note that most Chrysler automatic transmissions require an ATF+4® fluid, also available from Petro-Canada.

Typical characteristics are shown below:

		DEXRON®-VI ATF
Viscosity	**cSt @ 40°C**	29.8
	cSt @ 100°C	6.0
Viscosity Index		151
Brookfield Viscosity,	**cP @ - 20°C**	1,053
	cP @ - 30°C	3,164
	cP @ - 40°C	12,030
Pour Point, °C/°F		-54/-65
Flash Point, COC, °C/°F		206/403
Colour		Red

DEXRON® is a registered trademark of General Motors LLC.
ATF+4® is a trademark of FCA US LLC, used under license.

PETRO-CANADA ATF+4® AUTOMATIC TRANSMISSION FLUID

Petro-Canada ATF+4® is an automatic transmission fluid specially formulated to meet the needs of FCA Group LLC (formerly known as Chrysler Group LLC) automatic transmissions. This highly shear-stable fluid delivers superior shift performance and wear protection in the Chrysler transmissions for which it was designed. Meets Chrysler MS-9602 specifications. Suitable for top-up or complete fluid changes. It may also be used where earlier Chrysler fluids, such as Chrysler ATF+3® were recommended. Petro-Canada ATF+4® contributes to the overall performance of the transmission by delivering optimized shift efficiency, exceptional oxidation and shear stability and extended drain intervals over ATF+3® fluids.

Typical characteristics are shown below:

		PETRO-CANADA ATF+4®
Viscosity	**cSt @ 40°C**	33.2
	cSt @ 100°C	7.5
Viscosity Index		204
Brookfield Viscosity,	**cP @ - 29°C**	2,050
	cP @ - 40°C	8,380
Pour Point, °C/°F		-51/-60
Flash Point, COC, °C/°F		198/388
Colour		Red

ATF+4® is a trademark of FCA US LLC, used under license.

PETRO-CANADA UNDYED ATF (ONLY AVAILABLE IN EUROPE)

PETRO-CANADA UNDYED ATF is an automatic transmission fluid that demonstrates exceptional oxidation and thermal stability, giving extremely long service life. It meets the performance requirements of PETRO-CANADA ATF D3M but does not meet the colour requirement as this is an undyed product.

		PETRO-CANADA UNDYED ATF
Viscosity	**cSt @ 40°C**	34.3
	cSt @ 100°C	7.7
Viscosity Index		210
Brookfield Viscosity,	**cP @ - 20°C**	1,140
	cP @ - 30°C	3,160
	cP @ - 40°C	12,060
Pour Point, °C/°F		-51/-60
Flash Point, COC, °C/°F		185/365
Colour		Brown

PETRO-CANADA UNDYED ATF is only available for sale in Europe in bulk.

PETRO-CANADA HEAVY DUTY SYNTHETIC BLEND AUTOMATIC TRANSMISSION FLUID

Petro-Canada's Heavy Duty Synthetic Blend ATF is suitable for use in heavy duty fleets for up to 50,000 miles in severe service and 100,miles in normal service. **Approved for Voith (H55.6336.xx DIWA Service Bulletin 013 & 118, formerly G1363) 72,000 mile and ZF TE-ML 14B extended drain applications. Also approved for Allison C4 (legacy), ZF TE-ML 03D, 04D, 16L and 17C (ZF001236).** Fully qualified for use in transmissions where a fluid meeting the former DEXRON®-IIIH, -IIIG, -IIE, -II or MERCON® specification is recommended. Also suitable for use where Allison TES-295, Caterpillar TO-2, MB 236.1/.5/.6/.7, MAN 339 Typ Z2 & V2, Volvo 97341, or MERCON® V is recommended.

Typical characteristics are shown below:

		PETRO-CANADA HEAVY DUTY SYNTHETIC BLEND ATF
Viscosity	**cSt @ 40°C**	34
	cSt @ 100°C	7.8
Viscosity Index		208
Brookfield Viscosity,	**cP @ - 40°C**	9,700
Pour Point, °C/°F		-45/-49
Flash Point, COC, °C/°F		189/372
Colour		Red

DEXRON® is a registered trademark of General Motors LLC.
MERCON® is a registered trademark of Ford Motor Company.

AUTOMOTIVE GEAR OILS

Automotive gear oils protect gears, bearings and cross-shafts from premature failure, ensure reliable equipment operation and increase transmission and differential service life. Automotive gear oils achieve this by performing the following five vital functions:

- **Reducing friction and wear**
  An oil film of a certain thickness must be maintained between gear teeth at all times to prevent metal-to-metal contact between gear surfaces under extreme pressure conditions. Hypoid gear drives are especially tough systems to lubricate, since the gear contact motion severely shears the oil with sliding as well as rolling motions and the gears are severely shock loaded.
- **Providing oxidation stability**
  A gear oil should resist thermal degradation and sludging so that harmful viscosity increase is minimized over time.
- **Cooling the gear surfaces**
  Gear components are prevented from destructive over-heating, by circulating oil through the bearing and gear mesh zones, where frictional heat is generated.
- **Inhibiting rust and corrosion**
  A gear oil must be non-corrosive to bronze, and protect steel surfaces against rust, especially when water contamination is present.
- **Maintaining long clutch life and preventing seal leaks**
  Clutches used in wet brakes and manual transmissions can become “glazed” and lose their function, if gear oils decompose at high temperatures. Gear oils must, therefore, be thermally stable. Undesirable decomposition products can also coat seals with carbon, causing leakage.

GEAR OIL CLASSIFICATION SYSTEMS

SAE VISCOSITY GRADE

Gear lubricants must flow freely when the axle is cold, yet have sufficient thickness or viscosity to lubricate at normal operating temperatures.

Axle and transmission lubricant viscosity is indicated in the table below. Each viscosity grade has distinct criteria for low and high temperature performance.

AXLE AND MANUAL TRANSMISSION LUBRICANT VISCOSITY CLASSIFICATION SAE J306 (June 2005)

SAE Viscosity Grade	Max. Temperature for Viscosity of 150,000 cP (°C) [1,2]	Kin. Viscosity @ 100°C, cSt [3]	
		Minimum [4]	Maximum
70W	–55	4.1	—
75W	–40	4.1	—
80W	–26	7.0	—
85W	–12	11.0	—
80	—	7.0	<11.0
85	—	11.0	<13.5
90	—	13.5	<18.5
110	—	18.5	<24.0
140	—	24.0	<32.5
190	—	32.5	<41.0
250	—	41.0	—

NOTE – 1cP = 1 mPa.s; 1 cSt = 1mm^2/s

1. Using ASTM D 2983.
2. Additional low-temperature viscosity requirements may be appropriate for fluids intended for use in light duty synchronized manual transmissions. See text.
3. Using ASTM D445.
4. Limit must also be met after testing in CEC L-45-99, Method C (20 hours).

SAE viscosity selection should be based on the minimum and maximum service temperatures. Today's most commonly used gear lubricants are multi-grades (e.g. 75W-90, 80W-90 and 85W-140). These fluids meet both the low and high temperature requirements for the combined grades. For example, an 80W-90 oil must have the low temperature fluidity of an 80W as well as the viscosity of a 90 grade at higher temperatures.

API SERVICE DESIGNATIONS

Automotive gear lubricant performance is defined by the type of service it can be expected to perform satisfactorily. The API service designations were developed for manufacturers and end-users to assist them in selecting gear lubricants for a variety of operating conditions.

The API service designations range from GL-1 to GL-5 and describe gear lubricants in terms of general type, severity of service and application. The following table lists these designations.

The most commonly specified and available type of automotive gear lubricant in North America is API GL-5. In Europe and other parts of the world where manual transmissions are more prevalent, API GL-4 oils are used as frequently as API GL-5.

API SERVICE CLASSIFICATION

Classifications	Type	Typical Application
GL-1	Straight mineral oil (inactive)	Automotive manual transmissions
GL-2	Usually contains fatty materials (inactive)	Worm gear drives, industrial gear oils
GL-3	Contains mild EP additive (inactive)	Manual transmissions and spiral bevel final drives
GL-4	Equivalent to obsolete MIL-L-2105 Specification. Usually satisfied by 50% GL-5 additive level	Manual transmissions, spiral bevel and hypoid gears where moderate service prevails
GL-5	Part of SAE J2360 Specification (formerly MIL-PRF-2105E). Primary field service recommendation of most passenger cars and truck builders worldwide	Used for moderate and severe service in hypoid and all other types of gears. Also may be used in manual transmissions.
GL-6	(Obsolete.)	Severe service involving high-offset hypoid gears.
MT-1	Part of SAE J2360 Specification. Formulated to protect against thermal degradation, wear and oil seal degradation	Non-synchronized manual transmissions, used in buses and trucks

Each automobile manufacturer has a set of unique test requirements for rear axle factory-fill. An API GL-5 lubricant generally satisfies the majority of these requirements and is often recommended for service-fill.

NOTE – SAE J2360 is equivalent to API GL-5 + MT-1

LIMITED SLIP DIFFERENTIALS

In conventional differentials the same torque is applied to both wheels, regardless of traction conditions. Thus, if one wheel is on a surface with low enough traction for the applied torque to exceed the traction, that wheel will break loose and spin until it is revolving at twice the speed of the ring gear and the other wheel has stopped turning. All the power will then be delivered to the spinning wheel and no power will be transmitted to the wheel with traction. Limited slip or torque biasing, and locking type differentials have been developed to overcome this.

Limited slip differentials found on passenger cars all operate on the same principle. Clutches are inserted between the side gears and the case. When the clutches are engaged they lock the side gears to the case and prevent the differential action. Either stacked plate or cone type clutches are used for this purpose.

Torque biasing or locking differentials are used in on-road vehicles and in off-highway equipment. Some locking differentials lock and unlock automatically, while others are arranged so the operator can lock them when full traction is needed at both driving wheels.

PETRO-CANADA DEXRON® LS GEAR OIL 75W-90

Petro-Canada's DEXRON® LS (Limited Slip) Gear Oil 75W-90 is a synthetic extreme pressure automotive axle lubricant formulated for General Motors. DEXRON® LS Gear Oil 75W-90 provides excellent long-lasting wear protection to extend equipment life and reduce downtime and maintenance costs, providing year-round performance. This premium synthetic gear oil is designed with added friction modifiers to perform in limited-slip differentials† and is an API GL-5 quality product that meets GM requirements for 9986290 (or GMW16445).

		DEXRON® LS GEAR OIL 75W-90
Viscosity	**cSt @ 40°C**	83.8
	cSt @ 100°C	14.4
Viscosity Index		179
Brookfield Viscosity,	**cP @ - 40°C**	38,142
Pour Point, °C/°F		<-57/<-71
Flash Point, COC, °C/°F		183 / 361

Petro-Canada Lubricants also offers a non-LS gear oil - DEXRON Gear Oil 75W-90. Please speak to a Petro-Canada Lubricants representative to learn more.

DEXRON® is a registered trademark of General Motors LLC.

†DEXRON® Limited Slip (LS) Gear Oil is primarily for use in axles in cars and trucks with plate type GM LS differentials.

TRAXON™ GEAR OIL

TRAXON™ is Petro-Canada's premium multi-grade line of automotive gear lubricants. TRAXON™ gear oils are specially formulated to provide excellent shear stability and long oil life for outstanding long-lasting protection to help extend equipment life and reduce downtime and maintenance costs.

TRAXON™ gear oils are designed for use in most manual transmissions (excluding synchromesh manual transmissions), differentials, power take-off units and final drives found on passenger cars, trucks, and off-highway vehicles used in construction, agriculture, forestry and mining operations. Consult owner's manual for type and grade needed.

TRAXON™ gear oils meet API GL-5 and MT-1 requirements and are designed to meet or exceed the SAE J2360 global standard.

TRAXON™ gear oils are suitable for most oil-lubricated universal joints, wheel bearings, planetary gear sets, steering gears as well as certain industrial gear reducers requiring GL-3, GL-4, or GL-5 oils.

Due to specific lubrication requirements TRAXON™ gear oils must NOT be used in:

- Automatic Transmissions
- Powershift Transmissions
- Hydrostatic drives and systems that include the lubrication of wet clutches and brakes
- Manual Transaxles on front wheel drive vehicles where an automatic transmission fluid or engine oil is specified
- Spicer Manual Transmissions where single grade engine oils are specified
- Not for use in specific manual transmissions calling for the use of an API GL-4 rated oil only and a GL-5/MT-1 oil is not acceptable

TRAXON™ 80W-90 – HIGH PERFORMANCE PROTECTION

TRAXON™ 80W-90 provides outstanding long-lasting protection for reduced downtime and maintenance costs.

- Outstanding shear stability which ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at higher temperatures
- Resists degradation and sludging for longer oil life with fewer change-outs and better protection of gears
- Meets API GL-5, MT-1 and Meritor O76-D
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E), Mack GO-J, ZF TE-ML lubricant class 05A, 12M, 16B, 17B, 19B, 21A (ZF000764), and MAN 342 Typ M1

TRAXON™ XL SYNTHETIC BLEND 75W-90 – PREMIUM PROTECTION

TRAXON™ XL Synthetic Blend 75W-90 provides the same great long-lasting protection as TRAXON™ 80W-90 plus better low temperature protection and more efficient operating performance which could ultimately lead to lower fuel consumption.

- Shear stability ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at higher temperatures
- Excellent resistance to degradation and sludging for longer oil life with fewer change-outs and better protection of gears
- Excellent protection for cold weather conditions which means better gear protection at low temperatures and easier start-ups and cold weather shifting
- Better torque efficiency vs. GL-5 80W-90s (from 20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Meets API GL-5, MT-1 and Meritor O76-E
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E), Mack GO-J, ZF TE-ML lubricant class 17B (ZF000290) and Scania STO 1:0 (axle and gearbox/MT) specifications

TRAXON™ SYNTHETIC 75W-90 – ULTIMATE ALL SEASON PROTECTION

TRAXON™ Synthetic 75W-90 offers your equipment the same remarkable performance package as TRAXON™ XL Synthetic Blend plus it also provides outstanding protection in extreme cold weather conditions.

- Shear stability ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at higher temperatures
- Protection in extreme cold weather conditions which means easier start-ups and cold weather shifting
- Better torque efficiency vs. GL-5 80W-90s (from 20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Meets API GL-5, MT-1 and Meritor O76-E
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E)
- Suitable for use where Mack GO-J requirements are specified

Typical characteristics are shown below:

			TRAXON™ XL Synthetic Blend	Synthetic
		80W-90	75W-90	75W-90
Viscosity	**cSt @ 40°C**	137	109	96.7
	cSt @ 100°C	14.9	16.5	15.5
Viscosity Index		109	165	171
Flash Point, COC, °C/°F		219/426	183/361	202/396
Pour Point, °C/°F		-36/-33	-48/-54	-48/-54
Brookfield Viscosity, cP @ °C/°F		67,600 @ -26/-15	118,000 @ -40/-40	89,700 @ -40/-40
Phosphorus, % Wt		0.10	0.13	0.13
Sulphur, % Wt		2.32	2.09	2.00

Petro-Canada's TRAXON™ line includes SAE 140 grade oils for situations where tough, high-load, high operating temperatures are encountered and where an SAE 140 GL-5 gear oil is required.

TRAXON™ 85W-140 – HIGH PERFORMANCE PROTECTION

- Outstanding shear stability and anti-wear EP additives protects equipment in tough, high-load, high operating temperature conditions for extended equipment life and reduced maintenance costs
- Excellent resistance to degradation and sludging for long fluid life to reduce maintenance costs and increase uptime
- Meets API GL-5, MT-1 and Meritor O76-A
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E), Mack GO-J, ZF TE-ML lubricant class 05A, 12M, 16D, and 21A (ZF000778), and Scania STO 1:0 (axle) specifications

TRAXON™ XL SYNTHETIC BLEND 80W-140 – PREMIUM PROTECTION

- Excellent shear stability which ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially in tough, high-load, extreme high operating temperature conditions
- Exceptional resistance to degradation and sludging vs. GL-5 85W-140 oils for longer lasting oil life which helps reduce maintenance costs and increases uptime
- Better torque efficiency vs. mineral based GL-5 85W-140 oils (20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Suitable where API GL-5, MT-1, SAE J2360 Global Standard (formerly MIL-PRF-2105E), or Mack GO-J requirements are specified
- Approved against ZF TE-ML lubricant class 05A, 12M, 16D, and 21A (ZF000838)

Typical characteristics are shown below:

		TRAXON™	XL Synthetic Blend
		85W-140	**80W-140**
Viscosity	**cSt @ 40°C**	351	255
	cSt @ 100°C	26.0	25.2
Viscosity Index		98	127
Flash Point, COC, °C/°F		223/433	193/379
Pour Point, °C/°F		-27/-17	-36/-33
Brookfield			
Viscosity, cP @ °C/°F		74,000@ -12/10	105,200@ -26/-15
Phosphorus, % Wt		0.09	0.09
Sulphur, % Wt		2.60	1.84

TRAXON™ E SYNTHETIC

TRAXON™ E Synthetic is Petro-Canada's line of lubricants formulated to meet the "Genuine Roadranger" extended drain and warranty performance requirements set by Eaton Corporation (for transmissions) and Dana CVSD Corporation (for axles). The line consists of three viscosity grades:

TRAXON™ E SYNTHETIC 75W-90 AND 80W-140

- Contain extreme pressure additives and are specially formulated to operate under a variety of load conditions and protect gears and bearings against rust, corrosion and oxidation
- Exceptional resistance to oxidation for long lubricant life which extends drain intervals between change-outs for maximized oil life and less downtime
- High viscosity indices and good low temperature flow properties provide superior protection over a wide range of temperatures for increased productivity
- Possible improved fuel mileage capability provides reduced costs
- Since early 2015, TRAXON E Synthetic 75W-90 has demonstrated up to 1.5%* fuel efficiency benefits over the previous formulation
- Meets API GL-5, API MT-1, SAE J2360 (MIL-PRF-2105E), International TMS 6816 / Navistar MPAPS B-6816 Type I, Meritor O76-N (75W-90), and Meritor O76-B & O80 (80W-140) requirements
- Approved against Mack GO-J Plus (75W-90), Mack GO-J (80W-140) and Dana-CVSD SHAES256 Rev. C (75W-90) and SHAES429 Rev. A

TRAXON™ E SYNTHETIC CD-50

- Provides superior year-round manual transmission fluid performance where a non-EP transmission lubricant is required
- Contains an anti-wear additive, as well as rust, oxidation and corrosion inhibitors to protect vital transmission parts in severe heat, oxidation and shear conditions
- Less transmission friction and drag may help improve fuel economy
- Long lubricant life provides extended drain capabilities for less change-outs and reduced maintenance
- Meets API MT-1, International TMS 6816 / Navistar MPAPS B-6816 Type I, ZF-Freedom Line (ZF-AS Tronic) and Volvo 97305 requirements
- Approved against Mack TO-A Plus and Eaton PS-164 Rev 7

* Fuel Economy (FE) claims are based on improvements noted in both Industry and fleet testing, including SAE J1321, J1376 & J1526, versus previous formulation.

TRAXON™ E SYNTHETIC MTF

- Provides superior year-round manual transmission fluid performance where a non-EP transmission lubricant is required
- Contains an anti-wear additive, as well as rust, oxidation and corrosion inhibitors to protect vital transmission parts in severe heat, oxidation and shear conditions
- TRAXON E Synthetic MTF has demonstrated up to 1.6%** fuel efficiency benefits over TRAXON E Synthetic CD-50 fluid
- Long lubricant life provides extended drain capabilities for less change-outs and reduced maintenance
- Meets API MT-1 and International TMS 6816 / Navistar MPAPS B-6816 Type II requirements
- Approved against Mack TO-A Plus and Eaton PS-386
- Approved for use in Eaton transmissions such as UltraShift Plus, Fuller Advantage Series (FAS), FR and RT Series

Typical characteristics are shown below:

		TRAXON™ E Synthetic			
		75W-90	**80W-140**	**CD-50**	**MTF**
Viscosity,	**cSt @ 40°C**	103	284	132	95.1
	cSt @ 100°C	15.0	30.6	17.5	14.8
Viscosity Index		152	146	146	163
Flash Point, COC, °C/°F		215/419	200/392	221/430	238/460
Pour Point, °C/°F		-51/-60	<-40/<-40	<-45/<-49	-42/-44
Brookfield Viscosity,					
	cP @ -18°C/0°F	5,850	47,175	–	–
	cP @ -26°C/-15°F	–	71,200	–	–
	cP @ -30°C/-22°F	–	–	24,550	–
	cP @ -40°C/-40°F	90,000	–	104,000	51,900

**Fuel Economy (FE) claims are based on improvements noted in both SAE J1321 and fleet testing, versus TRAXON E SYNTHETIC CD-50.

DURATRAN™ - TRACTOR TRANSMISSION-HYDRAULIC FLUID

The DURATRAN™ line of heavy duty transmission-hydraulic fluids is designed for use in farm tractors, mining and construction equipment with a common oil system for transmission, differential, hydraulic, power take-off, wet brake and power-steering mechanisms.

Compared to competitive tractor fluids, DURATRAN™ fluids offer:

- *Outstanding resistance to breakdown caused by oxidation and high temperatures*

  Formulated with our HT Severely Hydrotreated and Severely Hydroisomerized base oils and special oxidation inhibitors, DURATRAN™ fluids strongly resist sludge and varnish build-up, as well as fluid thickening to extend fluid change intervals considerably, past the OEM recommendations.

- *Controlled Frictional Properties*

  DURATRAN™ fluids have excellent shear stability and the correct balance of lubricity and friction for the optimal operation of brakes, clutches and power-take off mechanisms. This helps prevent brake noise and brake chatter.

- *Protection against transmission gear wear*

  DURATRAN™ fluids exceed existing John Deere Extreme Pressure (EP) and Final Drive Gear Wear test requirements and perform well in the demanding Vickers Hydraulic Pump wear test. These features provide excellent wear protection to bearings and gears under demanding, shock-loaded operating conditions.

- *Exceptional Low Temperature Performance*

  Formulated with our HT Severely Hydrotreated and Severely Hydroisomerized base oils, DURATRAN™ fluids demonstrate exceptional low temperature fluidity, which allows easier cold weather start-up of all equipment, even at very low temperatures. DURATRAN™ XL Synthetic Blend and DURATRAN™ Synthetic may be used at temperatures down to -40°C.

Typical characteristics are shown below:

		DURATRAN™	DURATRAN™ XL Synthetic Blend	DURATRAN™ Synthetic
Viscosity	**cSt @ 40°C**	60.1	39.2	46.8
	cSt @ 100°C	9.5	8.3	10.0
	SUS@ 100°F	307	198	235
	SUS@ 210°F	57.9	53.6	59.6
Viscosity Index		140	195	208
Brookfield Viscosity,	**cP @ - 20°C**	2,670	1,300	1,260
	cP @ - 35°C	23,700	–	–
	cP @ - 40°C	61,200	13,500	15,740
Pour Point, °C/°F		-45/-49	-50/-58	-47/-53
Flash Point, COC, °C/°F		239/462	219/426	225/437
Base Number (D2896), mg KOH/g		10.6	10.4	10.0

DURATRAN™ fluids are recommended, where the following specifications are called for:

- **Farm Tractors**

John Deere	DURATRAN™	J20C
.....	DURATRAN™ XL Synthetic Blend	J20D
.....	DURATRAN™ Synthetic	J20C, J20D
CNH (Case I.H., J.I. Case New Holland Group)	DURATRAN™ - MAT3540, MS-1209/MAT 3505, MS-1210/JIC-145/MAT 3506, MS-1230/ CNH MAT 3509, ESN-M2C134-D/MAT 3525, MS-1207, MS-1206, MS-1205, MS-1204/ JIC-185, B-6, B-5, JIC-144, JIC-143, FNHA-2-C-201.00, ESN-M2C134-A/B/C, ESN-M2C86-B/C, ESN-M2C53-A, ESN-M2C48-B	
.....	DURATRAN™ XL Synthetic Blend - MS-1209/ MAT 3505, MS-1210/JIC-145/MAT 3506, MS-1230/CNH MAT 3509, ESN-M2C134-D/MAT 3525, MS-1207, MS-1206, MS-1205, MS-1204/ JIC-185, B-6, B-5, JIC-144, JIC-143, FNHA-2-C-200.00, ESN-M2C134-A/B/C, ESN-M2C86-B/C, ESN-M2C53-A, ESN-M2C48-B	
.....	DURATRAN™ Synthetic - MS-1209/MAT 3505, MS-1210/JIC145/MAT 3506, MS-1230/ CNH MAT 3509, ESN-M2C134-D/MAT 3525 MS-1207, MS-1206, MS-1205, MS-1204/ JIC-185, B-6, B-5, JIC-144, JIC-143, FNHA-2-C-201.00, FNHA-2-C-201.00A (134-D), FNHA-2-C-200.00, ESN-M2C134-A/B/C, ESN-M2C86-B/C ESN-M2C53-A, ESNM2C48-B	
White Farm (Oliver)	Q-1826, Hydraulic Transmission Fluid (HTF), Q-1802, Q-1766B, Q-1722, Q-1705	
Massey-Ferguson	M-1145* (DURATRAN™, DURATRAN™ Synthetic), M-1141, M-1135, M-1143, M-1129-A, M-1127-A/B, M-1110	

(*Note: For UTTO applications only. Do not use in STOU applications.)

AGCO / Deutz-Allis / Allis. Power Fluid 821XL, 272843, 257541, 246634

Kubota UDT, Kubota UDT^2 (DURATRAN XL Synthetic Blend only); Steiger (SEMS 17001); Versatile (ESN-M2C134-D); Landini (Tractor II Hydraulic Fluid); Hesston-Fiat (Oliofiat Tutela Multi-F); Volvo WB101 (DURATRAN™, DURATRAN™ Synthetic only)

ZF Transmissions: DURATRAN™ TE-ML 03, 03E, 05F, 6K, 06K, 21F (axles)
DURATRAN™ XL Synthetic Blend TE-ML 03E, 05F, 21F (axles)
DURATRAN™ Synthetic TE-ML 03E, 05F, 21F (axles)

- **Transmissions and Differentials**
  API GL-4 (Manual Transmissions, Spiral Bevel Axles, and Hypoid gears in moderate service)
  Allison Type C-4 and C-3 Fluids
  Caterpillar TO-2
  Sundstrand Hydrostatic Transmission Fluid
  Dresser Construction Equipment Division - Transmission/Hydraulic Fluid
  Clark Lift Truck Transmission Fluid TA12, TA18, HR 500 (DURATRAN™ XL, DURATRAN™ Synthetic), HR 600 (DURATRAN™)
- **Hydraulic Pumps**
  Parker / Abex / Denison: HF 0/1/2
  Eaton / Vickers: M-2950-S, 1-286-S
  Plessey-Sundstrand

PRODURO™ TO-4+ – TRANSMISSION/DRIVE TRAIN OIL

PRODURO™ TO-4+ products are a line of Transmission and Drive Train Oils (TDTO) formulated to meet or exceed Caterpillar's TO-4 requirements for transmission and drive line fluids.

PRODURO™ TO-4+ oils are available in six grades: SAE 10W, 30, 50, 60, XL Synthetic Blend LoTemp and Synthetic All Season. The last two products are formulated with special base oils which confer multigrade pumpability equivalent to SAE 0W-20 and SAE 5W-30 respectively. They have been fully tested and comply with the performance requirements of Caterpillar TO-4 and Allison C-4. They are recommended for use in hydraulics, manual transmissions and drive lines, where a TO-4 oil is recommended, or to replace TO-2 oils.

Typical characteristics are shown below:

	PRODURO™ TO-4+					
SAE Grade	**10W**	**30**	**50**	**60**	**XL Synthetic Blend LoTemp**	**Synthetic All Season**
Viscosity						
cSt @ 40°C	35.4	88.5	210	372	35.1	55.8
cSt @ 100°C	6.3	11.0	18.4	27.0	7.4	10.7
Viscosity Index	128	110	97	97	184	187
HT/HS @ 150°C	2.4	3.5	5.0	7.0	2.7	3.7
Flash Point, COC, °C/°F	239/462	259/498	253/487	253/487	209/408	222/432
Pour Point, °C/°F	-33/-27	-27/-17	-27/-17	-21/-6	-51/-60	-48/-54
Cold Crank Viscosity, cP @ °C/°F	5,219@ -25/-13	10,433@ -20/-4	11,167@ -10/14	15,854@ -5/23	4,403@ -35/-31	6,530@ -30/-22
Brookfield Viscosity, cP @ °C/°F	42,900@ -35/-31	26,620@-25/-13	63,400@ -15/5	106,000@ -10/14	10,140@ -40/-40	14,720@ -35/-31
Performance Level	Caterpillar TO-4 (June 05) Allison C-4 API CD API GL-3 ZF TE-ML 03C	Caterpillar TO-4 (June 05) Allison C-4 API CD API GL-3 ZF TE-ML 03C and 07F	Caterpillar TO-4 (June 05) – API CD API GL-3 –	Caterpillar TO-4 (June 05) – API CD API GL-3 –	Caterpillar TO-4 (June 05) Allison C-4 API CD – –	Caterpillar TO-4 (June 05) Allison C-4 API CD API GL-3 ZF TE-ML 03C

Generic Operating Temperature Range Based on Viscometrics (TO-4)

Application	SAE Grade		
Hydrostatic Transmissions	10W	-20˚C to +40˚C	(-4˚F to +104˚F)
	XL Synthetic Blend Lo Temp	-40˚C to +40˚C	(-40˚F to +104˚F)
	Synthetic All Season	-35˚C to +45˚C	(-31˚F to +113˚F)
Hydraulic	10W	-25˚C to +50˚C	(-13˚F to +122˚F)
	30	-15˚C to +50˚C	(+5˚F to +122˚F)
	XL Synthetic Blend Lo Temp	-40˚C to +40˚C	(-40˚F to +104˚F)
	Synthetic All Season	-35˚C to +50˚C	(-31˚F to +122˚F)
Powershift Transmissions	10W	-21˚C to +10˚C	(-5˚F to +50˚F)
	30	-9˚C to +35˚C	(+16˚F to +95˚F)
	50	+5˚C to +50˚C	(+41˚F to +122˚F)
	XL Synthetic Blend Lo Temp	-40˚C to +10˚C	(-40˚F to +50˚F)
	Synthetic All Season	-35˚C to +30˚C	(-31˚F to +86˚F)
Final Drives On-Highway	10W	-30˚C to 0˚C	(-22˚F to +32˚F)
	30	-25˚C to +25˚C	(-13˚F to +77˚F)
	50	-17˚C to +52˚C	(+2˚F to +126˚F)
	60	-9˚C to +55˚C	(+16˚F to +131˚F)
	XL Synthetic Blend Lo Temp	-45˚C to 0˚C	(-49˚F to +32˚F)
	Synthetic All Season	-37˚C to +25˚C	(-34˚F to +77˚F)
Final Drives Off-Highway	10W	-30˚C to -10˚C	(-22˚F to +14˚F)
	30	-25˚C to +15˚C	(-13˚F to +60˚F)
	50	-17˚C to +34˚C	(+2˚F to +93˚F)
	60	-9˚C to +52˚C	(+16˚F to +126˚F)
	XL Synthetic Blend Lo Temp	-45˚C to 0˚C	(-49˚F to +32˚F)
	Synthetic All Season	-37˚C to +15˚C	(-34˚F to +60˚F)

From time to time, Caterpillar publishes revisions to lubricant recommendations for their various equipment. Users are encouraged to visit the CAT website to download the most recent version of these recommendations, document SEBU 6250.

PRODURO™ FD-1 60 – FINAL DRIVE AND AXLE LUBRICANT FOR CATERPILLAR EQUIPMENT

PRODURO™ FD-1 60 is Petro-Canada's primary recommendation for the final drives and axles of Caterpillar off-highway equipment, especially those that operate under severe conditions. PRODURO™ FD-1 60 provides improved gear and bearing life in final drives and axles and can be used in final drives and axles that previously specified TO-4 lubricants and do not contain friction material and/or wet brakes. **PRODURO™ FD-1 60 should not be used in compartments containing friction material unless an FD-1 type of product is specified. This product is not for use in engines, transmission hydraulic systems, or older Caterpillar (789 series of haul trucks) final drive technology, under extreme loading.**

Typical characteristics are shown below:

		PRODURO™ FD-1 60
SAE Grade		60
Viscosity	**cSt @ 40°C**	349
	cSt @ 100°C	26.1
Viscosity Index		99
Flash Point, COC, °C/°F		297/567
Pour Point, °C/°F		-21/-6
Brookfield Viscosity, cP @ °C/°F		73,200@-10/14
Borderline Pumping Viscosity, cP @ °C/°F		6,825 (calculated) @+10/+50
Borderline Pumping Viscosity, cP @ °C/°F		86,850 @ -15/+5
Performance Level		Caterpillar FD-1 (Dec 01)

PRODURO™ FD-1 SYNTHETIC - FINAL DRIVE AND AXLE LUBRICANT FOR CATERPILLAR EQUIPMENT

PRODURO™ FD-1 Synthetic is a Caterpillar FD-1 type lubricant that provides improved gear and bearing life in final drives and axles. Oils meeting the FD-1 specification are preferred by Caterpillar in final drives and axles that do not contain friction material and that historically specified TO-4 oils. **PRODURO™ FD-1 Synthetic should not be used in compartments containing friction material unless an FD-1 type of product is specified.**

Typical characteristics are shown below:

		PRODURO™ FD-1 SYNTHETIC
SAE Grade		Multigrade
Viscosity	**cSt @ 40°C**	287
	cSt @ 100°C	31.8
Viscosity Index		152
Flash Point, COC, °C/°F		243/469
Pour Point, °C/°F		-39/-38
Brookfield Viscosity, cP @ °C/°F		126,000@-30/-22
Brookfield Viscosity, cP @ °C/°F		29,900@-20/-4
Borderline Pumping Viscosity, cP @ °C/°F		119,740@-30/-22
Performance Level		Caterpillar FDAO Synthetic

TWO-CYCLE ENGINE OIL

Petro-Canada's small engine oils are designed to give excellent performance in both air-cooled and water-cooled two-stroke cycle engines operating under all conditions. This oil is especially formulated for use in oil injection as well as conventional pre-mixed gasoline/oil lubricated 2-cycle engines.

Petro-Canada small engine oils contain high performance additives, which give excellent anti-scuff and anti-wear performance to ensure reliability, internal cleanliness and long engine life. The additive system used produces minimal spark plug, ring, piston and valve deposits and so allows good starting and continued efficient engine operation.

Petro-Canada small engine oils also contain special rust inhibitors with a high film strength, which protect engines against rust during use and in storage.

Basic manufacturers' recommendations should be followed so as to obtain maximum protection during prolonged storage. Care should be taken not to mix 2-cycle oils from different manufacturers.

SUPREME SYNTHETIC BLEND 2-STROKE SMALL ENGINE OIL

Petro-Canada SUPREME Synthetic Blend 2-Stroke Small Engine Oil is a premium synthetic blend low ash, two-stroke cycle engine oil for use in many conventional pre-mix fuel/oil, as well as oil injection lubricated engines.

Petro-Canada SUPREME Synthetic Blend 2-Stroke Small Engine Oil is certified against JASO FC and meets the requirements of ISO L-EGC and API TC.

It is designed to lubricate air-cooled, two-stroke cycle engines in Motorcycles, Mopeds, Snowmobiles, Chain Saws, Generators, Lawn Mowers, Weed Trimmers and other landscaping equipment. It is suitable for use in oil injection and premixed lubricated engines **at gasoline/oil ratios up to 100:1.**

It is recommended for use in 2-stroke snowmobiles including those manufactured by (and more): Bombardier, Arctic Cat, Polaris and Yamaha.

It is recommended for use in 2-stroke Lawn Maintenance/ Forestry Equipment including those manufactured by (and more):

- Hitachi
- John Deere
- Kawasaki
- Lawn Boy
- Massey Ferguson
- Polaris
- Powermate (formerly Honda Coleman)
- Tecumseh
- Weedeater
- Woods
- Yamaha
- Yardman

It is recommended for use in 2-stroke Small CC Motorcycles and Scooters including those manufactured by (and more):

- Yamaha
- TVS
- Bombardier (BRP)
- Honda
- Kawasaki

SUPREME Synthetic Blend 2-Stroke Small Engine Oil has the following features:

- Controls deposit formation, ring-sticking and prevents exhaust-port plugging
- Superior anti-wear and anti-scuff protection
- Minimizes spark plug fouling and engine preignition
- Provides excellent protection against rust and corrosion
- Mixes easily with gasoline and pumps readily down to -40 °C/°F
- Formulated for oil injection as well as premixed gasoline/oil lubricated engines
- Keeps smoke emissions low when used at recommended gasoline/oil ratios
- Dyed blue-green for easy detection of gasoline/oil mixtures

SUPREME Synthetic Blend 2-Stroke Small Engine Oil is suitable for use against API Classification TC, TISI, ISO-L-EGC, JASO FA, FB or FC and SAE Fluidity/ Miscibility (F/M) Grade 4.

OUTBOARD MOTOR OIL

Outboard Motor Oil is a premium two-stroke engine oil for use in water-cooled outboard motors (both large and small power outputs), used at all fuel to oil ratios specified by the Original Equipment Manufacturers (OEMs). It is also suitable for motorcycle and snowmobile engines, where the manufacturer calls for a NMMA TC-W3 certified oil. Outboard Motor Oil is especially formulated for oil injected engines. It also meets the SAE Fluidity/Miscibility (F/M) Grade 3.

Outboard Motor Oil has been certified by the National Marine Manufacturers Association (NMMA) against their TC-W3 (RL 00440K) specification. Its formulation also meets the warranty requirements of the following engine manufacturers: Mercury Marine, Bombardier (Formerly OMC which makes Johnson & Evinrude engines), Yamaha, Suzuki, Nissan, etc. Outboard Motor Oil has the following features:

– Ashless formula minimizes pre-ignition.
– Resists rust and corrosion.
– Contains a quick-mix additive.
– Reduces engine wear and varnish build-up.
– Suitable for oil injection (to -25°C/-13°F) as well as pre-mixed fuel/oil lubricated engines.
– Reduced smoke emissions.
– Virtually non-toxic to water inhabiting species such as fish.

Typical characteristics of Petro-Canada Two Cycle Engine Oils are shown below:

		Outboard Motor Oil	SUPREME SB 2-stroke Motor Oil
Viscosity	**cSt @ 40°C**	56	35.3
	cSt @ 100°C	8.8	6.9
Viscosity Index		136	158
Flash Point, COC, °C/°F		134/273	149/300
Pour Point, °C/°F		-48/-54	-48/-54
Brookfield Viscosity, cP @ °C		5,910@ -25	12800@ -40
Sulphated Ash, % Wt		<0.001	0.1
Colour		Blue/Green	Blue/Green
Suitable Performance Level			
	API	–	TC and TISI
	NMMA	TC-W3	–
	SAE F/M	Grade 3	Grade 4
	JASO		FA, FB and FC
	ISO-L		EGC

QUICK MIX CHART

Ratio	Millilitres (mL) / US Gallons (gal) Oil Added to Litres (L) / US Gallons (gal) of Gasoline		
Gasoline to Oil	**5 L / 1.32 gal**	**10 L / 2.64 gal**	**25 L / 6.60 gal**
16:1	315 / 0.0832	625 / 0.1651	1550 / 0.4095
24:1	210 / 0.0555	420 / 0.1110	1050 / 0.2774
32:1	165 / 0.0436	315 / 0.0832	800 / 0.2113
50:1	100 / 0.0264	200 / 0.0528	500 / 0.1321
100:1	50 / 0.0132	100 / 0.0264	250 / 0.0660


MAXIMUM PERFORMANCE
PERFORMANCE MAXIMALE
TM/MC

INDUSTRIAL LUBRICANTS

Businesses today place heavy demands on industrial plants and machinery. We expect equipment to operate at temperatures between -50°C and 150°C (-58°F and 302°F) without losing production or increasing maintenance costs. Notwithstanding these extremes of temperature, machines today are operated under heavier loads, run at higher speeds, with smaller oil reservoirs and at longer lubricating intervals than ever before.

Proper lubrication is vital to any operation and is determined by the “Five Rights”:

- Right Type of Lubricant
- Right Quality
- Right Amount
- Right Place
- Right Time / Frequency

Your Original Equipment Manufacturer (OEM) together with a Petro-Canada Lubricants Representative or a Technical Services Advisor can assist you in determining the “Five Rights” for your equipment or machinery.

VISCOSITY CLASSIFICATION OF INDUSTRIAL OILS

It was common practice in North America to define the viscosity of industrial lubricating oils in Saybolt Universal Seconds (SUS) at reference temperatures of 100°F and 210°F. However, there is now a growing world-wide acceptance of the International Organization for Standardization's (ISO) system for viscosity measurement in centistokes (cSt) at 40°C and 100°C.

ADVANTAGES OF ISO VISCOSITY GRADES

- International acceptance benefits customers, manufacturers and marketers.
- The lubricant grade recommended by the equipment manufacturer is often the same as the number in the product name.
- Conversion from one viscosity measurement to another is virtually eliminated.
- The number in the product name for most products represents the viscosity of an industrial oil.

Automotive engine and gear oils are not classified using the ISO measurement system. They continue to be described by the Society of Automotive Engineers (SAE) viscosity classifications (see Automotive Lubricants Section).

The table below shows the kinematic viscosity limits for each ISO Viscosity Grade. Each viscosity grade is 50% higher in viscosity than the preceding viscosity grade. These limits are set at a 10 percent tolerance level above and below the mid-point of a grade. Any product with a viscosity outside these tolerance levels is not a recognized ISO Viscosity Grade.

Viscosity System for Industrial Fluid Lubricants[A] – ASTM D2422 – 97 (2013)

Viscosity System Grade Identification	Mid-Point Viscosity, cSt (mm^2/s) at 40.0°C	Kinematic Viscosity Limits, cSt (mm^2/s) at 40.0°C [B,C]	
		min	max
ISO VG 2	2.2	1.98	2.42
ISO VG 3	3.2	2.88	3.52
ISO VG 5	4.6	4.14	5.06
ISO VG 7	6.8	6.12	7.48
ISO VG 10	10	9.00	11.0
ISO VG 15	15	13.5	16.5
ISO VG 22	22	19.8	24.2
ISO VG 32	32	28.8	35.2
ISO VG 46	46	41.4	50.6
ISO VG 68	68	61.2	74.8
ISO VG 100	100	90.0	110
ISO VG 150	150	135	165
ISO VG 220	220	198	242
ISO VG 320	320	288	352
ISO VG 460	460	414	506
ISO VG 680	680	612	748
ISO VG 1000	1000	900	1100
ISO VG 1500	1500	1350	1650
ISO VG 2200	2200	1980	2420
ISO VG 3200	3200	2880	3520

[A] This system implies no evaluation of quality.

[B] This system is used in ISO 3448.

[C] If 40°C is not the temperature used when determining the viscosity (as is sometimes the case with very viscous fluids) then the related viscosity at 40°C shall be established by using Viscosity Temperature charts found in ASTM D341.

AGMA NUMBERS

The American Gear Manufacturers Association (AGMA) has a numbering system to define gear oil viscosity required for various gear lubrication applications. These AGMA Lubricant Numbers are sometimes stamped on the manufacturer's metal name plate. ISO Viscosity Grade numbers and AGMA Numbers are compared in the table below.

AMERICAN NATIONAL STANDARD ANSI/AGMA 9005-E02

Viscosity grade requirements

ISO viscosity grade	Mid-point viscosity at 40°C mm²/s[1]	Kinematic viscosity limits at 40°C mm²/s[1]		Former AGMA grade equivalent[2]
		min	max	
ISO VG 32	32	28.8	35.2	0
ISO VG 46	46	41.4	50.6	1
ISO VG 68	68	61.2	74.8	2
ISO VG 100	100	90.0	110	3
ISO VG 150	150	135	165	4
ISO VG 220	220	198	242	5
ISO VG 320	320	288	352	6
ISO VG 460	460	414	506	7
ISO VG 680	680	612	748	8
ISO VG 1000	1000	900	1100	8A
ISO VG 1500	1500	1350	1650	9
ISO VG 2200	2200	1980	2420	10
ISO VG 3200	3200	2880	3520	11

NOTES:

[1] The preferred unit for kinematic viscosity is mm²/s, commonly referred to as centistoke (cSt).

[2] With the change from AGMA viscosity grade equivalents to ISO viscosity grade classifications, the designations S, EP, R and COMP will no longer be used as part of the viscosity grade nomenclature.

- S, EP, R and COMP categories from the former AGMA standard will align with the Former AGMA grade equivalent column above.
- TURBOFLO™ R&O can be used where former AGMA Rust & Oxidation Inhibited Gear Oils are required.
- ENDURATEX™ EP, ENDURATEX™ XL Synthetic Blend and ENDURATEX™ Synthetic EP oils can be used where former AGMA anti-scuff/anti-wear Extreme Pressure (EP) Gear Lubricants are required.
- ENDURATEX™ Mild Worm Gear Oils, which contain special lubricity additives, can be used where former AGMA Compounded (COMP) Gear oils are required.
- Automotive gear oils, such as TRAXON™, are defined by the SAE for viscosity and the API for quality. These oils can be used in gear boxes but industrial gear oils formulated to meet former AGMA requirements cannot be used in automotive differentials or transmissions.
- SYNDURO™ SHB is suitable for many gear oil applications such as worm gears and helical gear boxes and has an excellent FZG Failure Load Stage of 12+. For those applications that are subjected to heavy loads or shock loading and require a former AGMA EP type of fluid, ENDURATEX™ Synthetic EP is recommended.

VISCOSITY COMPARISONS

Viscosities designated by various organizations may be compared as shown in the table opposite. This is strictly a viscosity comparison and should not be construed as a quality level comparison.

ISO VG – Viscosity measurement in centistokes (cSt) at 40°C.

AGMA – Viscosity grades as formerly designated by the American Gear Manufacturers Association.

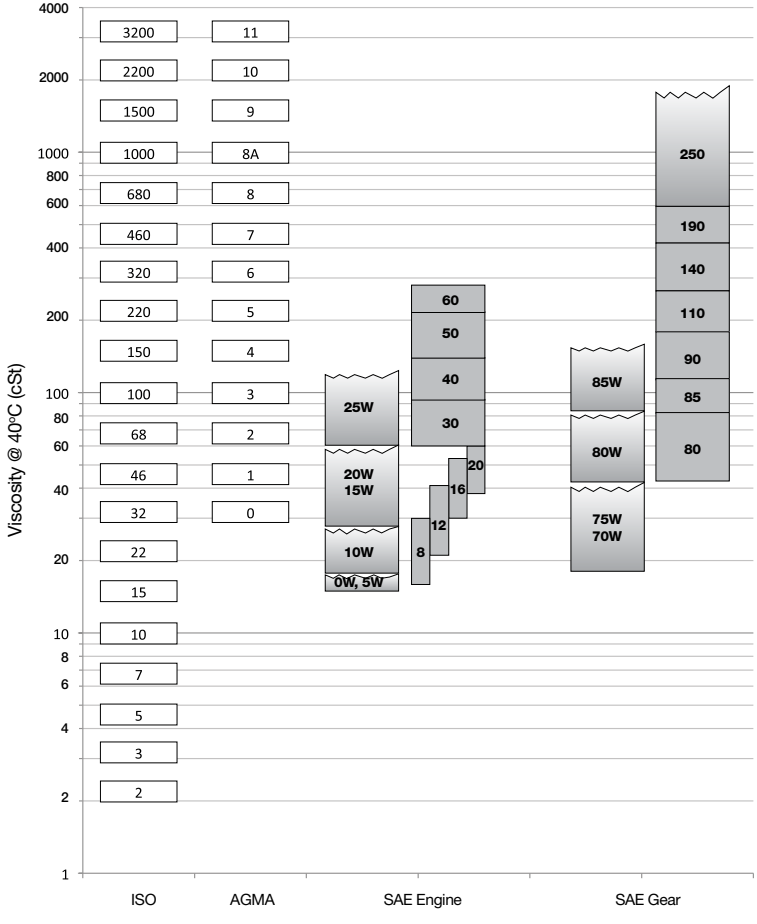
SAE – Society of Automotive Engineers viscosity measurement for automotive engine and gear oils e.g. SAE 30, SAE 90, etc.

How to use the chart:

For instance, if a manufacturer requires an SAE 20 oil for a piece of equipment, go to the SAE viscosity column and follow across horizontally to the left to read an ISO VG of 46.

VISCOSITY EQUIVALENTS

Comparison of ISO/AGMA/SAE Viscosities at 40°C



NOTE:

- Read horizontally.
- Equivalence is in terms of viscosity at 40°C only.
- Viscosities of SAE engine oils based on a VI of 150, an estimated average of current PCMO and HDEO products.
- Viscosities of SAE gear oils based on a VI of 130, an estimated average of current Automotive Gear products.
- Viscosity limits are approximate: for precise data, consult ISO, AGMA and SAE specifications.
- SAE W grades are represented only in terms of approximate 40°C viscosity. For low temperature limits, consult SAE specifications.

INDUSTRIAL LUBRICANTS

ACCUFLO™ TK - MACHINE TOOL LUBRICANT

ACCUFLO™ TK Oils are specially formulated to lubricate the slideways of machine tools and maintain smooth, uninterrupted operation. They may be applied to linear and rotating guideways, table elevating slideways on milling machines, lead-screw-and-nut systems, feed gears, milling heads and lathe saddles.

ACCUFLO™ TK Oils eliminate “stick-slip” or chatter on machine tables and contain inhibitors to protect ferrous and copper components against corrosion. Their unique zinc-free formulations provide excellent film strength, lubrication and machine table accuracy. They are highly tacky to resist removal by synthetic coolants and soluble oils. This cuts the consumption of lubricant and the generation of tramp oil which, in turn, improves coolant management.

ACCUFLO™ TK 68 is recommended for horizontal slides and moderately loaded machine tools, while ACCUFLO™ TK 220 is recommended for vertical slides or heavy duty machine tools such as planers and boring mills.

ACCUFLO™ TK 68 and 220 are GM LS2 approved, meet ISO-L-G standards, and are approved against Fives (formerly Cincinnati Machine) specifications P-47 and P-50 respectively. ACCUFLO™ TK 68 is approved for use in Bijur systems and passes Bijur’s filtration test #2107.

Typical characteristics are shown below:

		ACCUFLO™ TK	
		68	**220**
Viscosity	**cSt @ 40°C**	71	217
	cSt @ 100°C	9.9	21
Viscosity Index		122	118
Flash Point, COC, °C/°F		225/437	255/491
Pour Point, °C/°F		-33/-27	-24/-11
Stick-slip No.		0.76	0.78
Weld Point, kg / lb		200/441	250/551

ACCUFLO™ SS - PRESS OIL AND MACHINE TOOL LUBRICANT

ACCUFLO™ SS is specifically formulated to meet the lubrication requirements of both Goss International and MAN Roland printing presses.

- Meets the requirements of Goss Graphic Systems Service Bulletin "SBM 5078 Lubricating Oil Guidelines" (16/02/00) for Cosmo, Metro, Metroliner, Headliner, Colorliner and Metrocolour models.
- Meets specification standard CLP DIN 51517-3:2004-01 ISO VG 68 (MAN Roland Illustration Machines, Geoman and Colorman models).

ACCUFLO™ SS 68 is recommended for use in commercial printing machines for the lubrication of units, folders, angle bars and horizontal drive gear boxes. It can also be used to lubricate the linear and rotating guideways, and elevating slideways of machine tools. It is approved against Fives (formerly Cincinnati Machine) P-47 specification.

Due to the blend of additives used, this product is very dark in colour (>8.0 on the ASTM Colour Test) thus making it easier to see in operation.

Typical characteristics are shown below:

		ACCUFLO™ SS 68
Viscosity	**cSt @ 40°C**	74.3
	cSt @ 100°C	9.5
Viscosity Index		104
Flash Point, COC, °C/°F		229/444
Pour Point, °C/°F		-33/-27
Stick-slip No.		0.78
Weld Point, kg / lb		200/441

PC WAYLUBE - MACHINE TOOL LUBRICANT

PC WAYLUBE is formulated for the lubrication of the slideways of modern machine tools. It is approved against Fives (formerly Cincinnati Machine) P-47 specification and GM LS2. PC WAYLUBE is also approved for Bijur systems and passes Bijur's filtration test #2107.

Where greater oil adhesion is required, such as with vertical ways, we recommend Petro-Canada's ACCUFLO™ TK machine tool lubricants.

This product is formulated with an additive package that makes it very dark in colour (7.0 on the ASTM Colour Scale) which makes it easier to see in operation.

Typical characteristics are shown below:

		PC WAYLUBE 68
Viscosity	**cSt @ 40°C**	69.7
	cSt @ 100°C	9.5
Viscosity Index		115
Flash Point, COC, °C/°F		235/455
Pour Point, °C/°F		-27/-17
Stick-slip No.		0.76
Weld Point, kg / lb		200/441

ARDEE™ - ROCK DRILL OIL

ARDEE™ oils are formulated to lubricate and cool the mechanisms of air-operated rock drills. They are ideal for use in equipment running in demanding situations with high air-flow rates, drill shock-loading and high piston temperatures. There are six viscosity grades to meet temperatures ranging from -35°C / -31°F to 45°C / 113°F. ARDEE™ 32 is recommended for low temperatures and/or winter conditions. ARDEE™ 68 to 150 are recommended for underground operations, with the 150 grade being favoured in SECAN drills and in mining operations targeting reduction of oil consumption and misting. ARDEE™ 220 is recommended for use in open pit operations using drills with a bore larger than 10 cm / 4 inches during the summer or under warmer conditions.

ARDEE™ 32 is recommended for use in plant air-line lubricators, especially where the air is water laden.

Typical characteristics are shown below:

		ARDEE™ Oil					
		32	46	68	100	150	220
Viscosity	**cSt @ 40°C**	31.9	45.0	71.7	96.4	149	207
	cSt @ 100°C	6.0	7.4	9.9	11.5	15.0	19.0
Viscosity Index		137	129	119	107	101	103
Flash Point, COC, °C/°F		180/356	207/405	231/448	233/451	243/469	281/538
Pour Point, °C/°F		-48/-54	-42/-44	-42/-44	-33/-27	-30/-22	-24/-11
Timken OK Load, lb / kg		20/9	30/14	30/14	30/14	30/14	30/14
Weld Point, kg / lb		200/441	200/441	200/441	200/441	250/551	250/551

CALFLO™, PETRO-THERM™ AND PURITY™ FG – HEAT TRANSFER FLUIDS

CALFLO™ is a line of specialty heat transfer fluids produced from Petro-Canada's 99.9% pure base oils and proprietary additive technology. CALFLO™ Synthetic is based on PAO chemistry and specially selected additives. These fluids provide high temperature performance without raising the same adverse environmental or health and safety concerns caused by chemical aromatic fluids. The CALFLO™ family of advanced fluids is recommended for use in non-pressurized, liquid phase, closed heat transfer systems. For use in open systems, please contact a Petro-Canada representative. There are several formulations to meet a wide range of applications:

- CALFLO™ HTF is a premium high temperature heat transfer fluid recommended for systems operating with bulk temperatures up to 326°C/619°F. Typical applications include power generation, metal processing and chemical manufacturing.
- CALFLO™ AF is a highly efficient heat transfer fluid recommended for systems requiring a greater resistance to oxidation, operating with bulk temperatures up to 316°C/600°F. Typical applications include plastic extrusion, injection moulding and rubber manufacturing operations.
- CALFLO™ LT is a synthetic blend heat transfer fluid suitable over a wide temperature range from 5°C/40°F to 288°C/550°F. Excellent low temperature pumpability allows cold start-up in ambient temperatures as low as -40°C/-40°F.
- CALFLO™ Synthetic is a synthetic heat transfer fluid that delivers outstanding protection and is formulated virtually free of impurities and aromatic compounds that can be hazardous to workplace health and safety. CALFLO™ Synthetic's breakthrough chemistry balances low temperature fluidity at extreme conditions down to -48°C/-54°F with outstanding oxidative stability and volatility control. CALFLO™ Synthetic can also be used as a mechanical seal barrier fluid in process pumps.
- PURITY™ FG Heat Transfer Fluid, formerly CALFLO™ FG, is a food grade HT-1 registered heat transfer fluid for the food processing industry with systems operating at bulk temperatures up to 326°C/619°F. More details on this fluid may be found on **page 183**.
- PETRO-THERM™ Heat Transfer Fluid is a general purpose fluid which provides economical service in various industrial processes. More details on this fluid may be found on **page 132**.

In addition to heat transfer fluids, Petro-Canada offers two additional products for servicing heat transfer systems: Petro-Canada Cleaning Fluid and Petro-Canada Flushing Fluid. Details regarding the use of these fluids may be found on **page 129 and page 130**.

Typical characteristics are shown below:

		CALFLO™ Heat Transfer Fluid				PURITY™ FG
		HTF	AF	LT	Synthetic	HTF
Viscosity	**cSt @ 40°C**	35.2	32.3	7.5	5.3	37.1
	cSt @ 100°C	5.7	5.4	2.2	1.8	5.9
Viscosity Index		100	99	103	N/A	98
Flash Point, COC, °C/°F		231/448	217/423	176/349	163/325	237/459
Pour Point, °C/°F		-18/0	-39/-38	<-57/<-71	<-51/<-60	-18/0
Autoignition Temp, °C/°F		350/662	343/649	323/613	320/608	354/669
Max Bulk Temp °C/°F		326/619	316/600	288/550	N/A	326/619

COMPRO™ - AIR COMPRESSOR FLUIDS

COMPRO™ Compressor Fluids are ashless air compressor fluids formulated to provide long and highly reliable service life in industrial air compressor applications. COMPRO™ Compressor Fluids are available in 32 and 68 viscosity grades (for additional grades see COMPRO XL-S). They are suitable for use in compressors that handle air, and inert gases such as nitrogen, argon, hydrogen, neon, helium, carbon dioxide, carbon monoxide and blast furnace gas.

COMPRO™ Compressor Fluids can be used in rotary screw compressors to a maximum of 2,000 hours at air discharge temperatures up to 85°C/185°F, in centrifugal compressors for up to two years at air discharge temperatures up to 50°C/122°F, and in reciprocating compressors for shorter duration. COMPRO™ 68 meets the requirements of DIN 51506 VDL.

Air compressors in continuous service or operating at elevated discharge temperatures should use COMPRO™ XL-S, COMPRO™ Synthetic or SYNDURO™ SHB 32 or 46 Fluids for extended life.

		COMPRO™ Compressor Fluid	
		32	**68**
Viscosity	**cSt @40°C**	36	68
	cSt @ 100°C	5.7	8.7
Viscosity Index		96	99
Flash Point, COC, °C/°F		215/419	238/460
Pour Point, °C/°F		-39/-38	-30/-22

NOTE 1: Do not use in breathing air apparatus or medical equipment. COMPRO™ air compressor fluids should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, *no petroleum lubricant* is recommended.**

NOTE 2: Consult our Tech Bulletin “TB-1217 - Guidelines for Converting to COMPRO™ Compressor Fluids” before changing over to any of our COMPRO™ fluids.

COMPRO™ XL-S - AIR COMPRESSOR FLUIDS

COMPRO™ XL-S Compressor Fluids are formulated to extend compressor fluid life in rotary screw air compressors, with minimal carbon deposits or varnish formation.

COMPRO™ XL-S is particularly recommended for air compressors in continuous service operating at discharge air temperatures up to 85°C/185°F. Such rotary screw compressors may be run for up to one year (8,000 hours) in continuous operation. This is at least four times the life of conventional mineral oil based compressor fluids.

While particularly effective in rotary screw compressors, COMPRO™ XL-S can also be used in centrifugal compressors for up to three years at air discharge temperatures up to 50°C/122°F. COMPRO™ XL-S 68, 100 and 150 meet the requirements of DIN 51506 VDL, and can be used in reciprocating compressors for shorter duration.

Typical characteristics are shown below:

		COMPRO™ XL-S				
		32	**46**	**68**	**100**	**150**
Viscosity	**cSt @ 40°C**	37	47	66	93	147
	cSt @ 100°C	6.0	7.2	11.5	13.6	16.1
Viscosity Index		107	114	169	147	115
Flash Point, COC, °C/°F		243/469	244/471	258/496	266/511	287/549
Pour Point, °C/°F		-42/-44	-42/-44	-33/-27	-30/-22	-24/-11
Ramsbottom Carbon, % Wt		0.04	0.05	0.05	0.06	0.09

Note: Do not use in breathing air apparatus or medical equipment. COMPRO™ XL-S rotary screw air compressor fluids should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, *no petroleum lubricant* is recommended.**

COMPRO™ XL-R - RECIPROCATING AIR COMPRESSOR FLUID

COMPRO™ XL-R has been specifically developed for single and multi-stage reciprocating air compressors, particularly those with high air-discharge temperatures.

COMPRO™ XL-R is recommended for use in both the cylinder and crankcase lubrication of air compressors, where it may reduce varnish and carbon build up on valves and intercoolers. It is also fully compatible with petroleum oils and diesters, although significant dilution will reduce its performance.

COMPRO™ XL-R is recommended for use in reciprocating compressors up to a maximum of 2,000 hours at air discharge temperatures up to 150°C/302°F. In high severity applications, deposit formation on the valves may limit service life. Careful oil and equipment monitoring is necessary.

COMPRO™ XL-R meets the requirements of DIN 51506 VDL.

Typical characteristics are shown below:

		COMPRO™ XL-R Compressor Fluid
Viscosity	**cSt @ 40°C**	67
	cSt @ 100°C	8.3
Viscosity Index		91
Flash Point, COC, °C/°F		236/457
Pour Point, °C/°F		-18/0

Note: Do not use in breathing air apparatus or medical equipment. COMPRO™ XL-R reciprocating air compressor fluids should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, *no petroleum lubricant* is recommended.**

COMPRO™ SYNTHETIC - AIR COMPRESSOR FLUID

COMPRO™ Synthetic is a premium fluid that has been specifically developed for rotary screw air compressors operating in severe service environments, particularly those with high air-discharge temperatures up to 105°C/221°F. COMPRO™ Synthetic outperforms PAO synthetic based fluids at these high discharge temperatures - up to one year continuous service or 8,000 hours. (NOTE: This is a Polyalkylene Glycol / Ester blend and should never be mixed with mineral oils or Poly Alpha Olefin synthetics.)

Typical characteristics are shown below:

		COMPRO™ Synthetic Compressor Fluid
Viscosity	**cSt @ 40°C**	40.7
	cSt @ 100°C	7.6
Viscosity Index		157
Flash Point, COC, °C/°F		257/495
Pour Point, °C/°F		-51/-60

Note: Do not use in breathing air apparatus or medical equipment. COMPRO™ Synthetic air compressor fluid should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, COMPRO™ Synthetic must not be used.**

COMPRESSOR OIL RP
NATURAL GAS COMPRESSOR OIL

Compressor Oils RP 268 and RP 460 are specially designed for the lubrication of cylinders and rod packings in natural gas compressors having force-feed lubrication systems.

These compressor oils are formulated with an advanced, non-fatty additive package to provide excellent high temperature stability, very good lubricity and wear protection, as well as minimizing deposit formation. They are primarily recommended for use in compressing sour, wet or contaminated natural gas. The higher viscosity RP 460 is especially suited for use in higher pressure applications.

Compressor Oils RP 268 and 460 may also be used for the initial break-in (first 500 hours running) of compressor cylinders in sweet or dry gas service.

Typical characteristics are shown below:

		Compressor Oil RP	
		268	**460**
Viscosity	**cSt @ 40°C**	269	393
	cSt @ 100°C	22.0	28.0
Viscosity Index		98	97
Flash Point, COC, °C/°F		278/532	297/567
Pour Point, °C/°F		-18/0	-12/10
Ramsbottom Carbon Residue, wt%		1.17	1.23

Note: In selecting a compressor oil it is important to know not only the equipment manufacturer and model, but also the gas being compressed. In the table below, various gases are categorized for the type of lubricant required.

Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride *no petroleum lubricant* is recommended.

VARIOUS GASES	LUBRICANT
• Inert – Argon, Carbon Dioxide, Carbon Monoxide, Hydrogen, Helium, Neon, Nitrogen, Blast Furnace Gas.	Same as for air.
• Hydrocarbon Gases – Methane, Acetylene, Ethane, Propane, Butane, Coke Oven Gas.	Same as for natural gas.
• Chemically Active – Chlorine, Oxygen, Hydrogen Chloride.	No petroleum lubricant.
• Ammonia	REFLO™ 46A, 68A, REFLO™ 68 Synthetic REFLO™ XL Synthetic Blend

PC COMPRESSOR CLEANER

PC Compressor Cleaner is a semi-synthetic fluid, formulated to dissolve the varnish and sludge found in air compressors. PC Compressor Cleaner may also be used as an air compressor lubricant for up to 400 hours. It is an ideal flushing fluid for cleaning older, heavily varnished air compressors using mineral oils or diester fluids, and highly recommended when converting to Petro-Canada's COMPRO™ XL-S Compressor Fluid from non-compatible fluids, such as polyglycol synthetics.

Typical characteristics are shown below:

		PC Compressor Cleaner
Viscosity	**cSt @ 40°C**	40.7
	cSt @ 100°C	5.8
Flash Point, COC, °C/°F		239/462
Pour Point, °C/°F		-36/-33

Note 1: Do not use in breathing air apparatus or medical equipment. PC Compressor Cleaner should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases, such as chlorine, oxygen and hydrogen chloride, PC Compressor Cleaner must not be used.**

Note 2: Consult our Tech Bulletin "TB-1217 - Guidelines for Converting to COMPRO™ Compressor Fluids" before using our PC Compressor Cleaner and changing over to any of our COMPRO™ fluids.

CON-REL-EZE™ – CONCRETE FORM OIL

CON-REL-EZE™ is formulated to provide an excellent stain-free finish on concrete and has clean, quick release characteristics for plywood, metal, fibreglass and plastic forms. This product offers excellent rust protection to metal forms and is compatible with most caulking compounds.

CON-REL-EZE™ 60 is a ready-to-use, light viscosity oil for spraying on forms. It may also be used for rust protection of machinery and as a penetrating oil on nuts and bolts.

Typical characteristics are shown below:

		CON-REL-EZE™ 60
Viscosity	**cSt @ 40°C**	4.1
Flash Point, COC, °C/°F		53/127
Pour Point, °C/°F		-30/-22
Rust Test		pass

Note: The flash point method used for CON-REL-EZE™ 60 is ASTM D56.

DURATAC™ OILS

DURATAC™ Oils are an economical, tacky, “once-through” line of lubricants for use in hand oiling of drive chains, log decks and waste conveyors. It is also recommended for infeed and other sawmill chains, chain saw bars and in lubricating leaky, slow-speed journal bearings. These products are formulated with a tackiness additive which helps to reduce dripping and throw-off during use.

DURATAC™ Chain Oil 32 is dyed red and formulated for use in the winter at low temperatures. DURATAC™ Chain Oil 150 is dyed red and formulated for use in the summer.

Typical characteristics are shown below:

		DURATAC™ CHAIN OILS			
		32	**68**	**100**	**150**
Texture		Stringy	Stringy	Stringy	Stringy
Viscosity	**cSt @ 40°C**	32	68	100	150
	cSt @ 100°C	6.3	10.4	13.4	16.8
Viscosity Index		151	140	133	120
Pour Point, °C/°F		-42/-44	-39/-38	-36/-33	-30/-22
Flash Point, COC, °C/°F		190/374	200/392	210/410	210/410
Colour		Dark Red	Brown	Brown	Dark Red
Rust, A, 24 h		Pass	Pass	Pass	Pass
Four-ball Scar Diameter, mm					
1200 rpm, 1 h, 15 kg, 75°C		0.25	0.25	0.25	0.25

DURATAC™ NON-DRIP OILS – CHAIN OIL

Petro-Canada DURATAC™ Non-Drip Oil is a high quality lubricant, formulated with a tackiness additive that adheres strongly to metal surfaces. This feature, together with anti-wear plus rust and oxidation protection, makes it an ideal lubricant for use where oil control is required, such as with conveyor chains. Non-Drip Oils are undyed so they may be used where dyed chain oils are undesirable.

Due to its tacky nature, it is not recommended for use in drip-feed oilers.

Typical characteristics are shown below:

		DURATAC™ NON-DRIP OIL			
		32	**68**	**150**	**220**
Viscosity	**cSt @ 40°C**	29	69	155	220
	cSt @ 100°C	6.0	10.3	17.4	21.1
Viscosity Index		159	135	123	114
Flash Point, COC, °C/°F		204/339	220/428	270/518	278/532
Pour Point, °C/°F		-39/-38	-27/-17	-30/-22	-24/-11

ENDURATEX™ EP & ENDURATEX™ XL SYNTHETIC BLEND

ENDURATEX™ EP Oils are designed to lubricate enclosed gear drives operating in normal, heavy or shock-loaded conditions, as well as all types of heavy or shock-loaded bearings. They deliver sustained anti-wear and extreme-pressure protection to all industrial gear drives and bearings. ENDURATEX™ EP Oils are noncorrosive to bronze gears, copper lines and bearing materials at low to moderate operating temperatures (up to 90°C/194°F).

ENDURATEX™ XL Synthetic Blend are multi-grade EP gear oils designed to eliminate seasonal change-outs and provide equipment protection all year long - available in 68/150 and 68/220 grades. These multigrades complete the line, by extending AGMA EP viscosities over an extended temperature range. The 68/220 supports winter requirements (68 grade) and summer requirements (220 grade). The 68/150 delivers excellent low temperature properties versus leading all season competitive products for easier cold start-ups and better equipment protection.

ENDURATEX™ EP Gear Oils are suitable for use in most industrial gear sets that require a high quality EP lubricant.

ENDURATEX™ EP Gear Oils are typically suitable for use in situations requiring DIN 51517 Part 3, ISO 12925 – Type 1 CKC, AGMA 9005-E02, and AIST 224 (formerly US Steel 224) specifications.

The following products meet the specifications for ISO 12925-1 CKD:

- Enduratex Synthetic EP (Please refer to page 120)
- Enduratex XL Synthetic Blend 68/150 and 68/220
- Enduratex EP 32, 68, 100, 150 and 220

Fives Cincinnati (formerly MAG-IAS) Approval

ENDURATEX™ EP 150	P-77	ENDURATEX™ EP 320	P-59
ENDURATEX™ EP 220	P-74	ENDURATEX™ EP 460	P-35

ENDURATEX™ EP 460 is approved for Caterpillar Global Mining LLC (formerly Bucyrus International Inc.) Dragline enclosed gearcase lubricant (SD4721 Part A).

Typical characteristics are shown below:

	32	68	100	150	220	320	460	680	1000	XL Syn BL 68/150	XL Syn BL 68/220
AGMA Number	-	2EP	3EP	4EP	5EP	6EP	7EP	8EP	8AEP	3EP	4EP
Density, kg/L @ 15°C/60°F	0.847	0.864	0.872	0.882	0.890	0.899	0.903	0.912	0.902	0.868	0.870
Colour, ASTM	<1.0	<1.0	<1.0	2.5	3.0	4.0	<5.0	>8.0	<5.5	<1.0	1.0
Viscosity											
cSt @ 40°C	32.0	68.0	101	150	220	325	452	688	1077	98.2	152
cSt @ 100°C	6.0	9.1	11.3	15.0	19.4	25.2	30.4	37.0	55.0	14.3	22.2
Viscosity Index	136	109	97	100	99	100	97	88	100	149	183
Flash Point, COC, °C/°F	224/435	240/464	240/464	269/516	275/527	287/549	276/529	297/567	>250/482	250/482	251/484
Pour Point, °C/°F	-51/-60	-39/-38	-33/-27	-33/-27	-27/-17	-21/-6	-15/5	-9/16	-15/5	-39/-38	-33/-27
FZG Failure Load Stage	12	12+	12+	12+	12+	12+	12+	12+	12+	12+	12+
Oxidation Stability % Viscosity Increase 312 hours, 121°C / 250°F	3.7	2.7	3.7	3.8	4.9	7.3	7.9	17	—	3.5	3.5

ENDURATEX™ MILD WORM GEAR (WG) OILS

ENDURATEX™ Mild WG Oils are Non-EP lubricants recommended for service in some enclosed worm gear reducers and industrial machinery. ENDURATEX™ Mild WG Oils are also suited for lubrication of reciprocating steam cylinders.

Typical characteristics are shown below:

		ENDURATEX™ Mild WG Oils		
		460	**680**	**1000**
Viscosity	**cSt @ 40°C**	444	669	900
	cSt @ 100°C	28.6	36.5	42.3
Viscosity Index		91	89	84
Flash Point, COC, °C/°F		311/592	313/595	309/588
Pour Point, °C/°F		-3/27	0/32	0/32
Compounding, % Wt		5	5	5

ENDURATEX™ SYNTHETIC OHV 680

ENDURATEX™ Synthetic OHV (Off-Highway Vehicle) 680 is a premium performance, extreme pressure lubricant. It is designed to work in high temperature conditions and maintain exceptional lubricant film strength. Formulated using PAO and ester-based technology, this product is capable of withstanding severe load conditions, helping to reduce wear so that component life is maximized. It is approved by General Electric for the lubrication of both DC and AC motorized wheel gearbox applications in off-highway haul trucks.

Typical characteristics are shown below:

		ENDURATEX™ Synthetic OHV 680
Density, kg/L at 15°C		0.8607
Colour, ASTM		<1.0
Viscosity,	**cSt at 40°C**	707
	cSt at 100°C	64.4
Viscosity Index		161
Pour Point, °C/°F		-36/-33
Temperature required for 150,000 cP, °C/°F		-23/-9
Flash Point, COC, °C/°F		280/536
Rust, Procedure B, 4 h, at 60 °C		Pass
Copper Corrosion, 3h @ 100°C		1a
Timken OK Load, kg/lb		45/99
Four Ball EP weld, kg/lb		250/550

ENDURATEX™ SYNTHETIC EP

ENDURATEX™ Synthetic EP gear lubricants are premium performance, extreme pressure lubricants designed for enclosed industrial gears and bearings operating under severe load conditions and in wide extremes of temperature. They deliver excellent wear properties and outstanding extreme temperature performance for extended component and fluid life. ENDURATEX™ Synthetic EP enhances gear box performance over a wide temperature range. The high viscosity index of ENDURATEX™ Synthetic EP products means that they retain their viscosity at high operating temperatures. This often allows the use of a lower ISO grade than with conventional gear oils. ENDURATEX™ Synthetic EP gear lubricants meet the requirements of Siemens (Flender) Industrial Gear, AIST 224 (formerly US Steel 224), DIN 51517-3, David Brown S1.53.101 Type E, Fives Cincinnati (formerly MAG IAS), Eickhoff Gear, Jahnel Kestermann and qualify as premium synthetic EP gear lubricants. ENDURATEX™ Synthetic EP oils can be used where AGMA antiscuff/antiwear Extreme Pressure (EP) Gear lubricants are required.

ENDURATEX™ Synthetic EP oils (ISO 220, 320 and 460) are listed on Flender Gear Units and Geared Motors T7300 Approved Lubricants List and are suitable for use in GE787/GE788 drive systems.

Typical characteristics are shown below:

	ENDURATEX™ Synthetic EP			
	150	**220**	**320**	**460**
AGMA No.	4EP	5EP	6EP	7EP
Viscosity cSt @ 40°C	150	226	331	466
cSt @ 100°C	19.5	26.2	35.5	46.3
Viscosity Index	148	148	153	155
Temp for 150,000 cP, °C/°F	-41/-42	-36/-33	-32/-26	-24/-11
Flash Point, COC, °C/°F	232/450	235/455	237/459	237/459
Pour Point, °C/°F	-54/-65	-48/-54	-42/-44	-39/-38
Timken OK Load, kg/lb	>48/106	>48/106	>48/106	>48/106
FZG Failure Load Stage	>12	>12	>12	>12

ENVIRON™ AW HYDRAULIC FLUIDS

Petro-Canada's ENVIRON™ AW monograde hydraulic fluids are designed for use in mobile and stationary heavy duty hydraulic systems and are particularly suited for hydraulic applications in environmentally sensitive locations.

ENVIRON™ AW is free of heavy metals, non-toxic, inherently biodegradable and recyclable. ENVIRON™ AW is formulated to provide excellent anti-wear protection for extended equipment life. Its exceptional oxidation stability provides long oil life for fewer change-outs and helps prevent sludge and varnish deposits.

ENVIRON™ AW fluids are approved against the following hydraulic equipment manufacturers' specifications: Eaton (Brochure 03-401-2010), Parker/Denison HF-0, Engel (AW 46), and Krauss Maffei (AW 46). They are also NSF H2 registered (no allowable food contact).

ENVIRON™ AW is recommended for use in equipment manufactured by Eaton/Vickers, Parker/Denison, Sauer-Danfoss, Racine, Oilgear, Hydreco, Dynex and others.

ENVIRON™ AW 32, 46, and 68 meet the requirements of DIN 51524 Part 2 HLP and ISO 6743/4 (ISO 11158) HM. ENVIRON™ AW is suitable for use where Bosch-Rexroth RD 90220 is required.

Typical characteristics are shown below:

	ENVIRON™ AW		
	32	**46**	**68**
Viscosity cSt @ 40°C	31.7	45.4	69.3
cSt @ 100°C	5.7	6.8	9.1
Viscosity Index	121	104	106
Flash Point, COC, °C/°F	216/421	233/451	242/468
Pour Point, °C/°F	-42/-44	-33/-27	-33/-27
Oxidation Stability (D943), hours to 2.0 AN	10,000+	10,000+	10,000+

ENVIRON™ MV WIDE TEMPERATURE HYDRAULIC FLUIDS

Petro-Canada's ENVIRON™ MV multigrade hydraulic fluids are designed for year-round use in mobile and stationary heavy-duty hydraulic systems operating in wide extremes of temperature, particularly in environmentally sensitive locations. ENVIRON™ MV is free of heavy metals, non-toxic, inherently biodegradable and recyclable. Its energy conserving formula helps maintain optimum pump protection in an efficient manner over a wide range of temperatures.

ENVIRON™ MV fluids are approved against the following hydraulic equipment manufacturers' specifications: Parker/Denison HF-0 and Arburg (MV 46). They are also NSF H2 registered (no allowable food contact).

ENVIRON™ MV are recommended for use in equipment manufactured by Eaton/Vickers, Parker/Denison, Sauer-Danfoss, Racine, Oilgear, Hydreco, Dynex and others. ENVIRON™ MV 32 and 46 are suitable for use in Bosch-Rexroth equipment and when a DIN 51524 Part 3 HVLP or ISO 6743/4 (ISO 11158) HV fluid is required.

ENVIRON™ MV is formulated to provide excellent anti-wear protection for extended equipment life. Its exceptional oxidation stability provides long oil life for fewer change-outs and helps prevent sludge and varnish deposits.

Typical characteristics are shown below:

			ENVIRON™ MV	
			32	**46**
Viscosity	**cSt @ 40°C**		33.8	45.0
	cSt @ 100°C		6.7	8.2
Viscosity Index			160	158
Flash Point, COC, °C/°F			239/462	247/477
Pour Point, °C/°F			-48/-54	-48/-54
Oxidation Stability (D943), hours to 2.0 AN			10,000+	10,000+
Min. Start-up Temperature[1], °C/°F			-36/-33	-33/-27
Operating Temp. Range[2],				
	Mobile Equipment	**°C**	-15 to 76	-10 to 84
		°F	5 to 169	14 to 183
	Industrial Machinery	**°C**	-15 to 66	-10 to 74
		°F	5 to 151	14 to 165

[1]Start-up is defined as the temperature at which the oil viscosity reaches 10,000 cP.

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada has chosen to define the upper operating temperature to be the after-shear oil viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil viscosity of 750 cP for both mobile and industrial machinery.
These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxilliary components in place.

HARNEX™ 320 WIND TURBINE GEAR OIL

HARNEX™ is a premium ISO 320 synthetic gear lubricant designed to provide exceptional anti-wear/EP performance and protection from corrosion in wind turbine applications. The product uses synthetic PAO base oils, known for their excellent viscosity index and low pour point properties.

HARNEX™ 320 has GE service fill approval for 1.x and 2.x platforms with Winergy gearboxes.

HARNEX™ 320 meets the technical requirements of Shanghai Electric, and is approved for use in any gear box on a Shanghai Electric wind turbine. Please contact a Petro-Canada Technical Services Advisor for additional information.

In addition, **HARNEX™ meets the following industry requirements:** AGMA 9005-E02, DIN 51517-3 (CLP 320).

Typical characteristics are shown below:

	HARNEX™ 320
Density @ 15 °C	0.862
Viscosity cSt @ 40°C	323
cSt @ 100°C	34.9
Viscosity Index	153
Flash Point, COC, °C/°F	237/459
Pour Point, °C/°F	-42/-44
Temperature for 150,000 cP, °C/°F	-32/-26
Rust Test (Synthetic Sea Water)	Pass
Timken OK, kg	>48
4 Ball Weld, kg	250
4 Ball Wear @ 40 kg 1200 rpm, mm	0.33
FZG Scuffing Test A/8.3/90 Fail	12+
FZG Scuffing Test A/16.6/90 Fail	12+
FZG Micropitting Test @ 60°C	Fail 10
FZG Micropitting Test @ 90°C	Fail 10
FAG FE8 Test (Stages 1,2,3,4)	Pass

Note 1: Users should refer to Tech Bulletin TB-1257 for detailed changeout procedure and TB-1263 for the list of recommended lubricants for wind turbines.

Note 2: Contact a Petro-Canada Technical Services Advisor for used oil condemning limits of Harnex 320.

HYDREX™ AW – HYDRAULIC FLUIDS

HYDREX™ AW are premium performance, long-life, anti-wear hydraulic fluids. HYDREX™ AW fluids are primarily recommended for heavy-duty hydraulic systems that operate in industrial plants, and may also be used outdoors in mobile equipment if the ambient temperature range is suitable. HYDREX™ AW fluids have excellent thermal stability and oxidation life, which extend drain intervals and protect against corrosion and varnish formation. They also minimize harmful sludge build up in the reservoir that can lead to shortened oil life and equipment wear. Rust preventative properties minimize the possibility of corrosion occurring and excellent water separability and hydrolytic stability allow the oil to be used for longer periods which reduces equipment maintenance and downtime.

HYDREX™ AW fluids are approved against the following hydraulic equipment manufacturers' specifications: Parker/Denison HF-0 (AW 32, 46, 68), Eaton/Vickers E-FDGN-TB002-E, Fives Cincinnati P-68 (AW 32), P-69 (AW 68) and P-70 (AW 46), Engel (AW 46), Arburg (AW 46), and Marlen Hydraulic Power Unit (AW 68). HYDREX™ AW fluids have been successfully evaluated against Bosch Rexroth requirements.

HYDREX™ AW fluids are recommended for use in equipment manufactured by Eaton/Vickers, Parker/Denison, Komatsu, Sauer-Danfoss, Bosch Rexroth, Racine, Oilgear, Hydreco, Dynex and others.

HYDREX™ AW 46 is designed to provide optimum performance in injection moulding equipment manufactured by: Husky, Krauss-Maffei, Battenfeld, Demag, Soplar and Netstal. HYDREX™ AW 46 meets the requirements of the Komatsu HPV35+35 pump test.

HYDREX™ AW is approved as per the following:

HYDREX™ AW 32	Voith 3625-006072, 3625-006073 and 3625-008426
HYDREX™ AW 46	Voith 3625-006208 and 3625-006209
HYDREX™ AW 100	Voith 3625-006101

HYDREX™ AW fluids are NSF H2 registered (no allowable food contact).

HYDREX™ AW (22, 32, 46, 68, and 100) meets the following specifications: DIN 51524 Part 2 HLP, ASTM D6158 HM, and ISO 11158 HM. HYDREX™ AW 32, 46, and 68 are suitable for use where AIST 126 and 127 are required. HYDREX™ AW 46 is suitable for use where JCMAS HK is required.

Typical characteristics are shown below:

		HYDREX™ AW					
		22	**32**	**46**	**68**	**80**	**100**
Viscosity	**cSt @ 40°C**	22.0	31.5	46.4	67.4	79.4	101
	cSt @ 100°C	4.4	5.5	6.9	8.9	9.9	11.6
Viscosity Index		110	110	104	106	104	102
Flash Point, COC, °C/°F		196/385	206/403	236/457	242/468	258/496	266/511
Pour Point, °C/°F		-45/-49	-43/-45	-39/-38	-33/-27	-31/-24	-29/-20
Oxidation Stability (D943), hours to 2.0 AN		6500+	6500+	6500+	6500+	6500+	6500+

HYDREX™ MV – WIDE TEMPERATURE RANGE HYDRAULIC FLUIDS

HYDREX™ MV are premium performance, long-life, anti-wear hydraulic fluids designed for use over wide temperature ranges. HYDREX™ MV fluids are recommended for heavy-duty hydraulic applications operating at high pressure and with wide ranges of temperature. They are ideally suited for piston, gear and vane hydraulic pumps used in industrial, marine, woodlands, mining and other mobile hydraulic systems. These fluids offer minimal fluid friction at low start-up temperatures and maintain optimum viscosity at high operating temperatures. Its high viscosity index, energy efficient formulation helps your bottom line.

HYDREX™ MV fluids[1] are approved against the following hydraulic equipment manufacturers' specifications: Eaton E-FDGN-TB002-E, Denison HF-0 (MV 32, 46, and 68), and Fives Cincinnati P-68 (MV 32) and P-70 (MV 46). HYDREX™ MV 32, 46 and 68 have also been successfully evaluated against Bosch Rexroth requirements. HYDREX™ MV fluids[1] are recommended for use in equipment manufactured by Eaton Vickers, Denison, Komatsu, Sauer-Danfoss, Bosch Rexroth, Oilgear, Hydreco, Dynex and others. HYDREX™ MV[1] meets the following specifications: ISO 11158 HV, DIN 51524 Part 3 HVLP, ASTM D6158 HV, JCMAS HK (MV 46) and the requirements of Komatsu HPV35+35 pump test (MV 46). HYDREX™ MV 32, 46 and 68 are suitable for use where AIST 126 and 127 are required. All HYDREX™ MV fluids are NSF H2 registered (no allowable food contact).

HYDREX™ MV Arctic 15 is a premium, high performance hydraulic fluid designed for extremely cold temperature operations, particularly in arctic climates, allowing hydraulic systems to start at temperatures of -50°C (-58°F) under no-load conditions. It is also readily biodegradable as measured by OECD 301B and recommended for use in emergency shut-down valves or other critical low temperature heavy-duty hydraulic systems that are required to respond quickly and reliably.

Typical characteristics are shown below:

	HYDREX™				
	MV Arctic 15	**MV 22**	**MV 32**	**MV 46**	**MV 68**
Viscosity cSt @ 40°C	13.6	22.2	31.9	45.4	68.2
cSt @ 100°C	5.2	5.0	6.2	8.1	10.5
Viscosity Index	391	160	147	153	142
Flash Point, COC, °C/°F	132/270	222/432	236/457	256/493	230/446
Pour Point, °C/°F	-51/-60	-54/-65	-51/-60	-48/-54	-42/-44
Oxidation Stability (D943), hours to 2.0 AN	5000+	7000+	7000+	7000+	7000+
Min. Start-up Temperature[2], °C/°F	-50/-58	-44/-47	-37/-35	-31/-24	-24/-11
Operating Temp. Range[3]					
Mobile Equipment °C	-45 to 23	-22 to 64	-17 to 76	-13 to 86	-5 to 96
°F	-49 to 73	-8 to 147	1 to 169	9 to 187	23 to 205
Industrial Machinery °C	-45 to 23	-22 to 55	-17 to 66	-13 to 76	-5 to 86
°F	-49 to 73	-8 to 131	1 to 151	9 to 169	23 to 187

[1]Excludes HYDREX MV Arctic 15 low temperature fluid.
[2]Start-up is defined as the temperature at which the oil viscosity reaches 10,000 cP.
[3]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada has chosen to define the upper operating temperature to be the after-shear oil viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil viscosity of 750 cP for both mobile and industrial machinery.
These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxilliary components in place.

HYDREX™ XV – ALL SEASON HYDRAULIC FLUID

HYDREX™ XV All Season is an advanced formula, long life, anti-wear hydraulic fluid designed for all season use in heavy-duty hydraulic systems for increased productivity in very hot or cold temperatures.

HYDREX™ XV is recommended for year-round use in equipment that has to be started at temperatures as low as -34°C (-29°F) and it will continue to perform well at operating temperatures as high as 90°C (194°F). HYDREX™ XV gives excellent results in a wide range of industrial machinery and mobile equipment used in such industries as forestry, construction, mining, public utility and marine operations. Its very high viscosity index, energy efficient formulation helps maximize productivity.

HYDREX™ XV helps eliminate the need to change hydraulic oil seasonally. HYDREX™ XV is approved against the following hydraulic equipment manufacturers' specifications: Eaton E-FDGN-TB002-E and Denison HF-0. HYDREX™ XV is recommended for use in equipment manufactured by Eaton Vickers, Denison, Komatsu, Sauer-Danfoss, Bosch Rexroth, Oilgear, Hydreco, Dynex and others. It also meets the following specifications: ISO 11158 HV, DIN 51524 Part 3 HVLP, and ASTM D6158 HV. HYDREX™ XV is suitable for use where AIST 126 and 127 are required.

Typical characteristics are shown below:

		HYDREX™ XV
Viscosity	**cSt @ 40°C**	47.9
	cSt @ 100°C	9.7
Viscosity Index		192
Flash Point, COC, °C/°F		227/441
Pour Point, °C/°F		-48/-54
Oxidation Stability (D943), hours to 2.0 AN		10,000+
Min. Start-up Temperature[1], °C/°F		-34/-29
Operating Temperature Range[2],		
Mobile Equipment	**°C**	-14 to 90
	°F	7 to 194
Industrial Machinery	**°C**	-14 to 78
	°F	7 to 172

[1]Start-up is defined as the temperature at which the oil viscosity reaches 10,000 cP.

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada has chosen to define the upper operating temperature to be the after-shear oil viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil viscosity of 750 cP for both mobile and industrial machinery.
These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxiliary components in place.

HYDREX™ EXTREME – WIDE TEMPERATURE HYDRAULIC FLUID

HYDREX™ EXTREME is a high performance multi-grade hydraulic fluid designed for extremely wide temperature protection. Its excellent oxidation stability helps to extend drains and reduce sludge build-up and varnish deposits. HYDREX™ EXTREME is also zinc-free, inherently biodegradable and contains no heavy metals. Its anti-wear, energy efficient formula helps your bottom line.

HYDREX™ EXTREME is recommended for vane, gear and axial piston hydraulic pumps over an extremely wide range of operating temperatures. It is suitable for applications where systems must be started up at very low temperatures but have significantly higher temperatures during operation. It is also suitable for use in bucket trucks operating around power lines or in bucket truck hydraulic systems requiring extreme low temperature pumpability.

HYDREX™ EXTREME is suitable for use in Liebherr Cranes where extreme cold temperatures occur.

Typical characteristics are shown below:

		HYDREX™ EXTREME
Density, kg/L @ 15°C (60°F)		0.852
Viscosity,	**cSt @ 40°C**	33.6 (165)
	St @ 100°C	13.0 (71)
	cP @ -45°C (-49°F)	2985
Viscosity Index		404
Flash Point, COC, °C (°F)		141 (285)
Pour Point, °C (°F)		-54 (-65)
Oxidation Stability (D943), hours to 2.0 AN		8000+
Start-up Temperatures[1], °C (°F)		-48 (-54)
Operating Temp. Range[2],		
Mobile Equipment	**°C**	-35 to 76
	°F	-31 to 169
Industrial Machinery	**°C**	-35 to 68
	°F	-31 to 154

[1]Start-up is defined as the temperature at which the oil viscosity reaches 10,000 cP.

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada has chosen to define the upper operating temperature to be the after-shear oil viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil viscosity of 750 cP for both mobile and industrial machinery.
These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxiliary components in place.

HYDREX™ DT – DETERGENT HYDRAULIC FLUID

HYDREX™ DT is a special anti-wear detergent/dispersant hydraulic fluid containing the same anti-wear and anti-oxidant chemistry as HYDREX™ AW. HYDREX™ DT contains a detergent/dispersant package to keep systems clean. This fluid is intended for use in hydraulic systems that are prone to contamination.

Typical characteristics are shown below:

		HYDREX™ DT 46
Viscosity	**cSt @ 40°C**	46.3
	cSt @ 100°C	6.9
Viscosity Index		104
Flash Point, COC, °C/°F		237/459
Pour Point, °C/°F		-38/-36
Oxidation Stability (D943), hours to 2.0 AN		3000+

LUMINOL™ ELECTRICAL INSULATING FLUIDS

Petro-Canada's LUMINOL™ family of electrical insulating fluids represent a breakthrough in electrical insulating fluid technology. Unlike competitive products formulated with naphthenic mineral oils, LUMINOL™ uses Petro-Canada's ultra-pure severely hydrotreated isoparaffin base fluids to deliver worry-free, corrosive sulphur-free performance in your transformer.

LUMINOL™ TR and LUMINOL™ TRi are ideal for use in large power and distribution transformers as well as free-breathing units, and pole and pad mount transformers. LUMINOL™ electrical insulating fluids are suitable for commercial, industrial and institutional applications:

- LUMINOL™ TR and LUMINOL™ TRi meet or exceed the performance requirements of CSA C50 (Class A and B), ASTM D3487 standards, and DOBLE TOPS specifications.
- LUMINOL™ TR and LUMINOL™ TRi meet the CSA C50 upgraded oxidation stability Special Requirements for Type III and Type IV fluids, respectively.
- LUMINOL™ TR is designed for Type I and Type III applications and meets International Electrotechnical Commission, IEC 60296 General specifications for trace inhibited transformer oil.
- LUMINOL™ TRi is designed for Type II and Type IV applications and meets IEC 60296 General specifications for inhibited transformer oil.
- LUMINOL™ is approved for applications requiring Ontario Hydro M-104.

Typical characteristics are shown below:

		LUMINOL™ TR	LUMINOL™ TRi
Viscosity	**cSt @ 40°C**	9.2	9.2
	cSt @ 0°C	53	53
	cSt @ -40°C	1,230	1,230
Flash Point, COC, °C/°F		170/338	170/338
Pour Point, °C/°F		-60/-76	-60/-76
Dielectric breakdown voltage, after treatment - 60Hz, 2mm gap (ASTM D1816), kV		65	65
Power Factor @ 60Hz, 100°C		0.001	0.001
Interfacial Tension, 25°C, mN/m		48	48

NGS SYNTHETIC BLEND COMPRESSOR FLUIDS

NGS Synthetic Blend compressor fluids are a combination of hydrotreated (HT) and polyalphaolefin (PAO) base fluids, fortified with corrosion inhibitor, lubricity improver and antifoam additives. It is specifically designed for flooded screw compressors handling the lightest hydrocarbon gases (methane and ethane) where the expected dilution is **less than** 10% by weight, and where natural gas liquids are not significantly present. NGS 1000 and NGS 1500 will handle sour gas systems, and have good low temperature properties. By contrast, our SPX 7000 and SPX 7100 compressor lubricants are designed for use where heavier hydrocarbons or some natural gas liquids may be present alongside methane and ethane. SPX 7000 and SPX 7100 can be used for the compression of sour natural gas. SPX 5000 is intended for propane compression in refrigeration systems.

Typical characteristics are shown below:

		NGS	
		1000	**1500**
Viscosity	**cSt @ 40°C**	95	147
	cSt @ 100°C	13	19
Viscosity Index		139	149
Flash Point, COC, °C/°F		262/504	244/471
Pour Point, °C/°F		-33/-27	-33/-27

PETRO-CANADA CLEANING FLUID FOR HEAT TRANSFER SYSTEMS

Petro-Canada Cleaning Fluid is specially designed to help clean dirty or heavily carbonized systems which have been operating on overextended, contaminated or degraded heat transfer fluids. This fluid is recommended for use in closed heat transfer systems and should not be used in systems operating in food processing plants. The upper operating limit for Petro-Canada Cleaning Fluid is 100°C (212°F) and therefore should not be placed into an existing system while in operation warmer than this temperature. Once all the cleaning fluid has been drained, Petro-Canada Flushing Fluid should be used to help remove residual fluids and loose contaminants prior to recharging the system with new heat transfer fluid. Please refer to Tech Bulletin (TB-1158) for detailed instructions on how to clean Heat Transfer Systems.

Typical characteristics are shown below:

		CLEANING FLUID
Density, kg/L @ 15°C		0.924
Colour, ASTM		<2
Flash Point, COC, °C/°F		145/293
Viscosity	**cSt @ 40°C**	4.7
	cSt @ 100°C	1.6
Pour Point, °C/°F		-15/5
GC Distillation, 10% °C/°F		263/505
GC Distillation, 90% °C/°F		335/635

PETRO-CANADA FLUSHING FLUID

Petro-Canada Flushing Fluid is designed for flushing out dirty oil-circulating systems including those operating on heat transfer fluids. This fluid is also recommended to flush debris and water from pressure tests and contaminants from welding and construction in newly commissioned heat transfer systems. While it will not remove hard baked-on carbon, nor will it dissolve heavy sludge residues left by highly degraded fluids, it is effective in removing trapped residual fluids and in displacing system contaminants such as water, loose solids and debris. It operates effectively as a mechanical flushing agent for heat transfer systems changing over to CALFLO™ or PETRO-THERM™ Heat Transfer Fluids from other non-compatible materials. It is completely compatible with hydrocarbon based lubricants and with all grades of CALFLO™ or PETRO-THERM™. For systems that will subsequently operate on a low viscosity fluid please consult Petro-Canada's Technical Services. For systems in food processing plants where an HT-1 approved fluid will be used, we recommend to flush with PURITY™ FG WO White Mineral Oils found on page 188.

Typical characteristics are listed below:

		FLUSHING FLUID
Density, kg/L @ 15°C		0.864
Flash Point, COC, °C/°F		216/421
Viscosity	**cSt @ 40°C**	35.6
	cSt @ 100 °C	5.70
Pour Point, °C/°F		-18/0

PETROGLIDE™ - SAW GUIDE OIL

Petro-Canada's PETROGLIDE™ saw guide oils are specially designed for use with modern multi-blade gang saws and edgers to provide increased recovery rates and sawmill productivity.

PETROGLIDE™'s specially formulated additive package gives it the characteristics required for excellent saw guide lubrication. Its surface wetting coupled with good water separability and tackiness helps to hold it in place, without causing excessive sawdust clumping. PETROGLIDE™ has excellent extreme pressure properties to reduce friction and metal to metal contact, decreasing heat build-up and wear on both saw guides and blades. PETROGLIDE™'s blend of additives help to ensure a good cut, as well as a long saw guide and blade life. It also minimizes rusting throughout the operation cycle while reducing saw deviation and maximizing on-spec board production.

Typical characteristics are shown below:

		PETROGLIDE™	
		100	**150**
Viscosity	**cSt @ 40°C**	108	172
	cSt @ 100°C	14.1	17.7
Viscosity Index		131	113
Flash Point, COC, °C/°F		277/531	270/518
Pour Point, °C/°F		-36/-33	-33/-27
Four Ball EP Weld Load, kg		200	200

PETROGLIDE™ MC 32 - BANDSAW OIL

Petro-Canada's PETROGLIDE™ MC 32 is a premium quality bandsaw oil specially designed for mist lubricated bandsaws. Pitch control additives and rust inhibitor keep blades cleaner. Its tackiness and mist control are carefully balanced to effectively lubricate without excessive stray mist thus helping to minimize oil usage and contribute to a cleaner environment.

PETROGLIDE™ MC 32 may also be used in oil/water saw lubrication and cooling systems which require a saw guide oil with an ISO 32 grade.

Typical characteristics are shown below:

		PETROGLIDE™ MC 32
Viscosity	**cSt @ 40°C**	32
	cSt @ 100°C	6.0
Viscosity Index		131
Flash Point, COC, °C/°F		195/383
Pour Point, °C/°F		-51/-60
Four Ball EP Weld Point, kg		200

PETRO-THERM™ HEAT TRANSFER FLUID

PETRO-THERM™ is a general purpose heat transfer fluid developed for use in non-pressurized, liquid phase, closed heat transfer systems operating with bulk temperatures up to 315°C (599°F). It is specifically formulated to provide economical service in a variety of industrial applications while resisting oxidative and thermal degradation.

PETRO-THERM™ is particularly suitable for use in asphalt plants, marine applications, wood processing, dry kilns, institutional laundry and heating, and general processing.

Typical characteristics are shown below:

		PETRO-THERM™
Viscosity	**cSt @ 40°C**	35.8
	cSt @ 100°C	5.7
Viscosity Index		97
Flash Point, COC, °C/°F		225/437
Pour Point, °C/°F		-18/0
Autoignition Temp, °C/°F		351/664

For applications where specialty heat transfer fluids are required, see CALFLO™ on **page 111**.

REFLO™ – REFRIGERATION COMPRESSOR OILS

The REFLO™ line of refrigeration compressor fluids was developed for use in commercial refrigeration compressor systems.

REFLO™ CFC is formulated for use in systems using CFC (chlorinated fluorocarbon) refrigerants such as Freon, Genetron and Isotron. It is a highly refined naphthenic oil with excellent low temperature properties. It is not recommended in HFC (hydrofluorocarbons) systems such as R134a or R23. REFLO™ CFC can be used in ammonia refrigeration systems. REFLO™ CFC can also be used at moderate temperatures with HCFC (hydrochlorinated fluorocarbon) refrigerants such as R-22, R-123, R-124, R-141b, R-142b, R-502 as well as Methyl Chloride and Carbon Dioxide (R-744).

REFLO™ 46A and 68A are formulated from pure paraffinic base stocks and continue to provide exceptional service in ammonia refrigeration systems. REFLO™'s lower solubility in ammonia can reduce carryover and help to improve system efficiency and performance through proper system maintenance. Its excellent thermal and oxidative stability can also help to extend fluid life.

REFLO™ XL Synthetic Blend is a refrigeration compressor fluid used in industrial ammonia refrigeration systems. REFLO™ XL Synthetic Blend is formulated to outperform straight API Group II, solvent refined paraffinic and naphthenic refrigerant oils by extending service life. It is designed to have good compatibility with seal materials; it contains a seal swell agent to reduce fluid leaks. REFLO™ XL Synthetic Blend is miscible with similar paraffinic mineral oil based products.

REFLO™ products meet the requirements of many refrigeration OEMs, including Sabroe, Grasso, Frick, Mycom, Frigoscandia, Gram, Vilter, Huppmann GMBH, J&E Hall, Howden, FES, and Dunham-Busch. Check with the Original Equipment Manufacturer, the technical data sheet and consult with a technical services representative for details.

Please refer to TB-1164 and TB-1197 for change-out and warranty advice.

Typical characteristics are shown below:

		REFLO™ CFC	REFLO™ 46A	REFLO™ 68A	REFLO™ XL Synthetic Blend
Viscosity	**cSt @ 40°C**	59.6	46.0	57.8	59.3
	cSt @ 100°C	6.5	6.9	7.9	8.5
Viscosity Index		48	106	101	115
Flash Point, COC, °C/°F		191/376	222/432	236/457	227/441
Pour Point, °C/°F		-39/-38	-42/-44	-42/-44	-45/-49
Floc Point, °C/°F		-50/-58	NA	NA	NA
Minimum recommended evaporator temperature, °C/°F		-31/-24	-39/-38	-39/-38	-42/-44

Food Industry Approvals

• REFLO™ XL Synthetic Blend, REFLO™ 46A and REFLO™ 68A are NSF H2 registered.

REFLO™ SYNTHETIC

REFLO™ Synthetic is formulated to lubricate ammonia refrigeration compressors used in large commercial operations such as cold stores, marine systems and food processing plants; specifically blast freezers that have very low temperature control, such as pharmaceuticals and microelectronics. REFLO™ Synthetic can be used in ammonia refrigeration systems where evaporator temperatures are as low as -51°C/-60°F.

REFLO™ Synthetic is miscible with mineral oils such as hydrotreated (HT) and solvent refined (SR) paraffinic oils.

REFLO™ Synthetic is designed to have good compatibility with seal materials; it contains a seal swell agent to help reduce fluid leaks.

REFLO™ Synthetic is compatible with elastomers made of materials such as NBR, SBR, CR, NR, and MVQ.

Please refer to TB-1164 and TB-1197 for change-out and warranty advice.

Typical characteristics are shown below:

		REFLO™ Synthetic
Viscosity	**cSt @ 40°C**	61.8
	cSt @ 100°C	8.9
Viscosity Index		119
Flash Point, COC, °C/°F		245/473
Pour Point, °C/°F		-54/-65
Minimum recommended evaporator temperature, °C/°F		-51/-60

ROTARY COOKER FLUID

Rotary Cooker Fluid is designed for lubrication of continuous rotary cookers and sterilizers, and similar applications operating under high temperature and high humidity conditions. Rotary Cooker Fluid protects equipment from wear and corrosion, and has excellent detergency and dispersancy to prevent clogged lines. This product is free of heavy metals, including zinc.

• Rotary Cooker Fluid is NSF H2 registered (no allowable food contact).

Typical characteristics are shown below:

		ROTARY COOKER FLUID
Viscosity	**cSt @ 40°C**	151
	cSt @ 100°C	15.2
Viscosity Index		101
Flash Point, COC, °C/°F		267/512
Pour Point, °C/°F		-21/-6

A key concern in hydrocarbon applications is hydrocarbon gas dilution of the lubricant. This dilution can reduce the lubricant's working viscosity, which can be detrimental to equipment protection. That's why Petro-Canada uses the compressor operating conditions, and gas analysis results to assess the potential dilution of the lubricant for each application before making a product recommendation. Please contact a Petro-Canada Technical Services Advisor, who can recommend an appropriate fluid for your application.

SPX 5000, 7100, 7000, 7220 – COMPRESSOR OILS

SPX 5000, 7100, 7000 and 7220 are unique products specifically formulated for lubricating and cooling reciprocating and rotary screw compressors handling hydrocarbon gases, such as propane and natural gas. Unlike mineral oils, the SPX 7000 series PAG lubricants have a much lower gas solubility, which reduces dilution and the amount of decrease in viscosity and greatly improves separation of the lubricant from the hydrocarbon gases. These PAG based fluids are incompatible with all other oils; both mineral and synthetic based. Due to differences in base stock and additives between SPX 5000 and SPX 7000, these products should not be mixed. There are no compatibility issues but mixing will alter the characteristics and performance of the products.

SPX 7000 and SPX 7220 are available for once-through rod packing and cylinder lubrication (not crankcase) in reciprocating compressors at high pressures.

SPX 7000 and SPX 7220 are recommended for:
- Compression of heavy hydrocarbon and water contaminated natural gas streams
- Compression of dry Natural gas with CO_2
- Compression of dry Natural gas with H_2S
- SPX 7000 is an ISO viscosity grade 150
- SPX 7220 is an ISO viscosity grade 220

SPX 7000 and 7100 are recommended for screw compressor applications such as:
- Compression of hydrocarbon mixtures containing butane and other light hydrocarbon gases where the expected dilution by gases other than natural gas is greater than 10 wt%
- Sour natural gas and acid gas compression:
  – SPX 7100 and SPX 7000 will dissolve high levels of water at temperatures below 70°C / 158°F, helping to prevent corrosion during compressor shutdown
  – SPX 7100 is an ISO Viscosity Grade 100 and SPX 7000 is an ISO Viscosity Grade150

SPX 5000 is a PAG recommended for use in screw and reciprocating compressor applications for:
- Compression of propane in refrigeration systems
- Compression of sweet, dry natural gas where <10% dilution is expected
- SPX 5000 is an ISO Viscosity Grade 150

NGS synthetic blend compressor fluids (please refer to page 129) are recommended for:

- Compression of light hydrocarbon gases (methane, ethane) where expected dilution is <10%wt and where natural gas liquids are not significantly present
- Lubrication and cooling in gas rotary screw compressors
- Natural gas field booster service

Typical characteristics are shown below:

		SPX			
		5000	**7100**	**7000**	**7220**
Viscosity	**cSt @ 40°C**	146	102	151	220
	cSt @ 100°C	23	21	29	41
Viscosity Index		185	226	235	244
Flash Point, COC, °C/°F		260/500	249/480	268/514	240/464
Pour Point, °C/°F		-34/-29	-51/-60	-45/-49	-45/-49
ISO Grade		150	100	150	220

NG COMPOIL AW - COMPRESSOR OILS

Petro-Canada's NG CompOil AW 150 and 220 are mineral oil compressor fluids specially designed for use in both the frame and cylinders / packings of reciprocating compressors. These products are for sweet, mostly light natural gas service operating at low pressure and employ a non-detergent formulation.

NG CompOil AW can be used in natural gas compressor skids where the engine and compressor lube oil feeds are from separate tanks. This low pour point formulation is suitable for remote locations where climate control is not practical.

NG CompOil AW compressor oils are recommended for use in:

- Lubrication of cylinders / packings of reciprocating compressors in sweet, light natural gas service at low pressure
- Crankcase of natural gas reciprocating compressors where an R&O type oil is recommended

Typical characteristics are shown below:

		NG CompOil AW	
		150	**220**
Viscosity	**cSt @ 40°C**	141	218
	cSt @ 100°C	14.4	19.2
Viscosity Index		101	99
Flash Point, COC, °C/°F		277 / 531	291/556
Pour Point, °C/°F		-33 / -27	-30 / -22

NG COMPOIL PAO - SYNTHETIC COMPRESSOR OIL

Petro-Canada's synthetic compressor fluid NG Compressor Oil (CompOil) PAO 150, is specially designed for use in flooded screw compressors in natural gas production and service. It is intended for the compression of light hydrocarbon gases at elevated discharge temperatures.

This premium fluid, with a select performance additive package is compatible with sour (H_2S) hydrocarbon gas systems. NG CompOil PAO 150 can also be used in reciprocating compressors. Its excellent water separation characteristics and corrosion protection make it particularly beneficial for compression of acid gas streams in applications where the cylinder discharge pressure is moderate (<2000 psig).

NG CompOil PAO 150 is specifically recommended for:
- Compression of the lightest hydrocarbon gases (methane and ethane) where the expected dilution is <10 wt%, and discharge temperatures are elevated (>99 °C / 210 °F)
- Compression of sour natural gas streams
- Compression of natural gas with high CO_2 content

In reciprocating compressors, NG CompOil PAO 150 is particularly recommended for:
- Compression of natural gas with high levels of CO_2 contamination
- Compression of acid gas streams (water saturated Natural Gas with CO_2 and/or H_2S content)

Typical characteristics are shown below:

		NG CompOil PAO 150
Viscosity	**cSt @ 40°C**	150
	cSt @ 100°C	21
Viscosity Index		165
Flash Point, COC, °C/°F		284 / 543
Pour Point, °C/°F		-33 / -27

NG SCREW COMPOIL - COMPRESSOR OILS

Petro-Canada's NG Screw Compressor Oil fluids are designed for use in flooded screw compressors in natural gas production and service and are intended for the compression of the lightest hydrocarbon gases at moderate discharge temperatures.

These hydrotreated (HT) mineral oil based fluids include select additive chemistry to help protect metal surfaces against corrosion and to provide excellent performance in harsh natural gas streams. The additive system is compatible with sour (H_2S) hydrocarbon gas systems.

NG Screw CompOil compressor fluids are used for flooded screw compressors in natural gas field booster service. Although these fluids are primarily intended for dry, light and clean natural gas service, at moderate temperatures and pressures, they can be used in select applications where water, H_2S and/or CO_2 contaminate the natural gas streams.

NG Screw CompOil fluids are specifically recommended for:
- Compression of the lightest hydrocarbon gases (methane and ethane) where the expected dilution is <10 wt%, and discharge temperatures are moderate (<99 °C / 210 °F)
- Compression of sour natural gas streams
- Available in ISO 100 and ISO 150 viscosity grades

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For more difficult gas streams, where heavy hydrocarbons and/or high CO_2 are present, NG CompOil PAO 150 or the SPX 7000 series of PAG screw compressor fluids may be a better fit.

Please contact a Petro-Canada Technical Services Advisor, who can recommend an appropriate fluid for your application.

Typical characteristics are shown below:

		NG Screw CompOil	
		100	**150**
Viscosity	**cSt @ 40°C**	100	154
	cSt @ 100°C	12	17
Viscosity Index		108	121
Flash Point, COC, °C/°F		243/469	263/505
Pour Point, °C/°F		-33/-27	-30/-22

SENTRON™ - STATIONARY GAS ENGINE OIL

SENTRON™ Stationary Gas Engine Oils are premium performance, long life, engine oils specifically designed to lubricate stationary gas engines and their integrated compressors, running at gas plants and pipeline compression stations, as well as in power generation, cogeneration, landfill and sewage gas operations as well as in crude oil production operations.

SENTRON™ Stationary Gas Engine Oils are formulated with three different sulphated ash levels:

SENTRON™ ASHLESS 40..... Ashless - less than 0.1% wt ash

SENTRON™ 590, CG 40 PLUS, LD 3000,
LD 5000, LD 8000, LD Synthetic Blend,
VTP 0W-30, VTP 10W-40 ..... Low Ash - 0.1 to 0.6% wt ash

SENTRON™ CG 40, MID ASH 40..... Medium Ash - 0.6 to 1.0 % wt ash

ASHLESS

SENTRON™ ASHLESS 40

SENTRON™ ASHLESS 40 (0.05% wt ash) is recommended primarily for 2-stroke cycle stationary gas engines but may be used in certain 4-cycle or gas engines. SENTRON™ ASHLESS 40 minimizes combustion chamber and spark plug deposits.

LOW ASH

SENTRON™ 590

SENTRON™ 590 (0.59% wt ash) is a specialty product recommended for selected 4-cycle stationary gas engines experiencing nitrating conditions. It is suitable for use in engines fitted with catalytic converters. SENTRON™ 590 provides a high level of performance in high output turbocharged engines that prefer a low ash oil. It provides excellent control of engine deposits, and is specially formulated for engines that operate in severe nitrating conditions. Combined with Petro-Canada's engine optimization recommendations, and in severe nitrating conditions, SENTRON™ 590 can deliver up to 200%* longer drain intervals.

* Performance results may vary due to factors such as, but not limited to, engine optimization, load, fuel gas quality, proper maintenance, type of engine and application.

Please refer to page 143 and page 144 for a listing of the recommended SENTRON™ products by Manufacturer.

SENTRON™ CG 40 PLUS

SENTRON™ CG 40 PLUS (0.52% wt ash) is a uniquely designed low ash formula for 4-cycle stationary gas engines running in severe service landfill gas operations. It provides excellent control of deposits and other issues caused by high halogen gas levels produced by landfills. Unlike conventional landfill / biogas / sewer gas engine oils, SENTRON™ CG 40 PLUS is specifically designed to address current and future engines running in this severe contaminated gas application where higher BMEP engines are used.

SENTRON™ LD 3000

SENTRON™ LD 3000 (0.47% wt ash) is recommended for most 4-cycle and some 2-cycle stationary gas engines including Caterpillar, GE (Waukesha) and others in gas compression applications. It is suitable for use in engines fitted with catalytic converters. SENTRON™ LD 3000 helps provide a high level of performance in high output turbocharged engines that prefer a low ash oil. It provides excellent control of engine deposits, even when there is a need for added high temperature deposit control. It is suitable for severe service applications including high output, turbocharged engines that encounter high exhaust gas temperatures.

SENTRON™ LD 5000

SENTRON™ LD 5000 (0.60% wt ash) is a low ash SAE 40 oil recommended for use in Caterpillar, GE (Jenbacher / Waukesha) and many turbocharged or naturally aspirated, stoichiometric or lean burn engines that require a low ash stationary gas engine oil. It incorporates additives for the extra performance required for severe service applications, including high output, turbocharged engines that encounter high exhaust gas temperatures. SENTRON™ LD 5000 offers outstanding deposit control and excellent performance for up to 200%* longer drain intervals and exceptional overall engine protection for maximum reliability and savings. It can be used in Bio Gas/Digester Gas applications if the fuel sources are pre-treated to minimize harmful acidic constituents that a higher TBN based product may be more successful at neutralizing.

* Performance results may vary due to factors such as, but not limited to, engine optimization, load, fuel gas quality, proper maintenance, type of engine and application.

Please refer to page 143 and page 144 for a listing of the recommended SENTRON™ products by Manufacturer.

SENTRON™ LD 8000

SENTRON™ LD 8000 (0.52% wt ash) is a premium low ash SAE 40 lubricant, suitable for use in 4–cycle stationary gas engines operating on natural pipeline gas, pre-treated sewage/biogas and selective pre-treated process gases. It provides revolutionary performance of up to 300%* longer drain intervals over the leading global conventional competitor. SENTRON™ LD 8000 contains a specialized additive mix that provides greater TBN retention to help neutralize acids that can attack liner surfaces. SENTRON™ LD 8000 helps prevent deposits from ash and worn metal parts – deposits that could otherwise result in higher oil consumption due to increased liner wear. SENTRON LD 8000 combines a high degree of oxidative stability with nitration resistance.

*Performance results may vary due to factors such as, but not limited to, engine optimization, load, fuel gas quality, proper maintenance, type of engine and application

SENTRON™ LD SYNTHETIC BLEND

SENTRON™ LD Synthetic Blend (0.53% wt ash. Ref PLC 15869) is an SAE 15W-40 multigrade extension of the SENTRON™ line, formulated as a synthetic blend to extend drain intervals and give better low temperature performance in comparison to mono-grade SAE 40 oils. SENTRON™ LD Synthetic Blend is specifically recommended for use in large bore Waukesha VHP GL lean burn or low load Waukesha VGF engines. It is suited for colder environments where start up temperatures fall as low as -20°C/-13°F.

SENTRON™ VTP 0W-30

SENTRON™ VTP 0W-30 (0.63% wt ash. Ref PLC 15869) is a low ash, synthetic blend small stationary gas engine oil formulated specifically as an all season solution for small to mid-sized engines that are difficult to start in severe winter conditions. With a Pour Point of -45°C/-49°F, SENTRON™ VTP 0W-30 helps provide exceptional performance in extreme winter conditions, presenting opportunities for inventory consolidation. SENTRON™ VTP 0W-30 may also be suitable for use in engines equipped with certain on-road catalytic converters. Check with your service rep for suitability.

SENTRON™ VTP 10W-40

SENTRON™ VTP 10W-40 (0.59% wt ash. Ref PLC 15869) is specially formulated to meet the demands of small stationary natural gas engines for exceptional cleanliness of the engine through all seasons. It is recommended for use in gas fuelled engines that require high phosphorous for improved valve train wear while providing excellent cold start capability. SENTRON™ VTP 10W-40 is suitable for use in applications where Cummins CES 20074 is specified. SENTRON™ VTP 10W-40 may also be suitable for use in engines equipped with certain on-road catalytic converters. Check with your service rep for suitability.

Please refer to page 143 and page 144 for a listing of the recommended SENTRON™ products by Manufacturer.

MEDIUM ASH

SENTRON™ CG 40

SENTRON™ CG 40 (0.93% wt ash) is a medium ash SAE 40 oil, that is specifically designed for 4-cycle stationary gas engines running in severe service, such as cogeneration, bio gas, digester and low halogen landfill or sewage gas operations. SENTRON™ CG 40 gives exceptional performance in turbocharged, lean-burn and naturally aspirated gas engines. SENTRON™ CG 40 may be suitable for use in engines equipped with certain catalytic converters. Check with your service rep for suitability.

SENTRON™ MID ASH 40

SENTRON™ MID ASH 40 (0.80% wt ash) is a medium ash SAE 40 oil recommended for use in older 4-cycle stationary gas engines requiring medium ash oils. It has also been used successfully for engines where mid ash is preferred to combat high valve recession rates.

Typical Performance Data

		PETRO-CANADA STATIONARY GAS ENGINE OILS										
PROPERTY	ASTM TEST METHOD	SENTRON ASHLESS 40	SENTRON 590	SENTRON CG 40 PLUS	SENTRON LD 3000	SENTRON LD 5000	SENTRON LD 8000	SENTRON LD SYNTHETIC BLEND	SENTRON VTP 0W-30	SENTRON VTP 10W-40	SENTRON CG 40	SENTRON MID ASH 40
Ash Type	-	Ashless	Low Ash	Low Ash	Low Ash	Low Ash	Low Ash	Low Ash	Low Ash	Low Ash	Medium Ash	Medium Ash
Sulphated Ash, % wt	D874	0.05	0.59	0.52	0.47	0.60	0.52	0.53	0.63	0.54	0.93	0.80
SAE Grade	-	40	40	40	40	40	40	15W-40	0W-30	10W-40	40	40
Flash Point, COC, °C/°F	D92	276/529	277/531	283/541	273/523	272/522	277/531	247/477	239/462	245/473	273/523	269/516
Kinematic Viscosity												
cSt @ 40°C	D445	125	121	119	124	124	121	106	62.1	101	123	126
cSt @ 100°C		13.7	13.5	13.4	13.7	13.4	13.3	15.6	11.2	15.1	13.6	13.9
Pour Point, °C/°F	D5950	-27/-17	-30/-22	-27/-17	-27/-17	-30/-22	-27/-17	-42/-44	-45/-49	-42/-44	-27/-17	-33/-27
Total Acid Number	D664	0.7	0.98	1.53	0.86	1.1	0.86	1.02	1.8	1.9	0.58	2.0
Base Number	D2896	1.6	6.0	4.5	3.9	4.9	4.6	4.7	4.8	3.9	8.1	6.9

The values quoted above are typical of normal production. They do not constitute a specification.

Please refer to page 143 and page 144 for a listing of the recommended SENTRON™ products by Manufacturer.

PETRO-CANADA GAS ENGINE OILS SELECTION TABLE*

MANUFACTURER	ENGINE TYPE	FUEL GAS	ENGINE Model	MANUFACTURER'S ASH LEVEL REQUIREMENTS	RECOMMENDATIONS
2G	4-cycle	natural	All	0.4% to 0.6%	SENTRON LD 5000, LD 8000
Ajax (Cooper Energy Service)	2-cycle	natural	All - Ashless preferred	<0.1%	SENTRON ASHLESS 40
BU Drive	4-cycle	natural	All	n/a	SENTRON LD 5000, LD 8000
		biogas	All	n/a	SENTRON LD 5000, LD 8000, CG 40 PLUS
Caterpillar	4-cycle	natural	G3300, G3400, G3500, G3600	0.4% - 0.6%	SENTRON LD 3000, 590, LD 5000, LD 8000, LD SYNTHETIC BLEND
		biogas	All	0.4% - 0.6%	SENTRON LD 5000, LD 8000, CG 40 PLUS
Caterpillar Power Systems (MWM)	4-cycle	natural	All	0.5% max	SENTRON LD 5000, LD 3000, LD 8000
		biogas	All	0.5% - 1.0%	SENTRON CG 40, CG 40 PLUS
Clark Brothers (Dresser Rand)	2-cycle	natural	All	Ashless	SENTRON ASHLESS 40
				Low Ash acceptable	SENTRON LD 3000, LD 8000
Cooper Bessemer (Cooper Energy Service)	2-cycle	natural	All - Ashless preferred	<0.1%	SENTRON ASHLESS 40
	4-cycle	natural	All	Low Ash acceptable	SENTRON LD 3000, 590, LD 5000, LD 8000
Cummins	4-cycle	natural	LG10G, QSK19G, K19G, G19, G38, G50, G28,G855, G14	<0.6%	SENTRON LD 5000, LD 8000, LD SYNTHETIC BLEND
		natural	B, C, G5.9, G8.3	Suitable for CES 20074	SENTRON VTP 10W-40
		natural	All QSV, QSK except 19G	0.4% - 0.6%	SENTRON LD 3000, LD 5000, LD 8000
Detroit Diesel	4-cycle	natural	50G and 60G	<0.8%	SENTRON LD SYNTHETIC BLEND
Dresser Rand (Guascor)	4-cycle	natural	All	0.9% max	SENTRON LD 3000, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND
Ingersoll-Rand (Dresser Ind.)	4-cycle	natural	Category I	Approval based on field performance	SENTRON ASHLESS 40, LD 3000, LD 5000, LD 8000, LD SYNTHETIC BLEND
		natural	Category II - III	Approval based on field performance	SENTRON LD 3000, LD 5000, LD 8000, LD SYNTHETIC BLEND
GE Jenbacher	4-cycle	Class A	2&3	0.4% - 0.6%	SENTRON LD 5000, LD 3000, LD 8000
		Class A	4 (B version or lower) & 6 (E version or older) & 9	0.4% - 0.6%	SENTRON LD 5000, LD 3000, LD 8000
		Class A	6F (or newer) 4 (C version or higher)	0.4% - 0.6%	SENTRON LD 5000, LD 8000
		Class B	2&3	0.4% - 0.6%	SENTRON CG 40, CG 40 PLUS
		Class B	4 & 6 (E version or older)	0.4% - 0.6%	SENTRON LD 5000, LD 3000, LD 8000, CG 40 PLUS
		Class C	2&3	0.4% - 0.6%	SENTRON CG 40, CG 40 PLUS
		Class C	4 & 6 (E version or older)	0.4% - 0.6%	SENTRON CG 40 PLUS
GE Oil and Gas (Superior)	4-cycle	natural	All except 1700 & 2400, G-510, G 825, GT-825	0.4% - 1.0%	SENTRON, CG 40
		natural	1700 & 2400 Series G-510, G 825, and GT-825	0.4% - 0.6%	SENTRON LD 3000, LD 5000, 590, LD 8000
GE (Waukesha Engine Div.)	4-cycle	natural / biogas	VSG F11, G, GSI, GSID	0.35% - 1.0%	SENTRON LD 3000, CG 40, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND
		natural / biogas	F817, F1197	0.35% - 1.0%	SENTRON LD 3000, CG 40, LD SYNTHETIC BLEND, LD 5000, LD 8000, 590
		natural	Clinton, G2476, L3711, F1850, H884	Ashless preferred	SENTRON ASHLESS 40
		natural / biogas	VHP F2895, F3521, L5108, L5790, L7042, P9390, G, GSI	0.35% - 1.0%	SENTRON LD 3000, CG 40 PLUS, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND
		natural	VHP GL	0.35% - 1.0%[1]	SENTRON LD SYNTHETIC BLEND, LD 5000[2], LD 3000, LD 8000
		natural	VGF, F-18, H-24, L-36, P-48, GSI, GSID	0.35% - 0.5%[1]	SENTRON LD 3000, LD SYNTHETIC BLEND
		natural	VGF, F-18, H-24, L-36, P-48, G, GL, GLD	0.45% - 0.75%[1]	SENTRON LD 3000, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND

GE (Waukesha Engine Div.) continued		natural	AT 25/27GL Series	0.35% - 1.0%[1]	SENTRON LD 3000, CG 40, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND
		natural	VHP, F3524, L5794, L7044, GSI, L5774, LT (4 series)	0.45% - 0.75%[1]	SENTRON LD 3000, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND
		natural	16V150LTD, 220GL, 275 GL	0.40% -0.55%	SENTRON LD 3000, LD 5000, LD 8000
GM, Ford	4-cycle	natural	350	n/a	SENTRON VTP 10W-40, VTP 0W-30
Iveco	4-cycle	natural	All	0.45% max	SENTRON LD 3000
MAN	4-cycle	natural	All	0.4% - 0.7%	SENTRON LD 3000, LD 5000, LD 8000, 590, LD SYNTHETIC BLEND
		biogas	All	0.4% - 1.0%	SENTRON CG 40, CG 40 PLUS
M.E.P., Fairbanks Morse	2-cycle	natural	All	0.2% - 0.5%	SENTRON LD 3000, LD 5000, LD 8000, LD SYNTHETIC BLEND
	4-cycle	natural			
MHI	4- stroke cycle	natural / biogas	All	0.4%- 0.6%	SENTRON LD 5000, LD 8000, CG 40 PLUS
MTU	4-cycle	natural	MTU 400/4000	0.4% - 0.6%	SENTRON LD 5000, LD 8000
		biogas	MTU 400/4000	0.4% - 0.6%	SENTRON CG 40, CG 40 PLUS
Perkins	4-cycle	natural / biogas	All	0.5% min - 1.0% max	SENTRON LD 3000, LD 5000, LD 8000, 590, CG 40 PLUS
RRMEB	4-cycle	natural	All	0.4% - 0.6%	SENTRON LD 3000, LD 5000, LD 8000
Schnell	4-cycle	natural / biogas	All	0.4% - 0.6%	SENTRON LD 5000, LD 8000, CG 40 PLUS
TEDOM	4-cycle	natural	All	0.4% - 1.0%	SENTRON LD 5000, LD 8000
		biogas	All	0.4% - 1.0%	SENTRON CG 40, CG 40 PLUS
Wärtsilä	4-cycle	natural & periodic LFO	150SG, 175SG, 220SG 25SG, 28SG, 34SG, 32DF, 34DF, 50DF	0.6% max	SENTRON LD 3000, LD 5000, LD 8000, 590

[1] 0.1% Zn max. is recommended
[2]SENTRON LD 5000 should only be used in high load applications when using VHP GL Type engine
* The above table can be used as a guideline for product selection. Each stationary gas engine can have unique characteristics and variations in operating parameters, and therefore, it is recommended to consult with Petro-Canada Technical Services Advisor to ensure the most appropriate lubricant selection is made.

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FUEL APPLICATION GUIDE

FUEL GAS	RECOMMENDED PRODUCT
Natural/Pipeline Gas*	
"Light" Biogas/Digester/ Sewage Gas - Treated	SENTRON™ LD 8000 SENTRON™ LD 5000, LD Synthetic Blend
Natural/Pipeline Gas*	SENTRON™ LD 3000, 590, MID ASH 40, SENTRON™ LD 8000, SENTRON™ LD Synthetic Blend, SENTRON™ ASHLESS 40
Landfill Gas – Some treated, lower chlorine	Preferred: SENTRON™ LD 8000, SENTRON™ CG 40 PLUS, LD 5000 Secondary: SENTRON™ CG 40
Landfill Gas – Severe, untreated, high chlorine	Preferred: Pre-treat gas to reduce contaminates / align with OEM Fuel quality minimums. Secondary: SENTRON™ CG 40 PLUS, SENTRON™ CG 40
"Heavy" Biogas/Digester Gas/ Sewage Gas – Untreated	Preferred: SENTRON™ CG 40 PLUS Secondary: SENTRON™ CG 40 with more frequent combustion zone cleaning

* Please consult a Tech Service Advisor to discuss your application before choosing a gas engine oil so that you ensure correct product is being used.

SEPRO™ XL PAPER MACHINE OILS

For use in the wet and dry ends of paper machine circulating systems, SEPRO™ XL also provides excellent oxidation stability for extended drain intervals and excellent water separation for better equipment protection from rust, corrosion and wear.

Petro-Canada's SEPRO™ XL paper machine oils are particularly recommended for situations where there are environmental concerns regarding the quality of discharged waste water. SEPRO™ XL paper machine oils are free of heavy metals, recyclable and non-toxic to water-inhabiting species such as algae and fish in low concentrations (100 mg/L).

Typical characteristics are shown below:

		SEPRO™ XL	
		150	**220**
Viscosity	**cSt @ 40°C**	151	221
	cSt @ 100°C	15.2	19.2
Viscosity Index		101	97
Flash Point, COC, °C/°F		267/513	269/516
Pour Point, °C/°F		-21/-6	-21/-6
Oxidation Stability, Time to TAN of 2.0, hours		2800+	2800+
Rust Test, Procedure A&B, 24 hours		Pass	Pass
FZG Load Stage Fail		12+	12+
Zinc (ppm)		0	0
Barium (ppm)		0	0
Copper Corrosion @ 100°C, 3 hr.		1b	1b
Water separability (time) 82°C		40-40-0 (5 min)	40-39-1 (10 min)

SUPER VAC FLUIDS - VACUUM PUMP FLUIDS

Super Vac Fluids are specially designed to cool, lubricate and provide a seal in piston and rotary-vane air vacuum pumps. Blended with Petro-Canada's 99.9% pure base oils and incorporating a unique additive system, Super Vac Fluids allow for extremely low vapour pressures which help to maximize vacuum efficiency. These fluids have exceptional resistance to high-temperature breakdown and deliver extended lubricant life under severe operating conditions when compared to straight base oil. They can be used at higher operating temperatures (100-130°C / 212-266°F) at reduced service life.

Besides handling air, Super Vac Fluids may also be used with the following gases: nitrogen, hydrogen, carbon dioxide, carbon monoxide, argon, neon and helium. They should not be used in pumps handling aggressive vapours, such as nitric acid, sulphuric acid, chlorine, hydrogen sulphide or glacial acetic acid.

Food Industry Registration

Super Vac Fluids 15,19, and 20 are NSF H2 registered and are acceptable for use in Canadian food processing facilities where no food contact is allowed.

Typical characteristics are shown below:

		SUPER VAC FLUIDS		
		15	**19**	**20**
Viscosity	**cSt @ 40°C**	38	55	103
	cSt @ 100°C	6.2	7.6	11.4
Viscosity Index		110	100	97
Flash Point, COC, °C/°F		220/428	225/437	260/500
Pour Point, °C/°F		-18/0	-15/+5	-12/+10
Oxidation Stability, RPVOT minutes		800	800	800
Calculated Vapour Pressure, mBar @ 25°C		$3x10^{-5}$	$5x10^{-6}$	$3x10^{-6}$

SYNDURO™ SHB SYNTHETIC MULTI-FUNCTIONAL LUBRICANTS

SYNDURO™ SHB Fluids are a family of synthetic multi-functional lubricants designed to deliver excellent component protection for equipment operating at high speed or mild EP loads over a wide temperature range during extended service intervals. They have the added advantage of excellent low-temperature fluidity during start-ups, or during outdoor winter exposure. They are especially suitable for a wide range of gear, bearing and compressor applications in the forestry, mining, marine and heavy-duty industries where low seasonal start-up temperatures and/or high operating temperatures prevail. SYNDURO™ SHB 32, 46 and 68 can also be used in rotary screw air compressors, or as synthetic hydraulic fluids. SYNDURO™ SHB Fluids offer the potential to consolidate lubricants over many different applications and a wide range of environmental conditions. For those applications that are subjected to heavy loads or shock loading and require an AGMA EP type of fluid, Petro-Canada's ENDURATEX™ Synthetic EP or ENDURATEX Synthetic OHV 680 is recommended.

SYNDURO™ SHB 46 meets Voith Doc. 3625-008377 and is therefore suitable for lubrication of the Vorecon variable speed planetary gear type RWE11F6.

Typical characteristics are shown below:

		SYNDURO™ SHB					
		32	**46**	**68**	**150**	**220**	**460**
Viscosity	**cSt @ 40°C**	33	47	68	148	219	452
	cSt @ 100°C	6.2	8.3	11.1	20.3	27.4	46.9
Viscosity Index		142	151	155	159	160	162
Flash Point, COC, °C/°F		237/459	254/488	235/455	237/459	243/469	266/511
Pour Point, °C/°F		<-60/-76	<-60/-76	-54/-65	-45/-49	-42/-44	-39/-38
Oxidation Stability, 24h, 200°C (TAN increase)		0.4	0.4	0.5	0.5	0.5	0.7
FZG Failure Load Stage		12+	12+	12+	12+	12+	12+

Note: These oils should NEVER be used in equipment compressing pure oxygen or other chemically active gases such as chlorine or hydrogen chloride. DO NOT USE in breathing air apparatus or medical equipment.

TURBOFLO™ LOW VARNISH

TURBOFLO™ Low Varnish is a premium turbine fluid designed to lubricate and cool gas, steam and combined-cycle turbines and deliver excellent lubrication to bearings operating in severe conditions. TURBOFLO™ Low Varnish demonstrates an industry leading resistance to varnish and sludge buildup, which will contribute to optimum turbine performance and reliability. The product's outstanding resistance to oxidation and thermal stability minimizes fluid breakdown caused by air and high temperatures.

TURBOFLO™ Low Varnish fluids are suitable for use in gas, steam and combined-cycle turbines requiring the following major manufacturer and industry specifications:

ASTM	D-4304 TYPE I, III
DIN	DIN 51515 PART 1, 2
DIN	DIN 51524 PART 1
ISO	11158 HH, HL
ISO	808 TSA, TGA, TGB and TGSB
British Standard	BS 489
General Electric	GEK-32568H
Siemens	AG TLV 9013 04 STANDARD THERMAL STABILITY
Siemens	AG TLV 9013 05 HIGH THERMAL STABILITY
Alstom	HTGD 90 117

TURBOFLO™ Low Varnish is also suitable for use in turbines requiring Chinese National Turbine Specifications GB11120-2011 L-TSA and L-TSE Class B, in addition to the Technical requirements of L-TGA and L-TGSB.

		TURBOFLO™ LOW VARNISH	
		32	**46**
Viscosity	**cSt @ 40°C**	33.6	45.2
	cSt @ 100°C	5.68	6.79
Viscosity Index		108	104
Flash Point, COC, °C/°F		220/428	230/446
Pour Point, °C/°F		-39/-38	-33/-27
Oxidation Stability (D943), hours to 2.0 TAN		10,000+	10,000+

TURBOFLO™ XL – TURBINE FLUID

TURBOFLO™ XL is a premium turbine fluid designed to lubricate and cool steam, hydraulic and gas turbines and deliver excellent lubrication to bearings operating in severe conditions. TURBOFLO™ XL demonstrates exceptional oxidative and thermal stability, which surpasses that of many competitive turbine lubricants on the market. TURBOFLO™ XL's superior performance is especially important in severe service situations common to gas turbines. Its outstanding oxidation and thermal stability minimizes fluid breakdown caused by air and high temperatures. It is suitable for turbine applications with bearings operating in ambient temperatures above 260°C or 500°F.

TURBOFLO™ XL is designed to significantly exceed the demanding requirements of many steam and gas turbine lubricant specifications.

TURBOFLO™ XL can also be used, with careful system analysis, as a top-up product to enhance operating characteristics of used oil.

TURBOFLO™ XL fluids are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 32568F, GEK 46506E
Siemens	TLV 9013 05 (non EP) (ISO 32 and 46 only)
Siemens / Westinghouse	1500 0020, 5512 5Z3
Solar	ES 9-224W
Alstom (ABB)	HTGD 90 117
DIN	DIN 51515
ASTM	D4304 Type I (non-EP)
JIS	K 2213 Type 2

Typical characteristics are shown below:

		TURBOFLO™ XL		
		32	**46**	**68**
Viscosity	**cSt @ 40°C**	33.9	46.4	68.2
	cSt @ 100°C	5.6	6.8	8.8
Viscosity Index		101	100	102
Flash Point, COC, °C/°F		220/428	235/455	247/477
Pour Point, °C/°F		-30/-22	-30/-22	-24/-11
Oxidation Stability (D943), hours to 2.0 TAN		10,000+	10,000+	10,000+

TURBOFLO™ EP – TURBINE FLUID

TURBOFLO™ EP is a premium turbine fluid designed for the lubrication of geared heavy duty gas turbines with common gear and bearing lubrication systems. Its outstanding thermal and oxidative stability also makes it an excellent choice for severe service gas and steam turbine applications.

TURBOFLO™ EP with its zinc free, ashless anti-wear additive system delivers excellent wear and scuffing protection for heavily loaded geared turbines.

TURBOFLO™ EP fluids are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 101941A, GEK 32568H, GEK 46506E, GEK 28143A
Siemens	TLV 9013 04 (EP), TLV 9013 05
Siemens / Westinghouse	1500 00 20, 5512 5Z3
Solar	ES 9-224W
Alstom (ABB)	HTGD 90 117
DIN	DIN 51515
ASTM	D4304 Type II (EP)
JIS	K 2213 Type 2
Voith	Variable Speed Drives

Typical characteristics are shown below:

		TURBOFLO™ EP	
		32	**46**
Viscosity	**cSt @ 40°C**	34.2	46.4
	cSt @ 100°C	5.6	6.8
Viscosity Index		100	101
Flash Point, COC, °C/°F		220/428	237/459
Pour Point, °C/°F		-33/-27	-30/-22
Oxidation Stability (D943), hours to 2.0 TAN		10,000+	10,000+
FZG Failure Load Stage		12	12

TURBOFLO™ R&O/PREMIUM R&O 77– TURBINE/CIRCULATING OILS

TURBOFLO™ R&O/Premium R&O 77 Oils are high quality lubricants designed for use in steam and gas turbines, as well as the circulating oil systems of a wide range of industrial machinery. The R&O 10 and 22 grades are also suitable for use as spindle oils. These oils are designed to minimize rust and oxidation with blends of Petro-Canada's ultra-pure HT Severely Hydrocracked base oils and specially selected additives. In addition, they offer excellent water separability.

Premium R&O 77 meets National Defence Standard C-82-001-000/SF-001, Naval Steam Turbine and Main Gearing Lubrication.

TURBOFLO™ R&O 32, 46, 68 and Premium R&O 77 are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 46506E (ISO 32), GEK 32568J (ISO 32)
Siemens	TLV 9013 04 (non-EP) (ISO 32 and 46)
Siemens / Westinghouse	1500-00-20 (ISO 32)
GE (formerly Alstom)	HTGD 90 117 V0001X (ISO 32, 46)
Solar	ES 9-224W (ISO 32, 46)
ASTM	D 4304 Type I (non- EP) (ISO 32, 46, 68, 100)
JIS	K 2213 Type 2

Typical characteristics are shown below:

		TURBOFLO™ R&O					
		10	**22**	**32**	**46**	**68**	**Premium R&O 77**
Viscosity	**cSt @ 40°C**	9.8	22.1	32.0	44.4	65.0	78.0
	cSt @ 100°C	2.7	4.3	5.4	6.7	8.6	9.7
Viscosity Index		105	95	103	104	104	102
Flash Point, COC, °C/°F		182/360	204/399	220/428	224/435	234/453	240/464
Pour Point, °C/°F		-54/-65	-39/-38	-39/-38	-36/-33	-30/-22	-30/-22
Oxidation Stability (D943) hours to 2.0 TAN		5,900+	5,900+	5,000+	5,000+	5,300+	5,000+

		TURBOFLO™ R&O			
		100	**150**	**220**	**320**
Viscosity	**cSt @ 40°C**	94.3	139	203	298
	cSt @ 100°C	11.1	14.3	18.3	23.4
Viscosity Index		103	101	99	98
Flash Point, COC, °C/°F		262/504	282/540	282/540	268/514
Pour Point, °C/°F		-24/-11	-24/-11	-15/5	-18/0
Oxidation Stability (D943) hours to 2.0 TAN		6,300+	3,500+	3,500+	2,700+

TURBONYCOIL™ 600 - LAND BASED AERODERIVATIVE GAS TURBINE FLUID

Rolls Royce approved TURBONYCOIL™ 600 (registered trademark of NYCO SA) is specially designed to effectively lubricate land based aeroderivative gas turbines operating under extreme conditions. The fluid resists heat soak-backup to 350°C or 662°F. TURBONYCOIL™ 600 is based on polyol esters with high thermal stability and fortified with anti-oxidant, anti-wear and anti-corrosion additives. TURBONYCOIL™ 600 is approved by the following engine manufacturers for use in land based industrial and marine gas turbine applications where a MIL-PRF-23699G Standard (Non-Corrosion Inhibiting) Classification or Rolls Royce approved lubricant is required: Rolls Royce, Allison, CFM International, Turbomeca, Pratt & Whitney Canada, Hamilton Sundstrand/APIC, General Electric and Motor Sich. Turbonycoil 600 meets the following specifications:

Joint Service	OX-27/OX-28
NATO	Code 0-156
DEF STAN	91-101 Iss.3, Amd.1
SAE	AS5780 Class SPC

4

Typical characteristics are shown below:

		TURBONYCOIL™ 600
Viscosity	**cSt @ 40°C**	25.6
	cSt @ 100°C	5.1
	cSt @ -40°C	9,468
Flash Point, COC, °C/°F		270/518
Pour Point, °C/°F		-57/-71
Evaporation Loss, 6½h @ 204°C, % Wt		3.4
Total Acid No., mg KOH/g		0.16


MAXIMUM PERFORMANCE
PERFORMANCE MAXIMALE
TM/MC

GREASES

INTRODUCTION

Greases are designed to lubricate bearings and gears where a continuous oil supply cannot be maintained. Grease is a solid to semi-solid material produced by the dispersion of a thickening agent in a liquid lubricant. In many cases, specialty additives are also used to enhance the performance of the product. When selecting grease for an application, capabilities such as operating temperatures, water resistance, oxidation stability, etc. are important considerations. The grease's characteristics, including viscosity and consistency, are also key factors to consider.

The most important factors affecting the properties and characteristics of a grease are:
- Amount and type of thickener
- Oil viscosity and physical characteristics

A grease is expected to:
- Reduce friction and wear
- Provide corrosion protection
- Seal bearings from water and contaminants
- Resist leakage, dripping and throw-off
- Resist change in structure or consistency during service
- Maintain mobility under conditions of application
- Be compatible with seals
- Tolerate or repel moisture

REGULAR GREASE

Regular (or simple) greases are primarily made through the reaction of a metal hydroxide with a fatty acid. The metal hydroxide is typically lithium, calcium or aluminum and has an important impact on the characteristics of the grease.

Simple lithium greases provide wide temperature capabilities with good water resistance. Simple calcium greases provide good water resistance, but do not perform as well at high temperatures. Simple aluminum greases have inherent stringiness making them a good choice for semi-fluid greases and applications where adhesion is of primary importance.

COMPLEX GREASE

Complex greases are also made with fatty acids similar to regular greases except that they use an additional carboxylic acid, which is the complexing agent. This imparts good high temperature characteristics to the final product along with the characteristics of the base metal hydroxide. Common complex greases include lithium complex, aluminum complex and calcium complex.

Calcium sulphonate complex grease – Calcium sulphonate complex grease is based on a micelle structure rather than a soap. It provides both thickening and performance properties for the grease, including excellent corrosion protection.

LUBRICATING OIL

Greases typically contain 75-95% oil, which must be of high quality and proper viscosity for the intended application. Light viscosity or synthetic oils are normally used for low temperature, low load and/or high speed applications. Conversely, a heavy viscosity oil is generally used for high temperature, high load and/or slow speed applications.

ADDITIVES

The most common additives found in grease are as follows:

- Oxidation Inhibitors – prolong the life of a grease
- Extreme Pressure (EP) Agents – prevent welding and seizing at high loads
- Anti-Corrosion Agents – protect metal against attack from water
- Anti-Wear Agents – prevent abrasion and metal to metal contact

GREASE DEFINITIONS

- **Consistency** – is the degree of hardness of a grease and may vary considerably with temperature. This has been classified by the National Lubricating Grease Institute (NLGI) into the following categories:

NLGI GRADE	PENETRATION @ 25°C (1/10th mm)
000	445 - 475
00	400 - 430
0	355 - 385
1	310 - 340
2	265 - 295
3	220 - 250
4	175 - 205
5	130 - 160
6	85 - 115

- **Shear Stability** – is the ability of a grease to resist a change in consistency during mechanical working. Under high rates of shear, grease structures tend to change in consistency (usually becoming softer).
- **Oil Separation** – is the percentage of oil which separates from the grease under static (e.g. storage) conditions. It cannot predict separation tendencies in use under dynamic conditions.
- **High Temperature Stability** – is the ability of a grease to retain its consistency, structure and performance at temperatures above 125°C/260°F.

GREASE SERVICE CLASSIFICATION

The following five (5) categories for Automotive Service Greases have been developed by the NLGI. The scope of this classification (ASTM D 4950) covers greases designed for the lubrication of chassis components and wheel bearings of passenger cars, trucks and other vehicles. The NLGI classifies automotive service greases into two (2) main groups: Chassis greases designated by the prefix **L**, and Wheel Bearing greases designated by the prefix **G**.

The following table outlines the five (5) categories:

NLGI AUTOMOTIVE SERVICE GREASE CATEGORIES

Category	Service	Performance
LA chassis	Frequent relubrication intervals (<3200 km). Mild duty (non-critical applications).	Oxidation resistant, shear stable, and corrosion and wear protective.
LB chassis	Prolonged relubrication intervals (>3200 km). Mild to severe duty (high loads, vibration, exposure to water).	Oxidation resistant, shear stable, and corrosion and wear protective even under heavy loads and in presence of aqueous contamination. Temperature range -40°C to 120°C.
GA wheel bearings	Frequent relubrication intervals. Mild duty (non-critical applications).	Temperature range -20°C to 70°C.
GB wheel bearings	Mild to moderate duty (cars, trucks in urban and highway service.)	Oxidation and evaporation resistant, shear stable, and corrosion and wear protective. Temperature range -40°C to 120°C with occasional excursions to 160°C.
GC wheel bearings	Mild to severe duty (vehicles in frequent stop-and-go service, trailer hauling, mountain driving, etc.)	Oxidation and evaporation resistant, shear stable, and corrosion and wear protective. Temperature range -40°C to 120°C with frequent excursions to 160°C and occasional excursions to 200°C.

GREASE COMPATIBILITY

Not all grease thickeners are compatible and care must be taken when switching to a new grease. If the thickeners are incompatible, the mixture will fall short of the properties of the individual greases.

It is strongly advised that, in all cases, the old grease be purged or cleaned out from the system before a new one is introduced. Compatibility between greases is temperature dependent. As the temperature rises, the problems associated with incompatibility also increase. The following chart indicates the compatibilities of major Petro-Canada greases. Competitors' products should be treated as incompatible with Petro-Canada greases unless compatibility has been tested.

		Aluminum Complex VULTREX™ MPG	**Lithium** PRECISION™ General Purpose EP2	**Polyurea** Chevron SRI 2	**Lithium Complex** PRECISION™ XL EP2	**Barium Complex**	**Silica** THERMEX™	**Clay**
Lithium	PRECISION™ General Purpose EP2	Yes 140						
Polyurea	Chevron SRI 2	Yes 130	Yes 145					
Lithium Complex	PRECISION™ XL EP2	Yes 150	Yes 170	Yes 158				
Barium Complex		Yes 168	Yes 153	Yes 173	Yes 160			
Silica	THERMEX™	Yes 115	No (*)	No 80	No (*)	Yes 173		
Clay		No 58	No 95	No (*)	Yes 183	Yes 173	No 75	
Calcium Sulphonate Complex	PEERLESS™ OG-2	No 98	Yes 125	No 95	Yes 125	Yes 140	No (*)	No 95

Notes:
1. The number quoted indicates the temperature, in degrees Celsius, at which incompatibility sets in.
2. (*) Indicates the mixture is incompatible at all temperatures.

GREASE PROPERTIES

The following chart provides key properties of all the common grease thickener types.

	REGULAR GREASES				**COMPLEX**			**SYNTHETIC**	**CLAY**
Properties	**Calcium**	**Lithium**	**Sodium**	**Aluminum**	**Calcium**	**Barium**	**Lithium**	**Polyurea**	**Bentone**
Dropping Point °C	80-100	175-205	170-200	260+	260+	200+	260+	250+	None
*Max Temp °C	65	125	125	150	150	150	160	150	150
High Temp Use	V. Poor	Good	Good	Exc	Exc	Good	Exc	Exc	Exc
Low Temp Mobility	Fair	Good	Poor	Good	Fair	Poor	Good	Good	Good
Mech. Stability	Fair	Good	Fair	Exc	Good	Fair	Exc	Good	Fair
Water Resist.	Exc	Good	Poor	Exc	Exc	Exc	Exc	Exc	Fair
Oxidation Stability	Poor	Good	Good	Exc	Exc	Poor	Good	Exc	Good
Texture	Smooth	Smooth	Fibrous or Smooth	Smooth	Smooth	Fibrous	Smooth	Smooth	Smooth

*These temperatures refer to continuous operation. They may be exceeded temporarily in the case of complex greases, and where rigorous lubrication practice is followed.

APPLYING GREASE

The over-packing and over-greasing of bearings accounts for more failures than any other factor. Excess grease in a bearing cavity increases internal friction, which in turn raises the bearing temperature above the dropping point of the grease. This causes oil separation and eventually lack of lubrication.

Re-greasing intervals are determined from:

• severity of service • environment • condition of seals • shock loading

REGREASING AMOUNTS FOR BEARINGS

When packing a split housing pillow block bearing, ensure that the grease cavity is only 1/3 full. Rolling element bearings should be filled 1/4 to 1/2 the total capacity of the bearing housing. However, the following formulas can be used to determine the correct amount of grease for a greasing interval:

Regreasing amount in ounces: G(oz) = 0.114* W (bearing width in inches) * OD (bearing outer diameter in inches).

Metric Equivalent: G(gm) = 0.503 * W(in cm) * OD(in cm)

The proper technique for greasing a rolling element bearing is to wipe the grease fitting with a clean, lint free cloth and then to add the correct amount of grease to the housing. If a purge plug is present it should be removed and the bearing operated for 10-15 minutes to allow the level of grease to equalize and then replace the purge plug. If no purge plug is present the grease fitting should be removed (or replaced with a self-purging fitting) and operated for 10-15 minutes and then replaced. Always check the temperature before and after this procedure.

The following chart provides a guide to re-greasing intervals and the amount of grease to be applied. Please further confirm re-greasing amounts and intervals with your manufacturer.

GREASE LUBRICATION SCHEDULE
SPHERICAL ROLLER BEARINGS

Shaft Size		Amount of grease		Operating speed (rpm)									
				500	1000	1500	2000	2200	2700	3000	3500	4000	4500
Inches	MM	IN^3	CM^3	Lubrication cycle (months)									
¾-1	25	0.39	6.4	6	6	6	4	4	4	2	2	1	1
1⅛-1¼	30	0.47	7.7	6	6	4	4	2	2	1	1	1	1
1⅜-1½	35	0.56	9.2	6	4	4	2	2	1	1	1	1	½
1⅝-1¾	40	0.80	13.1	6	4	2	2	1	1	1	1	½	
1 15/16-2	45 - 50	0.89	14.6	6	4	2	1	1	1	1	½		
2 3/16-2¼	55	1.09	17.9	6	4	2	1	1	1	½			
2 7/16-2½	60	1.30	21.3	4	2	1	1	1	½				
2 11/16-3	65 - 75	2.42	39.7	4	2	1	1	½					
3 3/16-3½	80 - 85	3.92	64.2	4	2	1	½						
3 11/16-4	90 - 100	5.71	93.6	4	1	½							
4 3/16-4½	110 - 115	6.50	106.5	4	1	½							
4 15/16-5	125	10.00	163.9	2	1	½							

TEMPERATURE 90°C (200°F) HORIZONTAL SHAFT EQUIPMENT

GREASES

Petro-Canada greases are listed according to their performance or application, as follows:

- Regular Performance Greases
- Premium Performance Greases
- Synthetic Greases
- Specialty Greases for High Temperatures
- Specialty Greases for Water Resistance
- Specialty Greases
- Food Grade Greases
- Mining Greases and Drilling Compounds

• REGULAR PERFORMANCE GREASES

MULTI-APPLICATION LITHIUM GREASES

PRECISION™ GENERAL PURPOSE Greases are a series of high quality, lithium based extreme pressure greases for wide operating temperature ranges and water resistance.

PRECISION™ GENERAL PURPOSE EP2 Grease is used in bearings operating at low to moderate speeds and at medium temperatures.

PRECISION™ GENERAL PURPOSE EP1 Grease is recommended for centralized grease systems to lubricate heavily loaded conveyor bearings, mobile mining and forestry equipment and high speed industrial bearings.

PRECISION™ GENERAL PURPOSE MOLY EP2 Grease incorporates molybdenum disulphide and graphite (1.5% solids) for added protection. It is ideally suited for applications in truck fleets, mobile equipment and plant machinery which require a grease with good extreme pressure (EP) and shock resistant properties.

Typical characteristics for PRECISION™ GENERAL PURPOSE Greases are shown below:

	PRECISION™ GENERAL PURPOSE		
	EP2	**EP1**	**MOLY EP2**
Soap Type	Lithium	Lithium	Lithium
Colour	Brown	Brown	Grey
Worked Penetration @ 25°C	265	310	272
Dropping Point, °C/°F	198/388	191/376	191/376
Base Oil Viscosity			
cSt @ 40°C	159	159	159
cSt @ 100°C	14.9	14.9	14.9
Timken OK Load, kg/lb	18/40	18/40	18/40
Weld Point, kg	250	250	315
Operating Range, °C	-25 to 135	-30 to 135	-25 to 135
°F	-13 to 275	-22 to 275	-13 to 275
Minimum Dispensing Temperature, °C/°F	-25/-13	-30/-22	-25/-13

• PREMIUM PERFORMANCE LITHIUM / LITHIUM COMPLEX GREASES

PRECISION™ XL GREASES

PRECISION™ XL greases are versatile premium performance, long-life, lithium/lithium-complex greases designed to lubricate and protect automotive and industrial equipment over a very wide range of operating conditions. PRECISION™ XL greases are recommended for passenger cars, vans, highway truck fleets and all off-highway vehicles. They are also the prime recommendation for all industrial machinery, as well as pulp and paper & steel mills and mineral extraction equipment.

PRECISION™ XL EMB Grease – is an NLGI #2 lithium complex non-EP electric motor bearing grease. Applications include high temperature bearings on electric motors and generators (meets CGE specification 6298 for class B or F insulation) and high speed and anti-friction bearings found on direct-drive (non-speed reduced) fans.

PRECISION™ XL EP00 Grease – is a semi-fluid NLGI #00 EP lithium grease developed for centralized on-board truck chassis lubrication systems. Despite its soft nature, PRECISION™ XL EP00 retains a good dropping point, high base oil viscosity and the EP characteristics necessary to handle shock loads and reduce wear. PRECISION™ XL EP00 has been developed for centralized grease lubrication systems such as Groeneveld, Robertshaw, Lincoln, Grease Jockey, Interlube and Vogel. This grease handles all autogreasing points on a truck. PRECISION™ XL EP00 may be used also as a gear drive lubricant, where a high viscosity gear oil with good low temperature mobility is required, or in leaking gear-boxes.

PRECISION™ XL EP000 Grease – is an extreme pressure, semi-fluid lithium grease inhibited against wear, rust and oxidation. This grease was specifically designed for use in leaky or poorly sealed gear boxes. Applications in general industry include leaky speed reducers*, chain cases, bearings and in centralized grease systems. It is also well suited to the gear boxes of continuous miners operating in the coal and potash industries.
*Grease level must cover one-half the gear shaft bearings.

PRECISION™ XL EP1 Grease – is an NLGI #1 EP lithium complex grease designed for use in heavy duty and general purpose bearing applications supplied by centralized lubrication systems. PRECISION™ XL EP1 may be used as a winter alternative to PRECISION™ XL EP2, where greater mobility at low temperatures is desired. PRECISION™ XL EP1 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PRECISION™ XL EP2 Grease – is an NLGI #2 EP lithium complex grease designed for use in all types of heavy duty and general purpose bearings operating at both low and high speeds. PRECISION™ XL EP2 can be used for grease-gun application for a wide range of equipment and conditions. Applications include automotive wheel bearings (especially wheels fitted with disc brakes), chassis points (on-highway, off-highway and farm vehicles), and industrial machinery such as paper machines, presses, mills and crushers. PRECISION™ XL EP2 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PRECISION™ XL 3 Moly EP1 and EP2 Greases – are lithium greases compounded with 3% molybdenum disulphide. They are best suited for tough, heavy-duty shock loaded equipment in industrial and off-highway applications. They are also suitable for truck fifth wheels. PRECISION™

XL Moly 3 EP1 is formulated for better pumpability at lower temperatures than PRECISION™ XL Moly 3 EP2 and may be used in centralized greasing systems. Both grades are on the Certified Lubricants Listing for the Caterpillar Global Mining (formerly Bucyrus International) MPG - Multi Purpose Grease (SD 4711) specification.

PRECISION™ XL 3 Moly Arctic Grease – is an NLGI #1 lithium grease formulated with a low viscosity base oil for excellent low temperature mobility. It is compounded with 3% molybdenum disulphide for heavy duty shock loaded industrial and off-highway applications. It is also recommended for use in centralized lubrication systems especially at low temperatures for mining/forestry applications.

PRECISION™ XL 5 Moly EP0, EP1 and EP2 lithium greases contain medium viscosity oil and are compounded with 5% molybdenum disulphide. They are designed to meet Caterpillar lubricant specifications for their 5130 (7TJ & 5ZL), 5230 (7LL) model Mining Excavators and 994 (9YF) model Wheel Loaders. The EP0 is on the Certified Lubricants Listing for the Caterpillar Global Mining (formerly Bucyrus International) grease specification SD 4711 (Multi-Purpose Grease). Not recommended for applications requiring a tackified grease.

PRECISION™ XL HEAVY DUTY – This robust NLGI #2 lithium complex grease is formulated for use in centralized lubrication systems found in steel mills. It is also suitable for heavy duty, slow moving and/or high temperature applications.

PRECISION™ XL RAIL CURVE GREASE – is a water-resistant NLGI #1 lithium rail curve grease compounded with graphite. It offers enhanced wear protection, excellent adhesion and has a wide application temperature range. It is recommended for the following applications: track-side mechanical lubrication systems (Portec and Lincoln), on-board lubrication systems (Clicomatic), switches, switch plates (hand applied/brushed), fish plates, joint bars, and other railway applications where graphite greases are recommended.

Typical characteristics of our PRECISION™ XL line are shown below:

	PRECISION™ XL				
	EP2	**EP1**	**EP00**	**EP000**	**EMB**
Soap Type	Lithium Complex	Lithium Complex	Lithium	Lithium	Lithium Complex
Colour	Green	Green	Green	Dark Amber	Tan
Worked Penetration					
@ 25°C	274	324	415	463	291
Dropping Point, °C/°F	302/576	297/567	191/376	193/379	296/565
Base Oil Viscosity					
cSt @ 40°C	220	220	112	325	112
cSt @ 100°C	17.9	17.9	12.8	23.8	12.1
Timken OK Load, kg/lb	27/60	27/60	18/40	18/40	-
Weld Point, kg	315	315	250	250	-
Operating Range, °C	-20 to 160	-25 to 160	-35 to 100	-25 to 100	-25 to 160
°F	-4 to 320	-13 to 320	-31 to 212	-13 to 212	-13 to 320
Minimum Dispensing Temperature, °C/°F	-20/-4	-25/-13	-35/-31	-25/-13	-20/-4

	PRECISION™ XL				
	HEAVY DUTY (STEEL MILL)	**RAIL CURVE**	**3 MOLY EP2**	**3 MOLY EP1**	**3 MOLY ARCTIC**
Soap Type	Lithium Complex	Lithium	Lithium	Lithium	Lithium
Colour	Brown	Black-Grey	Green-Grey	Green-Grey	Grey
Worked Penetration @ 25°C	284	322	287	336	320
Dropping Point, °C/°F	284/543	186/367	241/466	220/428	185/365
Base Oil Viscosity					
cSt @ 40°C	420	28	403	210	34
cSt @ 100°C	25.6	5.3	25.1	17.3	6.1
Timken OK Load, kg/lb	27/60	18/40	27/60	27/60	18/40
Weld Point, kg	315	400	800	800	250
Operating Range, °C	-10 to 160	-50 to 120	-15 to 135	-25 to 135	-45 to 135
°F	14 to 320	-58 to 248	5 to 275	-13 to 275	-49 to 275
Minimum Dispensing Temperature, °C/°F	-10/14	-45/-49	-15/5	-25/-13	-45/-49

	PRECISION™ XL		
	5 MOLY EP0	**5 MOLY EP1**	**5 MOLY EP2**
Soap Type	Lithium	Lithium	Lithium
Colour	Grey	Grey	Grey
Worked Penetration @ 25°C	365	331	273
Dropping Point, °C/°F	214/417	227/441	187/369
Base Oil Viscosity			
cSt @ 40°C	133	159	204
cSt @ 100°C	13.7	14.9	19.4
Timken OK Load, kg/lb	23/50	23/50	20/45
Weld Point, kg	620	620	620
Operating Range, °C	-50 to 120	-30 to 135	-25 to 135
°F	-58 to 248	-22 to 275	-13 to 275
Minimum Dispensing Temperature, °C/°F	-45/-49	-25/-13	-25/-13

• SYNTHETIC GREASES

PRECISION™ SYNTHETIC GREASE

PRECISION™ Synthetic – is a long-life, premium performance, all-season, extreme pressure lithium complex (NLGI #1) grease containing a synthetic base oil. Originally developed to lubricate heavy mining equipment under Arctic conditions, this grease delivers outstanding cold weather performance without compromising high temperature lubrication. PRECISION™ Synthetic meets NLGI Automotive Service Classification GC-LB for wheel bearing and chassis lubrication.

PRECISION™ Synthetic Moly – is a variation of PRECISION™ Synthetic containing 3% molybdenum disulphide for added protection against vibration and shock loading. This grease is particularly suitable for on and off highway equipment subjected to heavy vibration and operating under extreme hot and cold temperature conditions.

PRECISION™ Synthetic Heavy 460 – is a synthetic, high temperature EP lithium complex NLGI #1 grease, containing a high viscosity base oil. It is designed for heavy duty, slow moving and/or high temperature applications including steel mills and paper machines.

PRECISION™ Synthetic Heavy 1500 – is a synthetic, high temperature EP lithium complex NLGI #1.5 grease, containing a very high viscosity base oil. It is designed for extremes of low speed, heavy load and high temperature, conditions which are typically encountered in mining, construction and forestry applications.

PRECISION™ Synthetic EP00 – is a synthetic semi-fluid lithium complex grease designed primarily for lubricating truck/trailer wheel-end bearings. This softer grade of PRECISION™ Synthetic Heavy is also recommended for use in leaky gear-cases.

PRECISION™ Synthetic EMB – is a non-EP, NLGI #2 synthetic electric motor bearing grease formulated for long service life and excellent high and low temperature performance. It meets CGE specification 6298 for Class B or F insulation.

Typical characteristics are shown below:

	PRECISION™ Synthetic					
		Moly	**Heavy 460**	**Heavy 1500**	**EP00**	**EMB**
Soap Type	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex
Colour	Gold	Grey	Gold	Gold	Gold	Tan
Worked Penetration @ 25°C	340	318	315	305	404	293
Dropping Point, °C/°F	301/574	296/565	301/574	277/531	286/547	309/588
Base Oil Viscosity						
cSt @ 40°C	130	130	507	1495	507	114
cSt @ 100°C	15.6	15.6	45.4	112	45.4	15.6
Timken OK Load, kg/lb	27/60	27/60	27/60	30/65	25/55	N/A
Weld Point, kg	250	400	315	315	315	N/A
Operating Range, °C	-40 to 170	-40 to 170	-30 to 170	-20 to 170	-40 to 170	-40 to 170
°F	-40 to 338	-40 to 338	-22 to 338	-4 to 338	-40 to 338	-40 to 338
Min. Dispensing Temperature, °C/°F	-35/-31	-35/-31	-25/-13	-25/-13	-35/-31	-35/-31

• SPECIALTY GREASES FOR HIGH TEMPERATURES

PEERLESS™ GREASES

PEERLESS™ LLG™ is an NLGI # 2 calcium sulphonate complex grease, specifically formulated for high temperature and very long life applications. It has excellent water washout resistance and corrosion protection, and meets NLGI Automotive Service Classification GC-LB. PEERLESS™ LLG is recommended for all sealed-for-life bearings found on automotive and industrial equipment, as well as other “life-pack” applications, such as constant-velocity joints. It is also recommended for equipment with bearings and slide-ways operating continuously at temperatures up to 200°C/392°F or intermittently as high as 300°C/572°F. It can also be used to grease electric-motor bearings.

	PEERLESS™ LLG
Thickener Type	Calcium Sulphonate Complex
Colour	Burgundy
Worked Penetration @ 25°C	284
Dropping Point, °C/°F	314/597
Base Oil Viscosity	
cSt @ 40°C	100
cSt @ 100°C	10.8
Timken OK Load, kg/lb	27/60
Weld Point, kg	500
Operating Range, °C	-20 to 200
°F	-4 to 392
Minimum Dispensing Temperature, °C/°F	-20/-4

THERMEX™

THERMEX™ is an NLGI #2 grease formulated with a silica gel thickener in a synthetic base oil. It is a non-melting grease with excellent shear stability and a good service life at temperatures in excess of 260°C/500°F. When exposed to high temperatures it does not harden or carbonize. The fluid component vapourizes slowly, leaving little or no deposit.

Typical characteristics are shown below:

	THERMEX™
Thickener Type	Silica Gel
Worked Penetration @ 25°C	280
Dropping Point, °C/°F	260+/500+
Base Oil Viscosity	
cSt @ 40°C	227
cSt @ 100°C	37
Weld Point, kg	160

• SPECIALTY GREASES FOR WATER RESISTANCE

PEERLESS™ OG GREASE

PEERLESS™ OG products are based on a special type of calcium sulphonate complex thickener, which retains its effectiveness in the presence of water. They are capable of absorbing moderate levels of water without softening or changing consistency, while still providing outstanding rust protection. PEERLESS™ OG greases are EP multipurpose, high temperature greases.

PEERLESS™ OG2 – is an NLGI #2 with excellent adhesiveness and is ideally suited for all types of industrial and automotive bearings, for fifth wheels, forklift mast slides, boat trailer wheel bearings, king pins, and for open gears. PEERLESS™ OG2 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS™ OG2 Red – is similar to PEERLESS™ OG2, but contains a red dye and an additional tackifier for enhanced adhesion. It also meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS™ OG1 – is an NLGI #1 with lower oil viscosity and thickener content for ease of pumpability under cooler ambient conditions. It meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS™ OG0 – is an NLGI #0 designed for use in low ambient temperature conditions.

PEERLESS™ OG Plus is an NLGI #2.5 tenacious grease with exceptional sealing properties and extremely low water washout. It contains a polymer-enhanced base oil which is suitable for heavily loaded bearings. It is recommended for the wet end bearings of paper mills and other applications requiring longer re-lubrication intervals.

Typical characteristics are shown below:

	PEERLESS™				
	OG0	**OG1**	**OG2**	**OG2 Red**	**OG PLUS**
Soap Type	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex
Colour	Tan	Tan	Tan	Red	Tan
Worked Penetration @ 25°C	366	329	276	270	249
Dropping Point, °C/°F	284/543	310/590	304/579	300/572	309/588
Base Oil Viscosity					
cSt @ 40°C	38	53	73	73	78
cSt @ 100°C	7.3	8.9	9.4	9.4	9.4
Timken OK Load, kg/lb	23/50	27/60	27/60	27/60	27/60
Weld Point, kg	315	400	400	500	500
Operating Range, °C	-35 to 163	-30 to 163	-25 to 163	-25 to 163	-20 to 163
°F	-31 to 325	-22 to 325	-13 to 325	-13 to 325	-4 to 325
Minimum Dispensing Temp °C/°F	-30/-22	-25/-13	-18/0	-18/0	-15/5

• SPECIALTY GREASES

PEERLESS™ SVG 102 – VALVE GREASE is an NLGI #1 calcium sulphonate complex grease formulated primarily for the lubrication of the internal parts of valves employed in the production and distribution of sour gas in natural gas plants.

It protects the valves against corrosion and the deleterious effects of hydrogen sulphide present in these gas streams. PEERLESS™ SVG 102 has also been successfully applied to valves used in LPG and water injection systems in the oil and gas industry.

PEERLESS™ XCG-Flex is an NLGI #1 calcium sulphonate complex grease with outstanding mechanical stability and resistance to oil separation. In addition, it has a high-load carrying ability, a high dropping point and excellent resistance to corrosion and water wash-out.

PEERLESS™ XCG-Flex is an ideal choice for use in high-speed flexible couplings, where severe centrifugal forces are generated. It prevents oxidative fretting corrosion and protects against wear under high gear tooth loadings and vibration. PEERLESS™ XCG-Flex meets AGMA coupling grease specifications CG-1 and CG-2.

Typical characteristics are shown below:

	PEERLESS™	
	XCG-Flex	**SVG-102 VALVE GREASE**
Thickener Type	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex
Colour	Brown	Green-Grey
Worked Penetration @ 25°C	335	324
Dropping Point, °C/°F	290/554	262/504
Base Oil Viscosity		
cSt @ 40°C	329	80
cSt @ 100°C	22.5	11.2
Weld Point, kg	500	620
Timken OK Load, kg/lb	30/65	27/60
Oil Separation, %	0.1	0.0
Water Wash-out, %	1.5	1.5
Operating Range, °C	-20 to 163	-35 to 163
°F	-4 to 325	-31 to 325
Minimum Dispensing Temp °C/°F	-20/-4	-35/-31

• FOOD GRADE GREASES

PURITY™ FG2, PURITY™ FG1, and PURITY™ FG00 greases are advanced food grade lubricants specially formulated to deliver exceptional performance under the highly demanding conditions of food processing operations. They can be used in a wide range of food processing applications including sleeve and anti-friction bearings, slides, and guides found on food processing machinery. PURITY™ FG greases exhibit good low temperature pumpability and excellent resistance to water wash-out and spray loss. In addition, they have exceptional anti-wear and extreme pressure properties, protect against rust and corrosion and are white in colour.

PURITY FG2 with **MICROL™ MAX**† grease is a new generation of lubricant specially formulated to inhibit the growth of microbes that cause product degradation in lubricants. PURITY FG2 with MICROL™ MAX is an NSF H1 registered lubricant formulated with a U.S. EPA registered antimicrobial preservative.

PURITY™ FG2 Synthetic grease is specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high and low temperature extremes. It is recommended as a multiservice or multi-application lubricant across all food processing applications such as cold temperature applications including freezers; high temperature applications including ovens, multi service bearings, canning, bottling equipment, and mixers.

PURITY™ FG2 Extreme grease is a high viscosity, semi synthetic, heavy duty food grade grease specifically formulated for low to medium speed, heavily loaded industrial bearings operating under severe conditions. PURITY™ FG2 Extreme exhibits excellent protection in applications subjected to high temperature, high pressure, and heavy loads while operating continuously, such as animal feed pellet mills and continuous rotary cookers. PURITY™ FG2 Extreme is best suited for applications under 1000 RPM.

PURITY™ FG2 Clear grease is an advanced colourless lubricant specially formulated to deliver superior performance under the highly demanding conditions of food processing operations when compared to other clear food grade greases. PURITY™ FG2 Clear grease was designed for use in anti-friction bearings, slides, and guides throughout food processing plants. It is specifically formulated for beverage production machinery such as canning and bottling equipment.

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

Typical characteristics are shown below:

	PURITY™ GREASES							
	FG2	**FG1**	**FG00**	**FG2 with MICROL™ MAX†**	**FG2 Synthetic**	**FG2 Synthetic Heavy 220**	**FG2 Extreme**	**FG2 Clear**
Thickener Type	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Calcium Sulphonate Carbonate/ Complex	Calcium Sulphonate/ Carbonate Complex	Aluminum Complex	Aluminum Complex
Colour	White	White	White	Cream	Tan	Tan	White	Clear
Worked Penetration @ 25°C	283	328	420	292	294	268	276	293
Dropping Point, °C/°F	277/531	266/511	211/412	287/549	304/579	>304/579	264/507	277/531
Base Oil Viscosity								
cSt @ 40°C	182	172	182	182	50	220	469	185
cSt @ 100°C	17	16	17	17	7.8	24	33	18
Timken OK Load, kg/lb	16/35	23/50	16/35	27/60	27/60	27/60	23/50	9/20
Weld Point, kg	500	400	620	315	500	400	400	200
Operating Range, °C	-20 to 160	-25 to 160	-35 to 120	-20 to 160	-40 to 200	-25°C to 200°C	-20 to 160	-20 to 160
°F	-4 to 320	-13 to 320	-31 to 248	-4 to 320	-40 to 392	13°F to 392°F	-4 to 320	-4 to 320
Minimum Dispensing Temperature, °C/°F	-20/-4	-25/-13	-30/-22	-20/-4	-35/-31	-20°C/-4°F	-20/-4	-20/-4

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†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

• MINING GREASES AND DRILLING COMPOUNDS

VULTREX™ OGL AND EGF GREASES

The VULTREX™ OGL family of grease-based gear lubricants are sophisticated, next-generation lubricants, designed for use on large, heavy-duty, open and enclosed gear drives, as well as bearings and exposed sliding surfaces. This machinery is most commonly found in open-pit mining operations using large mining shovels, excavators and draglines. The VULTREX™ OGL line of greases is designed with a darkening agent that allows mining operators to more easily identify gears that have adequate grease applied.

VULTREX™ OGL Synthetic 2200 is a high viscosity aluminum complex, solvent-free, open gear lubricant specifically designed to provide "ONE LUBRICANT" for mining shovels, draglines, excavators, drills and haul trucks. It is intended for summer use or for year round use in warmer climates, with a lower temperature limit of -15°C/5°F. It meets the P&H 520 Multiservice Mining Lubricant specification and the P&H 464 Open Gear Lubricant specification. It also meets the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification. Approved by Komatsu for lubrication of slew ring gear on Komatsu hydraulic shovels.

VULTREX™ OGL Synthetic All Season 680 is an aluminum complex, solvent-free, open gear lubricant. Its wide operating temperature range allows it to be used year-round at most mines. VULTREX™ OGL Synthetic All Season 680 resists water wash-off from the shovel stick under all weather conditions, and has a low temperature limit of -40°C/-40°F. It meets the P&H 464 Open Gear Lubricant specification and the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification. Approved by Komatsu for lubrication of slew ring gear on Komatsu hydraulic shovels.

VULTREX™ OGL Synthetic Arctic is an aluminum complex, solvent-free product with a proven track record in the very cold temperatures encountered during the winter season in sub-arctic regions. It meets the P&H 464 Open Gear Lubricant specification and the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification. Approved by Komatsu for lubrication of slew ring gear on Komatsu hydraulic shovels.

VULTREX™ OGL Heavy 6200 is an aluminum complex, solvent-free, open gear lubricant with higher viscosity and thicker consistency than the other VULTREX™ OGL lubricants. It is intended for the most demanding open gear lubrication requirements, including heavily loaded hoist gears and high temperature applications. It meets the P&H 464 Open Gear Lubricant specification and the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification, including the special requirements for electric mining shovel hoist gear lubrication.

VULTREX™ EGF 1000 (Enclosed Gear Fluid) is a semi-fluid aluminum complex grease intended for use in heavily loaded enclosed gear-boxes found on mining shovels, draglines and excavators. It is also recommended for use in the enclosed gear drives of underground mining locomotives, as a ball-mill gear lubricant and on open gears in heavily loaded mills and tumblers.

Typical characteristics are shown below:

	VULTREX™				
	OGL Synthetic 2200	**OGL Synthetic All Season 680**	**OGL Synthetic Arctic**	**OGL Heavy 6200**	**EGF 1000**
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex
Colour	Black	Black	Black	Black	Black
Worked Penetration @ 25°C	384	406	386*	361	451
Dropping Point °C/°F	239/462	223/433	191/376	248/478	205/401
Timken OK Load, kg/lb	22/50	14/30	14/30	–	23/50
Weld Point, kg	800	800****	800****	800	400
Operating Range, °C	-15 to 40	-40 to 25	-40 to 10	-5 to 60	-40 to 100***
°F	5 to 104	-40 to 77	-40 to 50	23 to 140	-40 to 212
Minimum Dispensing,					
Centralised System °C/°F	-15/5	-40/-40	-40/-40	-5/23	-30/-22

* Plastic cone used

** Based on pumpability test, but is dependent on the design and type of the dispensing systems, length and diameter of the lines, the mode of application and rate of pressurization.

*** Once the gear case is filled, the gearing system can operate at temperatures as low as -40°C/°F based on actual operation.

**** Measured before the addition of diluent, as per the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification.

• VULTREX™ MPG GREASES

VULTREX™ MPG Greases are high dropping point, heavy duty greases containing an aluminum complex thickener and a high viscosity base oil. They are designed to deliver outstanding service life and equipment protection over specific ranges of temperatures and environmental conditions. Unlike many other greases, they possess the unique property of reverting to their original consistency after overheating and recooling. The adhesiveness of these greases assures that they will stay in place.

VULTREX™ MPG Greases excel when used in bearings subjected to high pressures or heavy shock loading, where application is frequent and regular, such as in steel mills.

VULTREX™ MPG Synthetic Arctic is an NLGI # 0 grease recommended for centralized greasing systems on heavy duty off-highway and mining equipment, operating in extreme low temperature conditions. It has excellent Extreme Pressure, antiwear and water resistance properties.

VULTREX™ MPG EP1 is recommended for heavy-duty gear and bearing applications served by centralized greasing systems or requiring greater grease mobility than VULTREX™ MPG EP2.

VULTREX™ MPG EP2 is recommended for heavy-duty gear and bearing applications operating at low speed and high temperatures.

VULTREX™ G-123 and G-124 are red tacky greases designed for visibility and to lubricate heavy-duty truck components such as wheel bearings, bushings, kingpins and chassis points found on vehicles operated by the mining, forestry and transportation industries.

Typical characteristics are shown below:

	MPG SYNTHETIC ARCTIC	MPG EP1	VULTREX™ MPG EP2	G-123	G-124
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex
Colour	Brown	Green-Brown	Green-Brown	Red	Red
Worked Penetration @ 25°C	366	333	276	323	279
Dropping Point, °C/°F	244/471	247/477	276/529	271/520	277/531
Base Oil Viscosity					
cSt @ 40°C	151	473	473	220	220
cSt @ 100°C	21.6	28.7	28.7	17.9	17.9
Timken OK Load, kg/lb	18/40	23/50	23/50	23/50	23/50
Weld Point, kg	400	400	400	315	315
Operating Range, °C	-45 to 120	-25 to 160	-20 to 160	-25 to 160	-20 to 160
°F	-49 to 248	-13 to 320	-4 to 320	-13 to 320	-4 to 320
Minimum Dispensing Temperature, °C/°F	-45/-49	-20/-4	-15/5	-20/-4	-15/5

VULTREX™ SPECIALTY GREASES

VULTREX™ GEAR SHIELD NC is a semi-fluid lubricant designed for the open gear systems found in many types of ore-crushing mills, including ball, rod and sag mills, as well as kilns and dryers. It meets the requirements of most major mill and gear manufacturers, including UBE, Koppers, Falk, Dominion, Boliden-Allis, Metso (Svedala) and Fuller.

VULTREX™ GEAR DRESSING EP is a high quality water and heat resistant lubricant with very tenacious film characteristics. Having this feature provides increased protection against abnormally heavy loads and pressures. It is specially formulated for the lubrication of industrial open gears and chains when applied by a caulking gun.

VULTREX™ ROCK DRILL EP000 is a lithium semi-fluid grease specially formulated for mist-free operation when used in air-operated rock drills and similar mining equipment. It meets the requirements of rock drill manufacturers, such as Ingersoll-Rand, Worthington, Joy and Parts Headquarters. VULTREX™ ROCK DRILL EP 000 can be applied easily at low temperatures in the 0°C to 5°C/32°F to 41°F range and field testing has confirmed it will still flow down to -20°C/-4°F.

VULTREX™ DRILL ROD HEAVY is a barium complex grease recommended for use on diamond drill rods where it reduces friction between the rod and rock strata. This tenacious, long fibre barium grease has lubricated successfully to more than 2000 foot drill depths without wash off or wipe off.

VULTREX™ API MODIFIED THREAD COMPOUND is an aluminum complex grease which contains 64% solids (graphite, lead, zinc and copper) and conforms to API Bulletin 5A2 on “Thread Compounds for Casing, Tubing and Line Pipe.” It is designed to protect threads from galling and to provide a positive seal against drilling fluids.

VULTREX™ TOOL JOINT COMPOUND is an aluminum complex grease which contains 51% of finely powdered zinc and conforms to API Specification 7, Appendix F “Recommended Thread Compounds for Rotary Shouldered Connections.” It is applied to pipe connections to prevent galling and provide a positive seal against drilling mud pressure.

Typical characteristics are shown below:

	VULTREX™ GEAR SHIELD NC
Thickener	-
Colour	Black
Worked Penetration @ 25°C	395
Dropping Point, °C/°F	26/79
Base Oil Viscosity	
cSt @ 40°C (with diluent)	4,931
cSt @ 40°C (without diluent)	-
cSt @ 100°C (without diluent)	1,620
Timken OK Load, kg/lb	18/40
Weld Point, kg	400

	ROCK DRILL EP000	VULTREX™ DRILL ROD HEAVY	GEAR DRESSING EP
Soap Type	Lithium	Barium Complex	Clay
Colour	Dark Amber	Green/Brown	Black
Worked Penetration @ 25°C	458	234	305
Dropping Point, °C °F	158/316	201/394	>300/>572
Base Oil Viscosity			
cSt @ 40°C	129	163	26,554
cSt @ 100°C	13.1	14.8	646
Timken OK Load, kg/lb	18/40	-	20/45
Weld Point, kg	200	-	315
Operating Range, °C	-30 to 100	-12 to 135	-
°F	-22 to 212	10 to 275	-
Minimum Dispensing Temperature, °C/°F	-30/-22	-	-

	API MODIFIED THREAD COMPOUND	VULTREX™
Soap Type	Aluminum Complex	Aluminum Complex
Colour	Dark Brown	Grey
Worked Penetration @ 25°C	325	280
Dropping Point, °C/°F	138/280	196/385
Base Oil Viscosity		
cSt @ 40°C	103	103
cSt @ 100°C	11.5	11.5


MAXIMUM PERFORMANCE
PERFORMANCE MAXIMALE
TM/MC

FOOD GRADE LUBRICANTS

Petro-Canada PURITY™ FG fluids and lubricants are advanced products formulated to meet the tough demands of food and beverage processing operations while maintaining food grade purity.

PURITY™ FG products are fortified with specially selected additives to meet the application requirements such as protecting against wear, shock loading, and corrosion. These products are designed to be highly resistant to the harsh conditions found in food and beverage processing operations, which can include high pressure water sprays or water contamination as well as exposure to fats, acids, cleaning and sanitizing solutions. For the majority of PURITY™ FG products, a key component is 99.9% pure, crystal clear base oils produced using the HT Purity process.

PURITY™ FG with MICROL™† and MICROL™ MAX† lubricants feature an antimicrobial preservative to inhibit the growth of microbes that can cause product degradation. These new generations of lubricants are the first NSF H1 registered lubricants formulated with a U.S. EPA registered antimicrobial preservative to protect the lubricant.

PURITY™ FG Synthetic products are blended with PAO and PIB synthetic base stocks to provide the same outstanding lubrication performance over an even wider range of operating temperatures.

All PURITY™ FG products have been formulated to excel under harsh conditions, while meeting food industry safety standards and can be integrated in HACCP (Hazard Analysis Critical Control Point) Plans and GMP (Good Manufacturing Practice) Programs.

PURITY™ FG CHAIN FLUIDS

PURITY™ FG Chain Fluids are formulated to lubricate all types of drive and conveyor chains as well as bearings found on food processing machinery. They may be applied by brush or drip feed as well as by centralized lubrication systems. They can be applied at temperatures up to 200°C (392°F); however, equipment should be re-oiled more frequently at temperatures above 150°C (302°F).

These advanced food grade fluids include special tackifiers to ensure strong adhesion to metal surfaces and resistance to dripping, throw-off, and water spray loss.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG Chain Fluid	
		Light	**Heavy**
Viscosity	**cSt @ 40°C**	151	370
	cSt @ 100°C	20	44
Viscosity Index		150	175
Flash Point, COC, °C/°F		230/446	240/464
Pour Point, °C/°F		-12/10	-12/10
4 Ball Wear Scar Diam., mm		0.41	0.39

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives

PURITY™ FG COMPRESSOR FLUIDS

PURITY™ FG Compressor Fluids are formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance for long lasting protection and increased service life. Typical applications include the lubrication of air compressors and vacuum pumps used for producing, manufacturing, and preparing food and food packaging.

PURITY™ FG Compressor Fluids resist thermal and oxidative breakdown extending fluid life and reducing varnish build up on compressor parts. PURITY™ FG Compressor Fluids are recommended for use in rotary screw compressors for up to 4,000 hours at a maximum air discharge temperature of 85°C (185°F).

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Note: Do not use in breathing air apparatus or medical equipment.

Typical characteristics are shown below:

		PURITY™ FG Compressor Fluids			
		32	**46**	**68**	**100**
Viscosity	**cSt @ 40°C**	32	44	69	105
	cSt @ 100°C	5.3	6.6	8.9	11.9
Viscosity Index		101	99	103	101
Flash Point, COC, °C/°F		224/435	240/464	254/489	280/536
Pour Point, °C/°F		-42/-44	-45/-49	-36/-33	-33/-27
Oxidation stability RPVOT, minutes		1815	2061	2349	2894

PURITY™ FG SYNTHETIC FLUIDS

PURITY™ FG Synthetic Fluids are synthetic PAO based products formulated with specially selected additives to protect against wear, oxidation, rust and corrosion. Tough enough to handle wet food processing environments and wide temperatures, PURITY™ FG Synthetic Fluids can be used in compressor, vacuum pump, pneumatic and hydraulic applications, as well as in low temperature applications such as freezers.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Note: Do not use in breathing air apparatus or medical equipment.

Typical characteristics are shown below:

		PURITY™ FG Synthetic Fluids	
		46	**100**
Viscosity	**cSt @ 40°C**	46	99
	cSt @ 100°C	7.7	14.2
Viscosity Index		134	147
Flash Point, COC, °C/°F		262/503	269/516
Pour Point, °C/°F		<-57/<-70	-57/-70

PURITY™ FG CORRCUT-E FLUID

PURITY™ FG Corrcut-E Fluid is an advanced food grade lubricant formulated to improve slitter blade life on slitter scorer systems. This product helps to provide optimal performance, less maintenance and longer service life for cutting blades. It effectively removes starch from the blades which means sharper blades for cleaner cuts and longer blade life. This product can be utilized on most major OEM slitter scorer systems both below the line and above the line lubrication.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

		PURITY™ FG Corrcut-E Fluid
		15
Viscosity	**cSt @ 40°C**	22.2
	cSt @ 100°C	4.5
Flash Point, COC, °C/°F		224/435
Pour Point, °C/°F		-21/-6

PURITY™ FG SYNTHETIC ROLL CLEAN FLUID

PURITY™ FG Synthetic Roll Clean Fluid is an advanced, fully synthetic based food grade lubricant formulated to deliver fast cleaning protection. This product effectively and efficiently cleans starch from hot corrugating rolls on the single facer for optimal productivity and extended operation.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

		PURITY™ FG Synthetic Roll Clean Fluid
Viscosity	**cSt @ 40°C**	36.7
	cSt @ 100°C	6.7
Flash Point, COC, °C/°F		270/518
Pour Point, °C/°F		-51/-60

PURITY™ FG GREASES

PURITY™ FG Greases are advanced food grade lubricants specially formulated to deliver exceptional performance under the highly demanding conditions of food processing operations. They can be used in a wide range of general manufacturing machinery including sleeve and anti-friction bearings, slides and guides found in food processing machinery. PURITY™ FG greases exhibit good low temperature pumpability and excellent resistance to water wash-out and spray loss. In addition, they have excellent anti-wear, extreme pressure properties, and protect against rust and corrosion. PURITY™ FG2 Clear and PURITY™ FG1 are recommended for the greasing systems in canning fillers found in the beverage industry.

PURITY™ FG1 and 00 are also preferred for centralized greasing systems.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

	PURITY™ FG Greases		
	FG2	**FG1**	**FG00**
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex
NGLI Grade	2	1	00
Colour	White	White	White
Worked Penetration @ 25°C	283	328	420
Dropping Point, °C/°F	277/531	266/511	211/412
Base Oil Viscosity			
cSt @ 40°C	182	172	182
cSt @ 100°C	17	16	17
Timken OK Load, kg/lb	16/35	23/50	16/35
Weld Point, kg	500	400	620
Operating Temperature Range			
min, C°/F°	-20/-4	-25/-13	-35/-31
max, C°/F°	160/320	160/320	120/248

PURITY™ FG2 WITH MICROL™ MAX† GREASE

PURITY™ FG2 with MICROL™ MAX grease is a new generation of lubricant specially formulated to inhibit the growth of microbes that can cause product degradation in PURITY™ FG greases. PURITY™ FG2 with MICROL™ MAX is an NSF H1 registered lubricant formulated with a U.S. EPA registered antimicrobial preservative.

PURITY™ FG2 with MICROL™ MAX exhibits good low temperature pumpability and excellent resistance to water washout and water spray loss. It also has excellent antiwear and extreme pressure properties and protects against rust and corrosion.

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

	PURITY™ FG2 with MICROL™ MAX†
NGLI Grade	2
Soap Type	Aluminum Complex
Colour	Cream
Worked Penetration @ 25°C	292
Dropping Point, °C/°F	287/549
Base Oil Viscosity	
cSt @ 40°C	182
cSt @ 100°C	17
Timken OK Load, kg/lb	27/60
Weld Point, kg	315
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)
Antimicrobial Protection Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY™ FG2 SYNTHETIC GREASES

PURITY™ FG2 Synthetic and PURITY™ FG2 Synthetic Heavy 220 are specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high and low temperature extremes. They are recommended as multipurpose lubricants across all food processing applications such as freezers, high temperature applications including ovens, multi service bearings, canning, bottling equipment, and mixers.

PURITY™ FG2 Synthetic is particularly recommended for use in low temperature applications. PURITY™ FG2 Synthetic Heavy 220 is most suitable for use under heavy loads, higher temperatures and where greases need to stay in place.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

	PURITY™ FG2 Synthetic	PURITY™ FG2 Synthetic Heavy 220
NGLI Grade	2	2
Soap Type	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex
Colour	Tan	Tan
Worked Penetration @ 25°C	294	268
Dropping Point, °C/°F	>304/579	>304/579
Base Oil Viscosity		
cSt @ 40°C	50.0	220
cSt @ 100°C	7.8	24
Timken OK Load, kg/lb	27/60	27/60
Weld Point, kg	500	400
Operating Temperature Range	-40°C (-40°F) to 200°C (392°F)	-25°C (-13°F) to 200°C (392°F)

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

PURITY™ FG2 EXTREME GREASE

PURITY™ FG2 Extreme grease is a high viscosity, semi synthetic, heavy duty food grade grease specifically formulated for low to medium speed, heavily loaded industrial bearings operating under severe conditions. PURITY™ FG2 Extreme exhibits excellent protection in applications subjected to high temperature, high pressure, and heavy loads while operating continuously, such as animal feed pellet mills and continuous rotary cookers. PURITY™ FG2 Extreme is best suited for applications under 1000 RPM.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

	PURITY™ FG2 Extreme
Soap Type	Aluminum Complex
NGLI Grade	2
Colour	White
Worked Penetration @ 25°C	276
Dropping Point, °C/°F	264/507
Base Oil Viscosity	
cSt @ 40°C	469
cSt @ 100°C	33.2
Timken OK Load, kg/lb	23/50
Weld Point, kg	400
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY™ FG2 CLEAR GREASE

PURITY™ FG2 Clear grease is an advanced colourless lubricant specially formulated to deliver superior performance under the highly demanding conditions of food processing operations when compared to other clear food grade greases. PURITY™ FG2 Clear grease was designed for use in anti-friction bearings, slides, and guides through food processing and industrial plants. It is specifically formulated for beverage production machinery such as canning and bottling equipment.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

	PURITY™ FG2 Clear
Soap Type	Aluminum Complex
NGLI Grade	2
Colour	Clear
Worked Penetration @ 25°C	293
Dropping Point, °C/°F	277/531
Base Oil Viscosity	
cSt @ 40°C	185
cSt @ 100°C	18
Timken OK Load, kg/lb	9/20
Weld Point, kg	200
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY™ FG EP GEAR FLUIDS

PURITY™ FG EP Gear Fluids are formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance. These products provide long lasting protection and can be used on enclosed gear drives (worm, helical, bevel and spur) operating under normal or heavy shock-loading conditions in food processing machinery. They can also be used in bearings and chain drives, providing long service life and clean operation. PURITY™ FG EP Gear fluids are suitable for yellow metals.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG EP Gear Fluid				
		100	**150**	**220**	**320**	**460**
Viscosity	**cSt @ 40°C**	105	142	225	302	424
	cSt @ 100°C	12	14.6	19.7	23.8	29.8
Viscosity Index		103	101	100	99	99
Flash Point, COC, °C/°F		264/507	240/464	204/399	184/363	198/388
Pour Point, °C/°F		-39/-38	-39/-38	-36/-33	-39/-38	-39/-38

PURITY™ FG SYNTHETIC EP GEAR FLUIDS

PURITY™ FG Synthetic EP Gear Fluids are specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high or low temperature extremes. Typical applications include enclosed gear drives (worm, helical, bevel and spur), plain and anti-friction bearings, and chain drives used in food processing machinery. The ISO VG 220 grade can also be used as a blower lobe lubricant. PURITY™ FG Synthetic EP Gear Fluids are fortified with specially selected additives to provide outstanding resistance to oxidation and protection from wear and shock loading. These fluids are suitable for yellow metals.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

		PURITY™ FG Synthetic EP Gear Fluid	
		220	**460**
Viscosity	**cSt @ 40°C**	213	440
	cSt @ 100°C	26.4	40.0
Viscosity Index		158	143
Flash Point, COC, °C/°F		273/523	260/500
Pour Point, °C/°F		-40/-40	-40/-40

PURITY™ FG HEAT TRANSFER FLUID

PURITY™ FG Heat Transfer Fluid is a food grade NSF HT-1 registered heat transfer fluid formulated for use in non-pressurized, liquid phase, closed heat transfer systems operating with bulk temperatures up to 326°C (619°F). This thermally stable fluid is fortified with specially selected additives to provide outstanding protection from oxidative breakdown.

Typical applications include central cooking facilities, drying, edible oil deodorizing and heating of deep frying oils. PURITY™ FG Heat Transfer Fluid is also used in the equipment for manufacture of plastic bottles, films and containers for the packaging of food products.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG Heat Transfer Fluid
Viscosity	**cSt @ 40°C**	37.1
	cSt @ 100°C	5.9
Viscosity Index		98
Flash Point, COC, °C/°F		237/459
Pour Point, °C/°F		-18/0
Autoignition Temp, °C/°F		354/669
Max Bulk Temp, °C/°F		326/619

For details on the complete line of Heat Transfer Fluids, see CALFLO™ on page 111.

PURITY™ FG SEAMER-E FLUID

PURITY™ FG Seamer-E Fluid is an advanced food grade, mineral oil based, water emulsifying fluid that is formulated for use in high-speed continuous lubrication seaming units where contamination of the oil with water and sugar may occur. It is designed to lubricate the main turrets, bearings, chains and gears for smooth and reliable equipment performance.

PURITY™ FG Seamer-E Fluid is suitable for use in Pneumatic Scale Angelus™ series such as 61/62H, 80/81L, 100/101L, 120/121L, 140S, 180S and 12M.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG Seamer-E Fluid
Viscosity	**cSt @ 40°C**	155
	cSt @ 100°C	14.5
Viscosity Index		91
Flash Point, COC, °C/°F		240/464
Pour Point, °C/°F		-26/-21
4-Ball Wear, mm		0.37
4-Ball EP Weld Load, kgf		126

PURITY™ FG AW HYDRAULIC FLUIDS

PURITY™ FG AW Hydraulic Fluids are advanced food grade lubricants specially formulated to deliver exceptional, long lasting protection in hydraulic systems used in food processing and pharmaceutical operations. They provide excellent performance in high pressure systems including applications operating at more than 1000 psi (7000 kPa). They may also be used to lubricate anti-friction bearings in general circulating systems, and in inline (air line) oilers in pneumatic systems commonly found in food packaging applications.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG AW Hydraulic Fluid			
		32	**46**	**68**	**100**
Viscosity	**cSt @ 40°C**	30	45	63	102
	cSt @ 100°C	5.2	6.8	8.4	11.5
Viscosity Index		101	102	102	99
Flash Point, COC, °C/°F		225/437	245/473	253/487	267/513
Pour Point, °C/°F		-18/0	-18/0	-18/0	-15/5
Four-Ball Wear (mm)					
(40kg, 1200 rpm, 1 hr., 75°C)		0.46	0.48	0.49	0.44
Oxidation Resistance, RPVOT (minutes)		844	885	888	888
FZG, load stage fail		>12	>12	>12	>12

PURITY™ FG-X AW HYDRAULIC FLUID

PURITY™ FG-X AW Hydraulic Fluid 46 is an advanced food grade lubricant that is formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance and enhanced protection. This product resists oxidative breakdown from air exposure, high temperatures and water contamination that can lead to longer fluid and equipment life.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG-X AW Hydraulic Fluid 46
Viscosity	**cSt @ 40°C**	47
	cSt @ 100°C	6.9
Viscosity Index		102
Flash Point, COC, °C/°F		240/464
Pour Point, °C/°F		-48/-54
Four-Ball Wear (mm) (40kg, 1200 rpm, 1 hr., 75°C)		0.45
Oxidation Resistance, RPVOT (minutes)		1147

PURITY™ FG AW HYDRAULIC FLUIDS WITH MICROL™†

PURITY™ FG AW Hydraulic Fluids with MICROL™ are advanced food grade lubricants specially formulated to deliver exceptional, long lasting protection in hydraulic systems used in food processing and pharmaceutical operations. They provide the same excellent performance as our PURITY™ FG AW Hydraulic Fluids with the added advantage of an antimicrobial preservative to protect the lubricant and reduce product degradation caused by microbes.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG AW Hydraulic Fluid with MICROL™		
		32	**46**	**68**
Viscosity	**cSt @ 40°C**	31	46	65
	cSt @ 100°C	5.2	6.8	8.6
Viscosity Index		102	104	104
Flash Point, COC, °C/°F		215/419	241/466	253/487
Pour Point, °C/°F		-18/0	-18/0	-18/0
Four-Ball Wear (mm) (40kg, 1200 rpm, 1 hr., 75°C)		0.43	0.42	0.50

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

PURITY™ FG AEROSOL SPRAYS

PURITY™ FG line of aerosol sprays are advanced multipurpose food grade lubricants packaged in aerosol cans. All sprays are packaged with an application tube to provide a convenient way to lubricate specific areas or difficult to reach locations. Its unique spray valve allows the product to be sprayed even when the can is held upside down. PURITY™ FG aerosol spray lubricants also meet food industry standards and and can be integrated in HACCP (Hazard Analysis Critical Control Point) Plans and GMP (Good Manufacturing Practice) Programs.

PURITY™ FG SPRAY

PURITY™ FG Spray contains special tackifiers to reduce drips and 'fling off' from moving parts. PURITY™ FG Spray dispenses lubricant in a single direction streamline spray pattern. Typical applications include chains, rails, guides, slides, pivots, cables, linkages, gears, hinges and small bearings.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

PURITY™ FG2 WITH MICROL™ MAX† SPRAY

PURITY™ FG2 with MICROL™ MAX Spray is an advanced food grade grease specially formulated to deliver excellent performance under the highly demanding conditions of food processing operations. PURITY™ FG2 with MICROL™ MAX contains an anti-microbial preservative to protect the lubricant from deterioration, fouling and odour caused by microorganisms. Typical applications include bearings, slides, guides and couplings. For more information on PURITY™ FG2 with MICROL™ MAX, please see page 179.

PURITY™ FG SILICONE SPRAY

PURITY™ FG Silicone Spray is a silicone-based lubricant that forms a non-hardening film to resist moisture and help prevent corrosion around heavy water wash-up areas. It can be used in many metal to non-metal applications.

PURITY™ FG PENETRATING OIL SPRAY

PURITY™ FG Penetrating Oil Spray is a general purpose penetrating oil that can be used to help loosen rust and scale around fasteners to ease the disassembly of mechanical equipment and fittings. It is a silicone free formula to allow for easy clean up of treated surfaces to be repainted.

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

Typical characteristics are shown below:

Characteristics	Method	PURITY™ FG Spray	PURITY™ FG2 with MICROL™ MAX†	PURITY™ FG Silicone Spray	PURITY™ FG Penetrating Oil
Net weight (g)		290	312	284	312
NSF registration		H1	H1	H1	H1
PROPERTIES WITHOUT PROPELLANT					
NLGI grade		na	2	na	na
Grease Thickener Type		na	Aluminum Complex	na	na
Colour	Visual	Colourless	Cream	Colourless	Colourless
Viscosity @ 40°C (cSt)	ASTM D445	151	182 (base oil)	na	39
Four Ball Wear, scar diam, mm	ASTM D4172	0.4	na	na	na
Four Ball Wear, scar diam, mm	ASTM D2266	na	0.55	na	na

PURITY™ FG TROLLEY FLUID

PURITY™ FG Trolley Fluid is formulated to lubricate hook and trolley systems in meat processing operations. It can also be used as a low viscosity lubricating fluid for chains and conveyors, and as a rust protective oil. PURITY™ FG Trolley Fluid is fortified with specially selected additives to provide outstanding resistance to wear and corrosion, and to protect against oil drips. PURITY™ FG Trolley Fluid can also be utilized as a light chain oil in either a drip or atomized application.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

		PURITY™ FG Trolley Fluid 46
Viscosity	**cSt @ 40°C**	44
	cSt @ 100°C	7.3
Viscosity Index		131
Flash Point, COC, °C/°F		215/419
Pour Point, °C/°F		-15/5
Four-Ball Wear scar diameter, mm		0.45

6

†MICROL™ and MICROL™ MAX are antimicrobial product preservatives.

PURITY™ FG WO WHITE MINERAL OILS

PURITY™ FG WO White Mineral Oils are ultra pure, food grade white mineral oils specially formulated for agricultural and food processing industries. Blended with vitamin E as a stabilizer for extended shelf life, PURITY™ FG WO White Mineral Oils are ideally suited for applications that include direct and indirect food contact in the production, packaging, and processing operations. PURITY™ FG WO White Mineral Oils are commonly used for equipment wipe down and dust control. These products are NSF 3H and H1 registered for use as a release agent on hard surfaces to prevent food from adhering during processing and general incidental contact use.

Please refer to the Food Industry Registrations/Credentials chart on iLink (LUB3152) or contact your local Petro-Canada Lubricants Representative.

Typical characteristics are shown below:

	PURITY™ FG WO WHITE MINERAL OILS					
	10	**15**	**35**	**40**	**68**	**90**
Viscosity, cSt @ 40°C	13	15	36	40	68	103
cSt @ 100°C	3.1	3.4	5.8	6.2	8.9	11.8
Viscosity Index	100	98	105	100	100	104
Density, kg/L @ 15°C	0.846	0.850	0.866	0.865	0.867	0.872
Flash Point, COC, °C/°F	190/374	175/347	220/428	240/464	255/491	266/510
Pour Point, °C/°F	-24/-11	-18/0	-18/0	-18/0	-18/0	-15/5
Colour, Saybolt	+30	+30	+30	+30	+30	+30

SPECIALTY BASE AND PROCESS FLUIDS

INTRODUCTION

Petro-Canada's line of Specialty Base and Process Fluids are select blends of high quality base fluids, designed for use by industry in a wide range of finished products.

Petro-Canada's line of Specialty Base and Process Fluids includes:

- PARAFLEX™ HT Fluids
- VHVI Specialty Base Fluids

PARAFLEX™ HT FLUID

PARAFLEX™ HT Fluids are carefully controlled blends of the advanced base oils produced from Petro-Canada's HT Purity Process, which removes undesirable polar and aromatic compounds from the product. Composed of saturated hydrocarbons, PARAFLEX™ HT Fluids are crystal clear and have low toxicity.

PARAFLEX™ HT Fluids are recommended for use as raw materials in the manufacture of a wide range of chemical, elastomer and specialty products.

Typical characteristics are shown below:

	PARAFLEX™ HT					
	3	**4**	**5**	**9**	**10**	**15**
Density, kg/l @ 15°C	0.845	0.825	0.855	0.830	0.857	0.851
Colour, ASTM	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Viscosity						
cSt @ 40°C	3.6	3.7	5.7	9.6	9.9	15.5
cSt @ 100°C	1.3	1.4	1.8	2.6	2.6	3.5
Viscosity Index	–	–	–	103	81	100
Pour Point, °C/°F	-27/-17	-57/-71	-12/10	-42/-44	-20/-4	-24/-11
Aromatics, %Wt	2.2	<0.5	1.5	<0.5	<0.5	<0.5

	PARAFLEX™ HT				
	22	**32**	**46**	**68**	**100**
Density, kg/l @ 15°C	0.847	0.864	0.865	0.867	0.870
Colour, ASTM	<0.5	<0.5	<0.5	<0.5	<0.5
Viscosity					
cSt @ 40°C	20.6	34.4	46.0	67.0	102
cSt @ 100°C	4.2	5.7	6.8	8.8	11.5
Viscosity Index	107	104	103	105	101
Pour Point, °C/°F	-21/-6	-18/0	-18/0	-15/5	-15/5
Aromatics, % Wt	<0.5	<0.5	<0.5	<0.5	<0.5

VHVI SPECIALTY BASE FLUIDS

Petro-Canada VHVI Specialty Base Fluids are a series of severely hydrotreated, very high VI mineral base fluids of exceptionally high purity.

Typical characteristics for these fluids are as follows:

	VHVI				
	2	**3**	**4**	**6**	**8**
Density, kg/l @ 15°C	0.832	0.830	0.841	0.845	0.847
Colour, ASTM	<0.5	<0.5	<0.5	<1.0	<1.5
Viscosity, cSt @ 40°C	9.6	15.9	20.8	34.1	51.0
Viscosity Index	100	120	127	132	128
Flash Point, COC, °C/°F	185/365	204/399	215/419	230/446	258/496
Pour Point, °C/°F	-42/-44	-24/-11	-24/-11	-15/5	-15/5
Aromatics, Wt %	0.1	0.2	0.2	0.2	0.2


MAXIMUM PERFORMANCE
PERFORMANCE MAXIMALE
TM/MC

GLOSSARY OF TERMS

ACID NUMBER – (see NEUT NUMBER)

AGMA – American Gear Manufacturers Association, one of whose activities is the establishment and promotion of standards for gear lubricants.

ANTI-FOAM AGENT – (see FOAM INHIBITOR)

ANTI-WEAR AGENT – An additive that minimizes wear caused by metal-to-metal contact during conditions of mild boundary lubrication (e.g. stops and starts, oscillating motion). The additive reacts chemically with, and forms a film on, metal surfaces under normal operating conditions.

ANTI-OXIDANT – (see OXIDATION INHIBITOR)

API – (American Petroleum Institute) – society organized to further the interests of the petroleum industry. In this capacity, it serves to clear information, conduct research, improve marketing conditions, etc. One of the Institute's activities has been the development of the API SERVICE CLASSIFICATIONS for crankcase oils, and rules for Base Oil Interchange, which give rise to Base Oil Groups I-V.

ASH CONTENT – non-combustible residue of a lubricating oil (also fuels) determined in accordance with ASTM D582 – also D874 (sulphated ash). Since some detergents are metallic salts or compounds, the percentage of ash has been considered to have a relationship to detergency. Interpretations can be grossly distorted, however, for the following reasons: 1. Detergency depends on the properties of the base oil as well as on the additive. Some combinations of base oil and additive are much more effective than others. 2. Detergents vary considerably in their potency, and some leave more ash than others. Organic detergents have been developed, in fact, that leave no ash at all. 3. Some of the ash may be contributed by additives other than detergents. 4. There appears to be a limit to the effective concentration of detergent. Nothing is gained by exceeding this limit, and a superabundance of detergent may actually reduce cleanliness.

ASLE – (American Society of Lubrication Engineers) – the former name of an organization involved with friction, wear, and lubrication, which is now known as the Society of Tribologists and Lubrication Engineers (STLE).

ASTM – (American Society for Testing and Materials) – organization devoted to "the promotion of knowledge of the materials of engineering, and the standardization of specifications and methods of testing." In North America, a preponderance of the data used to describe, identify, or specify petroleum products is determined in accordance with ASTM Test Methods.

AUTO IGNITION TEMPERATURE – See description under FLASH POINT.

BASE NUMBER – (see NEUT NUMBER)

BLOCK GREASE – A very firm grease manufactured in block form to be applied to certain large open plain bearings operating at high temperatures and slow speeds.

BOUNDARY LUBRICATION – a state of lubrication characterized by partial contact between two metal surfaces, and partial separation of the surfaces by a fluid film of lubricant. Due to metal-metal contact, severe wear can take place during boundary lubrication. Specific additives in certain lubricants will minimize wear under boundary lubrication conditions. These additives prevent excessive friction and scoring by providing a film on the metal surface. There are varying degrees of boundary lubrication, and they are met with various additive types. For the milder conditions, OILINESS ADDITIVES may be used. These are polar materials that are oil soluble and have an exceptionally high affinity for metal surfaces. Plating out on these surfaces in a thin but durable film, oiliness additives give protection under some conditions that are too severe for a straight mineral oil. In addition, COMPOUNDED OILS which are formulated with polar fatty oils, are sometimes used for this purpose. Another class of boundary lubricants is that which contains ANTI-WEAR ADDITIVES. These additives, typically zinc-phosphorus compounds, reduce the wear of metal surfaces, as distinct from reducing the possibility of scoring. High quality engine oils contain anti-wear additives to protect the heavily loaded parts of modern engines, particularly valve trains. The more severe cases of boundary lubrication are defined as EXTREME PRESSURE (EP) conditions. These conditions are met with lubricants which contain EP additives. Under the less severe EP conditions, as in certain worm gear or shock loaded applications, a mild EP additive such as sulphurized fatty oil may be used. For somewhat more severe EP conditions, as occurs in many industrial gear sets, a moderate EP additive package is used. Under the most severe extreme pressure conditions, as occurs in automotive hypoid gears and in many rolling mill applications, for example, more active EP compounds containing sulphur, chlorine and/or phosphorus may be used. At the very high local temperatures associated with metal contact, these additives combine chemically with the metal to form a surface film. Not only is this film effective in reducing friction, but it prevents the welding of opposing asperities (high points) and the consequent scoring that is destructive to sliding surfaces.

BROOKFIELD VISCOSITY – viscosity, in centipoise, as determined on the Brookfield viscometer (ASTM D2983). The operating principle for the Brookfield viscometer is the torque resistance on a spindle rotating in the fluid being tested. Although Brookfield viscosities are most frequently associated with low temperature properties of gear oils and transmission fluids, they are in fact determined for many other types of lubricant, e.g. white oils.

CARBON RESIDUE – percent of coked material remaining after a sample of lubricating oil has been exposed to high temperatures under ASTM Method D189 (Conradson) or D524 (Ramsbottom). While carbon residue may have significance in the evaluation of roll oils and pneumatic-tool lubricants, it should be interpreted with caution. There may be little similarity between conditions of test and conditions of service. As far as the effects of residue on performance go, moreover, many consider that the type of carbon is of greater significance than the quantity.

CENTISTOKE (cSt) – (see VISCOSITY)

CENTIPOISE (cP) – (see VISCOSITY)

CGSB – (Canadian General Standards Board) – a consensus organization composed of people representing producers, users, and general interest groups, which develops standards for products and test methods specifically required in Canada.

CHANNELLING – formation of a "groove" in grease (or in oil too viscous to flow readily under existing conditions). Channels are cut by the motion of a lubricated element, such as a gear or the rolling member of an anti-friction bearing. The amount of channelling can be controlled to a large extent by the consistency or viscosity of the lubricant. While some degree of channelling is desirable to prevent excessive churning of the lubricant, particularly in high-speed rolling element bearings, a channel so permanent as to preclude further movement of lubricant to the contacting surfaces might cause equipment failure due to lack of lubricant.

CLOUD POINT – (see POUR POINT)

COMPOUNDED OIL – a blend of petroleum oil with small amounts of fatty or synthetic fatty oils is referred to as COMPOUNDING. Compounded oils are used for certain wet applications to prevent washing-off of the lubricant from the metal surfaces. The fatty materials enable the oil to combine physically with the water instead of being displaced by it. Cylinder oils for wet steam applications and for some air compressors are compounded. Because the fatty material imparts a strong affinity for metal surfaces, moreover, compounded oils are frequently used for applications in which lubricity or extra load-carrying ability are needed. They are not generally recommended, however, for service that requires high oxidation stability. (See BOUNDARY LUBRICATION).

COPPER STRIP CORROSION – evaluation of a product's tendency to corrode copper or copper alloys, ASTM D130. Test results are based on the matching of corrosion stains. Non corrosiveness is not to be confused with rust inhibiting, which deals with the protection of a surface from some contaminant, such as water, rather than from the oil itself.

CORROSION INHIBITOR – a lubricant additive for protecting surfaces against chemical attack from contaminants in the lubricant. The most common types of corrosion inhibitors generally react chemically with the metal surfaces to be protected, thus forming an inert film in these areas.

DEMULSIBILITY – test time required for a specified oil-water emulsion to break, using ASTM D1401 or D2711 test methods. Highly refined, unadditized mineral oils have inherently good demulsibility. Even after violently agitating an oil/water mixture, the oil separates and rises rapidly to the top of the water. This is true also of other oils formulated for good demulsibility. It is a desirable characteristic, for example, of circulating oils that must separate from water readily. Demulsibility is thus a measure of a lubricating oil's ability to separate from water, an important consideration in the maintenance of many circulating oil systems.

DETERGENT – an additive in crankcase oils generally combined with dispersant additives. A detergent chemically neutralizes acidic contaminants in the oil before they become insoluble and fall out of the oil, forming sludge. Neutral or basic compounds are created which can remain in suspension in the oil.

DISPERSANT – operates to break up insoluble contaminant particles already formed. Particles are kept finely divided so that they can remain "dispersed" or colloidally suspended in the oil.

DROPPING POINT – the temperature at which a grease changes from semi-solid to a liquid state under test conditions. It may be considered an indication of the high temperature limitation for application purposes.

EMULSION – a mechanical mixture of two mutually insoluble liquids (such as oil and water). Emulsification may or may not be desirable, depending on circumstances. Soluble cutting oils are designed with an emulsifier to maintain a stable emulsion of oil and water for lubricating and cooling machining operations.

EP AGENT – an additive to improve the extreme pressure properties of a lubricant. (see BOUNDARY LUBRICATION)

FIRE POINT – (see FLASH POINT)

FLASH POINT – minimum temperature of a petroleum product or other combustible fluid at which vapour is produced at a rate sufficient to yield a combustible mixture. Specifically, it is the lowest sample temperature at which the air vapour mixture will "flash" in the presence of a small flame. Flash point may be determined by the following ASTM Methods: CLOSED CUP (covered sample container): D93 "Flash Point by Pensky-Martens Closed Test" for fuel oils – also for cutback asphalts and other viscous materials and suspensions of solids: OPEN CUP (uncovered sample container): D92 "Flash and Fire Points by Cleveland Open Cup: for lubricating oils. As indicated, this last method provides also for the determination of a FIRE POINT. Fire point is the minimum sample temperature at which vapour is produced at a sufficient rate to sustain combustion. Specifically, it is the lowest sample temperature at which the ignited vapour persists in burning for at least 5 seconds. Since the fire points of commercial petroleum oils ordinarily run about 30°C above the corresponding flash point, they are often omitted from petroleum product data. Flash and fire points have obvious safety connotations – the higher the test temperature the less the hazard of fire or explosion. Of comparable significance, however, is their value in providing a simple indication of volatility, where a lower flash point denotes a more volatile material. The dilution of a crankcase oil with fuel, for example, lowers the flash point. Flash and fire points should not be confused with AUTO-IGNITION TEMPERATURE, the temperature at which combustion occurs spontaneously (without an external source of ignition).

FOAM INHIBITOR – an additive which causes foam to dissipate more rapidly. It promotes the combination of small bubbles into large bubbles which burst more easily.

FOUR BALL TESTS – two test procedures based on the same principle – the Four-Ball EP Test (ASTM D2596) and Four-Ball Wear Test (ASTM D2266). The three lower balls are clamped together to form a cradle upon which the fourth ball rotates in a vertical axis. The balls are immersed in the lubricant under investigation. The FOUR BALL WEAR TEST is used to determine the relative wear-preventing properties of lubricants operating under boundary lubrication conditions. The test is carried out at a specified speed, temperature, and load. At the end of a specified period, the average diameter of the wear scar on the three lower balls is reported. The FOUR-BALL EP TEST is designed to evaluate performance under much higher unit loads. In this test the top ball is rotated at a specified speed (1700±60 rpm), but temperature is not controlled. The loading is increased at specified intervals until the rotating ball seizes and welds to the other balls. At the end of each interval the average scar diameter is recorded. Two values are generally reported – LOAD WEAR INDEX (formerly mean Hertz load) and WELD POINT.

HYDROFINISHING – a term sometimes used to describe a catalytic, hydrogen process that is used as a finishing step to remove any residual deleterious compounds, which improves the colour and/or stability odour of fuels or basestocks.

HYDROISOMERIZATON – the Hydroisomerization process employs a special catalyst which selectively isomerize wax molecules to isoparaffinic lube oils. The process produces base stocks with higher VIs (Viscosity Index) and improved low temperature fluidity, compared to stocks produced with conventional dewaxing. This process can also be utilized to produce selected base oils with VIs approaching 130 and performance characteristics very similar to synthetic lubricants such as poly-alpha-olefins (PAO).

HYDROTREATING – a generic name for a refinery process for treating fuels and lubricant feedstocks, at elevated temperatures, in the presence of a pressurized hydrogen and a catalyst.

Petro-Canada utilizes a severe form of hydrotreating, referred to as the HT Purity Process, to produce high quality basestocks. The elimination of aromatics and polar compounds is achieved by reacting select feedstocks with hydrogen, in the presence of a specialized catalyst at temperatures as high as 400˚C /752˚ F and pressures as high as 3000 psi.

HYDRODYNAMIC LUBRICATION – a lubrication regime characterized by a full fluid film between two moving surfaces. The most common example is the type of lubrication which occurs in oil lubricated journal bearings. The movement of one surface (the shaft or journal) “pulls” lubricating oil into the space between the journal and the bearing. This action develops a high pressure in the fluid which completely separates the two surfaces. By contrast, in boundary lubrication there is only a partial fluid film separating the two surfaces and some surface-to-surface contact occurs.

INHIBITOR – additive for the control of an undesirable phenomenon in grease, oils, or fuels, etc., for example: oxidation inhibitors, rust inhibitors, foam inhibitors, etc.

ISO – (International Organization for Standardization) – an organization which establishes internationally recognized standards for products and test methods. One example is the ISO Viscosity Grade system for industrial oils.

KINEMATIC VISCOSITY – absolute viscosity of a fluid divided by its density at the same temperature of measurement. It is the measure of a fluid’s resistance to flow under gravity, as determined by test method ASTM D-445. To determine kinematic viscosity, a fixed volume of the test fluid is allowed to flow through a calibrated capillary tube (viscometer) that is held at a closely controlled temperature. The kinematic viscosity, in centistokes (cSt), is the product of the measured flow time in seconds and the calibration constant of the viscometer. See VISCOSITY.

NEUT NUMBER – or **NEUTRALIZATION NUMBER:** the specific quantity of reagent required to “neutralize” the acidity or alkalinity of a lube oil sample. Either of these characteristics – acidity or alkalinity – may be exhibited by an unused oil, depending on its composition. In addition, certain additives impart acidity, while alkalinity may be derived from the presence of detergents or of basic material added to control oxidation. In service, the oil will, in time, show increasing acidity as the result of oxidation and, in some cases, additive depletion. Though acidity is not, of itself, necessarily harmful, an increase in acidity may be indicative of oil deterioration, and neut number is widely used to evaluate the condition of an oil in service. The most common measurement is ACID NUMBER, the specific

quantity of KOH (potassium hydroxide) required to counterbalance the acid characteristics. How high an acid number can be tolerated depends on the oil and the service conditions; and only broad experience with the individual situation can determine such a value. Neut number is determined in accordance with the ASTM Method D664 or D974. The former is a potentiometric method, the latter, colorimetric. Values for TOTAL ACID, STRONG ACID, TOTAL BASE, and STRONG BASE can, where they exist, be obtained. Strong acid numbers are considered to be related to inorganic acids, such as those derived from sulphur, while the difference between the total and strong acid numbers is attributed to weak acids – possibly the products of oxidation. A total acid number (TAN) and a total base number (TBN) can exist simultaneously, both components too weak to completely neutralize the other. When results are reported simply as "neut number" or "acid number", a TOTAL ACID NUMBER (TAN) is implied.

OXIDATION – A form of chemical deterioration to which petroleum products – like most other organic materials – are subject. The resistance of many petroleum products to oxidation, however, is very high. Oxidation usually involves the addition of oxygen atoms, and the result is nearly always one of degradation. It is accelerated by higher temperatures, the reaction becoming significant at temperatures above 70°C. For every 10°C rise, the rate of oxidation essentially doubles. Oxidation is also promoted by the presence of catalytic metals, copper being particularly active in this latter respect. What is more, the peroxides that are the initial products of oxidation are themselves oxidizing agents. So the oxidation of petroleum products is a chain reaction; the farther it progresses, the more rapid it becomes. With fuels and lube oils, oxidation produces sludges, varnishes, gums, and acids, all of which are undesirable. Nevertheless, many oils, such as turbine oils, give years of service without need for replacement. Petroleum products that require a long service or storage life can be formulated to meet requirements by: 1. proper selection of crude type. Paraffinic oils are noted for natural resistance to oxidation: 2. thorough refining, which removes oxidation-susceptible materials and allows greater response to inhibitor; 3. addition of oxidation inhibitors. Long service is also promoted by good maintenance practices – filtration, centrifuging, or other means of controlling contamination; limiting duration or intensity of high temperatures; eliminating the presence of air and of catalytic metals. For information on determining the degree of deterioration sustained by a used oil and hence, its suitability for further service, see NEUT NUMBER.

OXIDATION INHIBITOR – chemical added in small quantities to a petroleum product to increase its oxidation resistance and hence to lengthen its service or storage life. An oxidation inhibitor may combine with the peroxides formed initially by oxidation, thereby modifying them in such a way as to arrest their oxidizing influence. Or the inhibitor (a passivator) may react with a catalyst either to "poison" it or to coat it with an inert film.

POISE – CGS unit of absolute viscosity: shear stress (in dynes per square centimeter) required to move one layer of fluid along another over a total layer thickness of one centimeter at a shear rate of one centimeter per second. Dimensions are dyne-sec/cm^2. The CENTIPOISE (cP) is 1/100 of a poise and is the unit of absolute viscosity most commonly used. Whereas ordinary viscosity measurements depend on the force of gravity on the fluid to supply the shear stress and are thus subject to distortion by differences in fluid density, ABSOLUTE VISCOSITY measurements are independent of density and are directly related to resistance to flow. (See also VISCOSITY.)

POUR POINT – is a widely used low-temperature flow indicator and is 3°C above the temperature to which a normally liquid petroleum product maintains fluidity. It is a significant factor in cold-weather start-up, but must be considered along with pumpability, the ease with which an oil pumps at low temperatures. Paraffinic oils contain wax which forms a honeycomb of crystals at low temperatures near the pour point. However, agitation by a pump breaks down this wax structure and allows paraffinic oil to be pumped at temperatures well below their pour point. Naphthenic oils, on the other hand, contain little or no wax and reach their pour point through increase in viscosity: they cannot be pumped readily near the pour point. ASTM D5950 is used to determine pour point. Another low temperature property that is characteristic only of paraffinic oils is CLOUD POINT, which is the lowest temperature at which wax crystals first appear in the sample as its temperature is reduced. It is determined by ASTM D2500 and is a consideration in the evaluation of fuels whose filtration might be impaired by the plugging effect of wax crystals.

RUST INHIBITOR – a lubricant additive for protecting ferrous (iron and steel) components from rusting caused by water contamination or other harmful materials from oil degradation. Some rust inhibitors operate similarly to corrosion inhibitors by reacting chemically to form an inert film on metal surfaces. Other rust inhibitors absorb water by incorporating it into water-in-oil emulsion so that only the oil touches the metal surfaces.

SAYBOLT VISCOSITY – the efflux time in Saybolt Universal Seconds (SUS) required for 60 milliliters of a petroleum product to flow through the calibrated orifice of a Saybolt Universal viscometer, under a carefully controlled temperature, as prescribed by test method ASTM D88. This test method has largely been replaced by the kinematic viscosity method (ASTM D445).. As a rule of thumb, the comparable KINEMATIC VISCOSITY of a given product whose viscosity in SUS at 100°F is known can be determined by using the following conversion formula: SUS @ 100°F / 5 ~ cSt @ 40°C. See VISCOSITY.

SCUFFING – engine wear resulting from the localized welding and fracture of rubbing surfaces.

SOLVENT EXTRACTION – a traditional refinery process that is used to upgrade chemical and physical properties in the manufacture of lube oil basestocks. The process relies on the solubility of impurities (especially aromatic components that may also contain sulphur and nitrogen) in an extractive solvent, usually furfural or phenol. The by-product of this process is highly aromatic EXTRACT, used to make EXTENDER oils, and as feed for other refinery processes.

STLE – (Society of Tribologists and Lubrication Engineers) – formerly known as ASLE.

SULPHATED ASH – (see ASH CONTENT)

SYNTHETIC LUBRICANTS - lubricants manufactured by a process, where a chemical conversion or transformation of one complex mixture of molecules into another complex mixture takes place. A simple purification or physical separation process, such as distillation or freezing, does not constitute a synthesis.

Common types of synthetic base oil include:

- Polyalpha olefins
- Hydrotreated/Hydroisomerized Unconventional Base Oils (UCBOs)
- Organic esters
- Polyglycols

Synthetic lubricants can exhibit one or more of the following advantages over conventional mineral oils:

- Excellent low temperature fluidity
- Low pour point
- High natural viscosity index
- Outstanding oxidation stability
- High flash and auto-ignition points
- Low volatility
- Non-toxic

Synthetic lubricants have been used for some time in applications such as jet engine lubricants, arctic lubricants and fire resistant hydraulic fluids. They are now starting to replace conventional mineral oils in a number of applications, where one or more of the above properties are required. Despite their higher price, synthetics offer operating advantages that can make them more economical in the long run. For example - reduced oil consumption, longer oil life, improved fuel economy and easier starting at low temperatures.

TIMKEN OK LOAD – measure of the extreme pressure properties of a lubricant. Lubricated by the product under investigation, a standard steel roller rotates against a block. Timken OK load is the heaviest load that can be carried without scoring.

TOTAL BASE NUMBER – (see NEUT NUMBER)

VISCOSITY – measure of a fluid's resistance to flow. It is ordinarily expressed in terms of the time required for a standard quantity of the fluid at a certain temperature to flow through a standard orifice. The higher the value, the more viscous the fluid. Since viscosity varies inversely with temperature, its value is meaningless unless accompanied by the temperature at which it is determined. With petroleum oils, viscosity is now commonly reported in CENTISTOKES (cSt), measured at either 40°C or 100°C (ASTM Method D445 – KINEMATIC VISCOSITY). An earlier method for reporting viscosity in North America was in Saybolt Seconds Universal – SSU or SUS – or, for very viscous oils, in Saybolt Seconds Furol – SSF (ASTM Method D88). Other less common viscosity units are the ENGLER and REDWOOD scales, principally used in Europe. (See also BROOKFIELD VISCOSITY, KINEMATIC VISCOSITY, POISE, SAYBOLT VISCOSITY.)

VISCOSITY INDEX (V.I.) – an indicator of the rate of change of viscosity with temperature. This change is common to all non-reactive fluids – some more, some less. Heating tends to make them thinner – cooling, thicker. The higher the V.I., the less the tendency for the viscosity to change. V.I. is determined by formula from the viscosities at 40°C and 100°C in accordance with the ASTM Test Method D567 or D2270. The latter test is required for V.I.'s above 100. High V.I. oils are often preferred for service in which a relatively constant viscosity is desired under conditions of varying temperature. Some hydraulic systems require this property. Paraffinic oils are inherently high in V.I., and the V.I. of any petroleum oil can be increased by the addition of a V.I. improver. Naphthenic oils are inherently low in V.I. and aromatic oils are still lower – often having negative numbers.

VOLATILITY – that property of a liquid that defines its evaporation characteristics. Of two liquids, the more volatile will boil at a lower temperature, and it will evaporate faster when both liquids are at the same temperature. The volatility of petroleum products can be evaluated by tests for FLASH POINT, VAPOUR PRESSURE, DISTILLATION, and EVAPORATION RATE.


MAXIMUM PERFORMANCE
PERFORMANCE MAXIMALE
TM/MC

VISCOSITY GUIDE

TABLE OF LIMITS

Maximum Viscosities

Centistokes	(Normally At Start-Up)
22,000	Probably maximum pouring viscosity.
11,000	Probably maximum for splash or bath lubrication.
8,600	Barely pumpable by gear or piston pump – too heavy to be serviceable.
2,200	Upper limit for an automatic oil lubricator.
2,200	Upper limit for circulation system (good practice).
2,200	Upper limit for an oil constituent of a grease for dispensing.
1,000	Ring or rolling element bearings.
860	Hydraulic Vane Pumps @ start-up temperature – to prevent cavitation and wear.
860	Fuel oil for good pumpability and atomizing.
220	Oil mist generators without heat at minimum operating temperature.
220	Hydraulic-piston pump – start-up temperature – to prevent wear.
54	Hydraulic Systems at operating fluid temperature.

Minimum Viscosities

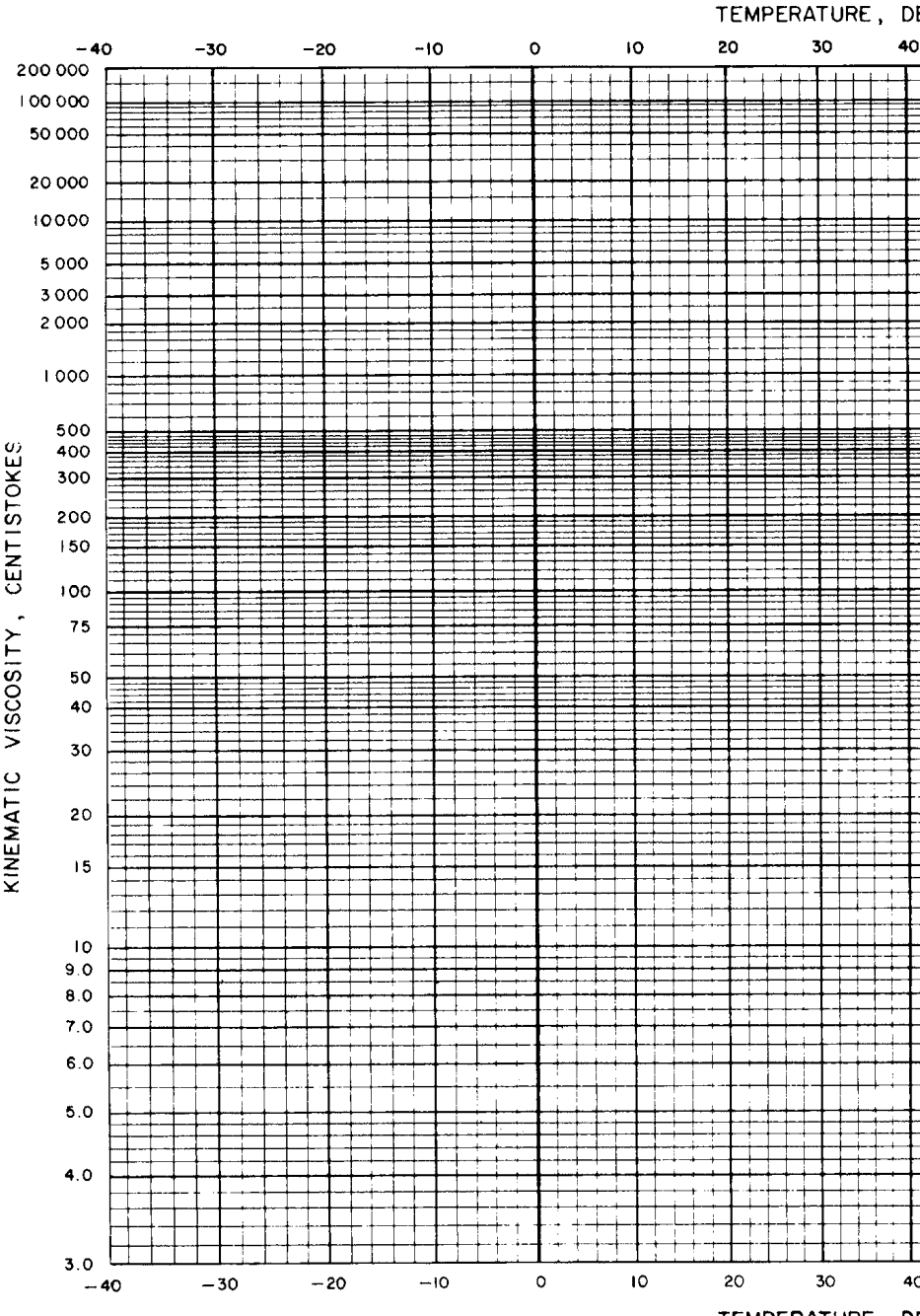
Centistokes	(At Operating Temperature)
33	For gear lubrication.
30	For a gear pump.
21	Spherical roller bearings.
13	Other rolling element bearings.
13	Hydraulic systems to prevent excessive pump wear and slippage.
13	Plain bearings.
4	Minimum viscosity to support a dynamic load.

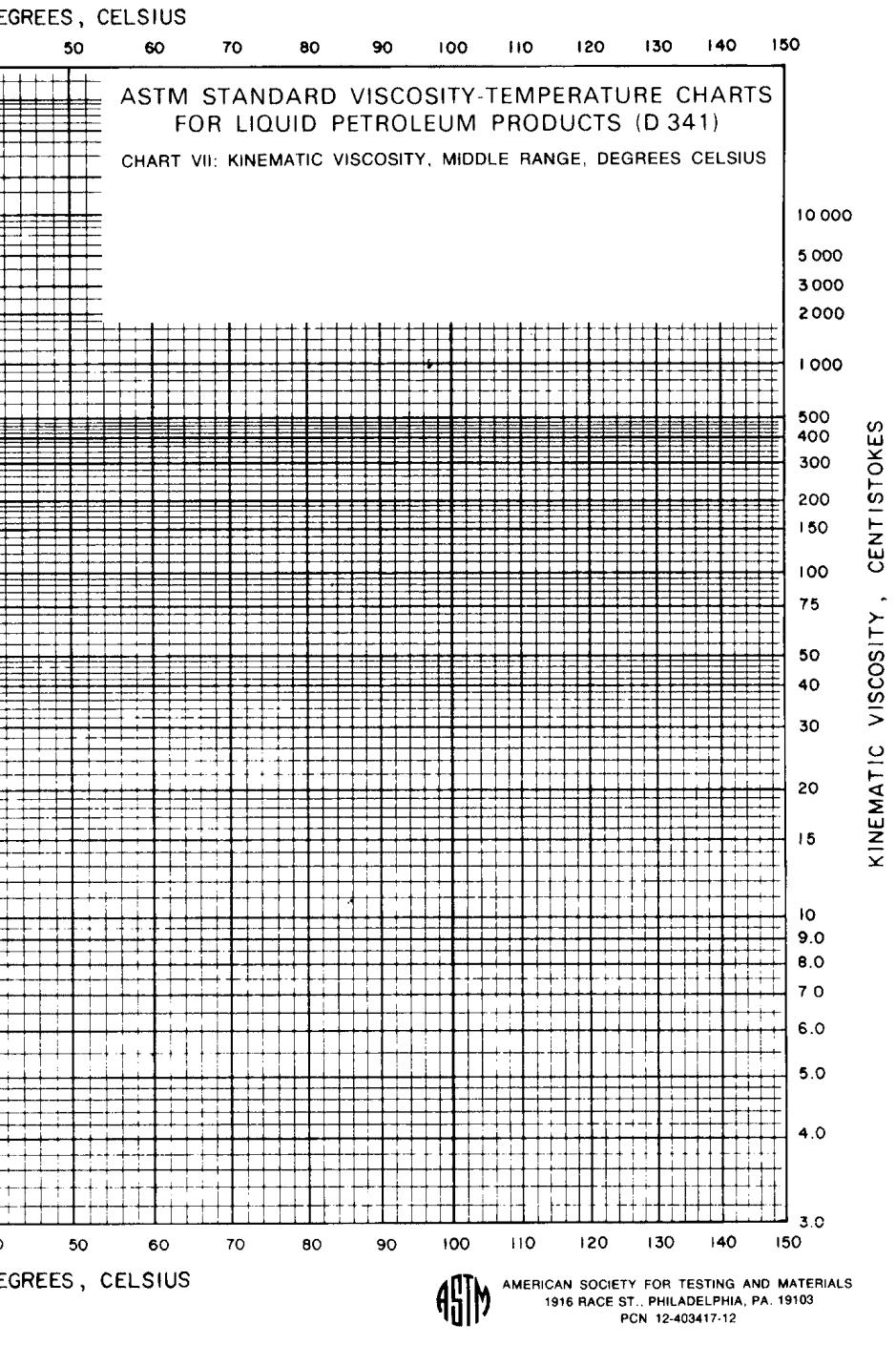
OPTIMUM VISCOSITIES

The optimum viscosity is the ideal allowable at the operating temperature.

Centistokes

25	Hydraulic systems
30	Plain Bearings
40	Spur & Helical Gears (e.g. ISO-VG 150 @ 60°C)
75	Worm Gears (e.g. 460 @ 75°C)

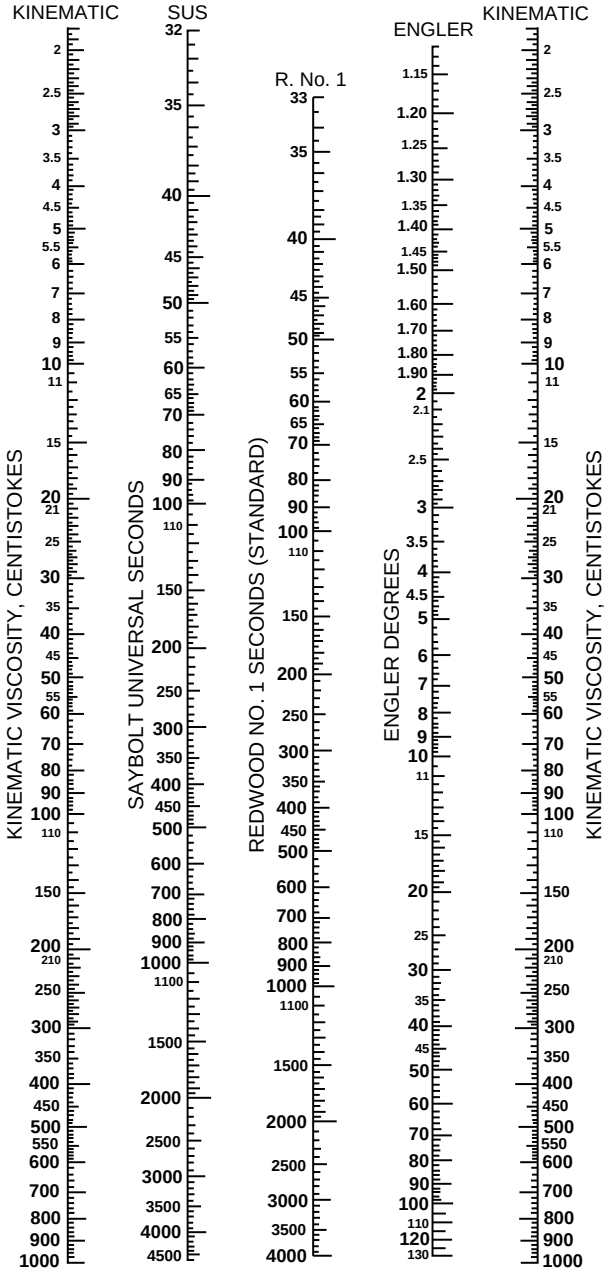

TEMPERATURE, DE
-40 -30 -20 -10 0 10 20 30 40
KINEMATIC VISCOSITY, CENTISTOKES
200 000
100 000
50 000
20 000
10000
5 000
3 000
2 000
1 000
500
400
300
200
150
100
75
50
40
30
20
15
10
9.0
8.0
7.0
6.0
5.0
4.0
3.0
-40 -30 -20 -10 0 10 20 30 40
TEMPERATURE, DE


EGREES, CELSIUS
50 60 70 80 90 100 110 120 130 140 150
ASTM STANDARD VISCOSITY-TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341)
CHART VII: KINEMATIC VISCOSITY, MIDDLE RANGE, DEGREES CELSIUS
10 000
5 000
3 000
2 000
1 000
500
400
300
200
150
100
75
50
40
30
20
15
10
9.0
8.0
7 0
6.0
5.0
4.0
3.0
KINEMATIC VISCOSITY, CENTISTOKES
0 50 60 70 80 90 100 110 120 130 140 150
EGREES, CELSIUS
ASTM
AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 RACE ST., PHILADELPHIA, PA. 19103
PCN 12-403417-12

VISCOSITY CONVERSION CHART

How to use: Place straight edge at equal centistoke values on both Kinematic scales. All viscosities on each scale will be equivalent for the same temperatures. To extend scale ranges to higher viscosities utilize powers of 10 in these scales between the 100 and 1000 divisions on the Kinematic scale.

Example: 3000 centistokes = 300 cSt x 10 and is approximately equivalent to 1400 x 10 = 14000 SUS.



TO USE:

Place straight edge at equal centistoke values on both Kinematic scales.

All viscosities on each scale will be equivalent for the same temperature.

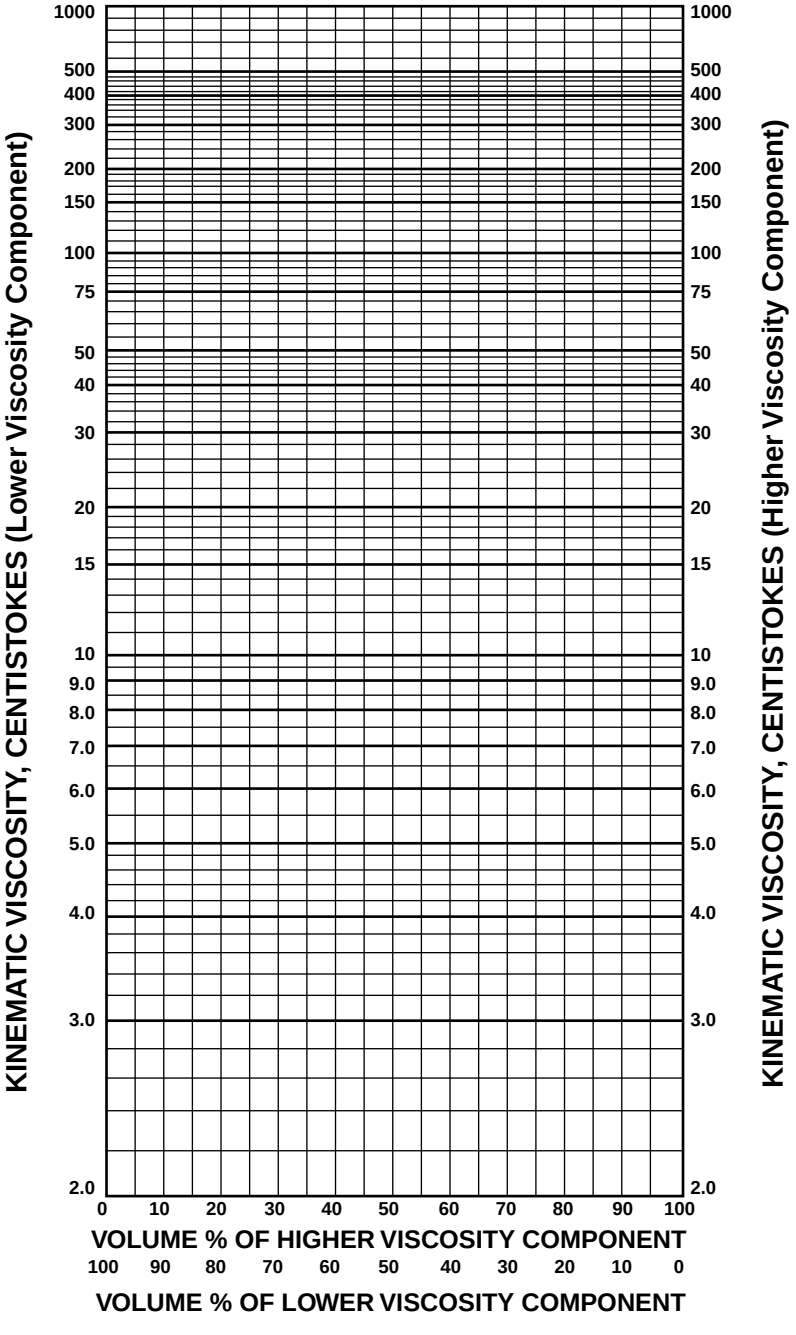
To extend scale ranges to higher viscosities, utilize powers of 10 in these scales between the 100 and 1000 divisions on the Kinematic scale,

i.e. 3000 centistokes = 300 cSt x 10
and is approximately equivalent to
1400 x 10 = 14000 SUS.

To convert from dynamic or absolute viscosity in centiPoise (cP) to kinematic viscosity in centiStokes (cSt), at a given temperature, use the following equation:

cSt = cP / density (Kg/L)

ASTM TWO BASE OIL BLENDING CHART – CENTISTOKES



Example: Two Base Oil Blending

Determine the relative viscosities, at a common temperature, of the two base oils to be blended.

i.e. 80 Neutral 15 cSt @ 40°C
160 Neutral 35 cSt @ 40°C

Locate these viscosities on the appropriate sides of the chart and join them with a straight line. From this chart and the line, you can:

1. Determine blend percentages to give a desired viscosity by reading down from intersection point of line and desired viscosity. In our example, if plotted, we could obtain 20 cSt @ 40°C oil with a 60/40 blend of the two base oils.

2. Determine the viscosity of a blended base oil if the volume percentages of the two base oils are known. Simply read up from the volume percentages point to the line and read across to the viscosity.

ISO 4406:1999 Scale Number Table		
Number of particles per millilitre		Scale number
More than	Up to and including	
2 500 000		> 28
1 300 000	2 500 000	28
640 000	1 300 000	27
320 000	640 000	26
160 000	320 000	25
80 000	160 000	24
40 000	80 000	23
20 000	40 000	22
10 000	20 000	21
5 000	10 000	20
2 500	5 000	19
1 300	2 500	18
640	1 300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0	0.01	0

NOTES:

For automatic particle counter analysis, the contaminant code is determined by allocating a first scale number to the total number of particles equal to or larger than 4 µm, allocating a second scale number to the total number of particles equal to or larger than 6 µm and allocating a third scale number to the total number of particles equal to or larger than 14 µm, and then writing these three numbers one after another separated by oblique strokes (slashes). For an example, see 22/18/13 in the table above. For analysis by microscope, use a "—" in place of the first scale number and allocate the second and third numbers based on the counts at 5 µm and 15 µm, respectively.

Reproducibility below scale number 8 is affected by the actual number of particles counted in the fluid sample. Raw counts should be more than 20 particles. If this is not possible, then the scale number for that size range shall be labelled with the symbol ≥.

EXAMPLE: A code of 14/12/≥ 7 signifies that there are more than 80 and up to and including 160 particles equal to or larger than 4 µm per millilitre and more than 20 and up to and including 40 particles equal to or larger than 6 µm per millilitre. The third part of the code, ≥ 7, indicates that there are more than 0.64 and up to and including 1.3 particles equal to or larger than 14 µm per millilitre, but less than 20 particles were counted, which lowers statistical confidence. Because of this lower confidence, the 14 µm part of the code could actually be higher than 7, indicating a particle count more than 1.3 particles per millilitre.

API GRAVITIES AND DENSITIES

Note: All conversions are at 15.6°C (60°F)

API Gravity	Density (kg/L)	API Gravity	Density (kg/L)
0	1.074	21	0.926
1	1.066	22	0.920
2	1.058	23	0.914
3	1.050	24	0.908
4	1.042	25	0.902
5	1.034	26	0.896
6	1.027	27	0.891
7	1.020	28	0.885
8	1.012	29	0.880
9	1.005	30	0.874
10	0.998	31	0.869
11	0.991	32	0.864
12	0.984	33	0.858
13	0.977	34	0.853
14	0.970	35	0.848
15	0.964	36	0.843
16	0.957	37	0.838
17	0.951	38	0.833
18	0.944	39	0.828
19	0.938	40	0.823
20	0.932	41	0.818

APPROXIMATE COLOUR SCALE EQUIVALENTS

ASTM Colour D 1500	Union (N.P.A.) Colorimeter ASTM D 155	N.P.A. Colour Descriptions
0	—	Standard White
0.5	1	Lily White
1.0	$1^{1/2}$	Cream White
1.5	$1^{3/4}$	—
2.0	2	Extra Pale
2.5	$2^{1/2}$	Extra Pale Lemon
3.0	3	Lemon Pale
3.5	$3^{1/2}$	Extra Orange Pale
4.0	4	Orange Pale
4.5	$4^{1/2}$	—
5.0	5	Pale
5.5	$5^{1/2}$	Light Red
6.0	6	—
6.5	$6^{1/2}$	Dark Red
7.0	7	Claret Red
7.5	$7^{1/2}$	—
8.0	8	—

VAPOUR PRESSURE OF LUBRICATING OIL

The vapour pressure of lubricating oil is very low and except for certain low vacuum or very high temperature applications, is not a limiting factor in typical lubrication practice. The data below were obtained by extrapolating the boiling points, at several reduced pressures, for three common viscosity grades of lube oil.

Oil Viscosity @ 40°C	30-35 cSt 150 SUS	65-70 cSt 300 SUS	80-85cSt 400 SUS
Oil Temp °C	**Vapour Pressure, millimetres of Mercury**		
40	0.00004	0.0000005	0.00000025
60	0.0003	0.000007	0.0000027
90	0.002	0.00008	0.000035
120	0.015	0.0009	0.0004
150	0.11	0.011	0.005
180	0.8	0.12	0.055
230	5.8	1.5	0.7
290	35	15	7.4

TEMPERATURE CONVERSION TABLE

°F to °C Example: What is the °C equivalent of 100°F? Look at 100 in the middle column. To the left, in the °C column, is the equivalent 37.8°C.

°C to °F Example: What is the °F equivalent of 50°C? Look at 50 in the middle column. To the right, in the °F column, is the equivalent 122.0°F.

To °C	From °T	To °F	To °C	From °T	To °F	To °C	From °T	To °F
–40.0	–40	–40.0	6.7	44	111.2	53.3	128	262.4
–38.9	–38	–36.4	7.8	46	114.8	54.4	130	266.0
–37.8	–36	–32.8	8.9	48	118.4	55.6	132	269.6
–36.7	–34	–29.2	10.0	50	122.0	56.7	134	273.2
–35.6	–32	–25.6	11.1	52	125.6	57.8	136	276.8
–34.4	–30	–22.0	12.2	54	129.2	58.9	138	280.4
–33.3	–28	–18.4	13.3	56	132.8	60.0	140	284.0
–32.2	–26	–14.8	14.4	58	136.4	61.1	142	287.6
–31.1	–24	–11.2	15.6	60	140.0	62.2	144	291.2
–30.0	–22	–7.6	16.7	62	143.6	63.3	146	294.8
–28.9	–20	–4.0	17.8	64	147.2	64.4	148	298.4
–27.8	–18	–0.4	18.9	66	150.8	65.6	150	302.0
–26.7	–16	+3.2	20.0	68	154.4	66.7	152	305.6
–25.6	–14	6.8	21.1	70	158.0	67.8	154	309.2
–24.4	–12	10.4	22.2	72	161.6	68.9	156	312.8
–23.3	–10	14.0	23.3	74	165.2	70.0	158	316.4
–22.2	–8	17.6	24.4	76	168.8	71.1	160	320.0
–21.1	–6	21.2	25.6	78	172.4	72.2	162	323.6
–20.0	–4	24.8	26.7	80	176.0	73.3	164	327.2
–18.9	–2	28.4	27.8	82	179.6	74.4	166	330.8
–17.8	0	32.0	28.9	84	183.2	75.6	168	334.4
–16.7	+ 2	35.6	30.0	86	186.8	76.7	170	338.0
–15.6	4	39.2	31.1	88	190.4	77.8	172	341.6
–14.4	6	42.8	32.2	90	194.0	78.9	174	345.2
–13.3	8	46.4	33.3	92	197.6	80.0	176	348.8
–12.2	10	50.0	34.4	94	201.2	81.1	178	352.4
–11.1	12	53.6	35.6	96	204.8	82.2	180	356.0
–10.0	14	57.2	36.7	98	208.4	83.3	182	359.6
–8.9	16	60.8	37.8	100	212.0	84.4	184	363.2
–7.8	18	64.4	38.9	102	215.6	85.6	186	366.8
–6.7	20	68.0	40.0	104	219.2	86.7	188	370.4
–5.6	22	71.6	41.1	106	222.8	87.8	190	374.0
–4.4	24	75.2	42.2	108	226.4	88.9	192	377.6
–3.3	26	78.8	43.3	110	230.0	90.0	194	381.2
–2.2	28	82.4	44.4	112	233.6	91.1	196	384.8
–1.1	30	86.0	45.6	114	237.2	92.2	198	388.4
0	32	89.6	46.7	116	240.8	93.3	200	392.0
+1.1	34	93.2	47.8	118	244.4	94.4	202	395.6
2.2	36	96.8	48.9	120	248.0	95.6	204	399.2
3.3	38	100.4	50.0	122	251.6	96.7	206	402.8
4.4	40	104.0	51.1	124	255.2	97.8	208	406.4
5.6	42	107.6	52.2	126	258.8	98.9	210	410.0

TEMPERATURE CONVERSION TABLE

°F to °C

What is the °C equivalent of 100°F?

Look at 100 in the middle column.
To the left, in the °C column, is the equivalent 37.8°C.

°C to °F

To °C	From °T	To °F	To °C	From °T	To °F	To °C	From °T	To °F
100.0	212	413.6	248.9	480	896	482.2	900	1652
101.1	214	417.2	254.4	490	914	487.8	910	1670
102.2	216	420.8	260.0	500	932	493.3	920	1688
103.3	218	424.4	265.6	510	950	498.9	930	1706
104.4	220	428.0	271.1	520	968	504.4	940	1724
105.6	222	431.6	276.7	530	986	510.0	950	1742
106.7	224	435.2	282.2	540	1004	515.6	960	1760
107.8	226	438.8	287.8	550	1022	521.1	970	1778
108.9	228	442.4	293.3	560	1040	526.7	980	1796
110.0	230	446.0	298.9	570	1058	532.2	990	1814
111.1	232	449.6	304.4	580	1076	537.7	1000	1832
112.2	234	453.2	310.0	590	1094			
113.3	236	456.8	315.6	600	1112			
114.4	238	460.0	321.1	610	1130			
115.6	240	464.0	326.7	620	1148			
116.7	242	467.6	332.2	630	1166			
117.8	244	471.2	337.8	640	1184			
118.9	246	474.8	343.3	650	1202			
120.0	248	478.4	348.9	660	1220			
121.1	250	482.0	354.4	670	1238			
126.7	260	500	360.0	680	1256			
132.2	270	518	365.6	690	1274			
137.8	280	536	371.1	700	1292			
143.3	290	554	376.7	710	1310			
148.9	300	572	382.2	720	1328			
154.4	310	590	387.8	730	1346			
160.0	320	608	393.3	740	1364			
165.6	330	626	398.9	750	1382			
171.1	340	644	404.4	760	1400			
176.7	350	662	410.0	770	1418			
182.2	360	680	415.6	780	1436			
187.8	370	698	421.1	790	1454			
193.3	380	716	426.8	800	1472			
198.9	390	734	432.2	810	1490			
204.4	400	752	437.8	820	1508			
210.0	410	770	443.3	830	1526			
215.6	420	788	448.9	840	1544			
221.1	430	806	454.4	850	1562			
226.7	440	824	460.0	860	1580			
232.2	450	842	465.6	870	1598			
237.8	460	860	471.1	880	1616			
243.3	470	878	476.7	890	1634			

COMMONLY USED CONVERSION FACTORS

To Convert From	To	Multiply by
Atmospheres	cm of mercury (0°C)	76
Atmospheres	feet of water (39.2°F)	33.899
Atmospheres	grams/sq cm	1033.3
Atmospheres	inches of mercury (32°F)	29.921
Atmospheres	kg/sq meter	10333
Atmospheres	mm of mercury	760
Atmospheres	pounds/sq ft	2116.32
Atmospheres	pounds/sq inch	14.696
Barrels, oil	gallon (US)	42
Barrels (API)	$meter^3$	0.1590
BTU (60°F/15.56°C)	joule	1055
BTU/minute	horsepower	0.0236
BTU/pound	calories/gram	0.5555
Calories (mean)	joule	4.190
Calories/gram	BTU/pound	1.8
Centimeters	feet	0.0328
Centimeters	inches	0.3937
Centimeters	yards	0.0109
Centimeters/second	feet/minute	1.9685
Centimeters/second	meter/minute	0.6
Centimeters/second	miles/hour	0.0223
Centipoises	newton-second/$meter^2$	1.000 x 10-3
Centistokes	$meter^2$/second	1.000 x 10-6
Cheval-vapeurs (C.V.)	horsepower	0.9863
Cubic centimeters	cubic inches	0.0610
Cubic centimeters	gallons (British)	0.00022
Cubic centimeters	gallons (US)	0.00026
Cubic centimeters	ounces (British, fluid)	0.0351
Cubic centimeters	ounces (US, fluid)	0.0338
Cubic centimeters	quarts (British,liquid)	0.00088
Cubic centimeters	quarts (US, liquid)	0.00105
Cubic feet	cubic centimeters	28317
Cubic feet	cubic inches	1728
Cubic feet	cubic yards	0.0370
Cubic feet	gallons (British)	6.2288
Cubic feet	gallons (US)	7.4805
Cubic feet	litres	28.3162

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
Cu ft of water (60°F)	pounds	62.37
Cubic inches	cubic cm	16.3872
Cubic inches	gallons (British)	0.0036
Cubic inches	gallons (US)	0.0043
Cubic inches	litres	0.0164
Cubic meters	cubic feet	35.314
Cubic meters	cubic yards	1.3079
Cubic meters	gallons (British)	219.969
Cubic meters	gallons (US)	264.173
Degrees (F)	degree Kelvin	tk = (t, + 459.67)/1.8
Degrees (C)	degree Kelvin	tk = (tc + 273.15)
Dynes	newton	1.000 x 10-fi
Fathoms	feet	6
Feet	meters	0.3048
Feet of water (39.2°F)	atmospheres	0.0295
Feet of water (39.2°F)	inches of mercury (32° F)	0.8826
Feet of water (39.2°F)	kg/sq meter	304.79
Feet of water (39.2°F)	pounds/sq ft	62.427
Feet of water (39.2°F)	pounds/sq inch	0.4335
Feet/minute	kilometers/hour	0.0183
Feet/minute	meters/second	0.0050
Feet/minute	miles/hour	0.0114
Foot pounds/minute	horsepower	0.0000303
Gallons (British)	cubic cm	4546.08
Gallons (British)	cubic ft	0.1605
Gallons (British)	cubic inches	277.418
Gallons (British)	gallons (US)	1.2009
Gallons (British)	litres	4.5459
Gallons (British)	$meter^3$	4.546 x 10-3
Gallons (British)	pounds of water (62°F)	10
Gallons (Imperial)	see Gallons (British)	
Gallons (US)	cubic cm	3785.434
Gallons (US)	cubic ft	0.1337
Gallons (US)	cubic inches	231
Gallons (US)	gallons (British)	0.8327
Gallons (US)	litres	3.7854
Gallons (US)	$meter^3$	3.785 x 10-3

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
Gallons (US)	pounds of water (60°F)	8.3370
Gallons (US)/minute	cubic feet/hour	8.0208
Grams	ounces (avoirdupois)	0.03527
Grams	pounds (avoirdupois)	0.0022
Grams/litre	parts per million (ppm)	1000
Grams/sq cm	atmospheres	0.000967
Grams/sq cm	feet of water (60°F)	0.0328
Grams/sq cm	inches of mercury (32°F)	0.02896
Grams/sq cm	mm of mercury (0°C)	0.7355
Grams/sq cm	pounds/sq ft	2.0482
Grams/sq cm	pounds/sq inch	0.0142
Horsepower	Cheval-vapeur (C.V.)	1.014
Horsepower	foot-pounds/second	550
Horsepower	Pferdestaerke (P.S.)	1.014
Horsepower	watts	745.7
Hundredweight (cwt)	pounds	100
Inches	centimeters	2.54
Inches of mercury (32°F)	atmospheres	0.0334
Inches of mercury (32°F)	feet of water (39.2°F)	1.133
Inches of mercury (32°F)	kg/sq meter	345.3
Inches of mercury (32°F)	pounds/sq ft	70.727
Inches of mercury (32°F)	pounds/sq inch	0.4911
Inches of water (39.2°F)	atmospheres	0.00245
Inches of water (39.2°F)	gms/sq cm	2.5399
Inches of water (39.2°F)	inches of mercury (32°F)	0.07355
Inches of water (39.2°F)	pounds/sq in	0.0361
Kilograms	ounces (avoirdupois)	35.274
Kilograms	pounds (avoirdupois)	2.2046
Kg/liters	pounds/US gallon	8.345406
Kg-meters (torque)	pound-feet	7.2330
Kg/cu meter	pounds/cu ft	0.0624
Kilometers	feet	3280
Kilometers	miles	0.6213
Kilometers	miles (nautical)	0.5396
Kilometers	rods	198.836
Kilometers	yards	1093
Kilowatt-hours	BTU	3413

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
Kilowatts	BTU/minute	56.884
Litres	cubic feet	0.0353
Litres	cubic inches	61.025
Litres	gallons (British)	0.2199
Litres	gallons (US)	0.2641
Litres	ounces (British, fluid)	35.196
Litres	ounces (US, fluid)	33.814
Litres	quarts (US, fluid)	1.0566
Meters	feet	3.2808
Meters	inches	39.37
Meters	yards	1.0936
Miles	feet	5280
Miles	kilometers	1.6093
Miles	rods	320
Miles	yards	1760
Miles (nautical)	feet	6080
Miles/hour	cm/sec	44.7
Miles/hour	km/min	0.0268
Millilitres	cu inches	0.061
Millilitres	ounces (British, fluid)	0.035
Millilitres	ounces (US, fluid)	0.0338
Millimeters	inches	0.039
Millimeters	mils	39.37
Millimeters mercury (0°C)	atmospheres	0.0013
Millimeters mercury (0°C)	feet of water (39.2°F)	0.0446
Millimeters mercury (0°C)	gm/sq cm	1.3595
Millimeters mercury (0°C)	kg/sq meters	13.595
Millimeters mercury (0°C)	pounds/sq ft	2.7845
Millimeters mercury (0°C)	pounds/sq in	0.0193
Ounces (avoirdupois)	grams	28.3495
Ounces (British, fluid)	cu cm	28.4130
Ounces (British, fluid)	gallons (British)	0.0062
Ounces (US, fluid)	cu cm	29.5737
Ounces (US, fluid)	cu inches	1.8047
Parts per million (ppm)	grains/gal (British)	0.0701
Parts per million (ppm)	grains/gal (US)	0.0584
Pferdestaerke (P.S.)	horsepower	0.986

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
Pounds (avoirdupois)	grams	453.5924
Pounds/foot	grams/cm	14.8816
Pounds/sq ft	atmospheres	0.000472
Pounds/sq ft	kg/sq meter	4.8824
Pounds/sq in	atmospheres	0.0680
Pounds/sq in	cm of mercury (0°C)	5.1715
Pounds/sq in	feet of water (39.2°F)	2.3066
Pounds/sq in	grams/sq cm	70.307
Pounds/sq in	inches of mercury (32°F)	2.0360
Pounds/sq in	newton/meter^2	6895
Pounds/US gallon	kg/litres	0.119826
Quarts (British, liquid)	cu cm	1136.521
Quarts (US, liquid)	cu cm	946.3586
Quarts (US, liquid)	cu inch	57.75
Quarts (US, liquid)	ounces (US, fluid)	32
Stones (British)	pounds (avoirdupois)	14
Tons (long)	kilograms	1016.047
Tons (long)	pounds (avoirdupois)	2240
Tons (long)	tons (metric)	1.0160
Tons (long)	tons (short)	1.12
Tons (metric)	kilograms	1000
Tons (metric)	pounds (avoirdupois)	2204.62
Tons (metric)	tons (long)	0.9842
Tons (metric)	tons (short)	1.1023
Tons (short)	kilograms	907.1848
Tons (short)	pounds (avoirdupois)	2000
Tons (short)	tons (long)	0.8928
Tons (short)	tons (metric)	0.907
Yards	centimeters	91.440
Yards	miles	0.00057

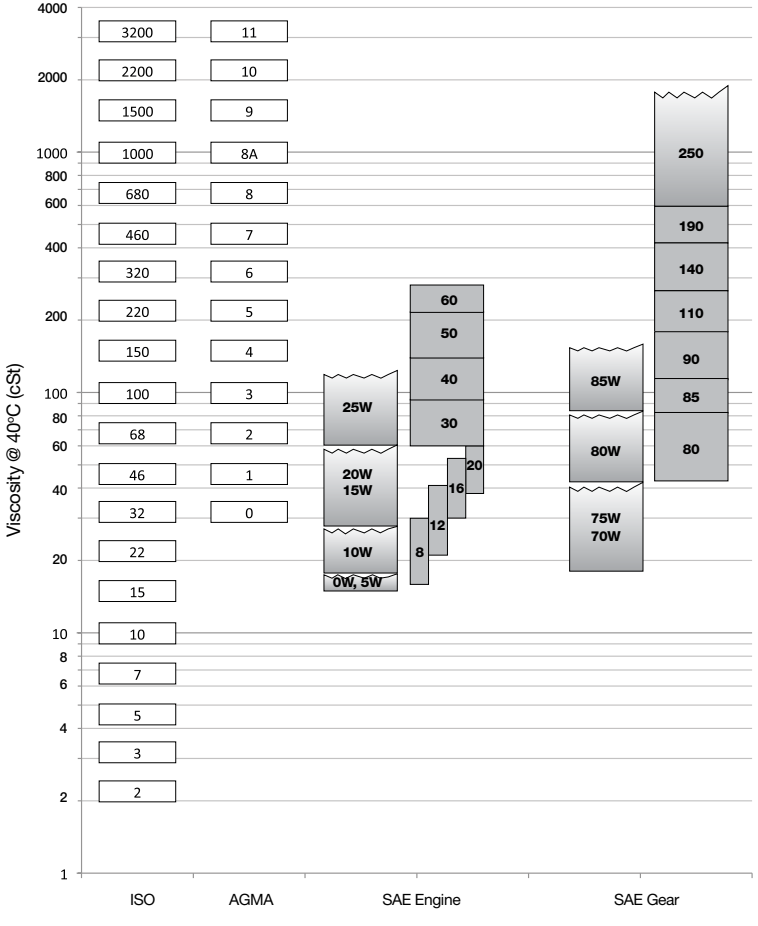
QUANTITIES FOR VARIOUS DEPTHS OF CYLINDRICAL TANKS IN HORIZONTAL POSITION

% Depth Filled	% of Capacity	% Depth Filled	% of Capacity	% Depth Filled	% of Capacity	% Depth Filled	% of Capacity
1	0.20	26	20.73	51	51.27	76	82.50
2	0.50	27	21.86	52	52.55	77	82.60
3	0.90	28	23.00	53	53.81	78	83.68
4	1.34	29	24.07	54	55.08	79	84.74
5	1.87	30	25.31	55	56.34	80	85.77
6	2.45	31	26.48	56	57.60	81	86.77
7	3.07	32	27.66	57	58.86	82	87.76
8	3.74	33	28.84	58	60.11	83	88.73
9	4.45	34	30.03	59	61.36	84	89.68
10	5.20	35	31.19	60	62.61	85	90.60
11	5.98	36	32.44	61	63.86	86	91.50
12	6.80	37	33.66	62	65.10	87	92.36
13	7.64	38	34.90	63	66.34	88	93.20
14	8.50	39	36.14	64	67.56	89	94.02
15	9.40	40	37.39	65	68.81	90	94.80
16	10.32	41	38.64	66	69.97	91	96.55
17	11.27	42	39.89	67	71.16	92	96.26
18	12.24	43	41.14	68	72.34	93	96.93
19	13.23	44	42.40	69	73.52	94	97.55
20	14.23	45	43.66	70	74.69	95	98.13
21	15.26	46	44.92	71	75.93	96	98.66
22	16.32	47	46.19	72	77.00	97	99.10
23	17.40	48	47.45	73	78.14	98	99.50
24	18.50	49	48.73	74	79.27	99	99.80
25	19.61	50	50.00	75	80.39	100	100.00

PETRO-CANADA LUBRICANTS

VISCOSITY EQUIVALENTS

Comparison of ISO/AGMA/SAE Viscosities at 40°C



NOTE:

- Read horizontally.
- Equivalence is in terms of viscosity at 40°C only.
- Viscosities of SAE engine oils based on a VI of 150, an estimated average of current PCMO and HDEO products.
- Viscosities of SAE gear oils based on a VI of 130, an estimated average of current Automotive Gear products.
- Viscosity limits are approximate: for precise data, consult ISO, AGMA and SAE specifications.
- SAE W grades are represented only in terms of approximate 40°C viscosity. For low temperature limits, consult SAE specifications.

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