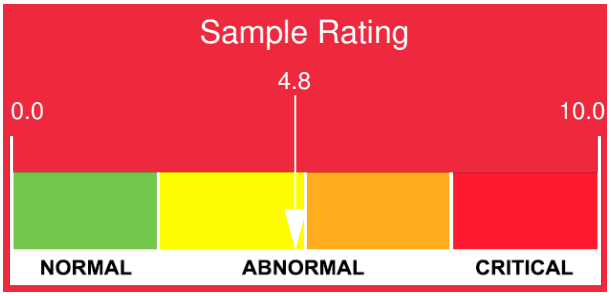
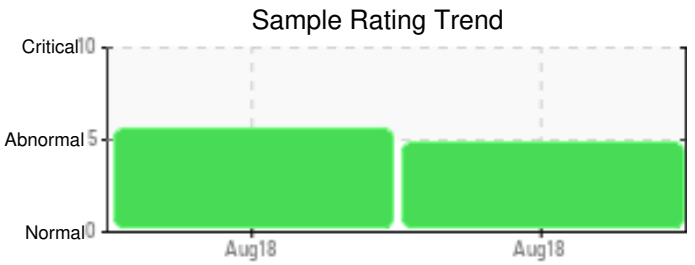




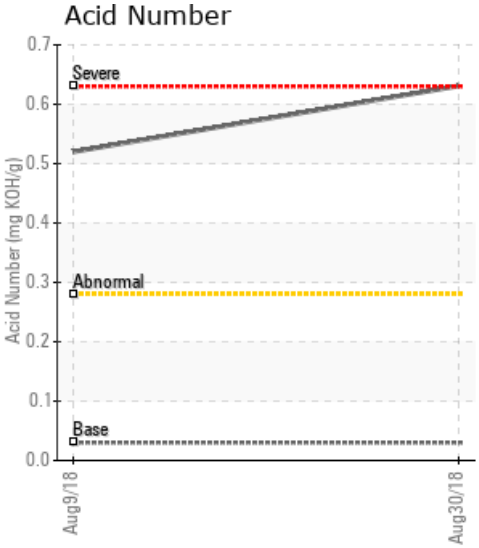
[CITY OF EDMONTON] A/C BOILER

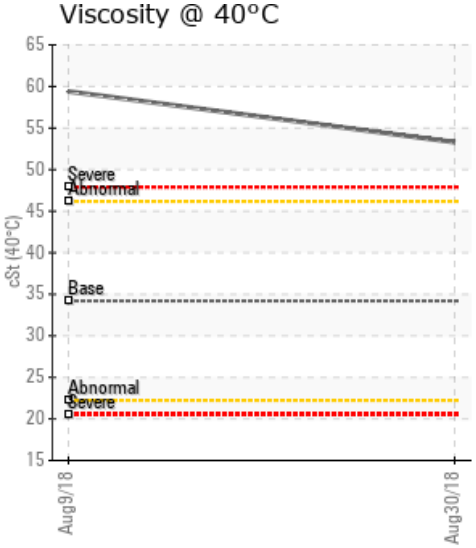
Customer: PTRHTF20202	System Information	Sample Information
CITY OF EDMONTON 14402 114AVE EDMONTON, AB T5M 2Y9 Canada Attn: Chris Lawrence Tel: E-Mail: chris.laerence@edmonton.ca	System Volume: 2000 ltr Bulk Operating Temp: 350F / 177C Heating Source: Blanket: Fluid: PETRO CANADA PETRO-THERM Make:	Lab No: 02237432 Analyst: Gordon Susinski Sample Date: 08/30/18 Received Date: 09/05/18 Completed: 09/06/18 To discuss this report contact Gordon Susinski at (587)582-4118

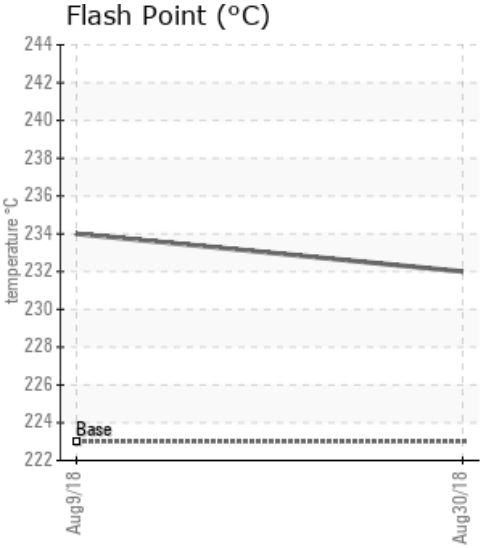
Recommendation: This is a resample from a system where there was not historical data to compare to, so a resample was requested. Based on the analysis results, it appears that the oil may have experienced one or both of the following deteriorating conditions. 1.) System wear, 2.) Heat transfer fluid oxidation, & 3.) Thermal degradation.The Pentane Insolubles levels are abnormally high. This analysis is used for the determination of contaminants in used heat transfer oils, and to determine the amount of insoluble materials such as oxidation by products, dirt, carbonaceous material, and system wear components. These contaminants as a group are called pentane Insolubles. They often appear as a result of thermal degradation, where in the presence of excess heat, the hydrocarbon molecules reach the breaking point of normally stable C-C covalent bonds and crack into lighter hydrocarbons chains. These chains, when formed may have lower viscosities, lower flash points and start to boil before normal fresh oil would thus, affecting the overall fluid efficiency in a negative way by requiring greater amounts of energy to produce the same amount of heat. As the oil thermally degrades it may deposit heavy carbonaceous material by baking it on the tubes and then act as an insulation layer. These carbonaceous layers can flake away and produce hot spots on the tubes possibly resulting in a tube rupture. The carbon residues that get carried away can settle downstream and obstruct the flow in small lines.The system acid number is severely high. The acid number is a measure of the acidic compounds in the oil. Increases in the acid number are likely due to the formation of oxidation by products in the oil. This value will increase exponentially once the process begins. Tendencies are for sludge and deposits to increase and corrosion to occur if the fluid continues to be utilized beyond its limits. The 40C viscosity is also severely high. The viscosity is the fluids ability to resist flow. Increases in viscosity in a heat transfer system is normally attributed to the oxidation process but may also be due to a heavier fluid being added. The oxidation process increases the size of the molecules and increases the oils viscosity. Oxidation is a reaction of hydrocarbons in the oil with oxygen from air, forming various species including weak organic acids. Oxidation is accelerated by contaminants such as wear debris, dust, water, metals, and high temperatures. Changes in the fluid will be seen as discoloration, increased viscosity, formation of varnish, increase in acidity and finally the formation of heavy insoluble compounds. Also to be noted is that the following parameters are within acceptable limits, but they have increased since the last sample. Fe, Na, & water. Iron typically comes from system components. Sodium is typically from contamination sources too numerous to mentions. The amount of water present in the product by Karl Fischer reagent and coulometric method. An elevated water content in conjunction with increasing iron, may lead to system corrosion. High water content can lead to safety concerns with hot oil gargling and splashing out of the expansion tank. Water content can contribute to the formation of fluid oxidation and the formation of acids. High water content can also be attributed to a dirty sampling port

Comments: Pentane Insolubles levels are abnormally high. Acid Number (AN) is severely high. Visc @ 40°C is severely high.

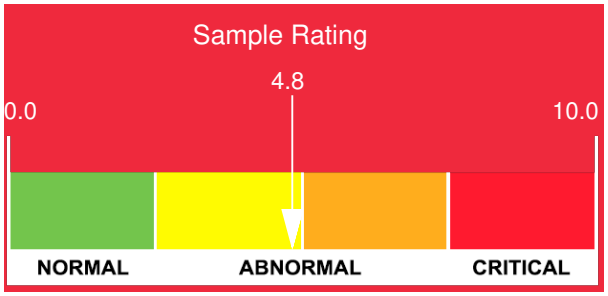
Sample Date	Received Date	Fluid Age	Sample Location	Flash Point (COC)	Water (KF)	Viscosity (40°C)	Acid Number	Solids	GCD 10%	GCD 50%	GCD 90%	GCD % < 335°C
	mm/dd/yy			°F/°C	ppm	cSt	mg/KOH/g	%wt	°F/°C	°F/°C	°F/°C	%
08/30/18	09/05/18	5y	BLEEDER VALVE	450 / 232	70.7	53.3	0.631	0.515	744 / 396	802 / 428	901 / 483	0.00
08/09/18	08/17/18	5y	LOWER SYS DRAIN VALV	453 / 234	5.6	59.4	0.520	0.175	748 / 398	852 / 456	976 / 524	0.00
Baseline Data				433 / 223		34.2	0.03		720 / 382	817 / 436	900 / 482	1.00

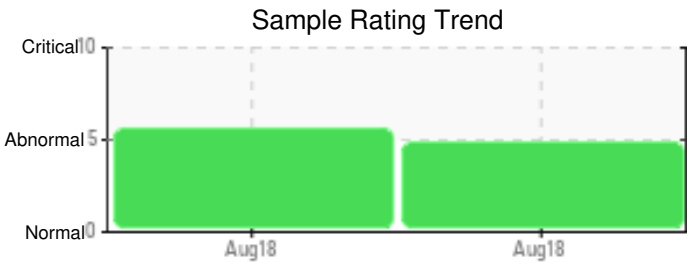






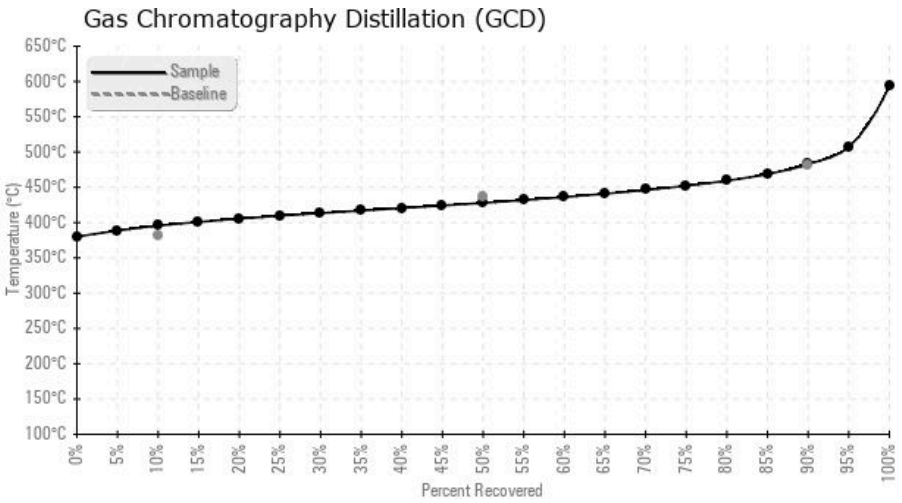
PETRO-CANADA LUBRICANTS

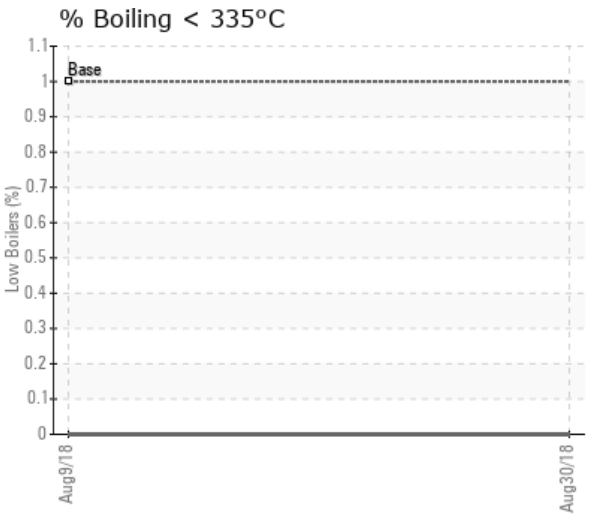




Sample Date	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorus	Zinc
08/30/18	36	0	0	0	0	0	0	0	0	0	7	19	1	0	0	0	1	0	0	0	2	0	6	1
08/09/18	2	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	0	0
Baseline Data			0	0						0			0	0					0				0	

Elemental anaysis results (above) in parts per million (ppm). [10,000 ppm = 1.0%]





Historical Comments

08/09/18	The acid number is abnormally high and is a measure of the acidic compounds in the oil. Increases in the acid number are likely due to the formation of oxidation by products in the oil. This value will increase exponentially once the process begins. Tendencies are for sludge and deposits to increase and corrosion to occur if the fluid continues to be utilized beyond its limits. Oxidation is a reaction of hydrocarbons in the oil with oxygen from air, forming various species including weak organic acids. Oxidation is accelerated by contaminants such as wear debris, dust, water, metals, and high temperatures. Changes in the fluid will be seen as discoloration, increased viscosity, formation of varnish, increase in acidity and finally the formation of heavy insoluble compounds. The GCD results are not as expected. We suggest taking another sample, to confirm the samples results. (GCD) 90% Distillation Point is severely high. Visc @ 40°C is severely high. Acid Number (AN) is abnormally high. (GCD) 10% Distillation Point is marginally high. (GCD) 50% Distillation Point is marginally high.