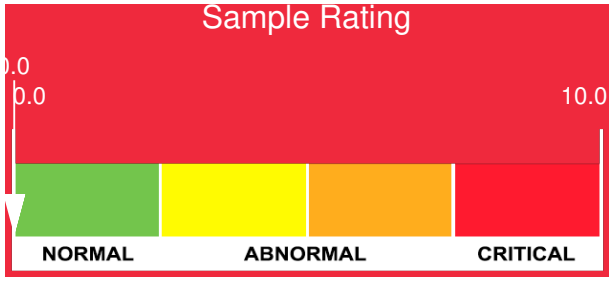
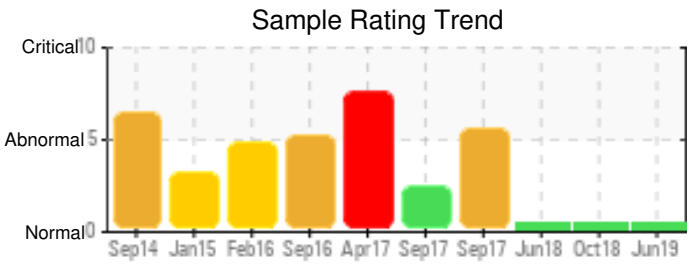




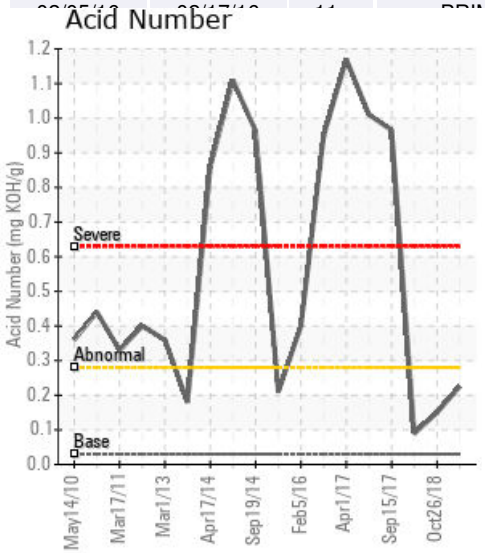
ENERGY PLANT HOT OIL

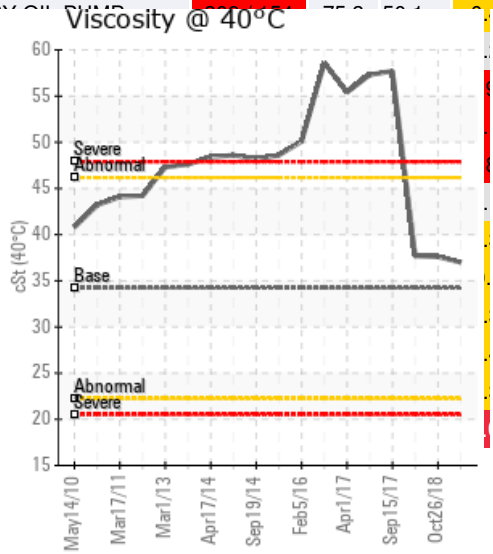
Customer: PTRHTF20043	System Information	Sample Information
WEST FRASER LVI PO BOX 1737 ROCKY MT HOUSE, AB T4T 1B3 Canada Attn: Renny Ceccato Tel: E-Mail: renny.ceccato@westfraser.com	System Volume: 38000 ltr Bulk Operating Temp: 500F / 260C Heating Source: Blanket: Fluid: PETRO CANADA PETRO-THERM Make: WELLONS	Lab No: 02291494 Analyst: Gordon Susinski Sample Date: 06/07/19 Received Date: 06/17/19 Completed: 06/19/19

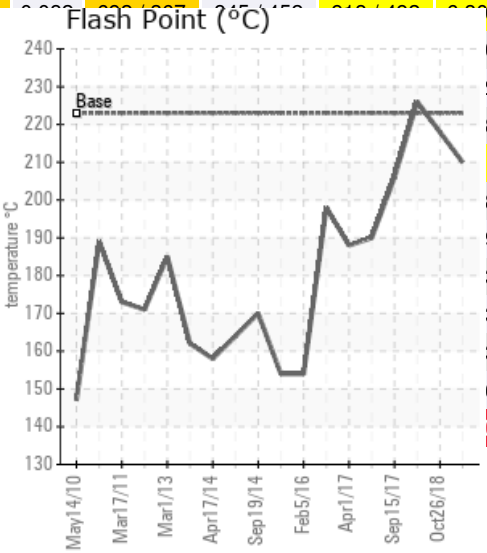
Recommendation: Results are normal

Comments:

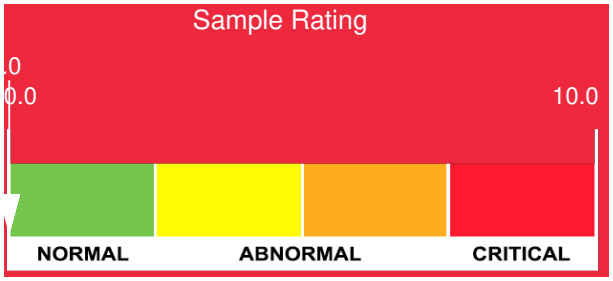
Sample Date	Received Date	Fluid Age	Sample Location	Flash Point (COC)	Water (KF)	Viscosity (40°C)	Acid Number	Solids	GCD 10%	GCD 50%	GCD 90%	GCD % < 335°C
	mm/dd/yy			°F/°C	ppm	cSt	mg/KOH/g	%wt	°F/°C	°F/°C	°F/°C	%
06/07/19	06/17/19	1y	HOT OIL PUMP	410 / 210	73.9	37.0	0.225	0.076	734 / 390	821 / 438	915 / 491	0.00
10/26/18	11/08/18	0y		424 / 218	151.4	37.6	0.150	0.364	728 / 387	810 / 432	902 / 483	0.00
06/22/18	07/04/18	0y	PRIMARY PUMP	439 / 226	159.0	37.7	0.09	0.259	715 / 379	794 / 423	899 / 482	0.00
09/15/17	10/10/17	0y	72116-4500RB	403 / 206	2467.2	57.7	0.965	1.65	700 / 371	828 / 442	912 / 489	3.98
09/07/17	10/10/17	0y	12116-4500RB	374 / 190	51.7	57.3	1.01	0.782	734 / 390	846 / 452	924 / 495	3.38
04/01/17	04/12/17	12y	PRIMARY PUMP	370 / 188	92.8	55.4	1.17	1.27	735 / 391	848 / 453	932 / 500	3.82
09/09/16	09/14/16	11y	PRIMARY OIL PUMP	388 / 198	77.1	58.6	0.949	1.65	724 / 385	844 / 451	915 / 491	4.35







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
06/07/19	4	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	9	0	1	0
10/26/18	8	0	0	0	0	0	0	0	0	0	0	16	1	0	0	0	0	0	0	0	24	0	1	0
06/22/18	6	0	0	0	0	0	0	0	0	0	0	10	2	0	0	0	0	0	0	0	35	0	2	2
09/15/17	6	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
09/07/17	7	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0
04/01/17	8	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
09/09/16	13	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	0
02/05/16	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
01/30/15	13	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	1	0	10	0
09/19/14	9	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0
06/20/14	16	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	2	0	1	2
04/17/14	7	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
11/01/13	28	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0
03/01/13	67	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	1	0	0	0	3	0	1	2
12/16/11	10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	11	0	3	3
03/17/11	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
11/26/10	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
05/14/10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	1

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

Historical Comments

10/26/18	Results are normal. Resample at the next interval and continue to monitor the system.
06/22/18	Calcium levels are higher than expected. Typical sources of this element are other 1.) heat transfer products and 2.) outside contamination. Resample, taking care to obtain a representative sample of the system. Calcium ppm levels are abnormally high.
09/15/17	We are unable to comment on competitive product. Water contamination levels are severely high. Water contamination levels are severely high.. ppm Water contamination levels are severely high. Pentane Insolubles levels are severely high. COC Flash Point is marginally low.
09/07/17	We are unable to comment on competitive product. Pentane Insolubles levels are severely high. COC Flash Point is abnormally low.
04/01/17	The oil service is indicated as 12 years, this is beyond the expected life of most heat transfer systems. Based on the information available to me, it appears the oil in service has been subjected to Oxidation and Thermal Degradation and corrective measures should be initiated to remedy the situation. The Pentane Insolubles are severely high. This analysis determines the amount of contaminants in used heat transfer oils which are typically from insoluble materials such as oxidation by products and carbonaceous material. The acid number is severely 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 oxidation 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 90% distillation Increase is due to high boilers and are normally associated with carbonaceous deposits in the system that can foul heat exchanger surfaces or plug small lines. The 40°C viscosity is abnormally high. Viscosity is the fluids ability to resist flow. Increases in viscosity in a heat transfer system is normally attributed to the oxidation process. The oxidation process increases the size of the molecules and increases the oils viscosity. The C.O.C. Flash Point is low (188C). This is the lowest temperature at which the fluids vapor will momentarily ignite when contacted by an ignition source. Reduction is typically associated with thermal degradation of the heat transfer oil or possibly contamination.Overall, the results indicate the fluid has been oxidized and thermally cracked and is in need measures to bring the product back into normal guidelines. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. (GCD) 90% Distillation Point is abnormally high. Visc @ 40°C is abnormally high. (GCD) 50% Distillation Point is marginally high. COC Flash Point is marginally low.
09/09/16	Based on the analysis results, it appears that the oil may have experienced one or both of the following deteriorating conditions. Insolubles and Oxidation. This may be due in part to the length of service on the oil (11 years indicated).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 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 for sludge and deposits to increases, and corrosion can occur if the fluid continues to be utilized beyond its limits. Pentane Insolubles are 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.Viscosity is the fluids ability to resist flow. Increases in viscosity in this heat transfer system is attributed to the oxidation process but may also be due to a heavier fluid being added. This process increases the size of the molecules and increases the oils viscosityObserved improvements in the system could be due to system filtration, sweetening with new oil or from previous samples that may have been taken from dirty sample points. Oil samples results indicate that the oil has reached the end of its useful life and that a system drain and clean process should be undertaken. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. Visc @ 40°C is abnormally high.
02/05/16	Based on the analysis results, it appears that the oil may have experienced one or both of the following deteriorating conditions. This may be due in part to the length of service on the oil (11 years indicated).Thermal degradation: 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.Oxidation: This is a chemical reaction between oxygen and the components of the oil whereby the hydrocarbon in the oil turns into weak carboxylic acids and other carbon-oxygen containing species. The higher the temperature, the worse the oxidation becomes and it will feed off of itself becoming exponentially worse over time when the additives are depleted. In a closed heat transfer system, the most probable place for fluid oxidation to occur is in the expansion tank (without an inert gas blanket). In an open system, the fluid oxidizes rapidly at its operating temperature. Different oils vary considerably in their resistance to oxidation largely due to the base oil used and the antioxidant additives used in the oil.After 11 years of service, this system may be due for an oil change? Resample at the next interval and continue to monitor the system. COC Flash Point is severely low. Acid Number (AN) is abnormally high. (GCD) 10% Distillation Point is abnormally low. (GCD) % < 335°C is marginally high. (GCD) 90% Distillation Point is marginally high.

01/30/15

This sample is showing signs of thermal degradation as well as signs of oxidation. The flash point is very low and the system needs to be vented immediately in order to bleed off the light ends from the system. This should help raise the flashpoint.After system has been vented, re-sample and send in for analysis. Pentane Insolubles levels are severely high. COC Flash Point is severely low.

09/19/14	

06/20/14	The oil condition remains concerning, therefore we are writing the same comments form the last sample in June. The oil is showing increased signs of degradation by oxidation with the TAN increasing to very high level. Solids content is also high. This system has shown degradation for a couple years at least and we suggest that if budget permits and if productivity is starting to be affected, that a system cleaning shoud be considered. If this is too costly and productivity has not been affected, maybe a drain and refill to remove this heavily degraded oil out of the system is a more cost effective solution that will bring value and delay a full system cleaning by a few more years. Keep running the system with this fluid degrading further will get to a point where it will require a costly cleaning and associated downtime. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. COC Flash Point is abnormally low. (GCD) 90% Distillation Point is marginally high.

04/17/14	The oil is showing increased signs of degradation by oxidation with the TAN increasing to very high level. Solids content is also high. This system has shown degradation for a couple years at least and we suggest that if budget permits and if productivity is starting to be affected, that a system cleaning shoud be considered. If this is too costly and productivity has not been affected, maybe a drain and refill to remove this heavily degraded oil out of the system is a more cost effective solution that will bring value and delay a full system cleaning by a few more years. Keep running the system with this fluid degrading further will get to a point where it will require a costly cleaning and associated downtime. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. COC Flash Point is severely low. (GCD) 10% Distillation Point is marginally low.

11/01/13	The distillation data has not changed much since the last sample. There is a significant increase in the acid number (AN) as well as the solids but other parameters not showing a concern. Very slight increase in the viscosity although would expect higher with TAN and Solids. Recommend to re-sample in 6 months. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. COC Flash Point is severely low. (GCD) 10% Distillation Point is abnormally low. (GCD) % < 335°C is marginally high. (GCD) 90% Distillation Point is marginally high.

03/01/13	The overall condition of the oil is not so bad. The amount of solids appears to be rising. The flash point decreased but this is strange considering the boiling curve (GCD) data indicate the amount of light hydrocarbons present in the oil dropped, which should have increased the flash point. The Acid NUmber dropped which is good news. Pentane Insolubles levels are severely high. COC Flash Point is severely low.

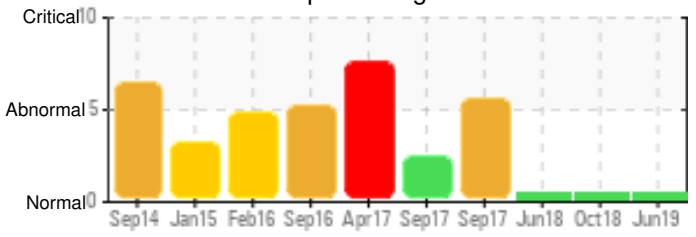
12/16/11	The flash point of this oil is low considering its high viscosity. Since the only benefit of having a high viscosity oil is normally its high flash point, in this case the flash point is even lower than most heat transfer fluids. The oxidation (degradation) level of the oil is roughly the same since the last sample, except the amount of solids in the oil is very high. Pentane Insolubles levels are severely high. Acid Number (AN) is abnormally high. COC Flash Point is marginally low.

03/17/11	The fluid seems to suffer from both thermal degradation and oxidation. Oxidation is noticeable by the high Total Acid Number. The thermal cracking is evident by looking ast the reduced flash point and lower GCD 10% (begining of the boiling curve of the fluid). The fluid is more volatile than fresh oil because thermal cracking formed low boiling point hydrocarbons ("low boilers") which represent 7% of the system currently. We strongly suggest to plan for action on this system, whether it's sweetening (partial drain&add fresh oil) or something to try to improve the fluid quality and run for a couple more years before having to do a complete clean-flush-refill of this system.

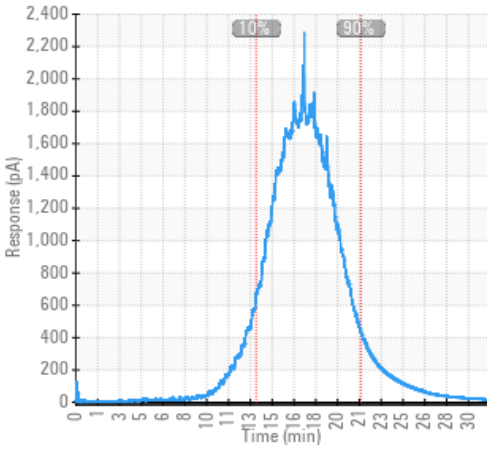
11/26/10	The condition of the Sun HT 21 has not changed much since the last sample. Flash point looks acceptable considering the operating temperature. Re-sample at next regular sampling interval

05/14/10	Some of the boxes are red (critical) but it's probably because we have the wror 10 years ago. Since then some smaller blenders still capitalize on the popularit may be different. Overall, the fluid looks better than it did in May, the flash poir oxidized. We suggest to re-sample in 6 months to monitor.

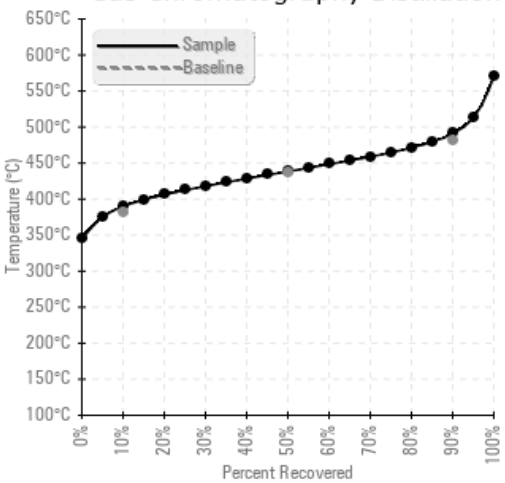
Sample Rating Trend



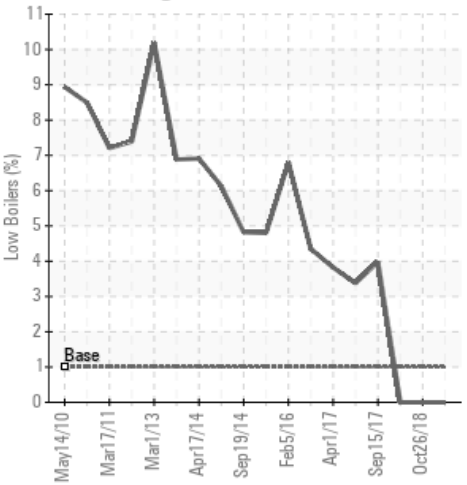
GCD Spectrum



Gas Chromatography Distillation



% Boiling < 335°C



The oil is either mixed with a lighter viscosity oil or has suffered thermal degradation. 8.9% by weight of the sample are low boilers that are not generally found in fresh oil. On the oxidation side, the Acid Number is moderately high at 0.36 mg KOH/g. In large systems this would be considered very high because of the large amount of oil that has oxidized to reach this level.