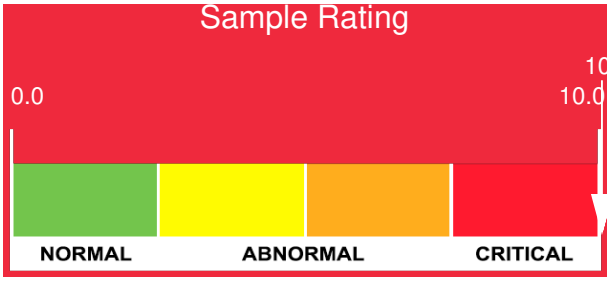
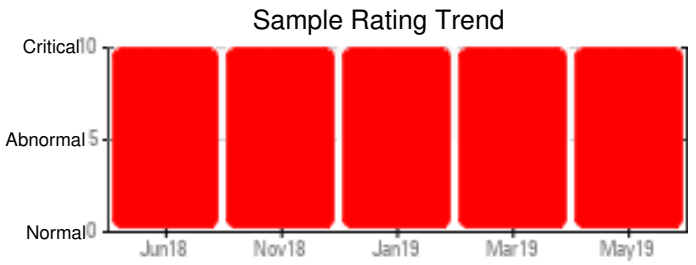




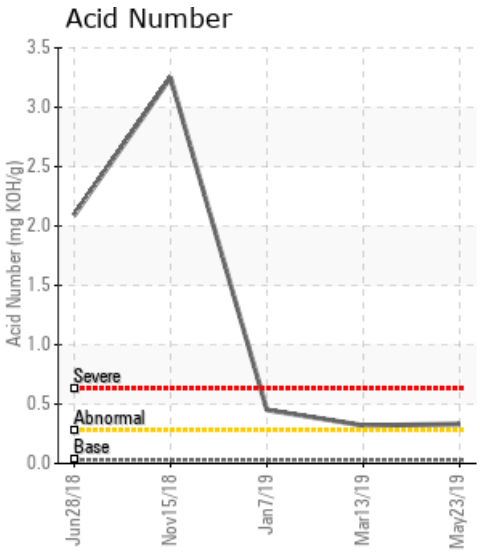
[TANGLE CREEK ENERGY 02-26-52-12W5M] HEAT TRANSFER

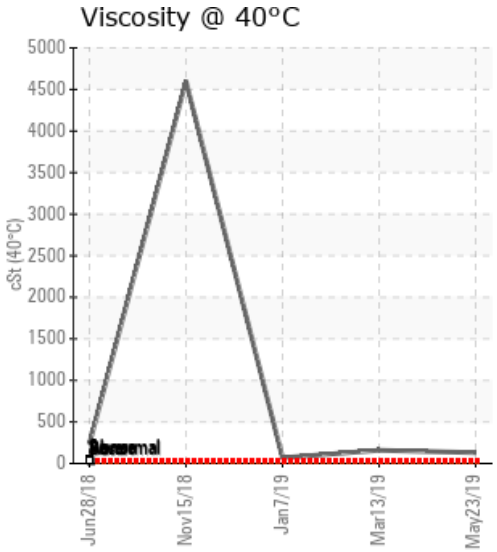
Customer: PTRHTF20201	System Information	Sample Information
TANGLE CREEK ENERGY 2-26-52-12W5M WHITECOURT, AB T7S 0A2 Canada Attn: Jason Kerr Tel: (780)706-1778 E-Mail: jkerr@tanglecreekenergy.com	System Volume: 1200 gal Bulk Operating Temp: 356F / 180C Heating Source: Blanket: Fluid: PETRO CANADA PETRO-THERM Make:	Lab No: 02288397 Analyst: Peter Harteveld Sample Date: 05/23/19 Received Date: 05/31/19 Completed: 06/03/19

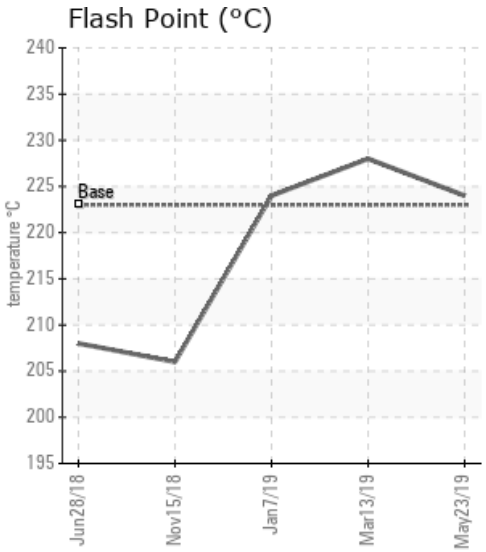
Recommendation: The fluid is in a poor condition and it is recommended to change out the fluid before the winter because efficient system operation can't be guaranteed for much longer. The Pentane Insoluble (solids) content is the main problem. At 2.78% it is more than 5x higher than the reportable limit of 0.5%. The solids content of the fluid is also partly the reason for the very high viscosity of 130 cSt/40C. The Fe content of the fluid is high but this is remaining from prior to sweetening of the fluid when the AN was at 3.25. The current AN is elevated but within limits. Please contact your Petro-Canada Tech Service Advisor for assistance with cleaning/flushing of the system.

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

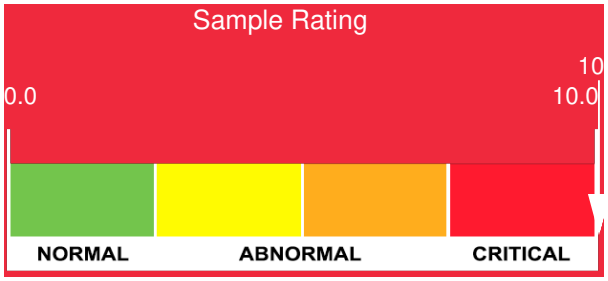
Sample Date	Received Date	Fluid Age	Sample Location	Flash Point (COC)	Water (KF)	Viscosity (40°C)	Acid Number	Solids	GCD 10%	GCD 50%	GCD 90%	GCD % < 335°C
	mm/dd/yy			°F/°C	ppm	cSt	mg/KOH/g	%wt	°F/°C	°F/°C	°F/°C	%
05/23/19	05/31/19	0h		435 / 224	63.3	130	0.332	2.78	723 / 384	814 / 434	915 / 490	0.63
03/13/19	03/20/19	0h	SIGHT GLASS	442 / 228	161.2	159	0.32	2.07	701 / 372	800 / 426	903 / 484	3.62
01/07/19	01/18/19	0h		435 / 224	25.8	68.8	0.451	1.64	697 / 370	786 / 419	886 / 475	1.66
11/15/18	12/05/18	0h		403 / 206	72.6	4599	3.25	1.10	728 / 386	827 / 441	933 / 500	1.13
06/28/18	07/17/18	0h	BOTTOM OF THE PUMP	406 / 208	263.9	238	2.09	0.749	714 / 379	779 / 415	881 / 472	0.00
Baseline Data				433 / 223		34.2	0.03		720 / 382	817 / 436	900 / 482	1.00

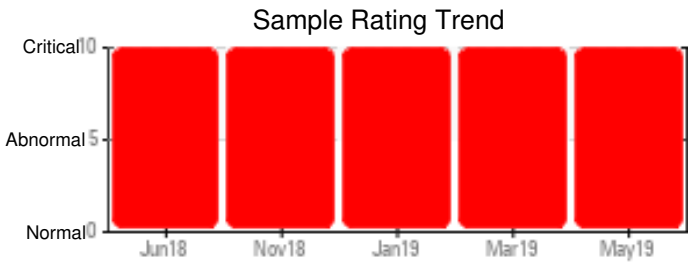






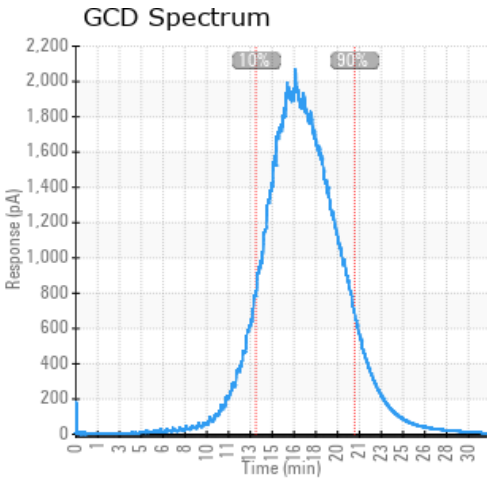
PETRO-CANADA LUBRICANTS

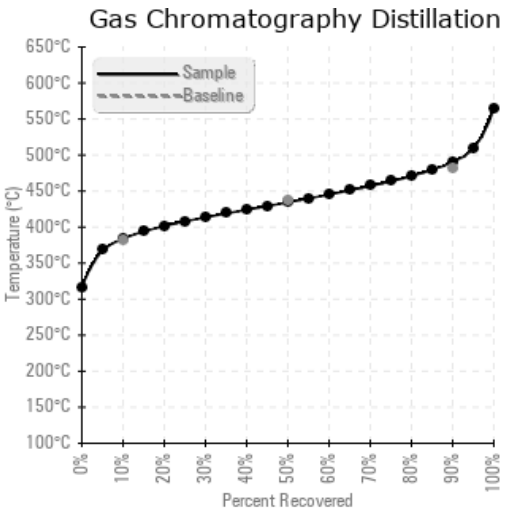


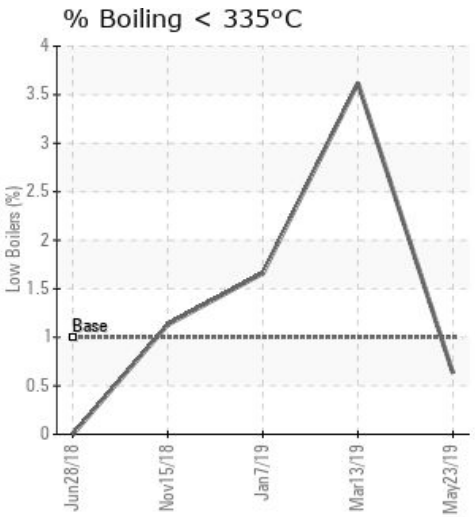


Sample Date	Iron	Chromium	Nickel	Aluminum	Copper	Lead	Tin	Cadmium	Silver	Vanadium	Silicon	Sodium	Potassium	Titanium	Molybdenum	Antimony	Manganese	Lithium	Boron	Magnesium	Calcium	Barium	Phosphorus	Zinc
05/23/19	836	0	0	3	0	0	0	0	0	0	5	5	0	0	0	0	11	0	0	0	2	0	2	1
03/13/19	1191	0	0	5	0	0	0	0	0	0	8	8	0	0	0	0	15	0	0	0	3	0	1	1
01/07/19	775	0	0	2	0	0	0	0	0	0	5	4	0	0	0	0	9	0	0	0	2	0	2	1
11/15/18	2153	1	0	7	0	0	0	0	0	0	14	11	0	0	0	0	25	0	1	0	4	0	0	1
06/28/18	1429	0	0	7	0	0	0	0	0	0	10	12	0	0	0	0	17	0	0	2	4	0	0	1
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

03/13/19	The fluid is in a poor condition but suitable for further use. Was this sample pulled from a low point in the system? (Increased water and solids content) Viscosity is high. It is recommended to start planning cleaning/flushing of the system.Iron ppm levels are severe. PQ levels are severe. Pentane Insolubles levels are severely high. Visc @ 40°C is severely high. Acid Number (AN) is abnormally high.
01/07/19	Sweetening of the fluid has achieved the goal of reducing Acid Number to below the limit of 1. The current Acid Number of 0.45 is low enough to stop further progress of corrosion within the system. Fe content has decreased to 775 ppm. This is still high but is the remainder of the Fe present before sweetening. The viscosity is still high with 69 cSt/40C but significantly lower than the 4599 cSt/40C of before. The solids content of the fluid is still high with 1.64% (from 1.1%) and although high it is currently of no concern unless there are problems with heat exchanger bundle plugging or pump seal leakage. The current condition of the fluid should allow system operation until Spring when system cleaning/flushing should take place. It is recommended to start planning the cleaning/flushing job now to be ready for it in the Spring. Please ensure blanket gas is in place to prevent further degradation of the fluid. Please re-sample early March.Iron ppm levels are severe. PQ levels are severe. Pentane Insolubles levels are severely high. Visc @ 40°C is severely high. Acid Number (AN) is abnormally high.
11/15/18	The fluid is in a poor condition and needs to be replaced asap. AN has exceeded the limit and viscosity is extremely high. In combination with a high 90% GCD temperature this indicates degradation by oxidation which is related to contact between hot oil and oxygen out of the air. Absence of blanket gas may cause this. The fluid has become highly acidic (AN = 3.25) Evidence of this is the Fe content of 2153 ppm which is generated by corrosion. Not replacing the fluid asap may lead to holes forming in steel components like piping, heat exchangers and vessels. Since the viscosity is extremely high and the Pentane Insoluble (solids) content is also high, the system needs to be cleaned/flushed prior to filling with fresh Petro-Therm. The high viscosity may complicate disposal of the fluid by solidifying at ambient temperature. Please contact your Petro-Canada Tech Service Advisor to discuss this.Iron ppm levels are severe. PQ levels are severe. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. Visc @ 40°C is severely high. (GCD) 90% Distillation Point is abnormally high. Manganese ppm levels are abnormally high.
06/28/18	The fluid is severely degraded and has to be replaced. The viscosity is very high. AN has exceeded the limit. The oil has become corrosive and therefore the Fe content is high. GCD 90% temperature is slightly low. The symptoms indicate degradation by oxidation. The Pentane Insoluble (solids) content has exceeded the reportable limit of 0.5% Since oxidation is usually caused by hot oil contacting atmospheric air, it is advised to check proper operation of the blanket gas system.Before filling with fresh fluid an internal inspection of the heater is recommended. This because the solids content is at 0.749%. If necessary the system needs to be cleaned/flushed prior adding a fresh fill. Please take a sample of the fresh fill in circulation while cold and another sample of hot fluid after 24 hours of service. The results will be used as baseline references. For further questions please contact your Petro-Canada Tech Service Advisor.Iron ppm levels are severe. PQ levels are severe. Pentane Insolubles levels are severely high. Acid Number (AN) is severely high. Visc @ 40°C is severely high. (GCD) 90% Distillation Point is marginally low.