

## TEXAS REFINERY: WET GAS COMPRESSOR LUBE OIL SYSTEM HIGH VELOCITY HOT OIL FLUSH

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### Summary

PetrolinkUSA performed flushing services on a Wet Gas Compressor Lube Oil System at a Texas Refinery. Services provided included a high velocity hot oil flush, reservoir cleaning and side stream filtration of the final fill oil.



### Introduction

PetrolinkUSA provided flushing services for the Wet Compressor lube oil system at a Texas Refinery. The services performed included:

#### Wet Gas Compressor Lube Oil System

- High velocity hot oil flush
- Reservoir cleaning
- Side stream filtration of final fill oil

### High Velocity Hot Oil Flush

PetrolinkUSA personnel and equipment arrived onsite on the morning of Day 1. Access badges and work permits were obtained in addition to the T/A onboarding safety training being completed. The flushing equipment was staged in secondary containment then barricaded in designated area near the compressor. The PetrolinkUSA team members conducted a job walk to identify the jumper locations and tie-in points.

On Day 2 following the the 7:00AM safety meeting, installation of the flushing equipment and flushing jumpers began. The flushing skid suction and discharge lines were connected to the LO system. The heater skid suction line connection was made. The discharge connection was not completed due to not being able to access the top of the reservoir. PetrolinkUSA and Refinery representative decided scaffolding was required to gain access to topside of reservoir. Refinery contact facilitated the scaffolding installation.

The “cooler” flush loop was modified and rigged up to designated flushing flow path. The following items were removed or installed to complete the remove or bypass sensitive items in the lube oil system:

- Temperature control valve - removed and FME installed
- PCV 554 - removed and jumped for flush; FME installed on valve
- Motor Inboard and outboard bearing LO jumpers installed
- Gearbox bearing LO jumper installed
- Compressor inboard bearing LO Compressor jumper installed

Temporary flush connection rig-up continued on Day 3. The cooler loop, heater skid loop, and the outboard compressor LO jumper installed. The rundown tank was visually inspected by PetrolinkUSA and Refinery representatives. It was found to be clean and it was decided to not include it in the HVOF. The rundown tank check valve was removed and the tank was blinded off from the flush.

The flushing circuit installation was completed and an operational walk down performed with PetrolinkUSA and Refinery representatives. At 1:30PM, PetrolinkUSA and Refinery Representative agreed that the system was ready to be flushed. PetrolinkUSA started the flush by performing a leak check on the system. The pump rate was brought up slowly until the flushing pump was flowing at max speed and the system was confirmed to be free of leads. Initial inspection screens were installed at 3:45PM in designated inspection locations. Flush was run at full speed for 1 hour before stopping the flush to remove inspection screens. All screens had visible contamination large and small. The designated inspection points are listed below:

- Motor inboard bearing
- Motor outboard bearing
- Gearbox bearing
- Compressor inboard bearing
- Compressor outboard bearing

**Acceptance Criteria As stated In**

Machinery Repair Standard Oil Flush Policy Document

As a minimum, final inspection screens/socks shall be installed after the filters, at the inlet to each bearing and seal housing, and at the system drain near the reservoir. The systems are acceptable if the number of particles caught in the screens (at all locations) does not exceed 16/14/11 (as per ISO 4406 v") after a one hour circulation at design flow rate, and operating temperature does not exceed the level specified in the following table.

**Table 1. Maximum Number of Particles**

<b>Maximum Number of Particles</b>				
Nominal Pipe Size (inches)	Schedule 40 or less	Schedule 80	Schedule 160	XX Strong
1" or less	6	4	3	-
1 ½"	13	11	9	6
2"	21	18	14	11
3"	46	41	34	26
4"	80	72	58	49
6"	180	163	132	117

The above particles must not exceed .010" (greatest dimension), or be abrasive in nature. No magnetic particles are acceptable, regardless of size. NOTE: If the pipe schedule is not known, then use the schedule 40 column to match the particular pipe diameter. If the pipe is larger than 6", then the criteria for 6" schedule 40 must be used.

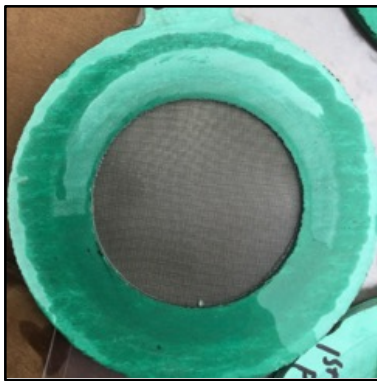
Particles should not be grouped in any portion of the screens. This would indicate insufficient flow during the test period and would not give an acceptable measure of cleanliness.

Final acceptance will be to the satisfaction of the Refinery representative, designated by the Mechanical Engineering Group (who will be determined prior to final acceptance run).

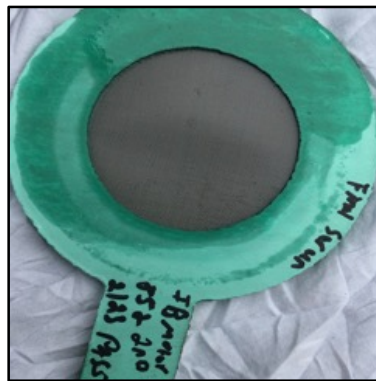
PetrolinkUSA shall provide a document stating the final ISO particle count and adherence to the inspection criteria. This document will be signed by the vendor's designated representative, and the Refinery designated representative.

The high velocity flush continued through the night into the Day 4. The piping removed from the compressor deck was hand cleaned and FME applied. Inspection screen checks were performed in accordance with Machinery Repair Standard Oil Flush Policy Document.

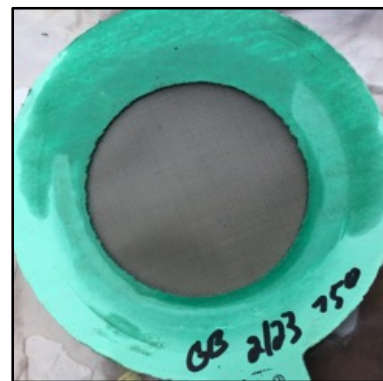
- Motor inboard bearing – passed inspection
- Motor outboard bearing – passed inspection
- Gearbox bearing - passed inspection



**Figure 1.** Motor inboard bearing first inspection 2/23/18 7:50AM



**Figure 2.** Motor inboard bearing final approved inspection screen 2/23/18 8:52AM



**Figure 3.** Gearbox approved first inspection screen 2/23/18 7:50AM



**Figure 4.** Gearbox approved second (confirmation) pass inspection screen 2/23/18 8:52AM



**Figure 5.** Motor outboard bearing approved first inspection 2/23/18 3:10PM

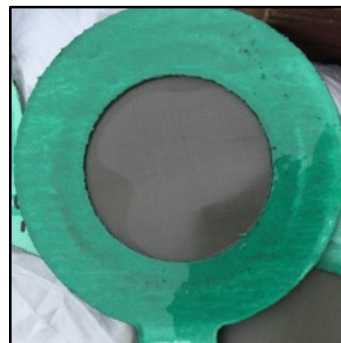


**Figure 6.** Motor outboard bearing approved second (confirmation) inspection 2/23/18 4:00PM

Flushing continued on Day 5 with the final inspection screens approved for the compressor inboard bearing and the oil cooler loop flush. Wet Gas Compressor. The high velocity hot oil flush of the Wet Gas Compressor was completed at 11:40AM with final inspection approved by Refinery representatives. The final ISO particle count was 14/13/09.



**Figure 7.** Compressor outboard bearing approved first pass inspection screen 2/23/18



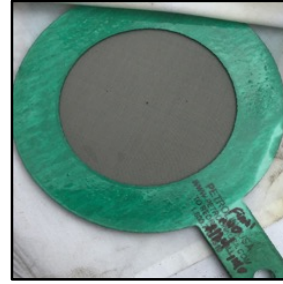
**Figure 8.** Compressor outboard bearing approved second (confirmation) inspection 2/23/18 8:52AM



**Figure 9.** Compressor inboard bearing approved first inspection 2/24/18 11:00AM



**Figure 10.** Compressor inboard bearing approved second (confirmation) inspection 2/24/18 11:40AM



**Figure 11.** Oil Cooler second (confirmation) inspection 2/24/18 11:40AM

Following the completion of the flush, PetrolinkUSA removed all jumpers, fittings, and hoses from the system piping on the compressor deck and installed FME on all open flanges. All PetrolinkUSA jumpers, fittings and hoses were flown back to the ground level. Refinery representative inspected and approved the stainless steel temporary storage totes prior to transferring the lube oil into them. PetrolinkUSA rigged down the jumpers on the Wet Gas lube oil skid. All jumpers removed had FME installed. The lube oil was transferred from the Wet Gas lube oil reservoir to the temporary storage totes.

### **Wet Gas Compressor Reservoir Cleaning**

The Wet Gas lube oil reservoir was cleaning on Day 6. The reservoir was blinded for Confined Space Entry (CSE) before breaking the plane into the reservoir. PetrolinkUSA personnel entered and cleaned the interior of the reservoir. The condition of the cleaned reservoir was inspected and approved by Refinery representatives. The reservoir blinds were removed and a new 1.5" valve for the sample port was installed by site contracted pipefitters.

The onboard filter vessels were cleaned and new filters installed. Final inspection and photo documentation was taken by Refinery Representative.



**Figures 12a & 12b.** Interior of the Wet Gas lube oil reservoir before cleaning (left) and post cleaning (right).



### Completion of Rig Down

The rig down of the flushing circuit and equipment was completed on Day 6. The following components were flown back into place and rough fit:

- Temperature control valve
- PCV 554
- Header piping for the LO pumps
- Valve and orifice assemblies for the pumps
- Spools and blinds for the service flanges on the cooler loop

As directed by Refinery representative: Gaskets were not installed and the flanges were not torqued as these items were to be completed by contracted pipefitters. All open connections had FME installed.

Tasks to be completed by site prior to the system being restored to operating condition:

1. Piping needs to be reinstated on the compressor deck.
2. The rundown tank still has a 4" blind flange installed isolating it from the LO system. 6" service flange on the rundown tank itself needs to be reinstated as well.

### Final Oil Fill

A sample from the final oil was taken as it was filter filled into the Wet Gas lube oil reservoir and send to the lab for particle count analysis. The lab results showed final particle count for the

lube oil was 16/14/11. The laboratory test reports are shown in Appendices I. Two oil samples were turned in for retention by Refinery.

On Day 7 PetrolinkUSA completed the final paperwork, cleaned the flushing site, finished loading all the flushing equipment and materials then demobilized from site.

### **Conclusion**

PetrolinkUSA safely completed the high velocity hot oil flush, reservoir cleaning, and final fill oil filtering on the Wet Gas Compressor lube oil system. The services performed successfully cleaned the lube oil system to the required specifications. The system cleanliness was verified by Refineries Machinery Repair Standard Oil Flush Policy and API 614 specifications. Producing clean inspection screen after a 1 hour run followed by another successful confirmation run. The final fill oil had a final ISO code particle count of 16/14/11 was confirmed by 3<sup>rd</sup> party laboratory testing.



# APPENDIX I. Final Fill Oil - Post Filtering Oil Analysis Results (Final Bill)



Machine Condition: **NORMAL**  
 Lubricant Condition: **NORMAL**  
 Machine Name: Motiva PAR - Centrifugal Compressor  
 Machine ID: DC02 Wet Gas Compressor

Component Information		Sample Information		Customer Information	
Machine Type: Centrifugal Compressor	Sump Size: Unknown	Received: 03/01/2018	PetrolinkUSA, LLC	3021 E. Fox	Columbus, OH 43219
Lubricant: SHELLTURBO T32		Report: 03/01/2018	3166 - 1 - 331 - 1	MM / PATKF	Jason Bandy
Machine MFG: UNKNOWN		Sample No.: 3166 - 1 - 331 - 1	Analysis/Test: MM / PATKF		
Machine MOD:					

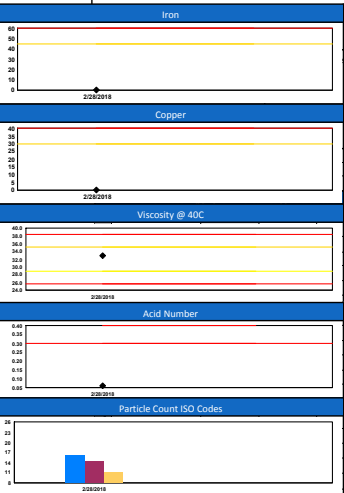
Machine Condition: **NORMAL**  
 Lubricant Condition: **NORMAL**  
 Machine Name: Motiva PAR - Centrifugal Compressor  
 Machine ID: DC02 Wet Gas Compressor

**PROBLEMS** No problems found with current sample.  
**COMMENTS** The results for this sample indicate normal conditions. Please continue scheduled sampling.

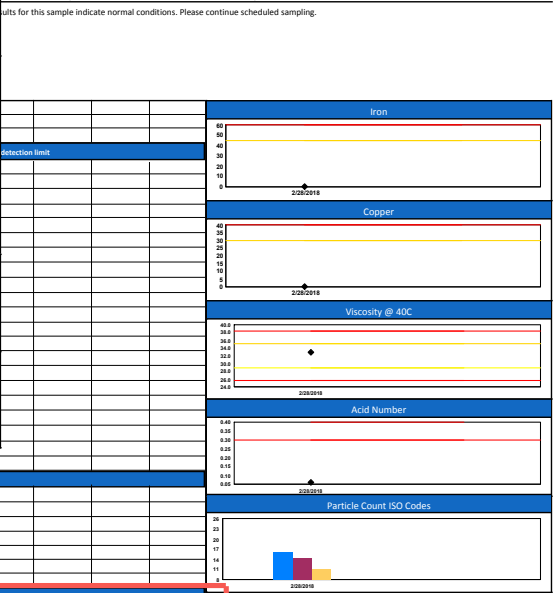
**CUSTOMER NOTES**

Component Information		Sample Information		Customer Information	
Machine Type: Centrifugal Compressor	Sump Size: Unknown	Received: 03/01/2018	PetrolinkUSA, LLC	3021 E. Fourth Ave.	Columbus, OH 43219
		Report: 03/01/2018	3166 - 1 - 331 - 1	MM / PATKF	Jason Bandy
		Sample No.: 3166 - 1 - 331 - 1	Analysis/Test: MM / PATKF		

Date Sampled	NEW OIL	2/28/2018	2170527
Lab No	T298573	2170527	
Machine / Lube Cond	N/A		
<b>ELEMENTAL SPECTROSCOPY (ppm) ASTM D6185 Mod ( ) indicates below detection limit</b>			
Iron	-	-	-
Copper	-	-	-
Lead	-	-	-
Aluminum	-	-	-
Tin	-	-	-
Nickel	-	-	-
Chromium	-	-	-
Titanium	-	-	-
Vanadium	-	-	-
Silver	-	-	-
Calcium	-	-	-
Magnesium	-	-	-
Phosphorus	-	-	-
Zinc	-	-	-
Barium	-	-	-
Molybdenum	-	-	-
Silicon	-	-	-
Boron	-	-	-
Lithium	-	-	-
Sodium	-	-	-
Potassium	-	-	-
<b>FTIR SPECTROSCOPY (Indexing Numbers) IM-110 TURBINE METHOD</b>			
Thermal Event Acid	0	0	
Acid Oxidation	0	8	
Ester	18	20	
Aromatic Additive	0	0	
Base Oil Aromatic	16	15	
Amine Antioxidants	61	67	
Phenolic Antioxidants	37	44	
<b>PARTICLE COUNT (particles per ml) ISO 4406-99</b>			
Pore Block Particle Count Alarm Limits Marginal (19/17/15)			
Pore Block ISO Code	17/15/11	16/14/11	
>4 Micron	682	355	
>6 Micron	265	138	
>14 Micron	20	10	
>50 Micron	0	0	
>100 Micron	0	0	
<b>VISCOSITY (centistokes) ASTM D445 MOD</b>			
Viscosity @ 40°C	32.2	32.9	
<b>ACID NUMBER (mg KOH/g) ASTM D974 MOD</b>			
Acid Number	0.06	0.06	
<b>WATER (PPM) ≥ ASTM D6304C d-WI-134* c-Crackle d-WI-135* e-WI-379*</b>			
Water		35 (a)	



Particle Count ISO Codes	Count
>4 Micron	682
>6 Micron	265
>14 Micron	20
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>6 Micron	265
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Testing performed by Insight Services \*, an ISO/IEC 17025:2005 accredited laboratory. L-A-B Accredited Certificate Number 2221. Testing. (\*) Not responsible for the application of and reliance upon results and recommendations reported by TestOil, whose obligation is limited to good faith performance.

Particle Count (particles per ml) ISO 4406-99	17/15/11	16/14/11
Pore Block Particle Count Alarm Limits Marginal (19/17/15)		
Pore Block ISO Code	17/15/11	16/14/11
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Water		35 (a)

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