Varnish Removal at K-Electric, Bin Qasim Power Station-II (Issued by K-Electric BQPS-II)

Technology Release document - as lessons learnt

Critically High MPC levels upto 30 were recorded at GE Frame 9E Gas Turbine, in April 2016 as per GE TIL 1528-3 Varnish Removal Skid feasibility study was carried out which was presented to Generation Management and budget got approved.

Different alternatives like replacement of lube oil, Consequences of Varnish, Rental Skid solution were studied as well, but it was found that replacement of oil will cause cost of down time + cost of lubricant and still the problem will not be resolved deposited varnish will get dissolve back to new Lubricant, furthermore the Varnish will again evolve in new oil over passage of time and considering three GT's it was not feasible.

TIL 1528-3
GE ENERGY SERVICES TECHNOLOGY
CUSTOMER TECHNOLOGY SERVICES
18 NOVEMBER 2005

Compliance Category - O
Timing Code - 7

TECHNICAL INFORMATION LETTER

LUBE OIL VARNISHING

APPLICATION
This TIL applies to all heavy-duty gas turbines.

PURPOSE
This TIL is to provide customers with information regarding the formation of varnish or lacquers within the lube oil system, their effects and information regarding mitigation technologies. Please note that this information represents the current information gathered to date.

Compliance Category

Hence the cost of a skid was almost equal to cost of lube oil of one GT and no downtime and Varnish will never reoccur and all three turbines will get clean.

Ruler Test ASTM D6971 was carried out on GT sample to ensure that satisfactory amount of anti-oxidants are still remaining in Lube Oil which revealed that Ruler was above 50% in each case, hence varnish removal from lubricant was going to a reasonable decision.

Different Varnish Removal technologies available were compared, and SVR-1200 from Hypro-Filtration US was selected with consensus of Mechanical department.

Manufacturer was approached which diverted us to authorized regional distributor Arab Advanced Technologies in Oman.

After satisfactory response on our several clarifications and queries, vendor finally arranged a Column Test of our Gas Turbine Lube Oil Sample in which sample was treated with Varnish Removal Skid filters on a Lab scale and results were in acceptable range

Different users of same product were approached, for their recommendations which were consistently in line with reliable performance of Skid.

PR # 1400012845 was created, and against PO # 7600003874 the product order was placed, and to meet the pre-requisites for installation of skid another PO# 7500031896 to APE was placed.

Hence after pre-requisites were arranged, Skid was delivered to site, Vendor mobilized his team from Oman and Successful Installation, commissioning & startup of Skid was carried out at GT-2 on July 14th, 2017, followed by product O&M training session to team.

Filters set was replaced after a month duration and on Aug 28th, 2017 the MPC levels dropped from 38 to 11. Results were verified through SGS Australia and comparable results were found. Confirming the success story.

Afterwards, the SVR skid was moved to GT-3 where again the varnish levels were dropped and then moved to Steam Turbine unit where it is currently performing its purpose.

Moving ahead, the decision has been taken to install dedicated HYPRO SVR skids during 2018, on each of the GTs 1,2,3 as a permanent mount to enhance the reliability of Gas Turbines.

EPT

Customer: Karachi Electric
Site: BQPS II
Unit: GT-2
Reservoir: 12500 Liters / 3303 Gal
Oil Type: Shell Turbo CC 32

PO/SO #: N/A
Contact: Neten Kara
Latest Sample Date: 28-Aug-17
Received Date: 7-Sep-17

HY-PRO FILTRATION

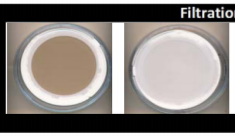
Recommendations & Notes

The sample taken on 28-Aug-17 has an acid number that is within target. The fluid's moisture content and viscosity are within target. The fluid's ISO particle count is also within target. The MPC ΔE is in the good range (<15) indicating that a low level of degradation by-products is present in the fluid (see filter micrographs below). This level of varnish precursors will not likely become a problem within the system in the immediate future. Spectrographic analysis reveals that phosphorus levels are below target; all other dissolved metal levels are within target. RULER analysis suggests that 69 % of the amine and 63 % of the phenol antioxidants remain.

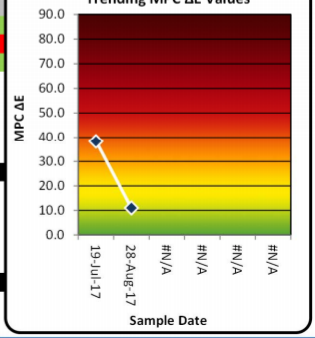
	AN	SAN	H2O	Viscosity (cSt)		ISO (particles / mL)			ISO Code	Resistivity	Chloride	Mineral Oil	Air Release
Sample Date	(mgKOH/g)		(ppm)	40 °C	100 °C	4 µm	6 µm	14 µm	4/6/14 µm	(G ohm-cm)	(ppm)	Cont. (%)	(min)
Target	0.16	N/A	< 200	33.2	5.45	480	120	8	16/14/10	N/A	< 4	N/A	4
19-Jul-17	0.11		337	35.2	N/A	20242	9944	3030	22/20/19	N/A	N/A	N/A	N/A
28-Aug-17	0.10		22	36.5	N/A	35	14	3	12/11/9	N/A	N/A	N/A	N/A

	FTIR Condition Monitoring					Membrane Patch Colorimetry (MPC)		
Sample Date	Oxidation	Amine	Phenol	POE deg	AW	Hold Time (hr)	Patch Wt (mg)	MPC ΔE
Target	0.0	N/A	N/A	< 8	> 55	68 - 76	< 2.0	< 15.0
19-Jul-17	N/A	N/A	N/A	N/A	N/A	70	2.9	38.3
28-Aug-17	N/A	N/A	N/A	N/A	N/A	70	1.1	11.0

Filtration Micrograph(s) in Chronological Order (L to R)



Trending MPC ΔE Values



EPT Lab : 403.450.1756 (lab@cleanoil.com) Hypro Filtration : Curt Martin 317.849.3535 (curt.martin@hyprofiltration.com)

Knowledge Base:

Lubricant = Base Oil + Additives

Base Oil > Additives; (Base Oil > 99.5%)

Base Oil is Synthetic or Mineral Based, whereas Mineral based oils are majorly used.

Turbine Oil = (99-99.5% Base Oil) + (0.5-1% Additives)
Additives are Anti-Oxidants (Amines and/or Phenols)

Mineral Oils + O2 $\xrightarrow[\text{Pressure}]{\text{Temperature}}$ Varnish

Antioxidants can't stop oxidation, can reduce/delay it but gets depleted/consumed overtime.

Varnish is an oxidation by product and is initially in soluble form.

Stage 1: Lubricant gets saturated.
Stage 2: Due to presence of Temperature Super Saturation level is achieved.
Stage 3: Now its not soluble anymore and will get deposited in sump, valves, piping, bearings etc.

It is in shape of sticky sludge type material deposited.

Once the temperatures are lowered, the Varnish will change into insoluble form.

Deposition of Varnish will lead

- Poor heat transfer
- IGV & Servo Valves sticking delayed response
- Reduced clearances
- Increased vibration levels

Existence of Varnish in lubricant can be assessed through Membrane Patch Colorimetry Test (MPC) ASTM D7843.

Supporting tests are

- Color Level ASTM D1500
- TAN ASTM D974
- Viscosity @ 40'C ASTM D445
- Particle Count ISO 4406

Solution to such problem as per GE TIL 1528-3 for GE Gas Turbines is to install Varnish Removal Skid.