KLEENTEK®

APPLICATION SPOTLIGHT

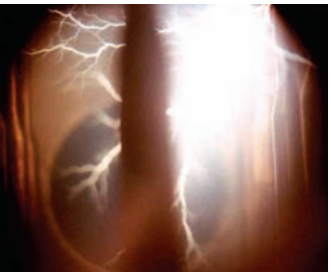
Varnish Solutions for Lubrication Systems in Steam Turbines

CONTROLLING VARNISH AND SUB-MICRON PARTICULATE

Varnish contamination is extremely common in steam turbines. In the long periods between major scheduled maintenance outages, heat and oxidation continuously cause deposits. Oil life is shortened, wear in seals, pumps, bearings and gears is accelerated, and cooling capacity in heat exchangers and oil cooled surfaces is severely reduced. Though reservoirs are often cleaned or systems flushed during major outages, the damage is done and time and money must be spent to correct problems that could have been eliminated years before at a fraction of the cost.

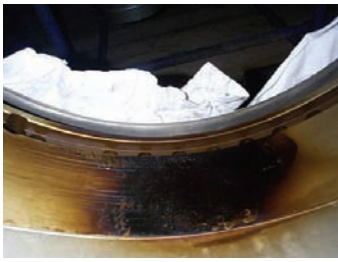
Issues of oil degradation and varnish contamination drive the majority of oil-related problems encountered in steam turbines of all sizes and types. In every turbine lube system, oxygen and heat continually degrade turbine oils and produce molecular by-products that, over time, deposit throughout the system as varnish. High water levels, adiabatic compression and micro-dieseling also play a role in varnish formation and oil degradation.

Often, spark discharge generated in mechanical filters is a key root cause of varnish, additive depletion and high particle counts. Sticky, high-friction varnish deposits coat all surfaces in contact with the oil and build up in critical areas like bearings, gears, filters, heat exchangers and pumps. Over time, these deposits dramatically affect the performance and reliability of every oil-related function on the turbine, including shortening the life of the lubricant.



Spark discharge

A serious concern for reliability engineers is that the onset of varnish cannot be predicted with most routine oil analysis. Indications from tests like RPVOT and TAN actually trail the onset of varnish creation by many months. Both newly commissioned turbines and older installations of all types are susceptible to the major costs and disruptions of varnish contamination.



Bearing Deposit

CONTAMINATION IN EHC SYSTEMS

When EHC systems use petroleum-based hydraulic fluid or turbine oils, the same varnish problems mentioned earlier occur. However, two key oil-related issues arise when EHC systems use fire-resistant phosphate ester fluids—acid levels from water contamination and small particle contamination known as ultra-fines. These factors cause a range of problems for reliable operation such as insoluble gels that plug orifices in servos and impede flow, and lead directly to valve failure and trips. Adiabatic compression in EHC systems produces large amounts of submicron and micron-sized carbon deposits that are not removed by mechanical filters. This particulate dramatically accelerates wear in pumps, servo valves and actuators.

Kleentek electrostatic oil cleaners for phosphate esters solve these problems. Though Kleentek systems don't directly control acid levels, they continuously remove insoluble gels and particulate of all sizes down to .01 micron for trouble-free, reliable EHC performance.

ROOT CAUSES OF VARNISH

Varnish is a result of the base oil and additive system deteriorating in the lubricant. Heat and oxidation are the biggest enemies of turbine oils, and neither can be completely eliminated. With both thermal breakdown and oxidation, hydrocarbon molecules begin to degrade and eventually form polymers that pollute the lubricant. Beyond general degradation, there are several major factors in varnish for steam turbines:

1. *Static discharge from mechanical filters*
2. *Hot and cool spots from pipe routing*
3. *Additive depletion*
4. *Implosion of air bubbles*
5. *Recent formulation and base oil changes in turbine oils*

SOLVING VARNISH PROBLEMS

Kleentek electrostatic oil cleaning technology solves varnish problems in steam turbines. Unlike traditional oil filtration, Kleentek's patented technology removes all insoluble contaminants, both hard contaminants and the degradation by-products responsible for varnish. Conventional filters remove only large particulate, but leave the submicron particles that are at the heart of varnish buildup. *"Clean" oil is not really clean if varnish is still in the system.*

Over time, Kleentek varnish removal systems actually clean the internals of the system. Rather than depositing varnish continuously as all lube systems do, oil cleaned with a Kleentek system does just the opposite; stripping away varnish one molecular layer at a time. Deposits are completely removed from the reservoir to the smallest servo orifice, leaving shining metal surfaces behind. Even systems with severe varnish contamination can often be reclaimed without flushing or oil change using Kleentek equipment.

Users of Kleentek on EHC systems have eliminated valve stiction and slow response problems as quickly as 14 days after installation. Kleentek units connect directly to the oil reservoir for continuous kidney loop cleaning. They run virtually maintenance-free, 24/7, requiring only a simple collector change about once a year.

BENEFITS OF KLEENTEK

Kleentek systems provide significant benefits for steam turbine users. Some of these include:

- Reliable, trip-free servo valve performance in integrated or separate EHC systems
- Varnish-free lube, seal and hydraulic control circuits and reservoirs
- Greatly extended oil and additive life
- Avoidance of unplanned outages
- Decreased bearing and gear wear
- Improved heat exchanger performance
- Extended mechanical and elastomer seal life
- Elimination of costly, imperfect system flushes and reservoir cleaning

Kleentek varnish removal systems provide unmatched return on investment. Systems often pay for themselves many times over in the first year of operation. Significant reductions in varnish-related maintenance, EHC trips and unplanned maintenance can easily cover initial costs. Kleentek solutions become a key element of your reliability program and an essential partner in profitable operations and maintenance.

ACTUAL TEST RESULTS FROM A MAJOR POWER COMPANY USING A 225-GALLON EHC SYSTEM WITH A 5-MICRON MECHANICAL FILTER.

Fluid Analysis Report

Standard Test Properties	Results	OEM Recommended Limits Min	Max
ACIDITY, MG KOH/G	0.08		0.2
VISCOSITY, SUS,100˚ F	206.3	200	230
WAYER CONTENT, WT%	0.13		0.2
PARTICLE COUNT/100 ml	–		
SIZE (Microns)	–		
5 -10	44096		24000**
10 - 25	5188		5360
25 - 50	244		780
50 - 100	8		110
>100	1		11
RESISTIVITY, G-Ohm-cm	10	5.0	
CHLORIDES CONTENT, ppm	17		100

Note: BEFORE KLEENTEK FILTRATION

Comment: **ONE (1) OR MORE SPECIFICATIONS HAVE EXCEEDED LIMITS.

Fluid Analysis Report

Standard Test Properties	Results	OEM Recommended Limits Min	Max
ACIDITY, MG KOH/G	0.04		0.2
VISCOSITY, SUS,100˚ F	204.7	200	230
WAYER CONTENT, WT%	0.15		0.2
PARTICLE COUNT/100 ml	–		
SIZE (Microns)	–		
5 -10	10242		24000
10 - 25	1494		5360
25 - 50	130		780
50 - 100	4		110
>100	2		11
RESISTIVITY, G-Ohm-cm	11	5.0	
CHLORIDES CONTENT, ppm	8		100

Note: AFTER 24 HOURS OF KLEENTEK FILTRATION

KLE-ASST-0506-PRO