CRV Plate helps protect servo-valve components against varnish

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Since 2004, many articles have been published on the subject of varnish and related problems in gas and steam turbines. They have discussed the causes of varnish, tests used to measure varnish levels, and the technologies available to "solve" the problem. But six years later, the war on varnish continues.

What is known

Simply defined, varnish is a thin insoluble film known to form on bearings and servo valves. It is a high-molecular-weight substance and insoluble in lubricating oil (LO). The "insolubles" are made up of more than 75% soft contaminants less than 1 micron in size. They have polar affinities and migrate from the body of lubricant to machine surfaces over time—a process influenced by the "conditions" of the system and lube oil.

The $64 question: What are these "conditions"?

The answer: Lubricant temperature and flow.

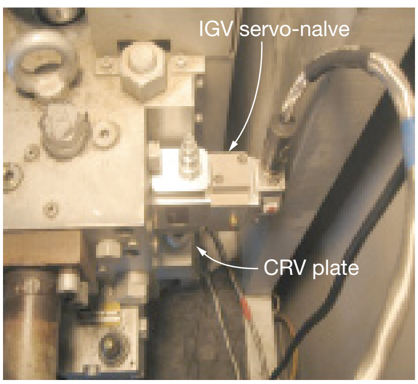
In a presentation at the 2008 meeting of the Society of Tribologists and Lubrication Engineers, James Hannon of ExxonMobil Corp presented a paper detailing the effects of LO temperature on varnish solubility ("Sensitivities in Turbine Oil Varnish Prediction").

ExxonMobil's research found that varnish goes back into solution as oil temperature increases; conversely, it becomes less soluble as temperature decreases. Some readers may recall Hannon as the author of a primer on LO sampling and analysis that appeared in the 2005 Outage Handbook (access www.combinedcyclejournal.com/archives.html, click 3Q/2004, click "Maintain lube oil within spec to ensure high reliability" on cover).

Additional research conducted in The Netherlands by Hans Overgaag and his colleagues at Ansaldo Thomassen (ATH), and made public last year, revealed that while temperature is a major factor in varnish plate-out on critical system components, insufficient LO flow is equally significant ("Up to Date Turbine Oil System Management"). For a backgrounder on the Ansaldo group of companies, return to the CCJ archives, click 3Q/2009, and click "Italian Power Generation" on the cover.

The ATH research demonstrated that when oil is stagnant (even at normal operating temperatures), conditions exist for varnish to agglomerate and plate out onto system components and surfaces.

Example: If a lubricating oil is at operating temperature and has been circulating through the system at the time of sampling, a QSA® varnish test performed onsite will report a low varnish potential rating (VPR). By contrast, the same sample submitted for QSA testing in the laboratory at ambient temperature (nominal 70F) that has been left standing for more than 72 hours could produce results indicative of a VPR "alert."



1. CRV Plate installed on the servo valve controlling the inlet guide vanes on a 7FA gas turbine mitigates varnish formation

The variability in results reflects the impact of differences in temperature and flow characteristics. Laboratory testing is important in that it clearly identifies the systems having high varnish potential and requiring intervention and corrective action—such as filtration, bleed and feed, or total fluid replacement.

References to terms like auto-degradation and thermokinetics, which imply a change in fluid chemistry, are incorrect. Onsite testing reflects the solubility of varnish particles at operating conditions, while QSA testing in a laboratory environment identifies the actual varnish potential.

To learn more about varnish in general, and QSA in particular, access the CCJ archives (see above), click 3Q/2006 (2007 Outage Handbook), and click the following articles on the issue cover: "Gas-turbine valve sticking . . . the plot thickens" and "Assess the condition of your oils, prior to the outage."

Addressing the symptoms

The major effects of varnish generally are identified with the hydraulic circuits for GT control systems. Inspections of circuit components have revealed plugged last-chance and pencil filters and lacquered servo-valve parts—conditions conducive to costly system flushes and unit trips, and possibly the inability to start the unit in the first place.

Focusing on the components most affected by varnish and the conditions that lead to varnish formation, Ansaldo Thomassen developed the Cross Relief Valve (commonly referred to as the CRV Plate). The operating principle of the CRV Plate is based on the creation of a controllable oil flow through the servo valve independent from control-system settings and commands, but without interfering with the principal control functions.

The nominal flow capacity of a servo valve rarely is attained. Most often, a steady-state or static condition exists and there is little oil flowing, perhaps none at all. Once installed, the CRV Plate allows oil to move through the servo valve up to the actuator, thereby assuring normal lube-oil operating temperature in the typically stagnant sections of the electrohydraulic control system.

This solution ensures that the control system is continually exposed to conditions that mitigate the formation of varnish on critical system components. The CRV Plate does not affect servo-valve operation and its installation does not require physical modifications to the control system. In some cases, minor modifications to the servo-valve conduit may be necessary.

Proof of the CRV Plate's value is illustrated in Figs 2 and 3, which show the last-chance filter for a gas splitter valve on a Frame 6 turbine. In Fig 2, varnish covers the filter inside and out. The operating time on the oil is approximately 4000 hours and QSA testing confirmed a VPR of 68 (an alert level).

The valve and filter were replaced and a CRV Plate was installed, but the LO was not changed-out. Fig 3 shows the filter after approximately 3000 hours of operation. Note that there is no agglomeration of varnish on the filter media, despite QSA results indicating an increase in the oil's VPR. Since installation of the CRV Plate, there have been no operating issues related to varnish formation in the corresponding servo valve.

2, 3. The positive impact the CRV Plate has on varnish mitigation is easy to see by comparing the two photos of the filter for a fuel splitter valve. At the left, note the extensive fouling prior to installation of the CRV Plate. Replacement filter at right has 3000 hours of operation on the same oil after the CRV Plate was installed

Continue the fight

The CRV Plate currently is designed for and applied on Moog Inc Type G771 and G772 servo valves used on GE frames. To date, the CRV Plate has operated over 50,000 hours at five sites problem-free. Extensive field testing over the past three years has revealed no sludge or varnish buildup in servo valves or last-chance filters in units where the CRV Plate is installed.

Important: The CRV Plate does not remove varnish from the system or reduce QSA VPR levels. However, it is an excellent tool for use as part of a comprehensive strategy to control the degradation of turbine lube oils and improve unit reliability. To date, there still is no silver-bullet fix for solving the varnish issue. Your best strategy may be a multifaceted approach incorporating the CRV Plate, fluid condition monitoring, and appropriate mitigation technologies (filtration, top-offs, etc).

In sum, the CRV Plate is a major advancement in the fight on varnish. It can mitigate immediately the effects varnish has on GT hydraulic control systems. Implementing the CRV Plate solution allows the time needed to properly evaluate the condition of your lube oil without risking a unit trip and to make the proper decision on how best to address the varnish issue in your system going forward. CCJ