Varnish contamination in hydraulic & lube oil systems

An Overview of Technologies Used To Detect and Resolve The Problem

By **Ken Kaihlanen,** *Director of Sales,Oil Filtration Systems*

Premature failure from lubricant breakdown is a primary cause of machinery failure, because it is largely misunderstood and ignored.

Warning Signs:

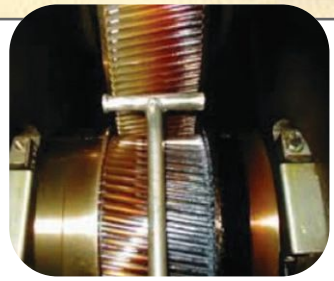
- Change in oil color
- Strong odor
- Change in oil consistency
- Sludge and hard deposits on metal surfaces
- Visible contaminants in oil samples

Any of these warning signs generally indicate that your oil has undergone a chemical change, and may no longer perform to its designed specifications. Premature breakdown of oil can be caused by a wide variety of conditions, including thermal stress, high pressure, fuel or gas entrainment, oxidation, and water contamination.

What is varnish?

Varnish is a soluble *and* insoluble contaminant made up of by-products of oil degradation. It can appear as a sticky or gel-like substance in the oil, or which plates out on the metal surfaces of lube systems. This can cause 'stiction' on servo-valves, and it can affect clearances and tolerances in bearings and hydraulic control systems.

As oil degrades, waste by-products from the additive package are formed, thus creating varnish. This is commonly observed in hydraulic components, inside engine rocker covers, and on journal bearings.



There are many causes of varnish and sludge, but clean oil is not one of them!

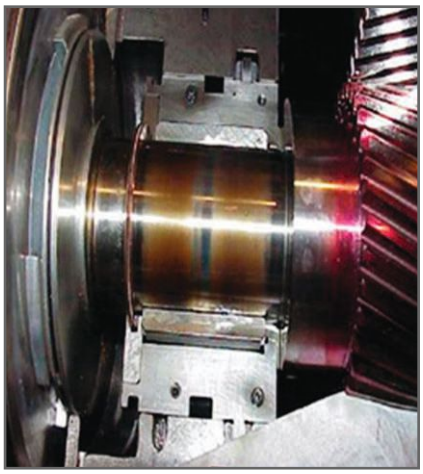
Is your system susceptible?

There are a number of reasons why lube oils suffer from high rates of varnish contamination. If your system ticks any of these boxes, then you should test your oil for varnish potential:

- Visible deposits or discoloration of lube circuit components
- If you switched from Group I to Group II oil, or if you have blended oils
- High flow rate of lube oil from a small lube oil reservoir
- High operating temperature
- Gas turbine, gas compressor, or hydraulic system

The effect of varnish on equipment

If left unchecked, varnish can propagate at an exponential rate, creating hot spots, prematurely plugging filters or oil gallery orifices, and coating heat exchangers, rendering them thermally inefficient. Hydraulic control systems and valves can gum up or seize, causing unit trips and starting faults. Also, hard particles can adhere to varnished components and cause premature wear.



The cost of a gas turbine or hydraulic system not starting quickly and efficiently can be enormous, as these are the assets that are designed to work on demand to meet supply requirements.

All lubricating systems are subject to varnish potential if not properly maintained. The biggest costs to industry from varnish are unscheduled downtime and lost production. There is a huge difference in cost between an unscheduled shutdown or unit trip in comparison to condition monitoring and effective varnish mitigation.

Often there is very little that an operator can do to help prevent or minimize the formation of varnish within a system, because the very design of many modern lube oil and hydraulic systems promotes "varnishing" within the oil:

- Higher operating temperatures
- Higher operating pressures
- Higher flow rates of oil with smaller in-line filter elements

It is therefore more important than ever to have a consistent oil analysis program whereby oil samples are pulled and analyzed on a regular basis to help measure the "health" of your oil and system.

It should also be noted that many major lube oil manufacturers are conducting significant research to develop new formulations of turbine and hydraulic oil designed to prevent or minimize the formation of varnish.

Varnish Detection

If you suspect that varnish could be a problem, then additional laboratory analysis can identify varnish potential within your system. Sometimes, it can be as simple as pulling filters and strainers and visibly checking them, looking for sludge that indicates oil breakdown. To be sure, a number of tests can be performed by your oil analysis lab:

- *Membrane Patch Colorimetry* (MPC)

This ASTM standard (D7843) measures "Varnish Potential" in oil, and it is the most widely recognized and accepted criteria in the industry today. It works by isolating oil degradation products on a patch membrane and measuring the total amount of color generated by the deposits with a spectrophotometer. Standard guides have been developed to interpret these empirical results and to assess the oil's potential to form varnish, and most labs now consider an MPC number of 40 or greater to indicate an "alarm" condition.

MPC 52 MPC 41 MPC 29 MPC 10

- *Remaining Useful Life Evaluation Routine* (RULER)

The "RULER" test quantitatively measures the remaining antioxidant concentration in the oil, and it can be used to determine the remaining useful life of the oil. This is a comparison test, and it ideally requires the original base oil to be supplied and tested also.

- *Other Tests*

MPC and RULER should be enough, but other methods to help determine varnish potential can include ultra-centrifuge, particle contaminant levels, TAN (Total Acid Number), moisture testing, and FTIR.

What should you do if you have varnish?

Don't ignore it …

Varnish, if present in a lube or hydraulic system, must be managed and controlled. Predictive maintenance of your unit is far less costly than reacting to an event, and if warning signs are there but ignored, then the repercussions can be significant.

Can you live with a major breakdown?

If you do nothing, varnish may cause the machine to suffer a breakdown or major component failure, potentially at a huge cost. You cannot predict when the failure will occur, so it is best to take a proactive approach and try to resolve the problem before it becomes serious.

What solutions can be deployed?

Certain types of specialty filtration equipment can effectively remove varnish from hydraulic and lube oil, but unfortunately there is no "silver bullet" which works every time in every situation, so a tailored solution is typically needed. Existing or used oil may or may not be able to be reclaimed, depending on the type and seriousness of the contamination, as well as additive depletion. For this reason, a thorough and detailed oil analysis with professional evaluation is critical to determine the proper path forward. A visual inspection of the reservoir and critical components will often reveal the level of varnish contamination within the system.

If a significant amount of varnish has already plated out on the metal surfaces, then a Varnish Flush may be needed to bring the system back to like-new condition. This process often involves a scheduled shut-down and a significant expense, but when done properly by an experienced crew, the result is a fully cleaned system and oil that is free of all varnish contamination. Steps can then be taken to prevent or minimize the formation of varnish within the oil and the system in the future.

If the problem is not yet severe enough to require a Varnish Flush, several types of Varnish Removal Systems utilizing different technologies are available on the market today, and they give varying degrees of performance and success depending on the application:

- Depth media filter elements can remove suspended varnish from oil at cool temperatures (typically 70 degrees F or lower)
- Electrostatic filters can remove varnish from oil by applying an electric charge to the oil and collecting "charged" particles on a collector plate
- Ion exchange resin bead filters (or granular adsorbent media) can remove dissolved varnish from oil at warm operating temperatures (typically 120 degrees F or higher).

It is a recognized phenomenon that as Varnish Removal Systems remove varnish from the oil, the hard varnish deposits on the metal surfaces within the system tend to "dissolve" back into the oil, so both the oil and the system itself can be cleaned. However, this process can take a long time, especially in systems with a severe amount of varnish contamination, and it can become costly in terms of required filter element change-out.

Several "Cleaning Agents" which are fully compatible with various turbine and hydraulic oils are also on the market today, which inhibit varnish from plating out on metal surfaces while promoting the separation of varnish from the oil, thereby allowing it to be more effectively removed by varnish removal technologies.

Summary

Varnish and sludge contamination in oil can be a very serious problem. Left untreated, it can spread and further propagate to the point of machinery failure.

Varnish detection and mitigation is far less costly than an unplanned shutdown. Consistent with a predictive maintenance culture, prevention is much less costly than the cure.

Oil Filtration Systems designs and builds the most effective and versatile Varnish Removal Systems on the market today. Utilizing Granular Adsorbent Media or Depth Media Filters, the OFS Varnish Removal System can remove both suspended and soluble varnish from oil, either at normal operating temperatures or at low ambient temperatures during an outage. These systems are available for purchase or rent.

In addition, we have the manpower, equipment, and expertise to perform turnkey Varnish Flushing onsite. With questions please contact: Ken Kaihlanen, Director, Kenk@oilfiltrationsystems.com (830-816-3332).

If you keep the varnish potential in your hydraulic and lube oil under MPC 15, then you will increase the life of your equipment and lube oil.

OIL FILTRATION SYSTEMS®

A CLARK-RELIANCE COMPANY

WE SET THE STANDARD FOR OIL PURIFICATION™

"Oil Filtration Systems® has been a key partner in providing oil purification equipment to the Chevron ISOCLEAN® Marketer network for many years. Their systems have provided reliable performance in the field, consistently achieving very low particle counts and water content to meet or exceed stringent cleanliness specifications. They provide excellent response time and level of support to meet the customers demanding requirements, which makes OFS a valuable partner to the Chevron ISOCLEAN® Marketer network".

Chevron

Jason Gerig, Americas Marketing – ISOCLEAN®, Chevron Lubricants

Vacuum Dehydrators - Varnish Removal Systems - Fuel Coalescers
Flushing Skids - Filter Carts – Filter Elements - Rental Units - Field Service

Oil Filtration Systems®

A Clark-Reliance® Company

135 Enterprise Parkway Drive ● Boerne, Texas 78006

(830) 816-3332 ● Fax (830) 816-3331

info@oilfiltrationsystems.com / www.oilfiltrationsystems.com