Chevron Industrial Lubricants

The Effective Chemical Removal of Varnish from Turbines and Centrifugal Compressors

March 2020

Introduction

Varnish is a common issue in circulating oil systems. It causes huge operational problems and costs businesses millions of dollars. Even the smallest amount of varnish in a system can result in erratic component operation such as valve sticking, poor heat exchanger performance and even bearing failure. These problems also lead to a shortened oil life and loss of equipment productivity.

Ways to mitigate varnish problems have consequently received much attention. Various methods have been used but most start with removing accumulated varnish from the oil system before implementing prevention and control methods. The most commonly used method for removing varnish from circulating oil systems such as turbines and compressors involves the temporary addition of cleaning chemicals to the system.

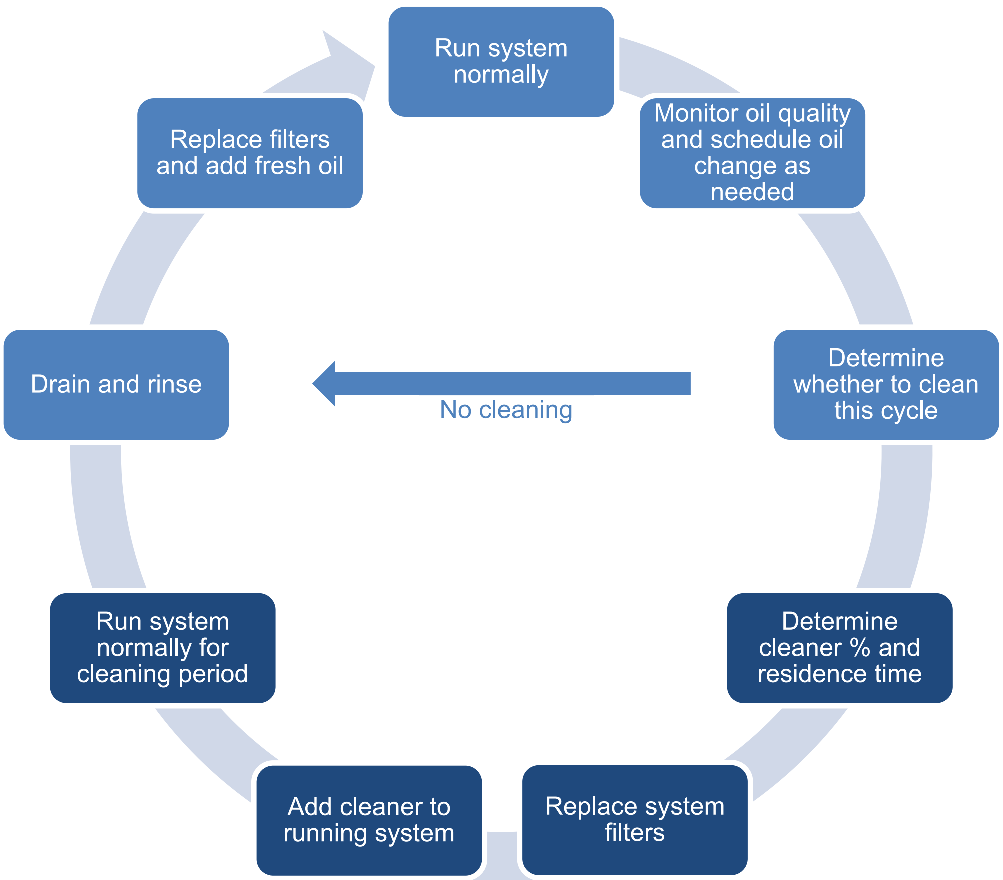
Images: Top left = varnish-covered thermostatic control valve
Top right = varnish in oil reservoir head space
Bottom left = varnish bathtub ring in oil reservoir
Bottom right = heat exchanger cooling plate with partially removed varnish

This document is intended to be a guide to the effective use of such chemicals in general and Chevron's revolutionary new VARTECH™ Industrial System Cleaner (ISC) in particular. The general guidance herein should not replace the specific use instructions of the relevant cleaning chemical and equipment manufacturers.

Typical Chemical Cleaning Cycle

The most widely used and proven approach involves the addition of a chemical cleaner to the in-service oil. The general approach is illustrated in the diagram below.

The cleaner is usually added at a 1-20% concentration to the end-of-life in-service oil. The cleaning chemicals may affect the long-term performance of the in-service oil so cleaning is best done shortly before a scheduled oil change. The oil/cleaner mixture is circulated through the system for a few days up to a few months. The oil and cleaner mixture, together with any varnish and other contaminants in suspension or solution, is then drained, rinsed out, and replaced with fresh oil. To be effective, some cleaners require a specialized varnish filtration skid to extract the removed varnish deposits from the oil.



Varnish Removal Parameters

Successful chemical removal of varnish from surfaces is generally dependent on:

- Chemistry
- Time
- Heat
- Flow

Adjusting these 4 factors to optimize the cleaning process will improve deposit removal success but care must be taken to avoid unintended consequences and damage.

Chemistry

The right chemistry helps dissolve and disperse varnish in the oil so it can be removed from the system without adversely affecting the equipment or lubricant. Poor cleaner chemistry can lower flash point, disrupt water separability, diminish oil oxidation stability, damage seals, plug filters, and cause high toxicity.

There are several commercially available varnish cleaners. They generally have solvency or detergent / dispersant properties to remove varnish from surfaces and dissolve and/or disperse it in the oil. The table below describes the most common types of cleaner as well as some of their benefits and drawbacks.

Cleaner Type	Product Challenges / Advantages
Detergent / dispersant package in a naphthenic oil carrier	• Small amounts of residual cleaner can greatly affect performance of the new charge of oil: - Diminished water separability performance - Remaining calcium can react with new oil rust inhibitor to create floc - Several rinse flushes are often required to remove residual cleaner • Included additives can sometimes plug tight filters • Contains no solvent so safe on most seals but the naphthenic oil carrier can still have seal swell impacts
Solvents	• Lowers flash point creating fire hazard • Volatile vapors • Significant seal swell concerns • Inexpensive • Generally compatible with the oil although may reduce viscosity
Synthetic ester / surfactant	• The esters cause seal swell • Included sodium may react with additive packages • Water separability could be negatively affected
Oil Soluble PAG	• Shown to lose oil solubility over time creating two-phase solution and rapid oil degradation • Paint compatibility challenges • Extended use has shown increase in deposit formation • High polarity may affect seal swell
Alkylated naphthalene synthetic solvency enhancer	• Effective at preventing some deposits but ineffective at cleaning deposits from surfaces • Possible reduction in water separability • Typically compatible with new turbine oil so a flush can often be skipped • Less impact on seals than esters • Often paired with resin type varnish removal filtration to improve effectiveness

In addition to cleaning effectiveness, selecting a cleaner should involve consideration of its:

- Effect on the spent oil during cleaning and the refresh oil after cleaning,
- Effect on the system,
- Propensity to release large, filter-plugging varnish particles.

Some cleaners may significantly reduce water separability so bowser, coalescer and centrifuge separators may not be effective during the cleaning stage. If water ingress in a steam or hydro turbine is significant, an auxiliary vacuum dehydrator may be needed to remove water. Alternatively, the turbine can be cleaned while not operating although this may greatly extend an outage time and external heat may be required to maintain operating temperatures.

In contrast to conventional cleaners, Chevron's revolutionary new VARTECH™ ISC:

- Is designed to dissolve varnish deposits from internal surfaces and then stabilize them for removal with the used oil,
- Has a viscosity of 53 cSt which makes it effective in ISO 32-68 viscosity oil as it will not significantly affect oil viscosity at the recommended concentrations.
- Is compatible with many in-service oils at the recommended concentrations of 5 - 20% by volume for the recommended cleaning durations (allowing longer residence times and generally removing the need for flushing),
- Has a minimal impact on lubricant water separability,
- Has minimal impact on long term new oil performance in residual amounts up to 2%,
- Causes minimal filter plugging,
- Has excellent seal compatibility,
- Has shown superior deposit removal effectiveness in extensive comparative laboratory and field testing.

Time

Generally, the longer a cleaner is in a system, the more varnish is removed. High flow areas such as oil coolers are often cleaned quickly, in as little as an hour. Systems with heavy varnish deposits, cool temperatures or low flow will benefit from extended cleaning time although the chemistry of some cleaners places tight limits on cleaning duration.

Even though the best cleaners show system performance improvements in hours, it takes time to remove years of baked-on varnish accumulation. For maximum effect cleaners therefore need to be in the system for an adequate period. There is no shortcut and the cleaner manufacturer's guidelines on residence time must be followed for effective cleaning.

Cleaner manufacturers generally recommend a cleaner residence duration of between 1 and 30 days. Shorter cleaning durations are often recommended not because the cleaner can effectively clean in that period, but because the harsh cleaner can only be in the system for a few days before it begins to damage the equipment either directly or through the effect of severely degrading the lubricant. In addition to the properties of the chemical used, the duration often depends on the amount of varnish fouling and cleaner concentration used.

Even with the best cleaner, there is a limit to how much varnish a severely degraded oil can absorb. Severely fouled systems may even require more than one cleaning cycle to get the most effect. Cleaning is generally done during normal operation before a shutdown begins so the impact on total shutdown time is minimal.

Some manufacturers claim their cleaners can be left in to protect the system indefinitely. Modern lubricants consist of carefully balanced additive technology and when assessing the validity of such claims, consideration should be given to the likely actual long-term effect on lubricant performance by the cleaner remaining in the system. While a cleaner may temporarily remove varnish plus associated particulate and other contaminants from metal surfaces, these contaminants remain in the system. The best practical removal method to deal with varnish already in the system is to drain and replace the oil/cleaner mixture so simply adding a cleaner to the system does not fully address varnish issues.

The use of varnish removal filtration systems either alone or in combination with a cleaner can be effective but these filters could remove some helpful additives from many oil formulas such as rust inhibitors and foam inhibitors. In addition, the varnish-removal efficacy of some cleaners is completely compromised by removal filtration.

New VARTECH ISC can clean high flow areas in as little as 15 minutes but is specifically formulated to maintain oil performance in circulation to allow for extended cleaning times of up to 30 days. Durations beyond 30 days are possible but contact your Chevron Representative for additional guidance and information. This allows for better cleaning of stubborn deposits and affords the system owner much greater operational flexibility than harsh cleaners that can only be the system for very short periods.

Temperature and flow

Varnish solubility in oil is temperature-dependent so more varnish will remain in the oil at higher temperatures. For most effective cleaning, the oil circulation temperature should be kept at the high end of the allowable operating temperature window and the spent oil and entrained varnish should be drained while still warm and recently circulated.

The higher the oil flow over a surface, the more effective the varnish removal. Locations with stagnant oil such as reservoirs, infrequently used valves, gauge feed tubes and un-used duplex coolers will often experience minimal cleaning. Artificially improving flow, such as cycling valves and swapping back and forth between duplex equipment can improve cleaning of these components.

Most cleaners are more effective at higher temperatures. VARTECH ISC is most effective at temperatures in the 140-250°F range. Lower temperatures may reduce cleaning effectiveness and demand extending cleaning times.

Filter Plugging

Filter plugging can occur during varnish cleaning but the cause may not be obvious. The released varnish is usually blamed for plugging filters but other causes are often the real culprit:

- Varnish is often is sticky and hard particles can get stuck in varnish deposits. As a cleaner pulls the varnish back into the oil, those particles also go back into circulation. Solid contaminants that have built up over many years may be released into the oil in a couple of days. This has the potential to create a high contaminant concentration that gets into places where it can cause damage. Hard particles released from the varnish will also not be dissolved / dispersed finely in the oil and will increase filter pressure differential.

When hard particle contamination is a high concern, an auxiliary kidney loop filtration skid can be installed to help system filters remove these contaminants. While this kidney loop skid usually has only a fraction of the main system flow, the filters can be tighter (down to 3 micron) and remove smaller particles than the system filters.

- The calcium in some cleaners can react with oil chemistry to create organic salts in the oil, causing floccing which blocks filters.

It is good practice to install a fresh set of filters prior to adding the cleaner to the system to maximize varnish and deposit collection. Additional system filters should be made available during cleaning as additional filter changes may be required due to the release of varnish and deposits.

In numerous laboratory and field tests, VARTECH ISC has quickly and effectively removed varnish without causing filter plugging and consequent system shutdowns. VARTECH ISC breaks down the deposits to finely disperse and stabilize the varnish in the oil rather than overloading filters.

System Draining

Even during a normal oil change, complete draining of all oil from a system including trapped oil is vital to remove all the degraded oil.

The addition of varnish cleaning chemicals magnifies this importance as the oil is now carrying even more things that can affect the new oil fill. To effectively remove all the cleaner, spent oil, dissolved varnish, and other contaminants, complete draining is vital.

The table below shows the significant effect cleaners can have on new oil performance and life:

	100% Chevron Turbine Oil	Chevron Turbine Oil + 2% popular competitor cleaner	Turbine Oil + 2% VARTECH ISC
Water separability (D1401)	40-40-0 (10 min)	2-26-52 (>60 min)	41-39-0 (10min)
RPVOT*	2,300 [100%]	782 [34%]	2,024 [88%]
Seal volume change (swell)		5.96%	3.75%
Seal hardness change (softening)		-3.5	-1

**Condemns at 25%*

There are several areas in circulating oil systems where oil will not drain back to the sump when circulation is stopped. In turbines, this retained oil may constitute up to 20% of system volume. At a typical 10% cleaner treat rate, a 20% retained volume means that the system contains 2% cleaner. The previous table indicates the likely effect of residual cleaners on oil life based on laboratory testing of fresh turbine oils with 2% cleaners. In the field, the residual mixture will contain aged oil species and contaminants which could magnify this detrimental effect.

Even when hot, the oil/cleaner mixture will only flow unaided in accordance with gravity. If an area of the system is lower than the drain point, it will not drain unaided. If an area of the system is separated from the drain point by a high area, it will not fully drain unaided.

Draining these trapped oil areas may require opening flanges and removing drain plugs. A system piping walkdown should be performed to identify these areas of trapped oil so a plan can be made on the best way to completely drain the system. The drain plan should be designed with care as time spent now on removing more used oil, cleaner, and contaminants will greatly extend oil life and increase operational reliability for years to come. The plan should account for the limitations of gravity-draining.

Examples of trapped oil areas on turbine and compressors include:

Trapped oil areas	Typical action
Filter housings	Open bottom drain valve, open top air bleed
Oil coolers	Open bottom drain valve, open top air bleed
Bearing supply lines	Loosen low point flange, drain to tub
Seal oil system	Loosen low point flange, drain to tub
P trap	Remove drain plug, drain to tub
Degassing tank	Identify specific drain process
Run down tank	Identify specific drain process
Bottom of reservoir	Squeegee to drain or use pump or vac truck

As described above, the solubility of varnish in oil is temperature-dependent. If the system cools for too long, the varnish just removed from surfaces may tend to re-deposit on the equipment. To avoid redeposition and to assist in draining, the oil/cleaner/varnish mixture should be kept circulating at operating temperature and then be immediately drained when system pumps are shut off. This obviously means that both drain pumps and waste oil truck need to be on-hand. The oil/cleaner mixture should be drained at the hottest temperature consistent with safety and the manufacturer's instructions.

Rinse Flushing

Rinse flushing is a best practice to fully gain the benefit of cleaning and switching to fresh, high-performance turbine oil, particularly when any of the following conditions exist:

- A complete drain is not possible, i.e., more than 10% of the oil-cleaner mixture remains,
- The in-service oil is experiencing rapid oil degradation or is extremely degraded,

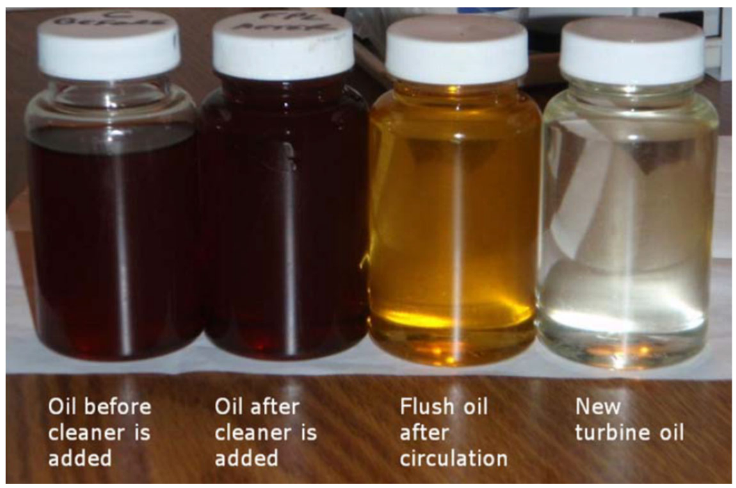
- There were severe deposits in the system,
- The new oil and previous oil are not compatible.

As discussed above, for many cleaners it is imperative to remove as much chemical as possible. For highly incompatible cleaners, ideally all of the cleaner should be removed. For such cleaners, one or more total system rinse flushings is required to augment effective draining protocols.

A displacement flush is a process used in simple piping runs where a small quantity of oil is pushed once through the pipe using an external pump. This approach does not work well in the more complex circulating oil systems (such as turbines) as it does not use the system pumps so flow rates are greatly reduced, the hydraulic system is not flushed, and particulates are not flushed back to the sump. This approach is not an effective rinse flushing methodology.

The only truly effective rinse flush uses a lot of flush oil by filling the reservoir, using the system pumps and moving oil through all parts of the system by cycling necessary valves. With proper, thorough draining of both old oil and flush oil, it is possible to rinse out enough cleaner from many systems with a single rinse flush. This can have a significant financial benefit but its applicability depends completely on the system and the thoroughness of the drain.

Draining and removing the rinse flush oil is important as it may contain high concentrations of cleaner and contaminants. The picture at right shows how clear virgin flush oil (bottle on extreme right) and the color it picks up as it flushes the piping. By the end of an effective rinse flush, the rinse oil coming out should be almost as clear as when it went in.



Rinse flushing is both expensive and time consuming. VARTECH ISC was formulated to be highly compatible with modern high-quality lubricants to minimize the risks of an incomplete drain or rinse.

Reservoir Cleaning

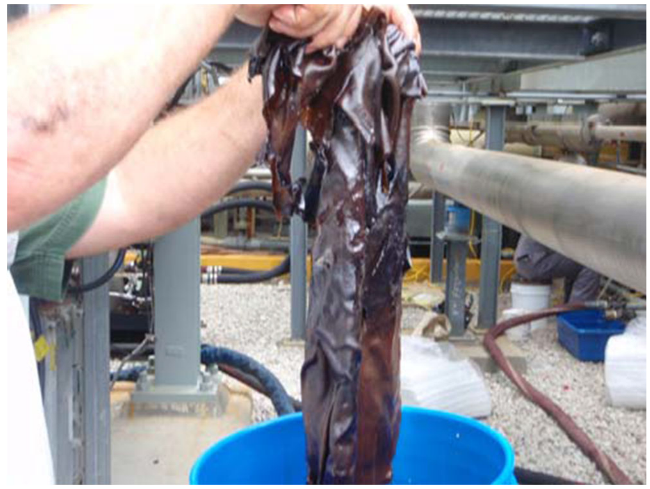
NOTE: all work inside confined spaces such as lubricant reservoirs should be undertaken only by properly trained and equipped personnel.

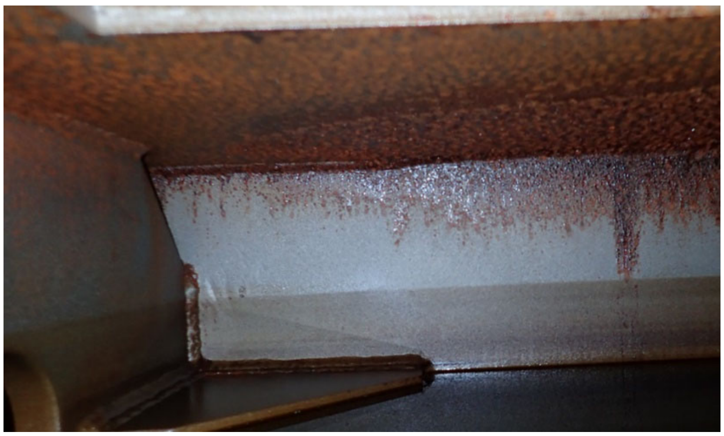
Varnish is occasionally found in the vapor space of the lubricant reservoir. These spaces, like the reservoir access hatch cover shown in the image on right, rarely contact flowing oil and will not be affected by an oil-carried chemical cleaner even if the cleaner is effective elsewhere in the system. Even a cleaner as effective as VARTECH ISC will not remove varnish from areas of the system it does not touch. Extra time will be required to wipe and sometimes scrape off this varnish.

The relatively stagnant conditions in oil reservoirs often cause them to be more heavily fouled with deposits (see image at left with 1½" deep varnish deposits under the filter). The conditions of low flow and heavy varnish also makes them challenging to clean. Even when varnish is not completely removed from reservoirs, the best cleaners such as VARTECH ISC loosen and soften these accumulations to ease manual removal. When possible, reservoir varnish should be removed as it can affect new oil performance. Gauge lines, bridle piping, and other areas with no or low oil flow will also not be cleaned and may need separate attention.

Miscellaneous detritus that may accumulate in the reservoir should be removed while it is empty. The images at right and below are all of items removed from turbine reservoirs.

As a final step, the reservoir walls, ceiling, piping, and floor should be wiped with lint-free rags. Detergents should not be used for this wipe-down as even a little remaining detergent remaining will negatively affect water separability of the refresh oil. If absolutely necessary, some solvents may be used as cleaning agents but should be completely removed prior to refill.





Cleaning the reservoir provides a perfect opportunity to inspect it for other issues such as coating failures and rust (see image at left). The 'insulating' varnish has now been removed so such issues could contaminate the fresh oil after refill. It is thus good practice is to effect repairs prior to refilling.

What Doesn't Work Effectively

Any methodology that does not involve heat and/or chemistry changes from normal operating conditions will not effectively remove most deposited varnish. Ineffective methods include:

- High temperature operations

  Since temperature affects varnish solubility, running the system 10 degrees hotter for the last week or so prior to an oil change will dissolve some varnish. Removing the oil while still hot will prevent redeposition as the oil cools and varnish comes out of the oil. Safety when handling hot oil is paramount and care should be taken not to exceed the Original Equipment Manufacturer's (OEM's) guidance on operating temperatures. This method alone will not remove stubborn varnish, is unlikely to alleviate many varnish-related issues, and can accelerate oil degradation and even machine wear if minimum oil viscosity at critical points is exceeded.

- High velocity flushing

  This method is often used by OEMs during commissioning to remove weld slag, construction debris, and hard particulates. This method is sometimes used later for varnish removal but the tenacity and relative softness of the varnish means many deposits remain intact. To achieve the high flow rates needed this type of flush also usually completely bypasses the components where varnish causes the most problems.

- Hydro-blasting

  Hydro-blasting uses high pressure water within piping to remove rust and scale. Most varnish deposits are insoluble in water so the pressure may distort the deposits without removing them. This method can also bypass varnish-filled crevices.

- Rinse flushing

  A 'rinse' or dilution flush consists of a charge of rinse oil being circulated through the piping. The flushing oil is added after the old oil is drained and removed before the new oil is added.. Flushing rinses out remaining old oil but does not by itself remove much, if any, deposited varnish. Rinse flushing is often conducted after chemical cleaning to avoid a residual mixture of old oil, cleaner, and contaminants damaging the fresh oil being installed.

Summary

Not all varnish is created equal. Varnish deposits within different parts of a system often have different chemistries and physical properties. Different oil chemistries over many years in service make their own unique contributions to varnish composition. Varying pressure, flow, and temperature combinations in different parts of the system also affect varnish make-up and deposition. Slight variations in these factors can make significant differences in varnish between otherwise identical systems. An effective cleaning process must therefore address many different types of varnish.

Not all chemical cleaners are created equal. Those currently on the market vary in their effectiveness but it is highly unlikely any of them will clean all varnish from every system in realistic time frames. Laboratory tests have shown VARTECH ISC to be among the very best cleaners on the market but even it does not remove all stubborn varnish deposits. Expectations of all cleaners should be kept realistic.

Good chemical cleaners will begin to remove varnish deposits within hours. The very best cleaners will remove the more stubborn deposits over a few days to a few weeks. As varnish is removed from vulnerable components such as cooler plates and valves, system performance will begin to dramatically increase. Once the spent oil/cleaner/varnish mixture is drained and fresh oil refilled, the system should maintain this increased system performance. A good quality lubricant with varnish controlling properties will retard the formation of varnish for years but eventually, most lubricants will begin to break down, varnish will be formed, and system performance will be affected. Monitoring oil quality and system performance will allow an informed decision on when to repeat the cleaning process.

Varnish build-up in circulating oil systems can have a serious adverse effect on system performance, equipment longevity, and lubricant life. Over the life of a piece of equipment, this can equate to a loss of millions of dollars. Chemical cleaning can be a very effective way to remove accumulated varnish if the correct chemical product and proper technique are used.

Chevron VARTECH Industrial System Cleaner has been specifically designed to eliminate or reduce the negative attributes of previously available cleaners and maximize the ease and effectiveness of chemical cleaning to remove varnish with the focused goal of preparing a system for the best performance of a Chevron premium lubricant.

Frequently Asked Questions

Identifying varnish-related issues

- How do I know I have a varnish problem?

Symptoms of varnish deposits vary in different systems and even between identical systems. Typical symptoms include sticky servo or thermostatic valves, sticking hydraulic cylinders, inefficient oil coolers leading to high oil temperatures, high bearing temperatures, and subsynchronous vibration in high speed bearings and seals.

- What tests will definitively prove I have varnish?

Oil analysis test methods fall broadly into two types: those that predict the life of the oil and those that measure the current performance of the oil. Note the key word 'oil'. The first test type will only indicate the varnish potential of the oil. At best, the second test type will only indicate the amount of varnish and varnish in the oil. Neither test type provides an indication of varnish deposits on equipment surfaces nor whether such deposits are problematic. Oil analysis is therefore merely suggestive with respect to confirming that a system's performance issues are varnish-related.

Several of the most commonly used test methodologies were developed by players in the lubricant or lubricant-cleaning businesses. Partisanship is therefore rife and caution should be exercised in believing the claims made for the reliability and predictive powers of all tests with respect to problematic varnish coating equipment, even those tests with an associated ASTM International standard.

In addition, all oil analysis tests used for identifying varnish problems present challenges such as:

- The oil sample tested may not be representative of the oil in the whole system,
- The potential for varnish may change through the year depending on system utilization rates as degradation products often come out of solution to form deposits in an idle system,
- Varnish precursors are difficult to measure as (a) they are very small (sometimes < 0.1µm) and (b) test methodologies measure only soft varnish precursors in suspension but the precursors are oil-soluble and can easily move in and out of solution depending on sample handling,
- As a proxy for varnish-potential which itself is a proxy for varnish deposition, tests measure the overall 'health' of the oil or the additive package or the amount of varnish precursors in the oil.

There is no direct, definitive way of identifying varnish-related system issues that do not involve measuring critical parameters like valve hysteresis or oil cooler effectiveness or even tearing down the system to visually ascertain root cause.

Time

- How long can I keep the cleaner in my system?

  For most cleaners, the duration for effective cleaning is usually from 1 to 30 days.

  Cleaners are designed to move varnish deposits from surfaces into the lubricant. Oil with these suspended contaminants is not as good a lubricant as fresh oil without them. It is best practice to change the oil once the cleaner has done its job.

  Modern lubricants consist of high performing advanced technology. Since cleaners were not an original part of the oil formulation, long term performance is hard to predict. Consideration should therefore be given to the likely actual long-term effect on lubricant performance by the cleaner remaining in the system

  Consult the cleaner manufacturer for definitive guidance on durations.

- How long should I keep the cleaner in my system?

  Generally, the longer a cleaner is in a system, the more varnish is removed, up to a limit. Even with the best cleaner, there is a limit to how much varnish a severely degraded oil can absorb. Information on how to determine whether the cleaner is still cleaning can be found below in *How do I know if the cleaner has worked?*

  Some cleaners are so harsh they can quickly degrade the oil or the system. Consult the guidance provided by your cleaner's manufacturer on precise time limits.

Chemistry

- How toxic are these cleaners? What handling precautions should I take?

  Consult the Safety Data Sheet (SDS) for your cleaner for definitive information.

  The Personal Protect Equipment (PPE) requirements for VARTECH ISC are the same as those for handling turbine oil.

- Will the cleaner remove all the varnish from my system?

  The varnish chemistry will vary throughout the system. Some chemistries like soft varnish in coolers and sludge in reservoir bottoms often clean quickly and completely. Hard, polymerized deposits or those containing contaminants can be very stubborn and may remain after cleaning.

  Areas with low flow or low temperatures will unlikely to be completely cleaned although a good cleaner will soften the varnish to ease manual removal.

- Can I use a cleaner as a top-treat life-extender to control varnish during operations?

  There are commercially available cleaner products that allegedly can be used indefinitely. Chevron does not endorse this approach as:

  - Modern lubricants are high performing advanced technology formulations and the chemicals in the cleaner can adversely alter the balance of the formulation which may in turn cause unexpected lubricant upset over time,
  - Varnish and other contaminant particles remain in the system until removed with the oil.

  VARTECH ISC is designed as an end-of-oil-life cleaner precisely to avoid these issues.

Heat

- Why shouldn't I drain my system when cold?

  Varnish solubility in oil is very temperature-dependent. Draining the oil while it is warm and recently circulated ensures maximum removal of the varnish deposits that have been moved into the oil. Allowing the oil to cool and stagnate for more than a few hours can re-deposit some of the varnish on the walls of the equipment.

- Why aren't my reservoir walls clean after using the cleaner?

  The varnish that deposits on reservoir walls (often at the top) has access to oxygen in the air headspace which often allows further polymerization of the deposits making them hard to remove.

  Reservoirs are often low flow and low temperature areas: both factors diminish cleaning. This is common to all cleaners.

Flow

- Why isn't my reservoir access hatch clean after using the cleaner?

  The reservoir hatch is usually on the top of the reservoir where the oil with cleaner in it does not touch. No cleaner will clean something it doesn't touch.

- Why didn't the cleaner clean stagnant areas in my system?

  Cleaning depends on lubricant flow to dissolve and remove the varnish from the area. Minimal flow often means minimal cleaning.

- Will the cleaner plug the system's filters?

  Some cleaners have a propensity for plugging filters although this depends on varnish and oil chemistry, the type of deposits, and the configuration of the system. It is good practice to have spare filters on hand during cleaning.

Filter differential pressure may increase during cleaning depending on the amount and characteristics of the varnish moved from surfaces into the oil as larger removed varnish pieces can lodge in the filter increasing pressure. Hard particles (if present) previously stuck in the sticky varnish will also be caught by the filter increasing differential pressure.

VARTECH™ ISC has been extensively tested in the field and has not plugged filters, even in equipment where other cleaners have done so repeatedly.

Operations

- Why should I clean varnish from my system?

Varnish affects both machine operation and the performance of newly installed oil. Removing varnish often restores machine operation, efficiency and prepares a system for better performance after an oil change.

- How will the cleaner affect how I operate my system?

Most equipment can be used in normal operation while the cleaner is in the system. After the cleaner is added to the existing oil, operating parameters should be watched to:

- Identify evidence of cleaning success,
- Watch for filters that need to be changed (some cleaners are prone to plugging filters).

- Why should I drain effectively before refilling with fresh oil?

Old, degraded oil mixed into the refill oil will diminish the performance of the fresh oil. Residual cleaner will affect both the performance and life of the fresh oil. Some cleaners are so incompatible with fresh oil that they can reduce by ⅔ the expected life of the oil based on Rotating Pressure Vessel Oxidation Test (RPVOT) tests.

VARTECH ISC is specifically formulated to be compatible with turbine oils and so minimize the impact of residual cleaner on the fresh oil.

- Do I have to rinse flush after cleaning?

Rinse flushing is a best practice for any oil change to completely remove old, degraded oil from all parts of the system, particularly when any of the following conditions exist:

- Prior to cleaning, the in-service oil was experiencing rapid oil degradation or was extremely degraded,
- Prior to cleaning, there were severe deposits in the system,
- More than 10% of the oil-cleaner mixture remains after draining.

Complete draining of all the old oil and cleaner mixture, including trapped mixture, helps mitigate the negative impacts on new oil performance and can reduce the need for flushing.

VARTECH ISC was formulated to be highly compatible with modern high-quality lubricants to minimize the risks of an incomplete drain or rinse.

- Can I use the cleaner myself or do I need a service provider?

That depends on the complexity of your system and the capabilities of your team. Simply adding the cleaner, operating the system, and then performing a thorough oil change can be an effective approach. A service provider often brings valuable experience and can be very beneficial in confined space entry for reservoir wipe down, certified oil disposal, filter changes, and providing auxiliary heat for offline cleaning. They can also aid in determining cleaner residence durations and application concentrations.

- How do I know if the cleaner has worked?

Evidence can be found in several areas although not all of these will apply to every system:

- Reduced temperature across oil coolers,
- Lower bearing temperatures,
- Reduced valve sticking or delayed actuation (hysteresis),
- Reduced vibration,
- Visual observation of reduced deposits,
- Darkening oil color - Membrane Patch Colorimetry (MPC) will often lower immediately and stay very low during the cleaning as the insoluble varnish precursors which register on the MPC remain stabilized in the oil.
- Captured debris in filters.

- How long will my system stay clean after I clean it?

That depends on whether the root cause of oil degradation has been addressed. Identifying and eliminating the root cause of oil degradation specific to your system will greatly improve oil life and system cleanliness.

Your system will stay cleaner for longer if you refill with a high grade, varnish-resistant oil.

- How often should I use the cleaner?

Many operators choose to use a chemical cleaner as part of every oil change process. Others choose to clean only when operational evidence of varnish deposits are present. Deliberate consideration of whether to clean or not should form part of the planning for every oil change.

VARTECH™ Industrial System Cleaner (ISC)

- Can I add VARTECH™ ISC to a lubricant to make it a varnish resistant oil?

  No. Chevron lubricants with VARTECH™ technology are specially formulated to incorporate varnish controlling properties into the lubricant. VARTECH™ Industrial System Cleaner is designed to clean systems and uses different formulations.

- Can I use VARTECH ISC as a top-treat life-extender?

  Chevron does not recommend this approach as:

  - Modern lubricants are high performing advanced technology formulations and the chemicals in the cleaner can adversely alter the balance of the formulation which may in turn cause unexpected lubricant upset over time,
  - Varnish and other contaminant particles remain in the system until removed with the oil.

  VARTECH ISC is designed as an end-of-oil-life cleaner precisely to avoid these issues. Its components are not tailored for long periods of operation such as the multiple years turbine oil is often in service.

- Where do I get more information about Chevron's holistic varnish solution portfolio?

  Chevron's LUBETEK support group at 1-800-582-3835 in the USA or www.chevronlubricants.com.

- Where can I buy VARTECH ISC?

  VARTECH ISC is available through Chevron's worldwide network of lubricant distributors. Distributors in the USA can be found at: https://www.chevronlubricants.com/en_us/home/where-to-buy/find-a-distributor.html?src-tab=wheretobuy

- Can I use VARTECH ISC in non-turbine applications?

  VARTECH ISC has proven effective in centrifugal compressors.

  VARTECH ISC could also benefit many screw compressors but this depends on application.

  - VARTECH ISC is intended for use in mineral and PAO synthetic oils but not in exotic synthetic chemical lubricants such as PAG, POE, or diester fluids,
  - Flooded screw compressors are used with a wide variety of gasses, not all of which have been tested so results may vary depending on the process gas,
  - VARTECH ISC is not ideal for reciprocating compressors as their varnish often occurs in valves which don't get much oil contact. In addition, the lower viscosity (55 cSt) of VARTECH ISC may lower the viscosity of the lubricant beyond OEM recommendations.

  Chevron has not yet completed testing the use of VARTECH ISC in screw compressors.

Testing of VARTECH ISC in heat transfer systems has not yet been undertaken as it is not ideal for natural gas engines as their varnish often occurs on valve stems and guides which don't get much oil flow, plus the lower viscosity (55 cSt) of VARTECH ISC may lower the viscosity of the lubricant (usually 150 cSt) beyond OEM recommendations.

Chevron has not yet completed testing VARTECH ISC in hydraulic systems.

Chevron designed and has successfully VARTECH ISC for use in turbines and centrifugal compressors. It may be viable for use in other applications but these have not been vetted by Chevron at this time.