Lube oil varnish is the largest problem facing the lube oil used in combustion turbines.

Varnish forms because of lube oil degradation, largely from the extreme temperatures and oxygen existing in combustion turbines. Varnish buildup causes excessive wear on parts, can lead to bearing failures and can cause critical components—*such as servomechanisms*—to seize. These failures are costly, not only because of the repair expenses, but also because of the off line lost revenue.

**What is varnish and where does it come from?**
Varnish results in a thin film deposit often found on bearings, servo-valves, and other metal surfaces. The film is made up of soft insolubles that fail to be removed by full flow filtration.

Thanks to advancements in high temperature-resistant materials, modern combustion turbines are able to operate at very high firing temperatures. This, in turn, causes high bearing compartment temperatures.

As the lube oil flows into and around the bearings, it gets hot and mixes with air in the bearing compartments. Each time the lube oil passes through a hot bearing compartment, it oxides a little. This oxidation causes the early depletion of antioxidant additives, and leads to the formation of insolubles, which are the beginnings of varnish.

These early insolubles are soft and do not have a definite shape, so the full flow filtration systems on combustion turbines cannot remove them.

If left in the lube oil, the insolubles will eventually stick to metal surfaces. Since most large combustion turbines also use their lube oil system to operate servomechanisms for fuel valves and variable vane actuators, filming can occur on these components and cause them to stick, malfunction, and eventually result in the engine tripping off line. Furthermore, varnish films will cause excessive wear to bearings, resulting in early bearing failures and unexpected maintenance requirements.

While oil degradation is the primary cause of varnish, oil degradation itself is caused by several factors. Poor filtration will allow particulates, wear particles and water to build up and contaminate the oil. Oxidation, high temperatures, and moisture will cause the depletion of antioxidant additives. All of these factors degrade the oil and allow insolubles to form. Furthermore, it has been found that wear debris—*especially of the sub-micron size*—acts as a catalyst for varnish formation.

**Do you have a varnish problem?**
All large combustion turbines with non-synthetic lubricating oil are vulnerable to varnish. As oil degrades, varnish is bound to form. The real question is, "when will the problem hit?"

**How can you control varnish?**
Varnish is composed of insolubles that have no fixed shape, so they simply "squeeze" through conventional filters, rendering the filters useless for varnish control. As a result, other filtration methods must be used. Current marketed varnish treatments are expensive, demand consistent maintenance, and are prone to expensive malfunctions. Products currently on the market include electrostatic precipitation systems and edge filtration units.

Electrostatic precipitation requires the use of complex and expensive components including PLCs. They also require high-voltage electricity to create positive and negative charges to particulates in the oil. These systems can cause breakdown of some additives. Meanwhile, edge filtration methods have a very limited amount of filter surface area at the edge of the discs. As a result, they have low flow rates and are prone to clogging in applications when filming occurs, as is the situation with varnish in the lube oil.

**Are there other options?**

According to Seaworthy Industrial Systems (SIS), its varnish removal system (see Fig. 1) has no PLCs, no high voltage and no complexity. It offers especially high flow rates and varnish capacity and is not susceptible to clogging.

This organic filtration system operates as a 3-micron mechanical filter and as an adsorbent/absorbent filter that literally draws the varnish out of the lube oil and holds it within the element to be discarded when the elements are changed. These filters operate in another unique way; they do not accumulate any static charge so that there is no Electrostatic Spark Discharge (ESD) to further degrade the lube oil.

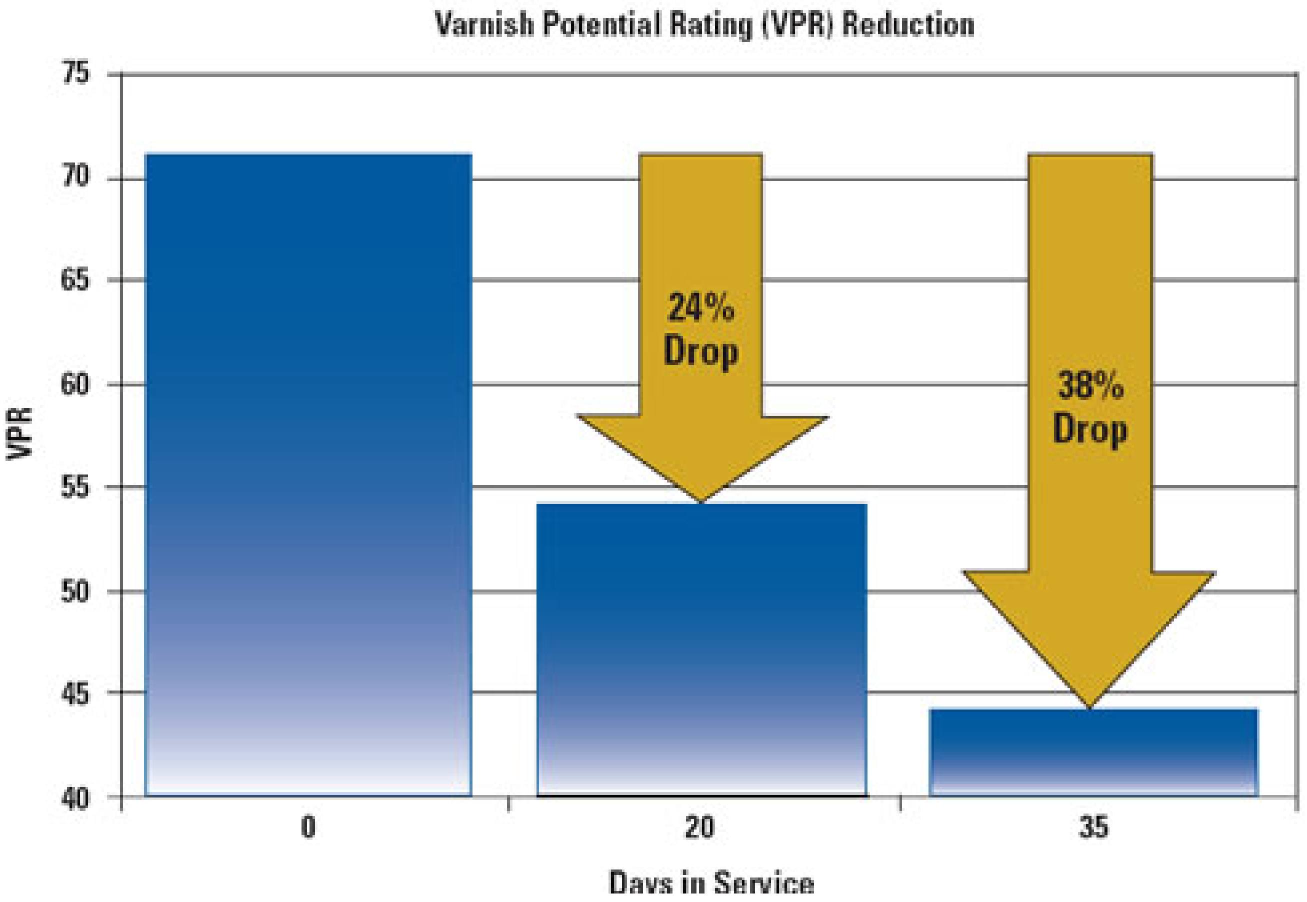
The system also incorporates magnetic filtration utilizing high strength, rare-earth, magnetic technology to remove the ferritic wear particles that act as catalytic particles that accelerate the degradation of the lube oil and its additives.

**How does it work?**

The Seaworthy system is designed to act in a side stream (kidney loop) configuration. Once connected to the oil reservoir, it is turned on and left on. With only a circulation pump and filter assembly, there is very little chance of error and no need for constant maintenance or expensive service technicians.

The system's depth filtration elements capture varnish, insolubles, particulate matter and water, while its added magnetic filtration catches wear particles of all sizes.

When first started, the filtration system begins to filter the lube oil, ridding it of varnish, particulates and water. Depending upon the severity of the turbine's varnish condition, the now-clean lube oil will begin to dilute the varnish film on the turbine's metal surfaces, drawing it back into the lube oil. Once again, the system removes that varnish from the oil. This cycle continues to "self-clean" the entire turbine lube oil system.




For systems without varnish, or for those that are now "clean" from the foregoing process, the Seaworthy works to ensure that varnish buildup does not occur. This is accomplished by filtering the insolubles from the oil before they reach high enough concentrations at which varnish forms, while simultaneously using magnetic filtration to capture wear debris which would otherwise act as a catalyst for varnish formation.

**How well does it work?**
Seaworthy notes that field tests performed by a large U.S. utility company (see Fig. 2) showed that in the first 20 days of operation, its filtration system reduced the lube oil varnish potential rating (VPR) by 24%—thus improving an "abnormal" varnish level to "acceptable."

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