What is Varnish?

- Varnish is a **soft contaminant** composed of lubricant degradation by-products that are **less than 1 micron** in size and is not measured by traditional particle count.
- Varnish deposit is a **thin-orange, brown or black insoluble film deposit** occurring on internal of lubricant systems.
- Varnish is a high molecular weight substance that is unstable in oil.
- Varnish deposit is unable to remove by mechanical filtration.

![Varnish formation on gas compressor gear](image1)
![Varnish formation on Inlet Guide Vane](image2)
![Varnish formation on pencil filter](image3)
![Varnish formation on spool valve](image4)
![Varnish formation on a turbine bearing](image5)
What is **Sludge**?

- Sludge is varnish which have higher water content
- Sludge looks like a **soft mud-like deposit** that settles out of the oil
- Sludge is also a **soft contaminant**.
- Sludge contaminant, if prolonged elevated temperatures will evaporate the moisture from the sludge contaminant.
What are the negative impacts?

Varnish build-up has long been a problem, particularly in turbine and hydraulic systems. System failures due to varnish problem can be:

- **Sticking or seized occurs in moving mechanical parts such as servo control valve.**
- **Plugged or restricted small oil flow orifices**
- **Loss of heat occurs in heat exchangers due to varnish’s insulation effect, cause to increase oil temperature**
- **Attract dirt and larger contaminants, increasing wears and component failure.**
- **Encourage premature bearing failure.**
- **Catalytic deterioration of turbine oils and hydraulic oils**
What is VsPI™?

- VsPI™ stands for Varnish & Sludge Potential Index™
- VsPI™ is a test method that has been developed by Focus Laboratories Ltd
- VsPI™ will predict varnish & sludge contamination condition and status in lubricant systems.
  Also, VsPI™ will monitor varnish & sludge build up rate in lubricant systems.
- Result of “VsPI™” will present in rating unit.
- Application: gas & steam turbines, hydraulic systems, turbo compressors and clean lubricant systems.
Importance of Varnish & Sludge Detection and Monitoring

Catching Varnish & Sludge Before It Costs You

1. Detect varnish & sludge levels in the lube oil system

2. Monitor the varnish & sludge build-up rate in the lube oil system
   - High build-up rate or Low build-up rate
   - If High build-up rate, will be critical and/or have any adverse impacts

3. Correction the problem in the early stage.

Varnish & sludge Problem
Servo Valve Trip /fault due to valve sticking

Sticky of Servo Valve and Filter plug
Sticky of Inlet Guide Valve
Turbine A, High build-up rate of varnish
Turbine B, Low build-up rate of varnish

Will you wait until servo valve trip/fault before you identify and dealing with varnish & sludge in gas turbine?
### Varnish & Sludge Potential Index Value (VsPI)

**Option Test: Varnish and Sludge Potential Index™ (VsPI™)**

**Testing for Predicting Varnish and Sludge Buildup**

<table>
<thead>
<tr>
<th>VPI Value</th>
<th>SPI Value</th>
<th>VsPI Value</th>
<th>Sludge Weight</th>
<th>Condition Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>60</td>
<td>59</td>
<td>5 mg/100 ml</td>
<td>Moderate</td>
</tr>
<tr>
<td>58</td>
<td>63</td>
<td>C</td>
<td>7 mg/100 ml</td>
<td>Present</td>
</tr>
<tr>
<td>73</td>
<td>66</td>
<td>C</td>
<td>6 mg/100 ml</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**VsPI™ Severity Limit Range Guideline**

- | New Oil | U-Caution | U-Action |
- Engine Turbine Steam GE MB DTE Light 32 (GlowSPP3) | | >60 | >80 |

**Abbreviation:**
- VPI™: Varnish Potential Index
- SPI™: Sludge Potential Index
- VsPI™: Varnish and Sludge Potential Index