

The background of the entire page is a close-up photograph of two large, industrial turbine gears. The top gear is dark, possibly black or dark brown, with a series of sharp, pointed teeth. The bottom gear is a bright, metallic copper color, also with sharp teeth. Both gears are mounted on polished metal shafts. The lighting is dramatic, highlighting the metallic surfaces and the precision of the engineering.

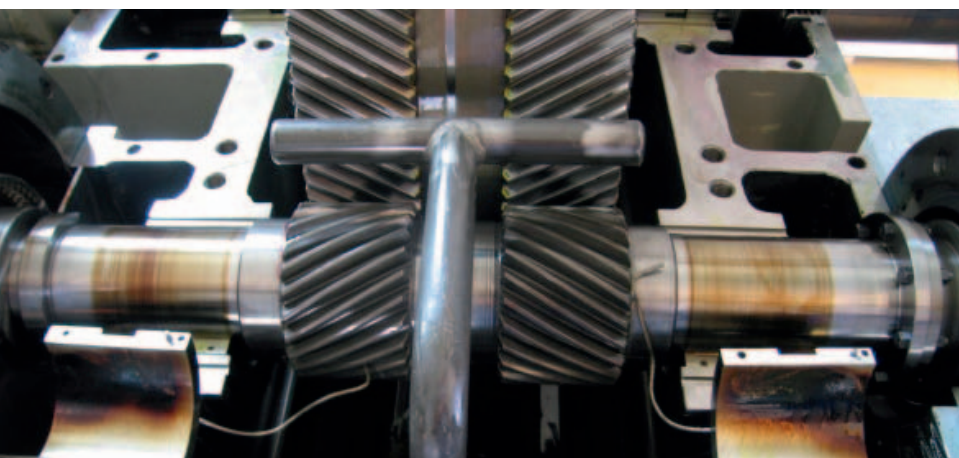
SIEMENS

Answers for energy.

Siemens Serviceinformation

Proactive turbine oil condition monitoring
and varnish prevention

www.siemens.com/energy



Deposits on turbo set gear box

Introduction

Siemens makes several types of turbo sets and compressor equipment which use turbine oil as the primary lubricant. Over time, if the fluids are not properly maintained, they can form deposits known as varnish, sludge or lacquer as they age. In some cases, these deposits can impact valve performance and reliable operation of the equipment. In other cases, turbine oil deposits can reduce the component life of the system, such as bearings and gear systems. If not addressed, these deposits can eventually increase plant Operation and Maintenance budgets, plant availability and system reliability.

This technical bulletin summarizes Siemens' experience with oil condition monitoring technologies intended to signal the onset of varnish formation and on contamination control technologies that can be successfully used to remove the contaminants in the turbine oil responsible for forming deposits.

Turbine oil degradation

Turbine oils are subjected to several different types of stresses as they are used, depending upon the type of system and operating environment that they are employed in. The most common modes of turbine oil degradation are:

- **Oxidation:** The most common turbine oil degradation regime that occurs when oxygen reacts with the turbine oil's additives and base oil, degrading the product. The most reactive species in a turbine oil formulation to which this will happen first are antioxidants. The antioxidants protect the base oil and once they are depleted, the base oil degrades.
- **Thermal degradation:** Thermal degradation is a high temperature process that occurs in the absence of oxygen. In operating systems this includes the phenomena of micro-dieseling or spark discharge.
- **Degradation from foreign contaminants:** Foreign contaminants may include incompatible lubricant formulations or other fluids improperly added to the fluid during maintenance activities. Other foreign contaminants such as moisture and debris can result in accelerated degradation. Special attention is necessary during oil (or oil brand) changes to ensure the removal of degrading products throughout a lubrication or control oil lubricating system.

What is varnish?

In many cases, the degradation of turbine oils creates organic, oil-insoluble, polar contaminants, better known as varnish. The origin of these deposits may be from depleted antioxidant additives or degraded base oils. These soft contaminants are responsible for settling out of the turbine oil and forming deposits in the system, especially on white metal surfaces and gear teeth.

The solubility of these contaminants is such that they can change from in solution to in suspension state, depending upon the temperature of the fluid. Many oil degradation products become soluble between 40–55 °C. Conversely, some oil degradation products will fall out of solution over the course of many hours or days when the temperature of the fluid drops below 40 °C. Soft contaminants can create varnish and (burned) deposits at the highest temperatures and load zones of the bearings, as well as in the more stagnant areas of the equipment. When the contaminants fall out of solution, these form particles that are sub-micron in size and can be unaffected by conventional filter technologies.

Siemens standard for monitoring turbine oils

Siemens has been directly involved with turbine oil analysis for many years and has established a large database based on thousands of turbine oil samples. As identified in Siemens operations manuals and instructions, Siemens recommends therefore the following oil condition monitoring tests:

Siemens standard for oil condition monitoring

- | | |
|-----------------|---|
| ■ Air release | ■ Individual antioxidant monitoring (RULER) |
| ■ Demulsibility | ■ Membrane Patch Colorimetry (MPC) |
| ■ Viscosity | ■ Foaming characteristics |
| ■ Cleanliness | ■ Water content |
| ■ Colour | |

The tests that provide the highest value in predicting turbine oil varnish are the individual antioxidant monitoring and Membrane Patch Colorimetry in combination with particle counting.

The earliest sign of oil degradation is detected with voltammetry (RULER method) since the antioxidants are the most reactive species in turbine oils and are the first to deplete.

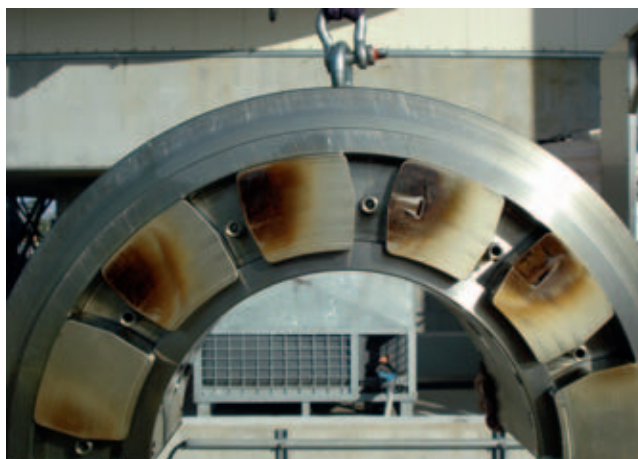
The most important test to predict varnish formation is the Membrane Patch Colorimetry test, which measures the color of the sub-micron oil degradation products, as well as particle counting.

It is preferential to use these tests together to provide a more complete picture of the varnish tendencies of the turbine oil.

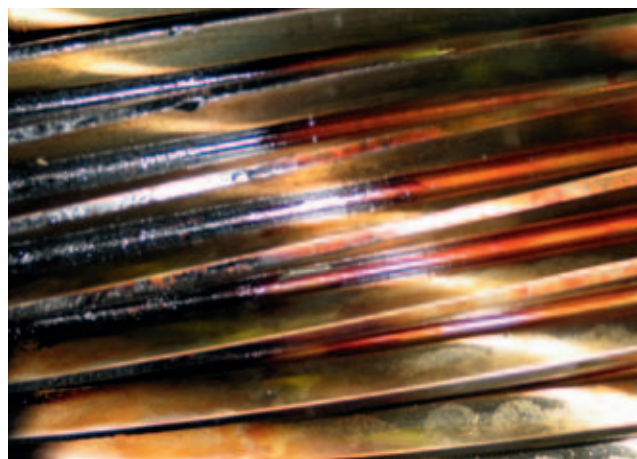
Siemens believes that the greatest value in an oil analysis program is trending the combined results from all of the recommended tests on a consistent sampling frequency.

Removing varnish-forming contaminants from turbine oils

There are technologies that can remove suspended contaminants in turbine oils. These include technologies based on electrostatic forces or depth media filters whose polar nature can adsorb some degradation products. Siemens has observed a wide range of success with these technologies in field applications. The removal efficiency of these technologies is strongly influenced by the physical condition of the contaminants which often results in the removal of the solid particles only. At operating temperatures the soft contaminants are in solution and can consequently not be removed by these technologies.



Deposits on thrust bearing



Deposits on gear compressor

Published by and copyright © 2011:

Siemens AG

Energy Sector

Freyeslebenstrasse 1

91058 Erlangen, Germany

Siemens Energy, Inc.

4400 N Alafaya Trail

Orlando, FL 32826-2399, USA

For more information, please contact
our Customer Support Center.

Phone: +49 180 524 70 00

Fax: +49 180 524 24 71

(Charges depending on provider)

Energy Service Division

Order No. E50001-D510-A209-X-7600

Printed in Germany

Dispo 34803, bdk 110177, P WS 1011

Printed on elementary chlorine-free
bleached paper.

All rights reserved.

Trademarks mentioned in this document
are the property of Siemens AG, its affiliates,
or their respective owners.

Subject to change without prior notice.

The information in this document contains
general descriptions of the technical options
available, which may not apply in all cases.

The required technical options should therefore
be specified in the contract.

Siemens recommended technology for removing varnish-forming contaminants from turbine oils is the Electrophysical Separation Process (ESP). This is a resin-based technology that has a capability of removing contaminants while in suspension or in solution. Siemens has seen several successful examples of this technology applied to large and small steam and gas turbines, as well as compressors. In all cases, the varnish-forming contaminants appeared to be removed from the fluid in a few weeks.

Please contact Siemens for additional recommendations regarding the detection and mitigation of turbine oil degradation and deposits.