

Turbine Oil Compatibility

Technical Topic

Turbines are the lifeblood of every power plant and care must be taken when changing lubricant types or manufacturers. When it becomes necessary to change oils, appropriate change management is necessary to ensure continued trouble-free performance. This generally means completion of compatibility testing before applying new oil to the turbine. But what is compatibility testing? What tests should be run and on what materials?

Basic Compatibility Testing Guidelines

Turbine oils are composed of base oils and additives. The main concern with turbine oil compatibility relates to the potential for interactions between the different additive chemistries of the two products to be mixed. If the additive systems are incompatible, performance loss (i.e. as measured by foam control and air release properties, demulsibility or oxidation life properties) or precipitates may form, leading to lower turbine system performance and/or the development of undesirable system deposits.

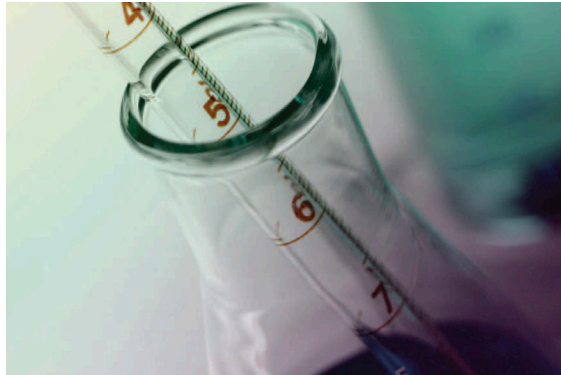
Further, significant changes in basestock composition between two turbine oils (e.g. moving from an API Group I to an API Group II, III or IV bases product) may also create potential incompatibilities due to differences in base oil solubility. Base oil solubility characteristics can influence pre-existing deposits becoming dislodged with the addition of the new oil. Also, seal compatibility may be an issue if an API Group IV or other synthetic material will be introduced.

ASTM D7155 – Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils offers valuable guidance in turbine oil compatibility testing. In many cases, the turbine oil manufacturer will have compatibility information on the various turbine oils that they offer. However, this data does not necessarily comprehend the condition of oils in service for every individual situation. As such, individual compatibility testing may be appropriate, depending on the age and condition of a turbine oil in specific systems.

Get a Base Line First

The first step in conducting a compatibility study is to evaluate the oil that is currently in service. The following tests are recommended on the used oil:

- **Viscosity** (ASTM D445)– this should be within +/- 5 percent of the new oil value.



- **Metals** (additive, contaminant and wear, ASTM D5185) – all of these should be within the turbine and oil manufacturers specifications.
- **Demulsibility** (ASTM D1401) – should not exceed 3ml emulsion after 60 minutes.
- **Foam Tendency and Stability** (ASTM D892 Seq. I) – should be no more than 450 ml tendency and 10 ml stability.
- **RPVOT** (ASTM D2272) – Greater than 25 percent of the new oil value.
- **Total Acid Number** (ASTM D974) – Should be no more than 0.3 to 0.4 above the new oil value.
- **Ultra Centrifuge** (M1169) – This determines the level of insoluble contaminants and oxidation by products. The level should be less than 4.

If the RPVOT value and TAN are out of specification, the system should be drained, flushed and refilled with new oil as soon as feasible. If the other parameters are out of specification, a case-by-case analysis should be conducted as to the best manner to remediate the situation.

In many cases, the addition of new oil may improve the performance parameter. Note that Voltammetry / RULER – ASTM D 6971 of mixed reservoirs is not recommended as the results can be misleading.

If the used oil is in reasonably usable condition, a second set of mixture tests should be completed to assess the compatibility of the existing oil with the new oil formulation to be introduced.

Testing Mixtures of New and Existing Turbine Oils

The next step in determining compatibility is to evaluate the storage stability and performance characteristics of the two different oils when they are in contact with each other.

Storage stability tests involve mixing varying ratios of the two oils and evaluating the impact on the key performance parameters noted above.

The ratios of the new and used oil can be varied to suit any particular set of conditions, but the following can be used as a guideline.

Percent New Oil	Percent Used Oil
0	100
10	90
50	50
90	10
100	0

The 100 percent ratios of either the new oil or used oil provide a control to the experiment and also further evaluate the suitability of the used oil. A 90 percent new oil to 10 percent used oil is suggested here as a guideline if the system cannot be thoroughly flushed and cleaned. This ratio can be adjusted to meet the conditions expected to be found in any particular situation.

The storage stability is assessed on these mixtures under 1) freeze thaw cycles, 2) heat soak at 140F and bench top UV lighting for two weeks. At the end of the two week period the sample mixtures are evaluated for haziness, sediment, floc and/or phase separation. If any of these issues are detected (provided the issue was not pre-existing in the current system oil) the oils are judged to be incompatible.

In addition, turbine oil performance tests may be conducted on the ratios of new oil and used oil that are expected to be encountered in the system. For example, if the reservoir is 5,000 gallons you expect to have 500 gallons of residual old oil in the system, the ratio at which to test is 90 percent new oil to 10 percent old oil. Typically Foam, Demulsibility, RPVOT and Ultra Centrifuge tests are evaluated. The results of these tests should be in line with the expected performance levels that would be obtained for a blend of the new oil and the used oil in the system.



Example of Stability Testing Results at Varying Ratios

Conclusion

Before changing to new turbine oil, care should be taken to determine the compatibility of the two lubricants. An evaluation should be conducted to determine the condition of the oil currently in service. Stability testing of various mixtures of the two oils should also be evaluated for unintended additive chemistry interactions. Performance tests should be conducted on selected mixtures of the new and used oils.

Reference:

- ASTM D4378 – In Service Monitoring of Mineral Turbine Oils for Steam and Gas Turbines
- ASTM D7155 – Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils