## On Condition Monitoring

# Analyzing gas turbine tests

**By Jack Poley**

We continue with our discussions from previous columns with tables suggesting preferred groups or suites of tests for routine monitoring of various components used in specific applications. In the November 2005 TLT, we looked at tests done on diesel engines. This month we focus on gas turbines.

### Gas Turbines

| TEST SET | Primary Objective(s) | Reasoning and Evaluation | Added Points / Caveats |
|---|---|---|---|
| **Analytical Ferrography (AF)** | Identify large particles that may portend catastrophic wear. | Gas turbines are very high speed machines. Developing problems, therefore, can quickly lead to failure even between sampling intervals. It is not unreasonable to include AF in the basic (every interval) test package, given the economics of machine cost and downtime. Safety is also a factor, particularly for aircraft applications. | Gas turbines can also justify onboard particle-monitoring sensors to serve as real-time aids to the laboratory oil analysis process. Warning levels can trigger sampling prior to regular intervals, and also taking the turbine off-line, if possible, until results are available. |
| **Spectro Metals (SMA)** | 1. Spot (some) wear events.<br>2. Check for abrasives.<br>3. (Some) Additive conformity. | Gas turbines offer perhaps the most difficult challenge for SMA. First, there are few particles relative to other systems; second, a high percentage of particles formed in such systems are greater than five microns, escaping SMA's detection capabilities. In addition, filters and (if employed) chip detectors remove particulate evidence, although this doesn't affect SMA as much. One should still use SMA for its support information. | In the early stages of oil analysis, the U.S. Navy installed spectrometric analysis to monitor jet engines. While there were many successes, there were also many misses, owing to SMA's detection limitations. Nowadays several types of large particle detectors are routinely applied. |
| **Micro-Patch Particle Debris Analysis (MP) and/or Particle Count (PC)** | Identify and quantify large particles not detectable via SMA. | As with hydraulics, some form of particle detection and sizing should be employed as a key or primary test. If AF is not to be employed, a particle count and a micropatch test would not be unreasonable, or one could add the weight measurement option to the micropatch and eliminate the particle count. | Chip detectors are common in gas turbines, however, metal detection sensors continue to improve to the point where it makes great sense to employ such devices in turbine systems and that ilk. This would augment, not preclude, the implementation of particulate detection in the standard test inspection testing suite. |
| **Viscosity (VIS)** | 1. Verify proper film strength.<br>2. Oxidation correlation. | The primary reason for measuring viscosity is for verification of the product in the system, mostly with respect to film strength. While there can be some indications of oxidation, this doesn't tend to manifest very often. | VIS should always be a part of an oil analysis test package, simply for negative (i.e., non-problem) inferences that it tends to offer when the value is as expected. |
| **Infrared Spectro (FTIR)** | 1. Additive depletion.<br>2. Contamination, wrong lube (1 & 2 as applicable).<br>3. Oxidation* | FTIR is often included in gas turbine analysis, but it has limited scope. Certain gas turbine lubes possess additives that can be effectively monitored via FTIR. FTIR may also identify some types of contamination, based on additive presence or absence. Oxidation detection is a rarer, possibility, but nearly impossible with synthetic lubes. | ****Note:*** FTIR will be ineffective in detecting oxidation when certain synthetics are employed, where the oxidation band overlaps significantly with the lube's chemistry. |
| ***Optional?*** **Acid Number (AN)** | 1. Oxidation correlation.<br>2. Additive depletion (as applicable).<br>3. Contaminaton. | Acid numbers don't tend to 'move' much with turbines, unless the component routinely maintains lube temperatures near 200 F. Furthermore, many turbines employ synthetic lubes that are highly oxidation resistant. | Synthetic lubes may have significant acid numbers. It is important, therefore, to establish a baseline prior to assessing AN in the used lube mode. The turbine's environment (e.g., in a plant) may produce airborne acids that are ingressed. |
| **Water Karl Fischer (KF)** | 1. Safety.<br>2. Poor lube handling techniques. | Water contamination is, of course, undesirable but there is particularly great risk in gas turbines should water be allowed to circulate with the lube for any length of time. The turbine's high rotational speed and tight clearances can quickly cause major damage or failure should water impair the lube's film. While it is unusual to find water in a gas turbine, the precaution is well worth taking, and a sensitive method is required. | We've noted that water quantity detection is particularly undependable in terms of repeatability because of its non-miscibility with oil. Care in sampling for KF water is particularly critical in this regard if meaningful results are to be obtained. |

### Postscript

**Steam turbines** (and to some extent, water turbines) have some similarity to the mechanical operation of gas turbines, perhaps without the added complexity of gear reduction systems. They must be treated somewhat differently in terms of test package application.

**Water** is the most obvious issue. It is not unusual to find low levels of water in steam turbine samples. The value of Karl Fischer Water testing is, therefore, marginal, although occasionally specified.

**Particle Count** is useful for monitoring steam turbines, but the presence of water will usually compromise results, unless a non-optical method is being applied. To judge whether or not to perform a particle count, a cursory test for water is a logical protocol. If water does preclude particle counting, then consider Micro-Patch testing.

All the other gas turbine tests listed can have some application in steam turbines, including **Analytical Ferrography (AF)** if Micro-Patch testing is not performed. If any kind of turbine is critical to production, which is almost always the case, AF is a logical monitoring strategy to be routinely employed.

### Closing points

Steam turbine environments are often more challenging than those of gas turbines. In addition, environmental considerations should always temper test selection for any system.

Steam turbines operate at a fairly slow rpm, particularly when compared with gas turbines. This usually translates to slower-developing failure mechanisms but not always. It is still essential to monitor large particles, preferably with each sampling. <<

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