

The ABCs (and AA) of lubrication analysis

by Jack Poley

Knowledge of a machine's condition, with emphasis on component wear, is the primary objective of lubricant analysis. Machines in commercial operation are either earning income or providing a necessary safety function. Sudden failure is potentially catastrophic or very costly at a minimum.

Consider these guidelines:

- If a repair can possibly be scheduled rather than performed as an after-failure event, downtime is often reduced, preserving loss of production time.
- It may be possible for another piece of equipment to substitute for the ailing one without any downtime loss.

As a corollary to determining machine condition or wear, knowledge of abnormal operating conditions, internal or external, is highly desirable. Consider:

- Detection of problems as early as possible usually allows more effective and less expensive repairs.
- In some instances, corrections can be made that result in the aversion of a mechanical failure.

Lubricant quality and suitability for continued or extended use is likely of interest, as well. Therefore:

- A lubricant that is not fit for service becomes a liability.
- The cost of acquisition and disposal of lubricants is a major expense in machinery operation. Having a means to provide information for safe lube drain extensions can offer savings approaching or exceeding program costs.

There are three basic purposes for

in-service used-lubricant testing:

1. Inspection for *wear* particles.
2. Inspection for *contamination* of the lube.
3. Inspection for lube *degradation*.

WEAR PARTICLES

Wear particles (iron, copper, lead, aluminum, etc.) were originally quantified using wet chemistry methods, but this proved to be impractical on any sort of scale both in terms of time to analyze and labor costs. The advent of the direct-reading, semi-automated atomic emission spectrometer, developed by Walter Baird, significantly expanded the practical application of testing for wear metals because 20 or more elements could be simultaneously analyzed with a cycle time of not much more than a minute per sample.

As a result, the direct-reading spectrometer (DRS) became the *de facto* hub for commercial lube analysis in particular and was occasionally installed in private facilities. Indeed the advent of the DRS effectively launched modern lube analysis, changing its focus to machine condition rather than lube condition.

But as time went on we discovered that the DRS had a major limitation when it came to detecting the presence of particles above 2-8 micrometers [microns] in size, dependent on the element and its chemical form. While these particles are usually in the minority, there are times when this isn't so. In high-speed rotary equipment, e.g., gas turbines, many catastrophic failures went undetected because the DRS was blind to large particle formation.



The DRS had first been applied to reciprocating railroad engines, and it was later learned that reciprocating equipment generates far more small, even submicronic particles, in comparison to rotary equipment. The DRS worked very well for the railroad industry and continues to do so, but it was not as effective for military aircraft, where it was first applied to turbines.

A semiwet-chemistry analysis, known as a carbon furnace, became available and operated as part of an atomic absorption spectrometer (AA), a device that worked on corollary principles to the DRS but could only analyze one element at a time. The sample was introduced to the furnace attachment, whereupon it was totally 'ashed,' thereby eliminating particle size issues.

This treatment, however, consumed additional time and required more highly skilled labor to operate the instrumentation. It never caught on in the lubricant analysis industry. AA minus the carbon furnace, however, achieved a fair amount of popularity and penetration in the 1960s and 1970s because it was substantially cheaper to acquire than a DRS. In time, the demand for more elements and reduced costs again made the DRS the *de facto* standard, although it still has the particle size detection limitation. <<

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