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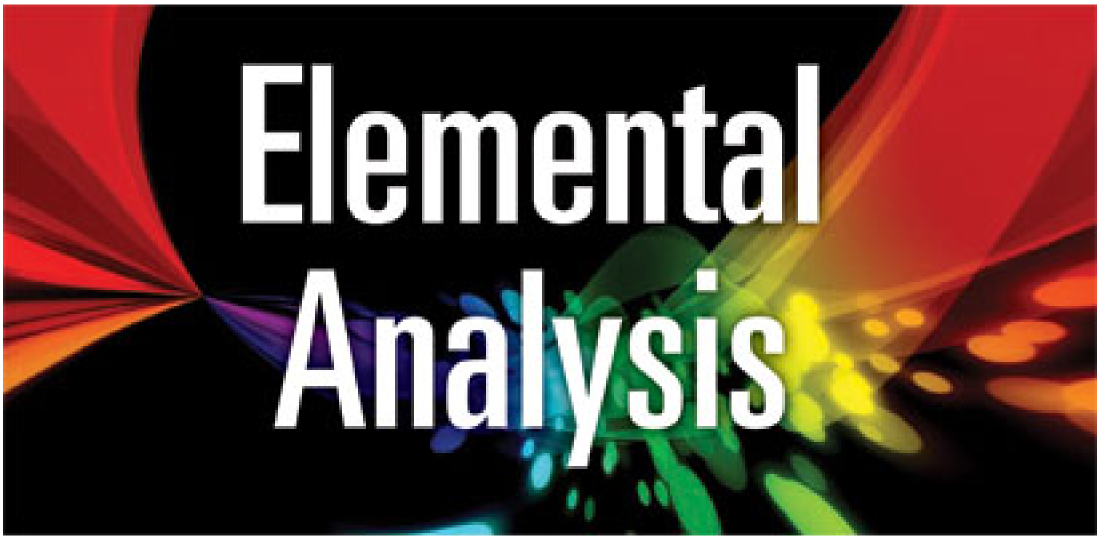

Make sure this ‘exciting’ methodology is part of your predictive maintenance toolkit.

An element, in the simplest of terms, can be defined as a pure, naturally occurring chemical substance made up of a single unique type of atom. Elements in an oil can come from additives added to the virgin base stock, as well as from contaminants, wear metals or coolants that have found their way into the lubricant over its life cycle. Analyzing used oil for these known elements can help determine if the lubricant is still fit for use or requires change. Has the original additive package been depleted? Has the lubricant become contaminated and to what extent? Have wear metals begun showing up and are they a problem?

Referencing used oil against a virgin oil sample can pinpoint which elements should and should not be present. Combined with an understanding of the industry and service for which the oil is designed (i.e., gearbox, internal combustion engine, hydraulic system, cooling system, etc.), this type of analysis can help detect where the unwanted elements may have originated and, in turn, predict impending mechanical failure.

Elemental analysis is done through emission spectrometry. Today, the most commonly performed procedure of this type is atomic emission spectroscopy (AES). This test has been around for approximately 60 years. Originally a tool of the railroad industry for monitoring wear metals in diesel-engine oils, it’s now used on all types of equipment—*and is a major component of comprehensive oil-analysis programs.*

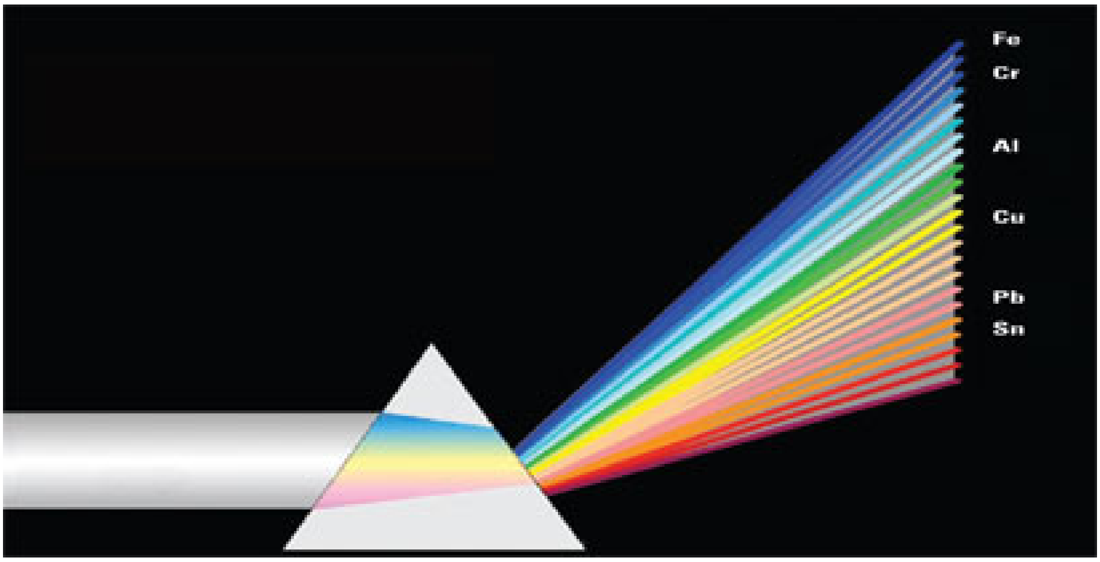

Fig. 1. Excitation of metal particles in an oil sample results in a spectrum that can be used to identify up to 75 elements.

Methodology

In AES, the electrons in metal particles are excited into a higher energy state. As they revert to a lower energy state, they release light energy—*which is inversely proportional to the wavelength and dependent on the atomic structure of the metal.*

Each metal will release energy at a specific, identifiable wavelength. The intensity of the light that's measured relates to the concentration of the metal present in the oil sample and is reported in parts per million (ppm). Based on the spectrum produced by the excited particles (see Fig. 1), and the method used to excite them, up to 75 metallic elements in a lubricant can be identified.

Inductively Coupled Plasma (ICP) and Rotating Disc Electrode (RDE) are the two methods used to excite the metal particles. In ICP, the elements are vaporized and excited by injecting a sample diluted with solvent into high-temperature argon plasma. The RDE method utilizes a high-energy electrode spark on a carbon wheel that rotates in the oil sample to excite the metallic elements.

Parameters

Elemental analysis (i.e., AES) is a powerful test, but not perfect. One of its major drawbacks involves the size limitation of the metallic elements that can be detected.

With RDE, the particle sizes detected are no larger than 8-10 microns. The ICP method detects metals no larger than 3-5 microns. Softer metals are easier to excite and can be detected at a higher size range than hard metals. Interestingly, while many labs are moving from RDE to ICP, both methods have advantages.

RDE…

- Detects larger particle sizes.
- Detects up to 25 metallic elements.
- No sample dilution is required.

ICP…

- Detects up to 75 metallic elements.
- Is more accurate at smaller size ranges and used for quality control of additive concentrations in finished lubricants.
- Newer, automated ICPs run samples faster.

Figure 2 depicts how elemental analysis data is typically documented in an oil-analysis report. It’s segregated into three major groups: Wear, Contaminants and Additives.

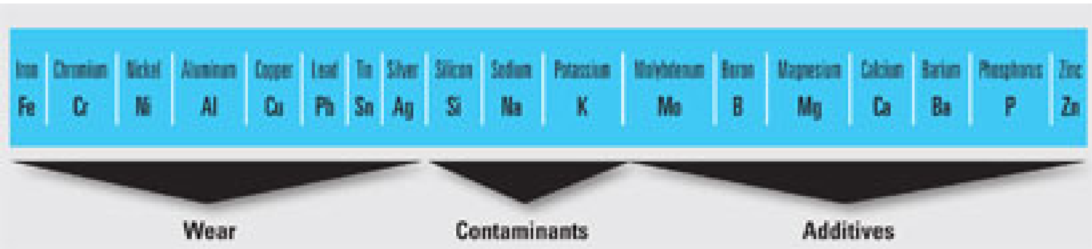

Fig. 2. Elemental analysis data as produced in a typical oil-analysis report

Conclusion

Elemental analysis—*in the form of atomic emission spectroscopy*—is a valuable predictive maintenance tool. Keep in mind, however, that it does have critical limitations (especially with regard to the size of particles it can pinpoint). While AES can identify early rubbing wear, it is unable to find large particles that lead to catastrophic failure.

The lesson? Don't depend solely on elemental analysis for particle detection. That said, in the September/October issue, we'll examine Ferrography Testing. **LMT**

This article is based on material from Ken Bannister's best-selling book, Lubrication for Industry (Industrial Press), and Ray Thibault's article "Introduction to the Use of Atomic Emission Spectroscopy as a Predictive Maintenance Tool" (pgs 30-35, Lubrication & Fluid Power *[now LMT], September/October 2006).*