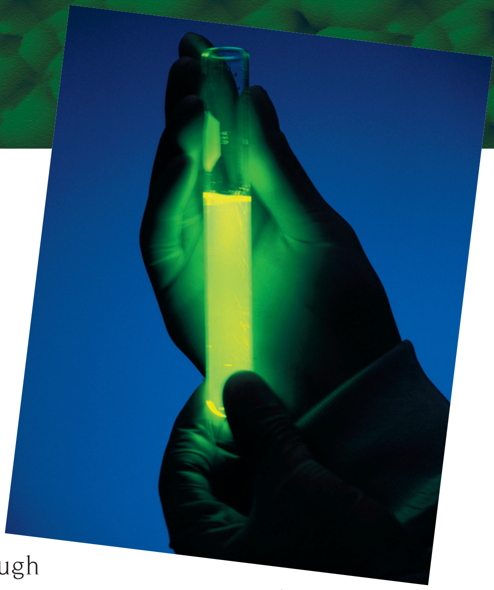

Understanding Spectrometric Metals

by Jack Poley

Previously we have discussed and described the most commonly utilized tests and inspections. Now let's look at these tests more deeply to see what can be gleaned from the inspection data. We will begin with elemental analysis.

Spectrometric Metals Analysis (SMA) is a single test yielding as many as 20-30 individual elemental concentration results. Commercial laboratories, which usually accept samples from widely varied systems, must consequently analyze for many elements. It is rare, however, when more than 10 different element results are needed or applicable for a specific component's assessment. Still, there is no money or time to be saved by reducing the amount of elements inspected since all elements are simultaneously measured. Therefore, it is most efficient to test for these elements all the time and filter the non-applicable elements[1] from consideration when the evaluation is conducted.

SMA results and indicators fall into three categories:

- Wear—metallic elements from the component's part.
- Contaminant—ingress of undesirable substances. If there is a metallic constituent to such contamination, SMA may be able to identify it.
- Additive—the detection and identification of metallic elements used in additive manufacture.

Example of metals sources with more than one possible category

	Wear	Contaminant	Additive
Iron	Rings, Cylinders, Pistons, Gears, Roller Bearings, Shafts	Rust	
Chrome	Ring Plating, Rod Plating, Liner Plating	Old Coolant Additive	
Copper	Bushings, Bearings, Thrusts, Lube Cooler Material	Lube Cooler Material Spent Additive	Oleate in some lubes ~150ppm
Lead	Bearings, Piston Plating	Gasoline Additive	Oleate in some lubes
Nickel	Stellite [Nickel/Cobalt]	Fuel Oil [withSodium/Vanadium]	
Silicon	Seal Material	1. Abrasive 2. Coolant Additive	Defoamant
Sodium		1. Coolant Additive 2. Fuel Oil [w/Nickel/Vanadium]	Some lubes and also as precursory additive compound
Boron		Coolant Additive	Some gear lubes
Magnesium	Various Aircraft Engine Components, e.g., bearing hubs	Spent Detergent Compound	Detergent
Calcium		Spent Detergent Compound	Detergent

All this would seem simple enough except that it is not uncommon for a given element to fall into more than one of the three categories. A few may even span all three. We might refer to such elements as chameleon elements (*see figure*).

A corollary to the chameleon element is that *the detection of an element does not necessarily disclose its chemical form*. This is particularly so with lubricant additive metals. A metallic detergent such as calcium sulfonate, upon being spent, may lead to the formation of other calcium salts such as carbonates. Depending on particle size, some of this material may get filtered out, but other amounts may simply circulate as debris in the sump. Our spectrometer still "sees" calcium, and while it may not necessarily be harmful, neither is it useful.

This leads to a simple axiom: *additive metals via* SMA *do not serve as indicators of the additive package efficacy*.

Of course, if one analyzes the fresh lubricant and notes such metals, it is reasonable to expect them to be indicative of a fully functional additive with the indicated metallic characteristics in as much as there has been no machinery activity where they would have changed from their original chemical form. But that is the only exception that can be applied with any degree of impunity. Even this conclusion could possibly be wrong if the lube had been in adverse storage conditions such that its additives'chemistry had been impaired. **<<**

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[1] *While it is true that detection of relatively few elements will 'get the job done' for most components, there are occasional, unexpected benefits from having the entire suite of elemental concentrations available for comparison and correlation. Consider the situation where a lubricant normally devoid of metallic additives is being analyzed. Suppose we were to ignore the results for additive metals, such as calcium, magnesium, phosphorus and zinc on a routine basis, but suppose as well that on a subsequent analysis, large amounts of these additive metals showed in the analysis. Were we paying attention to those 'useless elements' we might likely conclude, given no data transposition or analytical errors, that the wrong lubricant had been added to this sump. This is, of course, a surprise, but hardly unbelievable, and it happens often enough. Having these seemingly extraneous additive metals data might be the only clue to this event, which, in time, would likely prove harmful to the component. This is a simple case for metals detection — the more the merrier.*