Chevron

marine lubricants information bulletin 3

elemental analysis

Most laboratories in the oil industry are equipped with an emission spectrometer (ICP-AES or rotating disk spectroscopy), which can be used for analyzing impurities in marine lubricants.

Detection

Analysis techniques using emission spectrometers measure the light energy emitted by metal atoms when subjected to high levels of energy such as heat. All metals emit light of their own specific wavelength. Modern equipment is designed so that up to 20 different elements (i.e., metals) can be detected simultaneously. Lubricating oil samples often have to be diluted with a solvent before they can be tested. Lubricating greases and deposit samples should be ashed, and the resulting ash must be dissolved in water.

Table 1: Common sources of elements in lubricating oil

	Equipment	Cooling system	Environment	Lubricating oil	Grease	Fuel oil
Aluminum (Al)	✔				✔	✔
Antimony (Sb)	✔				✔	
Barium (Ba)		✔		✔	✔	
Boron (B)		✔		✔	✔	
Calcium (Ca)		✔	✔	✔	✔	
Chromium (Cr)	✔	✔				✔
Copper (Cu)	✔					
Iron (Fe)	✔	✔				
Lead (Pb)	✔			✔	✔	
Magnesium (Mg)	✔	✔	✔	✔		
Manganese (Mn)	✔					
Molybdenum (Mo)	✔			✔	✔	
Nickel (Ni)	✔					✔
Phosphorus (P)		✔		✔	✔	
Potassium (K)		✔	✔	✔	✔	
Silicon (Si)			✔			✔
Sodium (Na)		✔	✔	✔	✔	✔
Tin (Sn)	✔					
Vanadium (V)						✔
Zinc (Zn)	✔			✔	✔	

Limitations

Even modern techniques, however, have their limitations. One such limitation is that the origin of the chemical compound containing a particular metal present in the lubricant stays unknown. For example, zinc found in a lubricating oil sample could originate from the equipment as well as from a lubricating oil additive or from a tank coating material. Not all elements detected and reported originate from a single source. To make an educated guess, consult Table 1 when interpreting wear metal analysis.

Another limitation is the maximum particle size of the wear metals and contaminants that can be measured. Not all particles over five microns are detected. Particles over ten microns are not detected at all because these larger particles settle out in the equipment and in the test solutions and are not carried along into the energy source. For an accurate detection of metals in particles larger than five microns, other techniques such as X-ray spectrometry should be used. Normally wear particles range in size up to ten microns. However, excessive wear like piston or bearing seizures generate even larger particles and wear chips. These larger particles, as well as system debris, are often not detected because they may be removed by filters or settle out in places where the oil is stagnant.

Factors to consider

Only a few equipment manufacturers have established maximum limits for wear metals. Those that have only mention a few metals such as iron and copper. This can be expected because manufacturers do not know what kind of oil or grease will be used in their equipment. Therefore, the amount of wear metals is less important than the trending over time. An increase might indicate a change that has to be monitored. Additionally, spare parts installed during repairs may be manufactured with different alloys. Finally, it is important to consider the oil consumption of the equipment involved and, for some applications, purification and treatment of the oil during use.

Interpretation

To make wear metal analysis a useful tool in assessing the oil and/or equipment condition, be sure to monitor the results over a prolonged time period and look for sudden changes. Chevron's FAST™ used oil analysis service offers the possibility to view the four most recent results immediately on the report. Graphical representation is provided for the most important elements: iron and copper. Some types of failures occur so suddenly that metal analysis performed at any practical frequency might not provide an advanced warning. Also, some failures, such as bearing fatigue, can generate large particles that settle out or are removed by filters. The sample, however, will still show normal wear metal results.

Conclusions and possible corrective measures should always be taken based on trend changes in element concentrations in combination with the existing knowledge of the equipment and of the operating conditions onboard. ■