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Lubricating fluids degrade over time depending on various external and internal influences, including type and age of equipment, ambient temperature and humidity and degree of use and load on equipment, etc. It is well established that monitoring the health of lubricating fluids is an important and necessary part of high-value machinery maintenance. The traditional approach for determining the condition of these vital lubricants is to take a sample, send it off for analysis at a commercial testing lab, then track trends in changes in key lube parameters over time. When these analyses indicate a problem, corrective actions such as refreshing or changing the lubricant are taken.

As companies move from preventive maintenance to proactive maintenance, there is increasing interest in onsite lubricant testing because results can be obtained much faster—*and they may be more trustworthy*
. It allows lubrication specialists and maintenance personnel to take decisive action right away. This latter point is important since some of the degradation processes in lubricants occur nonlinearly in time and more quickly than one might expect, which can lead to increased

equipment wear or failure. Of course, the ability to use on-site testing equipment is predicated on the ability of the testing equipment manufacturers to make their products straightforward to use and provide valuable information.

A number of analysis methods have made the jump from use by experts off site to routine use by lubrication specialists on site. One technique not making that jump—*until now*—has been infrared spectroscopy. Infrared has been used for years to evaluate lubricating fluids, but virtually always in off-site commercial labs. Now, though, infrared analysis also is available for use in on-site facilities.

Monitoring critical lubricant parameters

There are several key parameters for which infrared is capable of providing highly accurate information in lubricants including:

- The level of water present
- The amount of oxidation and nitration by-products
- The amount of anti-wear, anti-oxidation and extreme pressure additives remaining

All of these parameters are critical—and some can be measured with other methods. No other technology, however, can provide information on all parameters simultaneously, in less than two minutes. The use of infrared analysis for each parameter will be explored here.

Infrared analysis for water

The amount of water that is present in lubricants is critical to the performance and longevity of the lubricated equipment. Lubricant properties affected by the presence of water include viscosity (measure of the oil's resistance to flow), specific gravity (density of the oil relative to that of water), and the surface tension (a measure of the stickiness between surface molecules of a liquid). All of these properties are important for the ability of the oil to coat, lubricate and protect the critical mechanical clearances. In addition, the presence of water can accelerate additive depletion and contribute to chemical degradation mechanisms such as oxidation, nitration and varnish formation.

Hydroelectric power generating operations are just one place where IR spectroscopy of lubricants can pay off beautifully.

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Table I. Water Measured by FTIR Infrared System vs. Karl Fischer Titration

PAL (ppm)	KF (ppm)	Difference (ppm)	% Error
508	504	4	0.8
1054	965	89	9.2
2043	2002	41	2.0
2946	2838	108	3.8
4710	4753	43	0.9

[redacted]

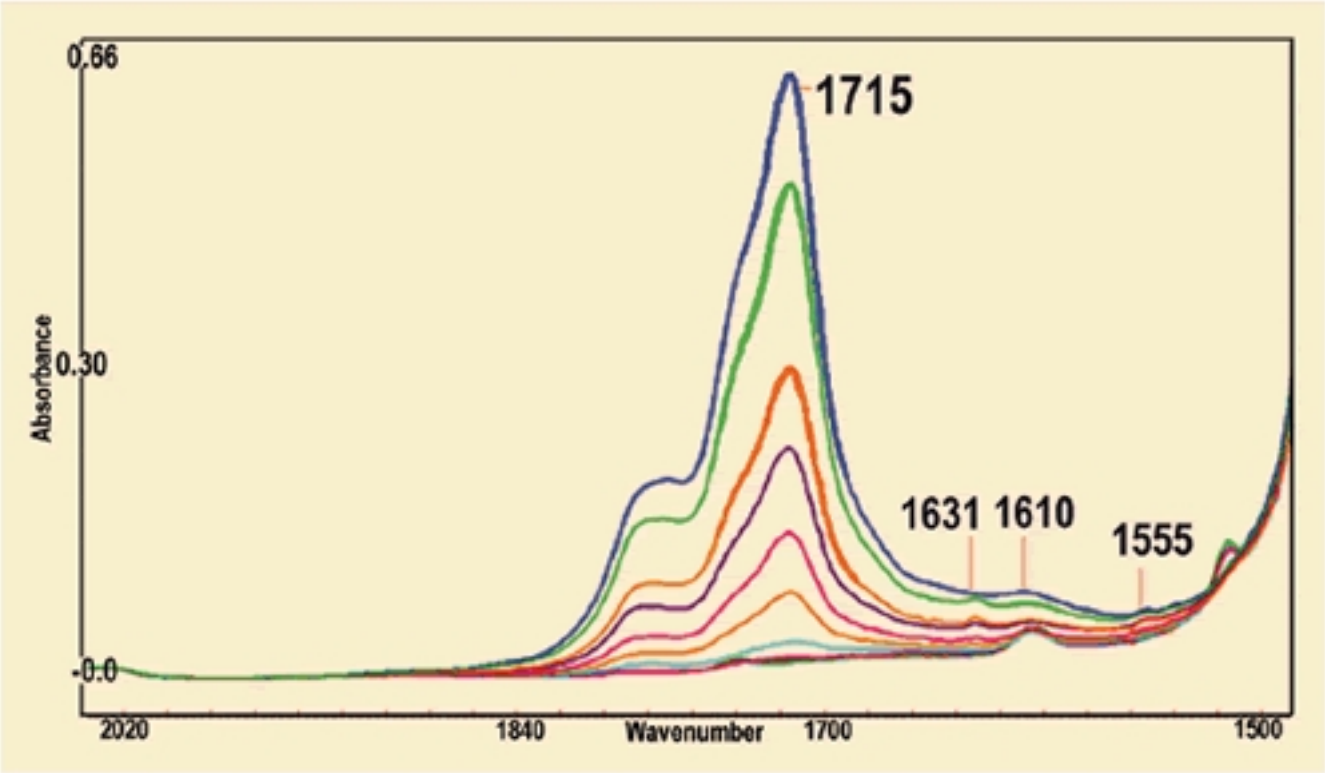

Fig. 1. FTIR detects the formation of carboxylic acids and increase in the peak at 1715cm-1 and nitration as an increase in the 1631 peak. Carboxylate sales are seen at 1555cm-1. In short, all the increases in the peaks in the region 1800 to 1500 cm-1 are caused by nitration.

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