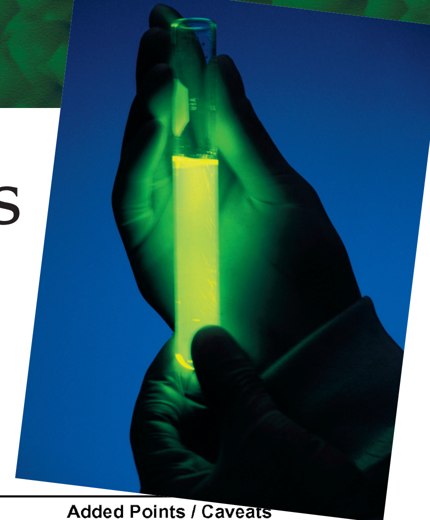

Analyzing diesel engine tests

By Jack Poley

We continue our discussions from previous columns with tables suggesting preferred groups or suites of tests for routine monitoring of various components used in specific applications. We'll now focus on diesel engines.

Diesel Engines

TEST SET	Primary Objective(s)	Reasoning and Evaluation	Added Points / Caveats
Spectro Metals (SMA)	1. Identify standard wear events. 2. Check for abrasives. 3. Coolant additives. 4. Lube additive conformation.	Reciprocating equipment creates many small particles that make SMA the *key* test for diesel engines, and SMA works well. It was the first instrumental technique employed for wear analysis, as opposed to lube condition measurement. Detection of coolant additives, as evidence of internal seepage, is a huge advantage.	Recall that SMA detects metals, but not their chemistry, e.g., measuring an additive metal provides a concentration result, but not the chemical form of that element.
Analytical Ferrography (AF)	Decision-making test when an internal inspection is contemplated.	Ferrography is one of the most expensive tests employed in routine oil analysis and is, therefore, used somewhat sparingly for small-to-medium-sized diesel engines, because they are not usually considered critical equipment. Further, particle counting and micro-patch testing is often negated by high soot levels.	Critical applications, such as emergency generation power e.g., hospitals, would justify the employment of ferrography on each sample. Oftentimes sampling intervals are very wide for such occasionally used equipment, emphasizing the need to be thorough.
Viscosity (VIS)	1. Verify proper film strength. 2. Oxidation correlation. 3. Fuel dilution correlation. 4. Fuel soot effect.	Even for used lubes, VIS is probably the second most important test available to the evaluator, but care must be taken not to mis-infer its meaning. It is possible for the VIS to be 'normal' with two opposing problems, such as a fuel leak, which would lower viscosity, along with a major amount of fuel soot, which would raise viscosity.	VIS should *always* be a part of an oil analysis test package, simply for negative (ie., *non-problem*) inferences that it tends to offer when the value is as expected.
Infrared Spectro (FTIR)	1. Oxidation* 2. Fuel soot. 3. Nitration (moreso with natural gas engines).	FTIR is useful for fuel soot detection, as well as oxidation monitoring. Occasionally, nitration may be detectable.	****Note**: FTIR will be ineffective in detecting oxidation when certain synthetics are employed, where the oxidation band overlaps significantly with the lube's chemistry
(Optional) Acid Number (AN)	1. Base depletion. 2. Oxidation correlation.	All diesel engines employ oils with basic neutralizers that impart a Base Number (BN). Some engine manufacturers suggest an oil drain when AN equals or exceeds BN.	Oxidation often causes AN increases, but not always. FTIR and VIS are more dependable oxidation indicators much of the time.
Base Number (BN)	Inspect for alkaline reserve.	BN is critical to the neutralization of strong acids (mostly sulfuric acid) formed during the combustion process. Because abnormal oxidation and fuel soot often preclude BN depetion due to low sulfur fuels, it might be considered an optional test, except when extended drains are employed, where it should be deemed essential.	There are several theories about how BN depletion limits are identified. Half of the starting value is typical. Nothing less than 2.0 is another. Intersection with AN yet another. Equipment and oil manufacturers, or qualified consultants, are proper sources.
Water (Cursory)	1. Poor sampling. 2. Poor oil handling.	A cursory check for water is a minimum test for any system. Water will usually indicate poor (cold) sampling or contaminated oil in the handling, storage or charging process.	It is possible for water to be a part of a coolant leak but, unless the leak is extremely large, such water will usually evaporate from the relatively high oil temperatures resulting from combustion heat

Postscript

The tests outlined here typically are applied to diesel engines; however, they can often be applied to a variety of reciprocating combustion engines with some variations. Fuel soot measurement and fuel dilution, for example, are usually confined to diesel engines. Many reciprocating compressors, therefore, will be well served with the remainder of the diesel engine tests, trading BN for AN, since there is no combustion process.

Natural gas engines (as opposed to gasoline) can use the same suite of tests with the fuel dilution test eliminated. BN will often be eliminated, trading it for AN. Again, it is a matter of exposure to sulfur or other strong acid environments.

Fuel soot is not found in quantity with two-cycle natural gas engines if the combustion chamber is separated from the sump, but it is found in four-cycle natural gas engines. As noted in the test grid, nitration is more common in these types of engines because of the combustion process. High nitration, detectable with FTIR, can indicate combustion timing problems.

Propane- and butane-fueled engines exhibit similar properties to natural gas engines; however, there is a greater tendency toward oxidation and varnish formation. Fuel soot is sometimes a consideration in certain components but normally not at the level found in diesel engines. The lube's routine color will advise one if a fuel soot inspection is appropriate.

Gasoline engines are usually not prone to soot formation, but peroxy acids and other oxidation and sludge promotion products do exist. FTIR will help identify such instances but not always, dependent on the chemistry mechanism or, more likely, overlapping or masking absorption. Strong acids are generally not an issue because gasoline doesn't contain significant sulfur. **<<**

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