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Total Acid Number (TAN)

Primarily used for non-engine samples (transmissions/gear oils/hydraulic fluids, etc.) the Acid Number, more commonly referred to as "Total Acid Number" (TAN) is a measure of the amount of acid present in an oil sample. The test detects the presence of organic acids that form as part of the natural oxidation process. TAN generally increases over time in used oils.

- **Test Method:** ASTM D664 (modified)
- **Unit of Measure:** mg KOH/g (milligrams potassium hydroxide per gram of sample)
- **Sample Amount:** 4g
- **Limitation:** Does not distinguish between strong or weak acids.

Total Base Number (TBN)

Primarily used for engine oil samples, the Base Number, more commonly referred to as "Total Base Number" (TBN) is a measure of a lubricant's alkaline reserve or remaining ability to neutralize acids. Acids are present as a result of combustion by-products and oxidation. Excessive acids will increase engine component wear.

- **Test Method:** ASTM D4739 (modified)
- **Unit of Measure:** mg KOH/g (milligrams potassium hydroxide per gram of sample)
- **Sample Amount:** 4g
- **Limitation:** Coolant contamination can artificially raise the Total Base Number

Elemental Analysis

Elemental Analysis (metal content) is measured using by ICP (**I**nductively-**C**oupled **P**lasma). This test detects up to 24 metals measuring less than 5µ in size. These elements can be present in both new and used oil and come from wear, contamination and/or additives. Wear Metals include iron, chromium, nickel, aluminum, copper, lead, tin, cadmium, silver, titanium and vanadium. Contaminant Metals include silicon, sodium, and potassium. Multi-Source Metals include molybdenum, antimony, manganese, and lithium. Additive Metals include boron magnesium, calcium, barium, phosphorous and zinc. Elemental Analysis is instrumental in determining the type and severity of wear occurring within a unit.

- **Test Method:** ASTM D5185 (modified)
- **Unit of Measure:** ppm (parts per million)
- **Sample Amount:** 2 mL
- **Limitation:** Elemental Analysis by ICP will not detect particles greater than 10µm in size

Fuel Dilution

Fuel Dilution is the amount of raw, unburned fuel that ends up in the crankcase. Fuel in the oil lowers the oil's Flash Point and Viscosity. Reduced viscosity can lead to wear due to reduced oil film thickness between contacting parts. Gas Chromatography separates the components of a mixture and measures the amount of each component present. Components are separated from one another by vaporizing the sample into a carrier gas stream that is passed through a column containing a substance that selectively adsorbs and then releases the components to be measured.

- **Test Method:** Fuel Dilution by Gas Chromatography - ASTM Method Pending
- **Unit of Measure:** % by Volume
- **Sample Amount:** 40 mL

Nitration (FTIR)

Nitration indicates excessive "blow-by" from cylinder walls and/or compression rings. It also indicates the presence of nitric acid, which can increase oxidation. Excess disparity between oxidation and nitration can point to air/fuel mixture problems. Oxidation and nitration increase may also be reflected in Total Acid Number and Viscosity while Total Base Number may also decrease. Nitration can be a problem in natural gas engines.

- **Test Method:** FTIR - ASTM E2412
- **Unit of Measure:** Abs/cm (Absorbance units per centimeter)
- **Sample Amount:** 40 mL
- **Limitation:** Contamination from water, glycol, soot or fuel may affect results.

Oxidation (FTIR)

Oxidation measures the breakdown of a lubricant due to age and operating conditions. It prevents additives from performing properly, promotes the formation of acids and increases viscosity.

- **Test Method:** FTIR - ASTM E2412
- **Unit of Measure:** Abs/cm (Absorbance units per centimeter)
- **Sample Amount:** 40 mL
- **Limitation:** Contamination from water, glycol, soot or fuel may affect results. Ester-based lubricants will show high oxidation values.

Particle Count

Particle Count is the measurement of all particles that have accumulated within a system, including those metallic and non-metallic, fibers, dirt, water, bacteria and any other kind of debris. It is most useful in determining fluid and system cleanliness in such filtered systems as hydraulics, turbines, compressors, auto/power shift transmissions, recirculation systems and filtered gear systems with a fluid viscosity of less than ISO 320.

- **Test Method:** ISO 11500 (modified)
- **Unit of Measure:** Number of particles per milliliter. Results are reported in the following eight (8) micron sizes: >4 µm, >6 µm, >10 µm, >14 µm, >21 µm, > 38 µm, >70 µm and >100 µm. ISO Cleanliness Code is also reported per ISO 4406. ISO Cleanliness Code is a unit-less number based on the Particle Counts measured in the 4, 6 and 14 µm regions. **Example**: ISO Cleanliness Code 19/16/13 means the sample contained 2500 to 5000 particles in the >4 µm region, 320 to 640 particles in the >6 µm region and 40 to 80 particles in the >14 µm region.
- **Sample Amount:** 80 mL
- **Limitation:** Particle Count is not a suitable for samples that are either opaque or dark and can be adversely affected by water contamination. Particle Count is quantitative, not qualitative and cannot identify the type of particles detected, only their size. Oils greater than ISO 220 are diluted prior to running the test.

Particle Quantifier (PQ)

Particle Quantifier or "Ferrous Density" exposes the sample to a magnetic field. The presence of ferrous metals (iron or steel particles) causes a distortion in the field, which is represented as the PQ Index. The PQ Index is an arbitrary unit of measurement that correlates well with Direct Read Ferrography (large). Particle Quantifier testing does not provide a ratio of smaller to larger particles; however, if the PQ Index is smaller than the ICP value (ppm) for iron, then it's unlikely there are any particles larger than 10 microns present in the sample. Over time, if PQ Index increases dramatically while iron content by ICP (ppm) remains consistent or goes down, then larger iron particles are being generated and Analytical Ferrography is recommended to provide a better understanding of the type of wear occurring in the sampled component.

- **Test Method:** Per manufacturer
- **Unit of Measure:** Per manufacturer
- **Sample Amount:** 4 mL
- **Limitation:** Detects only ferrous (iron) particles; cannot detect non-ferrous contamination or wear particles.

Viscosity

Viscosity measures a lubricant's resistance to flow (fluid thickness) at temperature and is considered an oil's most important physical property. Viscosity is measured at 100C depending on lube grade. Higher viscosities are tested at 40C.

- **Test Method:** ASTM D445 (modified)
- **Unit of Measure:** cSt (centi-Stokes)
- **Sample Amount:** 2 mL
- **Limitation:** Accuracy diminishes with lubricants above ISO 1000 grade

Water Content

Water is measured using the Karl Fischer test. It measures water by percent (%) using potentiometric titration.

- **Test Method:** ASTM D1744 (modified)
- **Unit of Measure:** percent (%)
- **Sample Amount:** 10 mL
- **Limitation:** Chemical compounds such as anti-wear additives and potassium borate can increase water content results.