Electrical Sensing Zone Advantages when Quantifying Particle Contamination in Lubricating Oils

by: Rick Shimkus, Instrumentation Specialist

It is very important to monitor the number and size of contaminants in lubricating oil used in power plant generators, as well as other equipment in many production processes. Contaminated lubricating oils can cause accelerated wear of critical parts, often resulting in premature failure of vital equipment. Reliable particle size and count data allow timely monitoring of lubricating oil cleanliness and scheduling of contaminated oil replacement before it can cause excessive parts wear or breakdown of critical equipment.

Three measuring techniques are generally used to monitor and analyze particle contamination in lubricating oils:

- light microscope
- light blockage (obscuration)
- electrical sensing zone (Elzone)

Microscopic Analysis

The microscopic technique entails examination of particles retained on a filter after a sample of the contaminated oil is passed through the filter. If the particles are unevenly distributed in the oil, this technique often misses one or more classes of particles. Also, microscopic examination only looks at a two-dimensional presentation of the particles, essentially length and width (Figure 1). It is very easy to obtain widely varying results depending on the orientation of the particles on the filter media, and microscopic analysis is tedious because many particles must be measured to give reliable statistics.

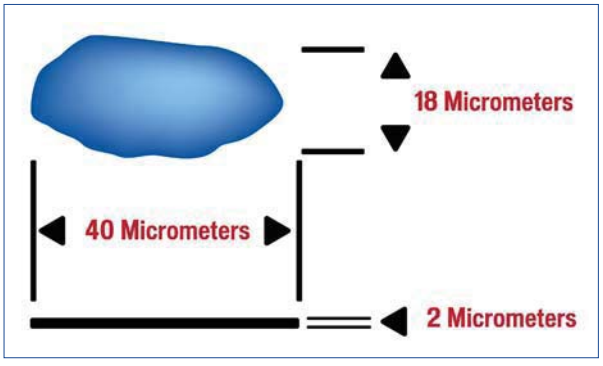

Figure 1. Microscopic examination of this particle could yield cross-sectional sizes from 36 to ≈ 700 μm² depending on particle orientation.

Light Blockage Analysis

The light blockage (obscuration) technique requires that particles pass, one at a time, between a light source, e.g., a high-intensity white light or a laser, and a detector. Each particle is counted as it passes through the beam and sized by mathematically analyzing its shadow on the detector. This type of analysis does not require capture of particles on a filter; however, some dilution of the sample may be needed to ensure particles pass individually through the beam. Like the microscopic technique, this technique looks only at two dimensions (Figure 1) or the shadow projected onto the detector, and can report particles undersize or oversize depending on their orientation. The size reported is the diameter of a sphere having the same projected cross-sectional area as the particle. Therefore, an individual flake of metal could have a range of sizes depending on its orientation when it transits the beam. Optical properties are also of concern with the light blockage technique. Transparent or nearly transparent particles may not be seen at all.

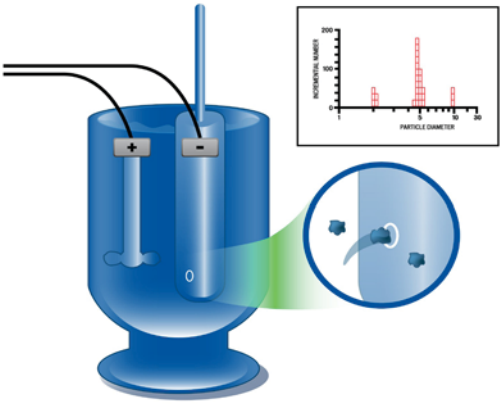

Figure 2. Schematic representation of an electrical sensing zone analyzer.

Electrical Sensing Zone Analysis

The electrical sensing zone technique, used by the Elzone II 5390 Particle Size Analyzer from Micromeritics, counts and measures the size of particles dispersed in an electrolyte or electrically conductive liquid or solution. The electrolyte containing dispersed particles is placed in a special beaker. An orifice tube (a closed-end tube with a small orifice near the closed end) is lowered into the electrolyte. A vacuum applied to the open end of the tube pulls electrolyte containing the dispersed particles from the beaker through the orifice and into the orifice tube. Two electrodes, one inside the orifice tube and one in the beaker, establish an electrical field through the orifice (Figure 2). As individual particles are pulled through the orifice, the electrical resistance between the two electrodes is disturbed as the volume of the particle displaces some of the electrolyte as it passes through the orifice. The change in electrical resistance between the electrodes is proportional to the volume of the particle. Therefore,

each particle passing through the orifice is counted and sized. The data are sent to a computer and presented as a histogram with up to 300 size channels. The sizes of the particles are reported as the diameter of a sphere of equivalent volume.

Optical properties, shape, and density are not problems for the electrical sensing zone technique. The particle's registered volume remains the same when passing through the orifice regardless of the orientation of the particle relative to the orifice. The electrical sensing zone technique also can detect particles in contaminated oil that may be missed by other techniques. Finding contaminated oil early allows prompt corrective action and avoids possible damage of critical, expensive equipment and costly downtime.

The electrical sensing zone technique also can be used to identify unclean containers, a major source of contaminated oil. Unused containers may look clean but often have unwanted particles inside. This can prevent clean oil from being placed into presumed-clean containers only to become contaminated.

Analysis Methods

The electrical sensing zone technique uses two methods for counting and sizing contaminated particles in oils:

- For light-weight oils such as heating oils, the contaminated oil is mixed with a solvating organic electrolyte and the particles are analyzed.
- For heavier oils such as hydraulic fluids, the contaminated particles are captured by filtration and the filter media with the particles is placed into an electrolyte where the particles are freed using ultrasonic energy. The filter media is removed and the electrolyte containing the particles is analyzed.

Micromeritics Elzone II

The electrical sensing zone (Elzone II) can be expected to provide more reliable and accurate data than an optical analyzer.