WearCheck FYI

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Direct-Reading and Analytical Ferrography

Ferrography is one technique that is used to monitor for wear modes that are undetectable to spectroscopy

According to Webster's dictionary tribology is "the study of lubrication", and comes from the Greek *tribein*, which means 'to rub'. When two components in a lubricated system rub, wear particles are generated. Contrary to what you might think, wear particles do not come in all sizes and shapes. There are, in fact, only a handful of distinct types of wear particles, and these particles occur in only specific size ranges. The most common wear particle in a lubricated system is the normal rubbing wear particle.

Rubbing wear particles are the normal wear particles generated as the result of sliding between opposing surfaces in a lubricated system. It is the rubbing wear particle that spectroscopic oil analysis measures in order to determine the wear condition of a lubricated system. When a system is operating normally, the amount of rubbing wear particles generated is fairly constant. When the system enters into an *abnormal wear mode* the quantity of rubbing wear particles increases noticeably. By analysing the exact part per million quantity of wear particles in the oil spectroscopy detects any increase in wear long before damage occurs to the system.

For some abnormal wear modes an increase in rubbing wear particles is not observed. In these situations spectroscopy is unable to detect the abnormal wear. Other methods must be used to detect the wear situation. Ferrography is one technique that is used to monitor for wear modes that are undetectable to spectroscopy.

Ferrography is "the study of ferrous metal wear", and comes from the Latin word *ferrum*, which translates to 'iron'. The two ferrographic techniques, *direct-reading ferrography*, and *analytical ferrography* have been developed to monitor the levels of wear particles in lubricated systems.

Direct Reading Ferrography (DR-Ferr), gives a direct measure of the amount of ferrous wear metals present in a sample of oil. The wear particles are divided into two categories, large particles, denoted D_L, and small particles, denoted D_S. Small particles less than 15 microns in size, and represent normal rubbing wear particles. Large particles are greater than 15 microns in size, and represent abnormal wear particles.

The particles are separated and measured by drawing a sample of diluted oil through a collector tube which lies over a magnetic plate. Larger particles in the oil, being strongly attracted to the magnet, accumulate at the entrance of the collector tube. Smaller particles which are only weakly attracted by the magnet deposit equally along the length of the collector tube. By measuring the blockage of light using fiber optics, one at the entrance of the collector tube, and the other just further up the collector tube, the quantities of large and small wear particles is determined.

Trending of the D_L and D_S readings reveals changes in the wear mode of the system. For example, an increase in the D_L value indicates that the system has entered into an abnormal wear mode. In comparison, an increase in the D_S value can indicate an increase in system corrosion (corrosion wear particles are less than 3 microns in size).

By trending DR-Ferr results the analyst accurately determines the wear condition of a lubricated system. When an abnormal wear mode is detected analytical ferrography is used for more detailed analysis.

Analytical Ferrography (A-Ferr) allows an analyst to visually examine the wear particles present in an oil sample. To create a ferrogram a sample of used oil is diluted, and passed over a glass slide. The slide rests on a magnetic plate that attracts ferrous wear particles out of the oil, and onto the surface of the slide. The ferrous particles line up with the largest wear particles, to the smallest wear particles in rows along the length of the ferrogram. Nonferrous wear particles (such as copper babbitt) can be easily distinguished from ferrous particles since they are deposited randomly across the length of the slide.

The ferrogram contains a snapshot of the wear particles present in the system at the time an oil sample is taken. Under high magnification the particles are readily identified and classified according to their morphology (size, shape, color, surface texture, *etc*.). A trained analyst can differentiate between cutting wear particles (caused by abrasives in the oil), or rolling wear particles (caused when surfaces roll in relation to each other, such as with a rolling element bearing), in addition to a host of other wear particle types. In examining the ferrogram, the analyst determines the type of wear occurring in the system, and the cause of such wear. Used in conjunction with spectroscopic oil analysis, ferrography completes the picture of a systems wear condition.

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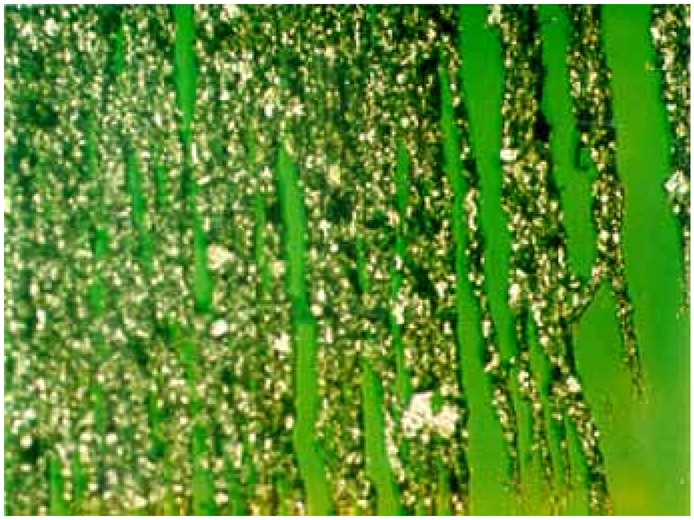

An analytical ferrogram *at 200X magnification reveals an abnormal quantity of combined rolling and sliding wear particles indicating abnormal gear wear in the system.*