HTI FILTRATION CORP.

Technical Bulletin
 # 94-01

WATER CONTAMINATION EFFECTS ON OIL AND EQUIPMENT

Of all the contaminants that are found in hydraulic and lubricating systems, free water is one of the most common. It is also one of the most damaging because of its' chemical effect on the protective additives in oil and its' direct, corrosive effect on metal surfaces. In relatively small quantities free water can also quickly react with metal particulate to create severe acidity and sludge problems in hydraulic and lubricating systems.

Dissolved and Free Water

Low levels of "dissolved" water exists in all oils and is relatively harmless if held to under 300 PPM in hydraulic systems and 400 PPM in lubricating oils. New oil frequently has up to 100 PPM (.01%) of water in it when received from the manufacturer and unless steps are taken to control it, this water content will increase until the oil is saturated. At the saturation level the oil begins to turn hazy as the "dissolved" water coalesces into droplets and forms "free" water which begins aggressively destroying the protective properties of the oil and attacking metal surfaces. Typical sources of this invasive water are water accumulation during storage, leaking heat exchangers, damaged seals, condensation in reservoirs and contaminated make-up oil. Among the effects of free water are:

- Oil additive depletion
- Oil oxidization
- Reduced lubricating film
- Increased acidity
- Sludge formation
- Metal etching through corrosion
- Accelerated surface fatigue
- Increased abrasive wear
- Decreased pumping capacity
- Oil viscosity changes

Oil Damage From Free Water

Free water in oil typically attacks the anti-wear additives, the anti-oxidant chemicals and the viscosity enhancing polymers. Depending on the hydrolytic stability (water resistance) of the oil, the operating temperature and amount of water present, the damaging effects of free water can range from slight to catastrophic in a short period of time. Typical effects of free water are the precipitation of the anti-wear additives as an acidic sludge, the formation of sticky varnish from the polymer materials and the creation of sulfuric acid. These by-products will clog filters, reduce the transfer efficiency of heat exchangers, plug oil galleys and bleed holes, cause sticking valves, etch metal surfaces and create accelerated surface fatigue in bearings.

Mechanical Damage Causes and Characteristics

When the anti-wear and anti-oxidant additives react with water metal wear rates increase dramatically as the lubricating film breaks down. Studies have shown that a 1% water content can reduce gear pump output by up to 25% and increase wear rates by over 100%! When water is allowed to build to more than .5% level a catalytic effect begins to take place with any metal particulate in the oil, especially with iron and copper. The water reacts with the metals to dramatically raise the acid number of the oil and to create acidic sludge. As the acid number approaches 2.0, the oil loses lubricity which creates excessive heat and rapid adesive wear. After only 400 hours with .5% water and trace iron in the oil the acid number can rise from .5 to 8, with copper and water it takes only 100 hours to raise the acid number to 11! Oils with a rising acid number and increasing viscosity typically will have water impaired lubrication film properties and should be replaced. Continued use of wet, acidic oil will result in heat generation, accelerated surface wear, fatigue fracturing, metal debris generation, spalling and eventual seizure.

Testing For Water Contamination

There are some basic tests that can be performed on the shop floor to test for water contaminant but the most informative and accurate tests require sampling and laboratory analysis. A basic test for water is observing the oil's clarity. By retaining a sample of clean oil in a clear tube, subsequent samples can be compared for visual clarity. Haziness or milky white coloration are clear signs of increased water content. Acidic oil will also have a "sour" smell compared to clean oil. Another simple water detection method is the crackle test. This involves heating a spoonful of oil to create water vapor bubbles which generate a crackling noise and causes bubbling of the oil. Testing sticks are also available which turn color when exposed to wet oil. These are very subjective tests and should be used only as guidelines for determining the need for more exact laboratory testing.

Laboratories can apply several different tests for determining the water content of your oil and they will report them to you in terms that your oil supplier can use to determine how much longer the oil can be left in service and what corrective action, if any, should be taken. Typical water related tests will include Viscosity, Total Acid Number and Oxidation Absorption, and Water Content in % of content or PPM. A more detailed explanation of these tests and what they mean is found in our Technical Bulletin 94-03.

Many oil suppliers offer free or low cost laboratory analysis services for their products. These companies are also good sources of information on how to protect your equipment from excessive wear and premature replacement. There are also several independent laboratories that offer complete oil analysis services. A low cost, basic testing service is available to our customers, through our Stanton, California Technical Services Department.