Chevron

marine lubricants information bulletin 2

what about water?

Chevron's FAST™ Service is a comprehensive equipment condition monitoring program which reports the condition of oil in service and plots the trends of important properties, including presence of water.

The used oil report, issued by Chevron's laboratory, lists the test results obtained and includes comments and recommendations on the suitability of the oil for continued service. Each used oil sample is tested for water presence.

Testing the oil

The water content of used lubricating oils can be measured in a number of ways. A simple test for water is the "crackle test." A few drops of oil are placed on an electric hot plate. If the oil starts to bubble and spatter, water is present. This test can detect as little as 0.1% water in the oil. However, the test does not indicate the exact amount of water in the oil.

A rapid and accurate test method for the quantitative measurement of the water content in oil is based on the chemical reaction of water with calcium hydride. The reaction releases a small amount of hydrogen gas, which is captured in a container. The pressure increase in the container is measured and then converted to the amount of water present in the oil sample. Many onboard test kits for water determination are based on this principle.

Test method ASTM D-95 is based on a different principle. For this test, equal volumes of oil sample and diluent solvent are subjected to a distillation test. The water and solvent vapors are condensed in a cooler and the condensed liquid is collected in a trap. The water separates from the solvent at the bottom of the trap because of its higher density. At the end of the test, the total volume of water collected in the trap is recorded and converted to the water content in the oil.

Another well-known test method, which determines very low quantities of water, is ASTM D-6304-04a, or the Karl Fischer method. This procedure can detect water levels as low as 10 mg/kg (ppm). The method is based on a chemical reaction of the water with the Karl Fischer reagent.

Finally, a number of laboratory test methods are based on the use of a centrifuge to separate the water from oil samples.

Origin of water contamination

The water contamination of fresh and used lubricating oils may originate from various sources. Lube oil storage tanks are continuously breathing because of differences between day and night temperatures. During the night, when temperatures are lower than in the daytime, ambient air containing a certain amount of water vapor is drawn into the tank's vapor space. Some of the water vapor will condense on the tank walls. As a result, a significant amount of water may collect at the bottom of a storage tank over time.

Inside a ship, temperatures are more stable because the surrounding seawater temperatures do not greatly vary and engine room temperatures are stable. Condensation has a smaller impact in this case. In-board and double-bottom tanks, however, usually de-aerate toward the deck and seawater can enter through the venting pipes. Therefore, tank vents should be shielded in heavy weather to prevent the ingress of rain or seawater. It is important to regularly check for the presence of water. If a significant amount of water is detected, it should be removed.

In some equipment, free water and/or water vapor is unavoidably generated during operation. Air compressors are very prone to water contamination, because during compression, the water vapor present in the air condenses under certain unfavorable operating conditions. Regular removal of condensed water is of utmost importance to protect the equipment.

Diesel engines produce water vapor during fuel combustion. Under adverse operating conditions this water vapor, and the moisture from humid combustion air, may condense in the crankcase and mix with the oil. Large quantities of water sometimes enter the crankcase from leaking cooling systems.

Another well-known problem area is stern tube seals. Even though most systems are equipped with gravity tanks or pressurized systems, which should keep any water out, it is very common to see water ingress in stern tube systems. Damaged seals usually cause this problem; however, a pumping effect caused by wear grooves in the shaft bushing can also allow water to enter the system.

Why all this attention to water?

Water is the most common contaminant present in used lubricant oil samples. Excessive water contamination over a prolonged period of time eventually leads to equipment failure from the following problems:

- Sludge formation in the oil, followed by possible oil line plugging
- Reaction of the lubricant additives with water that impairs the effectiveness of the additives, which, in extreme cases, may result in precipitation of the additives
- Rusting and corrosion leading to high wear and bearing failures
- Impaired lubrication film from water or steam pockets in heavily loaded bearings
- Formation of emulsions that impede oil purification and lubrication
- Bacterial growth on the water/oil interface leading to corrosion and undesired changes in the lubricating oil characteristics

The nature of water

In some cases, it is very important to know if the ingress of water is pure seawater or fresh water. In many cases when seawater is detected, the vessel will have to be dry-docked.

The nature of water is determined by performing a routine spectrographic element analysis on the oil sample. When water is detected, the amount of sodium (Na) and chlorine (Cl) can be extrapolated and their concentrations in the water phase can be calculated. Sodium chloride (NaCl) is the predominant salt in seawater. Typical deep ocean seawater contains about 55% chlorine (Cl) and 31% sodium (Na).

To determine the nature of water, we must focus is on its chlorine content. Sodium is also present in water cooling treatments and lubricant additives, and sodium content can be influenced by sediments and rocks and fuel-related materials. Based on international studies, water can be subdivided into various salinity levels. Depending on measured chlorine concentration, water can be defined as salt, brackish or fresh, as shown in Table 1.

Table 1: Salinity levels

	mg/l Cl	Nature of Water
Very Fresh	< 110	FRESH
Fresh	+ 110 to 220	
Slightly Fresh	+ 220 to 440	
Rather Fresh	+ 440 to 880	
Slightly Brackish	+ 880 to 1,760	BRACKISH
Brackish	+ 1,760 to 3,520	
Very Brackish	+ 3,520 to 7,040	
Slightly Salt	+ 7,040 to 14,080	SALT
Salt	+ 14,080	

Example: A sample containing 0.5% water and measuring 100 ppm Cl will show a chlorine content of 20,000 ppm in the water phase. This means that the nature of water is "salt".

Determining the nature of water provides valuable information for establishing the source of water ingress, especially in stern tubes, thrusters, or settling and storage tanks. The nature of water is displayed on the FAST™ used oil analysis reports for these systems.

In-service warning limits

The maximum tolerated level of water contamination differs for the various types of equipment being lubricated, kinds of lubricating oils, and operating conditions. Table 2 contains a summary of the warning limits for water contamination of in-service lubricating oil. This information is based on general experience and manufacturer's requirements.

Table 2: Warning limits for water (%)

Equipment	Attention	Urgent
Medium-speed Diesel Engines	0.2	0.5
Slow-speed Engine System Oil	0.2	0.5
Turbo Chargers	0.05	0.5
Turbo Generators	0.05	0.5
Steam Turbines	0.05	0.5
Gear Boxes	0.05	0.5
Hydraulic Systems	0.05	0.5
Air Compressors	0.05	0.5
Refrigeration	0.05	0.5
Compressors	0.01	0.05
Stern Tubes	1.0	3.0

Finally, the best recommendation is to be alert and stop water ingress as soon as possible to keep your oils dry. ■