CURTISS WRIGHT Flow Control Company SCIENTECH

Measuring Lubrication Effectiveness

Oil performance conditioning

Stress Wave Analysis (SWAN™) can be employed to assess the condition of lubricants and to measure their relative effectiveness under different operating conditions. Fluid or particulate contamination of a lubricant or "microskidding" will result in randomly occurring, high amplitude friction events. Even though these events have very short durations, they result in a measurable increase in friction/Stress Wave Energy (SWE), and a change in the shape of the Stress Wave Amplitude Histogram.

A test was performed to measure the relative effectiveness of three synthetic oils under different operating conditions. The test fixture was a Dead Weight Loading System, which uses weights on an arm to load a bearing rolling element. This test fixture also has a removable sump. The Stress Wave Energy was measured under different loads to compare effectiveness of the oils over a range of normal operating conditions. The oil sump was then removed to measure the protection provided by residual amounts of lubricant, after a loss of lubricant supply/pressure.

Figure 1

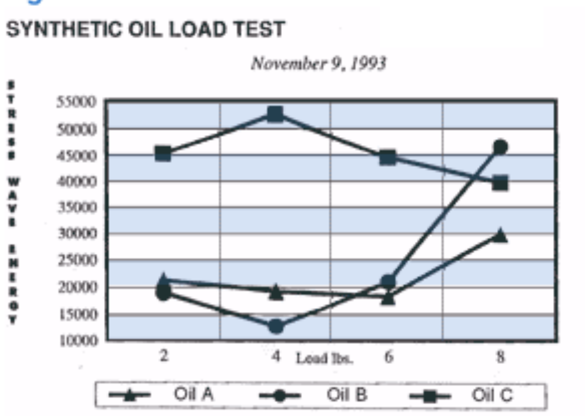


Figure 1 shows the Stress Wave Energy readings at four different load settings for the three different oils. The results of the test show how the oils compare under different load conditions. As a further test of the oil's ability to provide protection after a loss of supply, the test fixture was run at a constant load and the sump was removed.

Figure 2

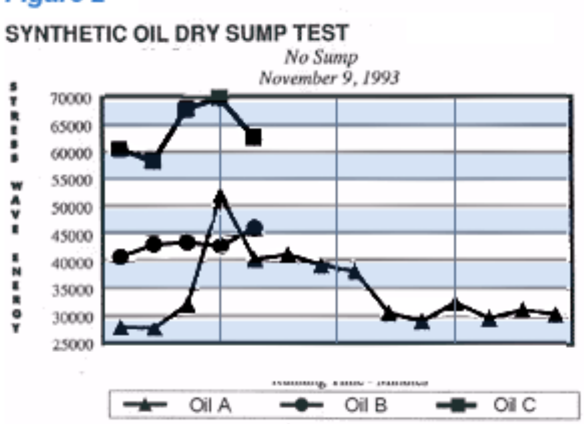
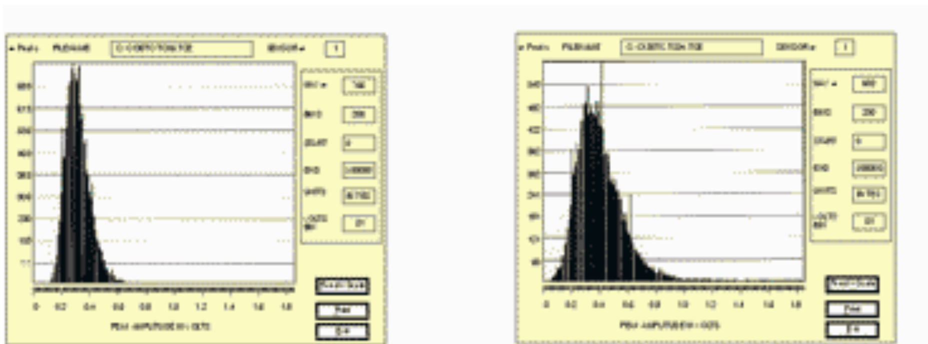


Figure 2 shows the SWE readings as a function of running time after sump removal. The results of these tests show the ability of the different oils to provide "dry running" protection to the parts after a loss of lubricant supply. For two of the three oils, testing had to be stopped in less than 1.5 minutes, due to excessive temperature. However, the third oil was still running with only slightly increased friction after four minutes.

Another test was performed, on a C-130 turbine engine gearbox to measure the lubrication effectiveness over a range of temperatures. A sensor was externally mounted on the gearbox and, during a ground run, the oil flow rate through the oil cooler was adjusted to collect data at two stabilized oil temperatures.



HSGI, XDCR #2, OIL TEMP = 75°C

HSGI, XDCR #2, OIL TEMP = 90°C

Figure 3a Figure 3b

Stress Wave Amplitude Distribution as a Function of Oil Temperature

The SWAN data in Figures 3a and 3b show a measurable change in viscosity of the oil over the range of 75 degrees Celsius to 90 degrees Celsius. At the higher oil temperature, the thickness of the lubricant boundary layer is reduced. This causes an increase in friction due to randomly occurring, short duration, high amplitude, skidding events (Figure 3b) and a 10%

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