SENGENUITY
Sensor Engines by Vectron International

Gearbox Oil Contamination Detection Using Vectron ViSmart Viscosity Sensor

SenGenuity ViSmart™ was tested on industrial gearbox oil samples that were directly obtained from a customer site. The three samples of oil were as follows:

- oil that was present in the gearbox for 9 months (referred to as "Used"; time interval of operation October 03-June 04);
- oil that was present in the gearbox for 6 months but at elevated contamination levels (referred to as "Contaminated"; time interval of operation Jan-June 2003), and
- oil that was new and ready to be placed into the gearbox (as part of the preventative maintenance program; referred to as "New").

The primary goal of the test was to verify the ability to of the ViSmart™ to measure viscosity of the different samples. The samples once acquired were tested at the SenGenuity lab.

Data points were taken continuously; the sensor was fully immersed into the sample oil container. The temperature at which the data was taken was room temperature which fluctuated between 22° – 25°C. The temperature noted is for the value measured in the sensor itself where the temperature chip is embedded; there is a variance between what the ViSmart™ measures and the "true" temperature of the samples due to the thermal mass of the ViSmart™.

Viscosity data is shown in Figure 1. It is displayed in acoustic viscosity (AV) units which are equal to centipoises (cP) x specific gravity.

The data indicates an artifact of employing mineral oils as the calibration standard for a high shear rate (30,000 – 3,000,000 for the various liquids tested) viscometer such as the ViSmart™. Mineral oil begins to exhibit shear thinning at these shear rates and the degree of thinning that the standards exhibit is biased into the calibration functions. Materials that exhibit more shear thinning than the specific calibration oils read differently than their expected "low shear" viscosity, while materials like water, iso-propanol, and aromatics tend to exhibit less shear thinning than oils and read higher than expected. Mineral oil is employed as the standard due to the low reactivity, high stability and ability to measure from –40°C to +140°C over the required viscosity range with a single family of chemicals.

As observed there are some shear thinning effects. But more importantly, what is observed that the each of the samples has a different viscosity value. The data can also be explained further:

- The value for the "New" oil is the lowest because it experiences the most amount of shear-thinning.
- The value for the "Contaminated" sample is lower than the "Used" sample, because there is more water and organic content (the color of the "Contaminated" sample is dirty green, while the "Used" sample still retains a brown hue similar to the "New" sample).

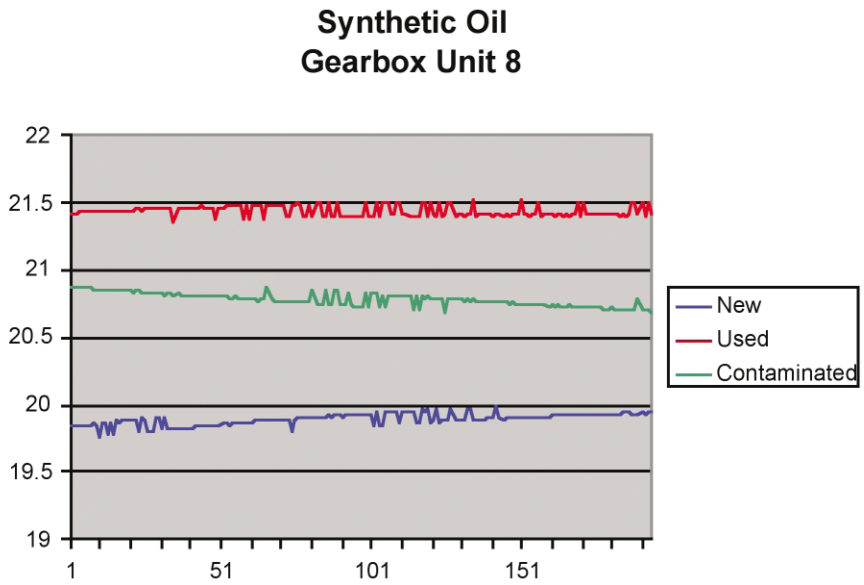

Figure 1: Viscosity data at room temperature for three in-situ conditions of the synthetic oil

The data acquired clearly indicates the following:

1. The ViSmart™ shows the shear thinning effects at the high shear rates that it is measuring at.
2. The ViSmart™ can measure various degrees of viscosity of the samples submitted.
3. With the appropriate control limits, the ViSmart™ can notify change in viscosity in reference to a baseline that corresponds to a needed oil change interval.

Given the size of the ViSmart™ sensor, it can be envisioned that the sensor be directly integrated to the drain plug on the industrial gearbox to provide continuous oil viscosity data feedback customer maintenance personnel to determine the appropriate gearbox oil change interval time. The drain plug access location provides the easiest minimal footprint for personnel and allows for absolutely no invasive mechanical changes. Since the ViSmart™ is a solid-state viscometer it provides the OEM customer with tools for remote site access and monitoring for its cost-effective budgetary and operation requirements.

DISCLAIMER

SenGenuity • 267 Lowell Road, Hudson NH 03051, USA • Tel: 1.603.578.3025 • Fax: 1.603.578.4060 • www.sengenuity.com