



"We Can Sense It"

Monitoring Oil Viscosity in Machine Tools Using ViSmart Viscosity Sensor

Commercializing technology based on quartz crystal acoustic wave research Vectron International introduced the first commercially available solid state viscometer designed for integration into in-line, real-time viscosity oil condition monitoring for rigorous machine tool applications.

Machine tools and other production equipment rely on the quality of various fluids to maintain optimum performance. Lubricants in gearboxes, fluids in hydraulic systems and coolants used to flood the workzone or cool machine components provide essential functions. They reduce friction and control thermal effects, for example. If these fluids are allowed to deteriorate or become contaminated, the machine's ability to produce acceptable workpieces is jeopardized. The machine may not be able to hold tolerances or meet production goals because of unplanned downtime.

New sensor technology is making it possible to monitor one of the key properties of a fluid and to detect early warning signs that the fluid may no longer meet requirements. This sensor technology automatically measures the viscosity of industrial fluids. Because viscosity is linked to fluid performance and because changes in viscosity are symptomatic of many negative conditions, monitoring this property is proving to be a very effective diagnostic tool. Preventive maintenance activities can be targeted to true root causes and the results of these activities can be verified.

In the past, viscosity (a measure of a fluid's resistance to flow) has been difficult to measure quickly, accurately and in a digital format. As a result, other properties have been monitored instead. Shops have been checking color, transparency, acidity or even odor, but the results were not always reliable or scientific. Now viscosity can be measured precisely by a sensor device that is immersed directly under a stream of fluid or mounted in the fluid tank or pipeline. In simplified terms, the sensor uses sound waves that lose energy when emitted along surfaces of a quartz crystal in contact with the fluid. This energy loss is proportional to the viscosity of the fluid. Thicker fluids draw off more energy than thinner fluids, so to speak. Measuring the change in energy gives highly accurate viscosity readings through a wide range of temperatures.

The ViSmart from Vectron International is such an acoustic sensor. It is smaller than a matchbox. Onboard electronics control sensor operation while communicating with an external display unit. The sensor lies in contact with or under the surface of the fluid with a cable attached to the display unit. The company offers a handheld display unit that be connected to the cable for monitoring by a machine operator or for data collection and downloading. The display unit can be left in place or carried from machine to machine for connection to sensors in each location.

Conventional mechanical and electro-mechanical viscometers designed primarily for laboratory measurements are difficult to integrate into the control and monitoring environment. As a consequence, many companies rely on decisions based on intermittent "snapshot" data acquired from periodic sampling where conventional instrumentation can be affected by temperature, shear rate and other variables.

Acoustic wave sensors offer a number of advantages over conventional mechanical and electromechanical viscometers as they are small solid-state devices that can be completely immersed in the oil providing an instantaneous viscosity data stream for embedded OEM or end-user spot-check applications. The sensors are unaffected by shock or vibration or by flow

conditions so they can be used in harsh operating conditions to measure viscosity from 0 to 10,000 cP with a temperature range of -25°C to 125°C. At the same time, sensor measurements are not affected by particulates.

Measurements are made by placing a hermetically packaged quartz crystal chip with an abrasion resistant proprietary hard-coat surface in contact with the oil. The oil's viscosity determines the thickness of the oil hydro-dynamically coupled to the surface of the sensor. As the acoustic wave penetrates the oil, viscosity is calculated by measuring the power loss. Because the acoustic wave sensor is a solid-state device no bigger than a matchbox, it requires no calibration, contains no moving parts, and can be completely embedded for hardware integration to instrumentation platforms.

Several customers are using the ViSmart to monitor lube oils in gearboxes on production equipment as well as to monitor coolant in machine tools. For now, these applications tend to be in higher volume production facilities because preventive maintenance is a high priority in places where the consequences of production equipment malfunctions or process instability are drastic. However, as smaller plants and job shops become more disciplined about preventive maintenance and move to more automated production, these users to seek sensor-based technology for monitoring the condition of critical fluids.

One such customer is a global leader in the spline roll machining for automotive applications (see Figure 1) and continuously monitors the viscosity of the cutting oil to ensure that all machining parameters are satisfied.



Figure 1: An acoustic sensor instantaneously measures the viscosity of cutting oil being used on a spline rolling machine. Changes in viscosity are indicators that the cutting oil may not be functioning as required.

