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Lubricant Viscosity Control for Gas Compressors

If you're running one of the 140 working refineries in the US, the last thing you need is an unplanned shutdown. But a production standstill is exactly what is at risk if you don't keep an eye on the viscosity of the lubricating oil used in any of the rotary compressors in the plant, with the highest risk of these being the gas compressors. One minute all processes are up and running, and the next there's a bearing failure and production stops.

It's not just the cost of lost production, either - a compressor failure in a single part of the refinery can run in the tens of thousands a day in lost revenue, similar amounts to rebuild a compressor, and hundreds of thousands of dollars for a replacement - not to mention the sunk cost of maintaining spares.

Clearly managing lubricant viscosity is critical to maintaining compressor health, yet it is common practice to monitor lubricant viscosity in each major compressor once a month by sending a sample to a lab for testing. For compressors where lubricant comes in contact with methane and other light hydrocarbon gases, the lubricant's viscosity can break down much more quickly, increasing the risk of failure. Through hard luck, refiners also have found that real-time temperature monitoring is inadequate to monitor lubricant viscosity.

A major Gulf Coast refinery engineer indicates they solved the problem by moving to real-time monitoring of lube oil viscosity in the critical compressors. "We recognized that in-line viscometers are the best way to know what is happening to the lube oil in our large screw compressors," says the plant manager. "Further, we have found in-line lubrication viscosity monitoring offers a cost-effective way to keep track of compressor health."

The true measure of the health of a lubricant's viscosity can only be gauged when measured in situ with gas vapors dissolved in the lubricant. Further, monitoring lubricant temperature isn't sufficient to protect compressor bearings, especially in applications where process starts and stops can occur.

What's needed is in-line viscosity monitoring to help provide plant operators with real time data on lubricant viscosity. There is a solution for refinery managers working to keep plants online and producing. New, inexpensive and rugged in-line viscometers are able to monitor real-time changes in lubricant viscosity, offering a cost-effective way to keep track of compressor health in real time.

Refineries and compressors

Rotary compressors are used throughout oil refineries in applications ranging from vapor recovery to gas processing operations. Screw and scroll compressors make up a significant portion of this equipment.

Screw compressors use two reciprocal screws to compress gases. Gas is fed into the compressor by suction and moved through the threads by the rotating screws. Compression takes place as the clearance between the threads decreases, forcing the compressed gas to exit at the end of the screws.

Scroll compressors use two interleaved spiral vanes to move and compress fluids and gases. Typically found in intermediate and end-product applications, scroll compressors are valued for reliability and smooth operation.

The importance of lubricant viscosity

In both types of compressors, lube oil is used to seal the

compressor from gas leaks, lubricate moving parts and manage temperature during operation. The condition of lubricant oil is a critical factor in extending a compressor's bearing life and overall reliability. Monitoring and managing lubricant viscosity can prevent costly breakdowns due to bearing failure. Viscosity also plays a role in energy efficiency - demand for more efficient compressors is driving the use of lower-viscosity lubricants.

A range of lube oils, typically synthetic in composition, is available for use in compressors. Water resistance, thermal stability, long life, resistance to oxidation and resistance to absorption of process gasses are important characteristics. While the goal is a lubricant with a long useful life, harsh environments, contaminants and even humidity in the refinery's external environment can greatly reduce lube oil's useable lifespan.

Monitoring lube oil viscosity is the best way to prevent bearing wear and prevent compressor failure. While some plants may monitor as infrequently as once a month, rapid changes in viscosity happen - and the results can be severe.

Changes in viscosity - and consequent risks

Compressor lube oils are formulated to work well and remain stable at high temperatures and pressures. Hydro-treated mineral oils are used for their low gas solubility (1-5 %.) Synthetic compressor lubricants (PAO, PAG) are used depending on the process and how much gas dilution is present. PAO (Poly Alpha Olefin) oils, for example, have excellent water resistance and resistance to oxidation; PAG (Poly Alkaline Glycol) oils, which do not readily absorb gasses, are used in applications where process gasses are compressed.

Many factors can affect lube oil viscosity. These include:

- Oxidation - caused when churning lube oil foams, exposing more oil to surface air and causing oxidation that lowers viscosity and threatens useful lubricant life.
- Bubbles - as foaming oil churns against the screws or vanes of the compressor, bubbles form, instantly dropping the viscosity of the oil.
- Dilution - caused when the lubricant oil is diluted with gas such as methane, dropping viscosity.
- Contamination - vapors from hydrocarbons being processed can mix with lube oil. This light hydrocarbon and methane contamination - one refinery manager calls it 'a witches' brew' - makes measuring viscosity challenging.
- Temperature change - typically at start-up, significant changes in temperature can occur that affect the viscosity of the underlying lube oil as well as any contaminants, further aggravating the situation.

A range of compressor failures can result: bearings, both rotary and thrust, can fail, which in turn causes wear on the rotor assembly. Replacing bearings is less

costly than a total rebuild or replacement; either way, the plant faces downtime.

The unpredictability of viscosity change means monthly viscosity checks are not enough to prevent bearing failure and subsequent plant downtime. Some compressor customers are designing in-line viscometers into compressors to monitor real-time changes in viscosity that happen between standard oil lab analyses, viewing this 'preventative' approach as an ideal way to ensure bearing life and minimize the costs associated with unscheduled downtime.

Process viscometer approaches

Not all process viscometers are created equal. Cambridge Viscosity instruments, for example, employ an innovative sensor technology that uses an oscillating piston and electromagnetic sensors. Other process viscometer technology approaches include falling piston, falling sphere, glass-capillary, U-tube, and vibration designs.

In all cases, plant managers should look for the following characteristics for in-line lubricant viscosity measurement:

- Menu-driven electronic controls are powerful and easy to use.
- Self-cleaning sensor - using the in-line fluid to clean the sensor while it is taking measurements reduces unscheduled maintenance.
- Built-in temperature detection - the sensor should show temperature as an analog reading
- Multiple output signals - the sensor should display temperature and temperature-compensated viscosity readings.
- Automatic viscosity control - look for a sensor that is pre-set but reconfigurable. The sensor should be able to 'learn' how much control is needed for each fluid setting.
- Data logging - date and time-code should be automatically logged, creating an audit trail and simplifying performance and quality trend measurement.
- Security and alerts - designed to prevent unauthorized changes and sound an alarms when setpoints are reached so operators can take action quickly.
- Quick-change memory settings - for process lines that run more than one fluid, this feature simplifies changing settings.

About Rob Kasameyer

Robert Kasameyer is the President and CEO of Cambridge Viscosity, Inc., a global leader in fluid viscosity measurement. The company's major applications include life sciences and pharmaceuticals as well as oil and gas exploration; oil analysis, chemical processing, and coatings. Mr. Kasameyer holds a BSME from Tufts University and an MBA from Harvard University.