Using Viscosity Measurements for Leak Detection in Crude Oil Pipelines

APPLICATION

Leak Detection in Crude Oil Pipelines

CHALLENGE

Rapid detection of pipeline leaks is crucial in preventing environmental disasters and protecting operators & investors from the financial and regulatory fallout which would follow. It is a tremendous responsibility and managing leaks in large crude oil pipelines is no easy task. It requires highly trained engineers, reliable instrumentation and most essentially the ability of both to quickly respond. Complicating the job of leak detection are a variety of factors from the length of the pipeline systems, which can be hundreds or thousands of miles, to the variety of products being transported with viscosities ranging anywhere from 0.1cP (natural gas oil) to 700cP (heavy crude oil) in piping with diameters of 8" to 46". Identifying what is a leak from what is a normal change in process conditions is difficult, but essential and success depends on speed and accuracy.

Pipeline operators and Leak Detection groups use a material balance system (MBS), where many conditions and parameters are monitored to make sure conditions entering the system are the same as those leaving the system. This MBS is compared against a known model of the pipeline. "If the model and real time measurements are the same then everything is okay; when it is different, then there might be a leak". More often than not, it can be very difficult to differentiate between a leak and acceptable deviations from the model due to changing conditions in the pipeline, measurement errors and changes with temperatures and pressures. When examining the signals from an instrument it is important to have both Reliability, which is dependent on the number of false alarms operators receive and Sensitivity which looks at detection time (how fast they can receive a good signal) and tolerance (how small the tolerance band can be). If each signal has errors then that error is compounded as it is input into the algorithm, causing errors against the known model. These errors can lead to false alarm conditions.

When an alarm condition occurs pipeline operators have 10 minutes to validate the alarm. If a failure or root cause of the alarm cannot be determined, then the line must be shut down for safety. Shutting a line down can cost anywhere from $200,000USD to $1,000,000USD per hour depending on the line. End users are paying to have their product transported and the pipeline operators

RESULTS

Inline Viscometer to:
- Detect potential leaks in pipelines
- Avoid environmental disasters due to unknown leaks
- Validate flowing commodity for batch detection
- Measure under high pressures (up to 1440psi)

are liable to penalties when they cannot meet schedules. Reliable equipment is a necessity if you are going to reduce the number of false alarms and keep the process running smoothly. While many instruments are required for leak detection, a viscometer is the most important, since the viscosity input is driving the leak detection model and it must be reliable or the method simply breaks down. Viscosity is also a critical measurement used for batch interface purposes and for correction purposes in the process. Pipeline operators are by necessity dependent on accurate, fast detecting viscosity signals.

There is another parameter which is also crucial; uptime. Systems that are hundreds of thousands of miles in length can have hundreds of viscometers installed in remote locations all over the grid. Operators simply don't have the manpower, especially with the current price of oil, to be constantly servicing instrumentation that requires intensive maintenance. An offline viscometer can not only render the MBS data useless and potentially lead to a shutdown, it can cost the operator hundreds of thousands of dollars just to service the remote installation.
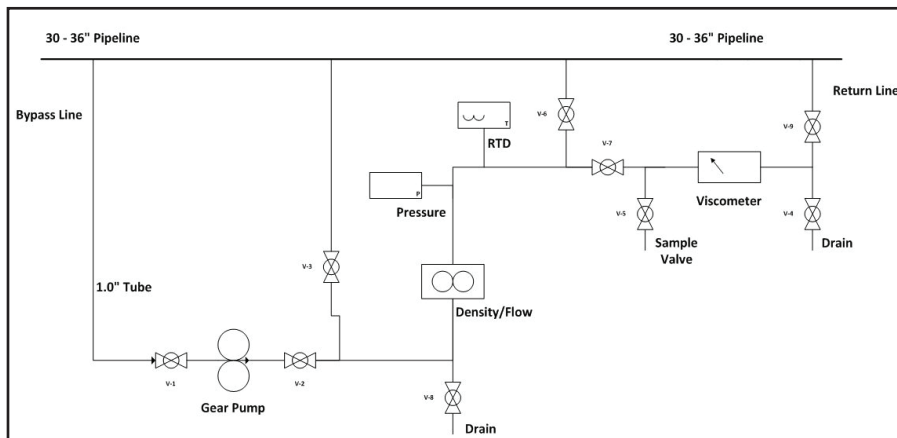

Figure 1. Typical remote leak detection cabinet in analyzer shelter. Cabinets are generally fed from 1"-1.5" bleed off from the main pipeline with the flow created by the use of an educator or gear pump to create a pressure drop. The product is channeled past a series of instruments which can include pressure transducers, thermal probes and a flow meter in addition to the viscometer. Most of the instrument arrangements are set up in a bypass to allow for periodic maintenance without disruption of the process. Cabinets can vary in size but will be 6'W x 2.5'D x 8'H at a minimum.

SOLUTION

A large pipeline company located in the US and Canada found their existing viscometer technology was too maintenance intensive. The vibrational technology that they were using was continually going out of calibration due to coating issues and was unreliable at lower viscosities. Because of its size it required two people to pull it out of line and clean it. Maintenance for these instruments was costing in excess of 2 million dollars per year. This company looked to Cambridge Viscosity to provide a robust solution for their process measurement. Cambridge provided one of their oscillating piston viscosity sensors which was designed to meet the demanding conditions of the pipeline. The sensor, model SPC-302, is made of Inconel 718 to meet the pressure and corrosion requirements of the pipeline. It uses a-threaded connection to quickly and easily adapt to any part of the process line without the head for a large and expensive "J" housing. The customer preferred the Cambridge Viscosity sensor because the compact size, ease of installation, rugged design, stable calibration, accuracy and speed. The sensor specifications can be seen below.

302 INLINE VISCOMETER

Ideal where threaded connections are desired, the in-line 302 Sensor has a 1.25" (31.75 mm) NPT thread to easily install into a process line using a 'Tee' or into a tank or pipe using a weld ferrule. Pressure rating of 1440psiwith CSA approval or higher pressures in other regions and temperatures up to 374°F. Common applications for the 302 sensor include pipelines, coatings, fuels, petrochemical, refineries, oil analysis and lubricants.
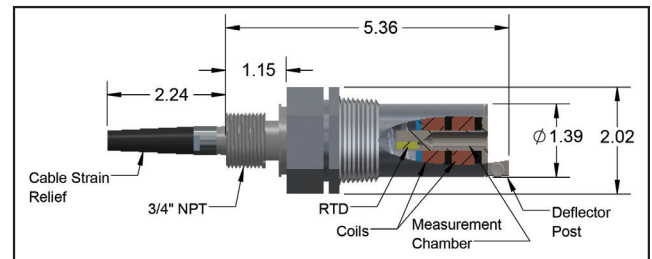
ABOUT CAMBRIDGE VISCOSITY

With more than 20,000 installations worldwide and over 30 years of experience, Cambridge Viscosity is the proven leader in viscosity management technology. Cambridge Viscosity understands and meets the needs of laboratory researchers and process engineers in a wide range of industries whose jobs depend on the quality, accuracy, and reliability of viscosity measurement equipment. Cambridge Viscosity is part of the PAC team.

For more information about Cambridge Viscosity and its viscometer solutions visit:
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