White paper

Remote Monitoring of Sand Build-up

Latest Generation Level Monitoring Devices Optimize Separator Efficiency

EMERSON

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Latest generation of level monitoring devices optimizes separator efficiency to avoid unplanned shutdowns

Abstract

Separators are used in the oil and gas production process to segregate a well stream into its individual components of oil, gas, and water. They are also the point at which sand is removed. Awareness of sand build-up within separators is crucial for operators, as excessive accumulation can prove extremely damaging and costly. This white paper explains how separators work and looks at the level of damage that can be caused when sand builds up within them. It also examines the technology that can be used to provide the safe and reliable monitoring of sand deposits. The paper reveals how the latest vibrating fork level detectors provide greater visibility of sand build-up, therefore helping to avoid unplanned shutdowns and improve production efficiency.

Figure 1-1. Separators

Introduction

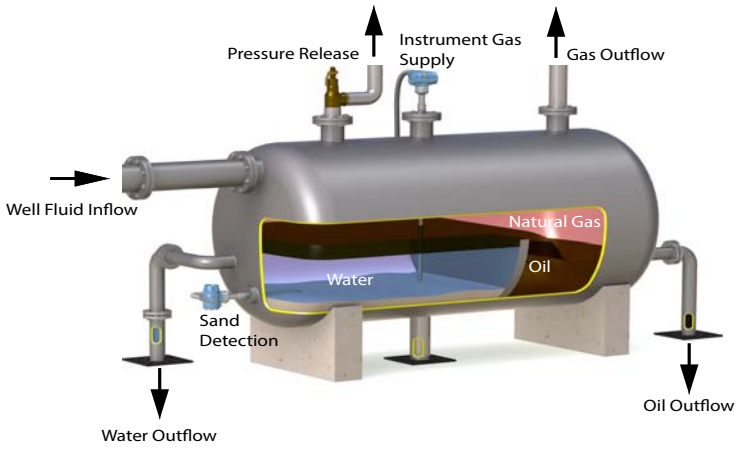
Porous and permeable sand formations filled with large volumes of hydrocarbons that flow easily into an oil well are every petroleum engineer's dream. However, when the sand formation turns out to be so poorly cemented together that sand grains flow into the well along with the oil, it can lead to major problems. The task of segregating the well stream into its individual components of oil, gas, and water, while also removing sand is a vital step in the production process. This is typically performed by a device known as a separator.

Segregating the well stream in this way enables hydrocarbon recovery levels to be optimized, and facilitates measurement of the flow or production rate of these individual components. This then provides essential production data from the various wells in a field. However, the excessive build-up of sand within a separator can lead to serious problems, such as the device's inlets and sand drain pot becoming clogged. This accumulation limits the separator's valuable capacity. Performing a manual clean-out procedure may require an unplanned shutdown to take place, affecting production. Therefore, one of the major challenges facing operators is to ensure that sand build-up can be detected and deposits removed before they become excessive and lead to serious problems. Consequently, installing reliable monitoring technology is essential.

Separators

Separators are used for periodic well testing (as a test separator) or continuous production measurement (as a production separator). Two-, three- and four-phase versions can be deployed – the phases referring to the number of streams that leave the separator. In two-phase devices, the well stream is segregated into gas and liquids, while three-phase separators are used to segregate gas, oil, and water. When well streams also contain sand and other solid particles, four-phase separators incorporate internal devices to collect and dispose of this material.

Figure 1-2. Typical Separator



Operating principle

Separators rely on gravity to segregate the different components of the well stream. After the well stream has entered the device, the gas will quickly separate from the liquid, because its density is far less than that of either oil or water. The segregated gas then exits the separator via an outflow pipe to a gas processing system. Meanwhile, the segregated liquid is routed to the bottom of the vessel, where the oil forms a layer on top of the water because it is less dense. The layer of oil then flows over a weir and into

the separator's oil chamber. The oil and water then flow from different outflow pipes to their respective processing systems.

Protective sand control measures

If the reservoir or type of production application is one which produces sand, deposits will accumulate over time within a lower chamber of the separator. To limit the amount of sand that reaches the separator, operators will typically employ protective sand control measures such as expandable sand screens and gravel packing. However, it is not a straightforward process to implement measures of this kind. The fact that well pads are often geologically different, even if they are relatively close to each other, makes it difficult to predict the level of sand control required. Some wells produce a great deal of sand and some very little. Each well pad may therefore require a different sand control technology, which makes operations more complex.

Even if such protective measures are implemented and are working correctly, a certain amount of sand will still accumulate in the separator over a long period. However, should there be a failure in sand control, this would accelerate the sand build-up in the separator, which could eventually clog the sand drain pot. An excessive amount of sand in the separator encourages the formation of unwanted emulsions between the oil and water, limits the separator's capacity by taking up valuable volume, and leads to a reduction in the oil flow rate. Also, when the build-up of sand in the separator reaches a certain level, it risks being pumped out along with the water. This can then cause devices downstream of the separator - pumps, valves and flow meters, for example - to suffer costly damage through blocking, abrasion or erosion.

Figure 1-3. Before and After

Sand and sediment builds up inside separator tanks and must be cleaned out to maintain capacity and prevent shutdowns.

Should the build-up of sand become excessive and lead to the separator's lower chamber having to be cleaned out manually, this could result in an unplanned shutdown, which would be extremely costly in terms of lost production. Therefore, constant awareness of sand build-up is crucial in enabling sites to schedule separator clean-outs before a problem occurs. Technology that provides reliable monitoring of sand build-up enables separator and production efficiency to be maximized, and helps prevent downstream devices from suffering costly damage.

Sand monitoring technologies

Despite sand build-up having the potential to cause major problems, many operators do not have a regular inspection routine. Therefore, they have little or no insight that sand is building up in separators, which continue to run until a problem occurs. Technology that provides continuous and reliable monitoring of sand accumulation is therefore of significant benefit. Nucleonic technology – in which a gamma source emits radiations towards a detector at the other side of the vessel – has been used for this application. However, this technology has several drawbacks, including radiation hazard, complexity, yearly validation requirements, the necessity to comply with local laws, and the high cost of ownership. Oil and gas operators are therefore keen to find alternative sand monitoring technologies that are not only reliable and safe, but also less complex and costly than nucleonic technology.

Figure 1-4. The Rosemount™ 2140 Vibrating Fork Level Detector

Vibrating fork level detectors

One such alternative is provided by the latest vibrating fork level detectors from Emerson™ Automation Solutions. The unique functionality provided by the Rosemount 2140 Vibrating Fork Level Detector enables the build-up of sand within a separator to be constantly monitored, thereby enabling a clean-out to be scheduled before the deposits become excessive, and avoiding a costly unplanned shutdown.

Vibrating fork switches are traditionally used to monitor air-to-liquid interface (liquid point level), and their operation is based on the concept of a tuning fork. When the two fork tines are immersed into a vessel, an internal piezo-electric crystal oscillates them at their natural frequency, and changes to this frequency are continuously monitored. The frequency will vary depending on the medium in which the tines are immersed – the denser the medium, the lower the frequency will be. This principle also enables the device to be used for monitoring liquid-to-sand interface via a special 'sand switch' function, which makes it an ideal choice for separator applications. Data from the device can be transmitted to a control room, therefore enabling the build-up of sand deposits to be monitored remotely, and avoiding the need for personnel to visit the well pad. This helps to increase worker safety and efficiency.

Configuring the device for sand detection is straightforward. Because sand properties vary across different well pads, there are four sensitivity settings - least, medium, high or most compacted sand. As well as detecting sand build-up, these vibrating fork level detectors can also be used in a control system to automate the chamber's clean-out cycle. This eliminates the need for this process to be performed manually, therefore preventing the need to expose cleaning teams to a potentially hazardous environment.

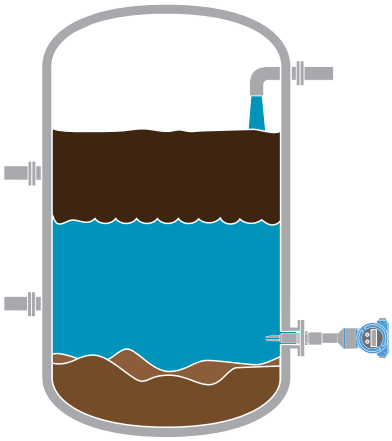
Vibrating fork switches have several other benefits, including being compact, lightweight, and easy to install. The shape of the fork tines makes it less likely for sticky or viscous material to attach itself to these devices and it instead drains away quickly, making it ideal for separator applications. Also, there are no moving parts that can freeze or get stuck, which increases device reliability and makes them virtually maintenance-free. HART® communications can be used to deliver the benefits of advanced smart diagnostics. This provides greater insight into the condition of the device, and supports predictive maintenance practices by identifying any potential problems before they become serious. This includes detection of external damage to the fork tines, internal damage to the sensor, corrosion, and over-temperature. Also, by monitoring frequency, it is possible to detect the gradual build-up of media on the fork tines. Vibrating fork technology has good resistance to light-to-moderate build-up, but growing deposits can lead to an incorrect wet signal if left unchecked, especially if the fork tines become bridged. The ability to monitor media build-up on level instrumentation can be particularly useful in oil and gas production because of the presence of coating materials such as paraffin wax. All diagnostic information can be accessed either directly or from the control room – the latter option eliminating the need for field trips and therefore again increasing worker safety and efficiency.

Case study - effective sediment build-up monitoring

An oil and gas company in Sichuan, China, is using a Rosemount 2140 Vibrating Fork Level Detector to monitor sediment deposits in an oil, gas, and water separator. As part of the company's shale gas extraction process, a four-phase separator provides effective de-sanding of the mixture of oil, gas, and water. The sand level within the separator must be monitored and alarmed to avoid the problems of pipeline corrosion and pump abrasion that can be caused by crude with a high sand content. To achieve this, Emerson's Rosemount 2140 has been installed and is providing reliable detection

of sediment build-up. Qualification was straightforward, with the device meeting material certification requirements for its wetted parts; a necessary requirement since units are installed in H2S-containing environments. Data from the vibrating fork is transmitted via HART communications and used to alarm when sediment deposits reach a critical level. Clean-out can be proactively scheduled, eliminating risk that the deposits will damage the system.

Figure 1-5. Sand Sediment Build-up



Summary

Separators play a fundamental role in the oil and gas production process. Excess build-up of sand within a separator is undesirable, as it can clog the sand drain pot. This limits the separator's capacity and potentially causes devices downstream to be damaged by sand that is pumped out with the water. When the build-up of sand becomes excessive and causes a problem that requires the separator's lower chamber to be cleaned out manually, this can result in a costly unplanned shutdown. Despite this, many operators do not have a regular separator inspection routine. It is therefore crucial to implement technology that constantly and reliably monitors sand build-up, enabling a clean-out procedure to be either performed manually during a scheduled period of downtime, or automated. The latest generation of vibrating fork level detectors feature a unique liquid-to-sand interface option which enables reliable monitoring of build-up, and the ability to optimize or automate clean-out cycles, increasing worker safety and production efficiency.

For more information on the latest generation of Rosemount level monitoring devices, see Emerson.com/Rosemount-Level.

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