The Key to Successful Automation and Improvement of Separation Processes

Simple liquid measurements can improve separator efficiency and protect against metal corrosion while minimizing product loss

'It's best to look for a pH sensor with a microporous junction and a high surface area.' By Dave Joseph

FACTS TO REMEMBER

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Many chemical plants rely on processes that contain two different phases of chemicals that do not mix, such as organics and water, solids and water or gas and liquid. Typically, these components are mixed and react, and then the products are separated by settling in a pond or a vessel called a separator. Separators are used in a variety of industries including the following: &#149 Chemical processing &#151 separation of aqueous and non-aqueous solutions &#149 Alkylation processes &#151 polymer surge drum &#149 Secondary oil production &#151 water recovery &#149 Environmental &#151 recovery of contaminated water

Separators are used to remove accumulated water from oils or solvents such as kerosene.

Petroleum refineries, in particular, process large amounts of crude oil to make gasoline, diesel, heating oil and other products. The processing steps produce water in oil emulsions that are difficult to treat and dispose of. The water produced by a refinery tends to extract the water-soluble components of the crude, including acids, heavy metals, sulfides and salts that can require substantial wastewater treatment prior to discharge. Separator vessels are used to collect the water phase separately from the organic products and to remove solid contaminants from the water phase prior to discharge. Selecting appropriate liquid measurement instrumentation for these vessels optimizes removal of waste products and minimizes product loss. The separator is charged with the mixture, which is allowed to separate into two phases, the aqueous (water-based solution) and the non-aqueous (oil, fuel, organic solvent). Depending upon the density of the non-aqueous component relative to water, the mixture will either float to the top of the water &#151 the usual case &#151 or drop to the bottom. The separated components are simply pumped or allowed to drain from the separator. The separator design may incorporate an open or vented vessel to overflow with the organic phase, while leaving the water phase behind in the vessel. The water slowly accumulates and must be discharged periodically. Although many measurement technologies are able to distinguish between the oil and water phases, electrical conductivity is probably the most cost-effective method for water level control in the separator. The use of conductivity is based on the simple principle that aqueous solutions are good conductors of electricity, while non-aqueous solutions do not appreciably conduct electricity. Thus, a conductivity measurement can be used to signal the presence of the aqueous or non-aqueous phase. As water accumulates in a separator, a conductivity sensor mounted above the vessel outlet can sense the presence of the aqueous phase due to the increase in conductivity. Typically, the conductivity of the "rag" water layer directly adjacent to the organic layer is quite high because impurities tend to collect there. This makes detection of the interface quite easy as the organic layer will not conduct but the "rag" layer will conduct well. Control action can be activated based on the increased conductivity using a simple high alarm contact, and a discharge valve can be opened until the conductivity drops back to near zero. Since non-aqueous solutions, especially oils, can coat the metal electrode surfaces of traditional conductivity sensors, only toroidal conductivity sensors should be used. Toroidal, also called electrode-less or inductive, sensors are resistant to surface coating because they have no metal electrodes in the process solution. It's best to look for a sensor with convenient mounting options for easy maintenance. Mounting a conductivity sensor near the bottom of a separator unit is a common method of monitoring operation. Another form of separator is used to remove solids from oily wastewater prior to discharge. A prime example is the American Petroleum Institute (API) separator, which is used frequently in the treatment of wastewater that has been contaminated by oil and oil-bearing sludge. Separators use the difference in specific gravity to allow heavier liquids to settle below lighter liquids. The lighter liquid is skimmed off, while the heavier liquid remains behind. Wastewater may contain insoluble oil, sludge and some soluble components. Soluble or emulsified oil cannot be removed by settling and requires further treatment.

An API separator removes solids and trace oils from wastewater.

In a typical API separator, wastewater is first collected in a pretreatment section that allows sludge removal. A diffusion barrier slowly lets the wastewater flow down the separator toward the outlet while lighter oil fractions can be skimmed off. Conveyors may be used to remove heavier solids and help separate the lighter oils. Baffle plates are used to prevent oil from escaping into the outlet section. Following this primary step, further treatment processes are used to completely remove entrained oil in all forms, including emulsified oil, and to condition the water to meet the specifications for release into a stream or body of water. Downstream treatment can include chemical flocculation to remove emulsified oil and special processes for the removal of phenols and sulfides. Factors such as oil globule size, specific gravity, temperature and viscosity are involved in separator design and affect downstream water characteristics. Generally, pH is controlled within a chemical plant to minimize corrosion due to acid, meet environmental discharge regulations and optimize chemical reactions that can depend on the concentration of hydrogen ion. Because it can be difficult to measure in streams with high concentrations of oil, it can be hard to control acid levels in these streams. When pH is measured at the discharge from the separator, upstream control allows protection of metal surfaces and enhances the efficiency of secondary waste treatment processes such as flocculation. However, because some emulsified oil may still be present at this stage, the pH sensor can still become coated, resulting in slow response and eventual failure. Obtaining the benefits of an accurate pH measurement may require regular attention by removing and cleaning the sensor or by automating a cleaning regimen using a cleaning nozzle or retraction device. The characteristics of the oily waste itself will determine how often the sensor needs cleaning. It's best to look for a pH sensor with a microporous junction and a high surface area to prevent the formation of a continuous coating on the sensor, thereby preserving the pH signal. A sensor designed specifically for the rugged environment found in refineries and chemical plants will resist damage due to solids and other coating agents. Some sensors also simultaneously measure both glass and reference impedance as diagnostics &#151 a technology that can be used to alert the user to pH glass breakage or the buildup of a coating and help predict maintenance schedules. Dave Joseph is the industry manager for the chemical and pulp and paper industries for the Liquid Division of Emerson Process Management, Rosemount Analytical, 2400 Barranca Pkwy., Irvine, CA 92606. He has a bachelor's degree in chemical engineering from the California Institute of Technology and a master's degree in chemical engineering from UCLA. He has more than 17 years of industrial process and control experience and is a member of AIChE. Questions about this article can be addressed to him at 949-757-8531 or dave.joseph@emersonprocess.com.pipvus the control system or operator to take corrective measures before the pump bearings are overheated and fail. Among the many types of point flow/level switches available are those that offer dual alarm capability. One alarm detects low flow between 0.01 and 3 feet (0.003 and 0.9 meters) per second and can be regarded as a pre-warning signal for the control system or operator, who then can decide to keep the pump running or shut it down. The second alarm occurs when the feed line to the pump is running dry. It is an emergency signal to shut down the pump immediately. In this case, the bearings have gas instead of liquid as a heat transfer medium, causing the temperature of the bearings to rise very quickly. The flow switch prevents permanent damage to the pump\rquote s bearings, but an overhaul of the pump is required to prevent more damage. The flow switch is a dual-function instrument that indicates both flow and temperature or level and temperature sensing in a single device. Available in either insertion or in-line styles for pipe or tube installation, a single switch measures and monitors flow or level and temperature simultaneously.

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