PROCESS INSTRUMENTATION

Safe flow measurement of corrosive chemicals

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The facility that the chemical company was planning to upgrade, manufactured glyphosate at an annual production rate of 20,000 tons. With the expansion, the manufacturer would add another 50,000 tons to the facility's output, making it the largest glyphosate manufacturing facility in Asia. Glyphosate is considered one of the most commonly used chemicals to kill weeds and plants.

Background

One major step in glyphosate manufacturing is to make dimethyl phosphate in which phosphorus trichloride (PCl_3) is used. As part of this process, PCl_3 and methanol are pumped at a set ratio through two separate lines to a reactor where a chemical reaction under vacuum conditions takes place (esterification), leaving behind only dimethyl phosphate.

The quality of the glyphosate product is directly related to the precision of the injection ratio between the PCl_3 and methanol. One major problem with PCl_3, however, is its aggressive nature, making it challenging to control:

- It is highly flammable, generating toxic hydrochloride fumes when burning
- When in contact with air, PCl_3 becomes very corrosive
- In an uncontrolled or poorly controlled environment, PCl_3 crystallizes easily
- It becomes explosive when in contact with water or acid

Due to the chemical properties of PCl_3, it had been difficult to find a flow measurement technology capable of obtaining the desired results in regards to precision and reliability while maintaining the required degree of safety.

Problem

In the past, the Chinese chemical company had been using mechanical rotary piston insertion-type flowmeters whose gears were easily corroded by the chemical.

This would result in crystal build-up with poor or failing meter performance as a consequence. To remedy the situation, the meters had to be frequently removed for cleaning. Due to these problems, it was only possible to control the process manually, which caused much higher raw material consumption compared to what could be obtained by automating the process. Additional issues included fluctuations in product quality.

Although the chemical company had considered using clamp-on ultrasonic flowmeters, which would normally be considered an optimal solution for such an application due to the non-intrusive installation method, only narrow beam meters had been used to conduct tests. The results were not promising, primarily because of the low flow rates of 0.1-0.15 m/s (0.3-0.5 ft/s), small diameter pipes in the DN50 (2 inches) range, and the presence of aeration in the chemical. All of these factors prevented the narrow beam clamp-on ultrasonic flow meters from performing optimally, forcing the tech-nology to be discarded as a viable option.

Solution

For the facility expansion project howev-er, the clamp-on ultrasonic flow mea-surement technology was given a sec-ond chance. Siemens offered to conduct a test that would demonstrate how pre-cise and reliable measurement could be obtained while allowing for the esterification process to be fully automated. The means to achieve this was the SITRANS FS230 clamp-on ultrasonic flow meter.

The dual channel meter was tested for one month under various conditions. With reference flow volumes ranging from 186 to 744 m^3/m (6,570 to 26,275 ft^3), the SITRANS FS230 was able to measure with an accuracy of up to 0.44 percent of flow rate. The customer was very satisfied with the results, especially when considering the low flow rates, small pipes and aeration conditions of the liquid.

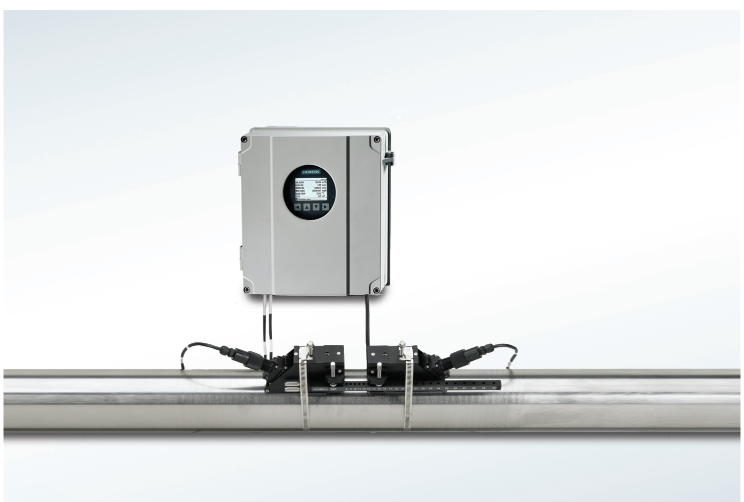
The determining factor was the SITRANS FS230's ability to deliver on the desired parameters through its use of the Wide-Beam transit time technology, in which the pipe wall is used as a wave guide. This optimizes the signal to noise ratio, pro-vides a wider area of vibration than the narrow beam technology and increases precision by reducing sensitivity to changes in the medium.

Accuracy, however, it not the only impor-tant benefit of the SITRANS FS230. With a dual channel flow meter the customer could measure both PCl_3 and methanol using only one flow transmit-ter, ensuring additional benefits. First and foremost, it reduces the total invest-ment at each measurement point be-cause only one meter is needed to mea-sure on two pipes. It also maintains the system's integrity since the same suppli-er's flow meter delivers the complete so-lution. This facilitates the elimination of any errors and increases measurement repeatability and accuracy.

Another benefit of using the SITRANS FS230 is that it could be used to measure the aeration percentage of the chemical. This information was used to identify process conditions in real-time, which aided in the selection of the optimal location – with less aeration – for the flow meter installation. Additionally, the clamp-on ultrasonic could be installed without opening the pipes or stopping the process, eliminating costly manufacturing down-time and subse-quent system re-optimization.

Conclusion

In the glyphosate manufacturing process, a varying ratio of PCl3 and methanol will yield a differing end-product quality. By installing several SITRANS FS230 clamp-on ultrasonic flow meters from Siemens, the Chinese customer was able to improve the accuracy of the raw material injection ratio into the reactor, optimizing the manufacturing process and the product quality while reducing raw material consumption. All in all, the Siemens solution resulted in increased economic return and overall satisfaction.



What makes the wide beam technology so suitable for chemical applications is that the resonant frequency of the pipe wall is utilized to achieve a strong ultrasonic signal. Upon installation, the sensors broadcast signals with varying frequencies with the aim of finding the frequency that best matches the pipe wall. When found, the signal is transmitted into the flowing media with the wall of the pipe acting as a waveguide.

This method allows for a low transmit voltage of approximately +/- 15 volts and produces a focused, coherent signal that covers a large axial area. It makes wide beam much more resilient to aeration and suspended solids that may exist in the fluid.

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