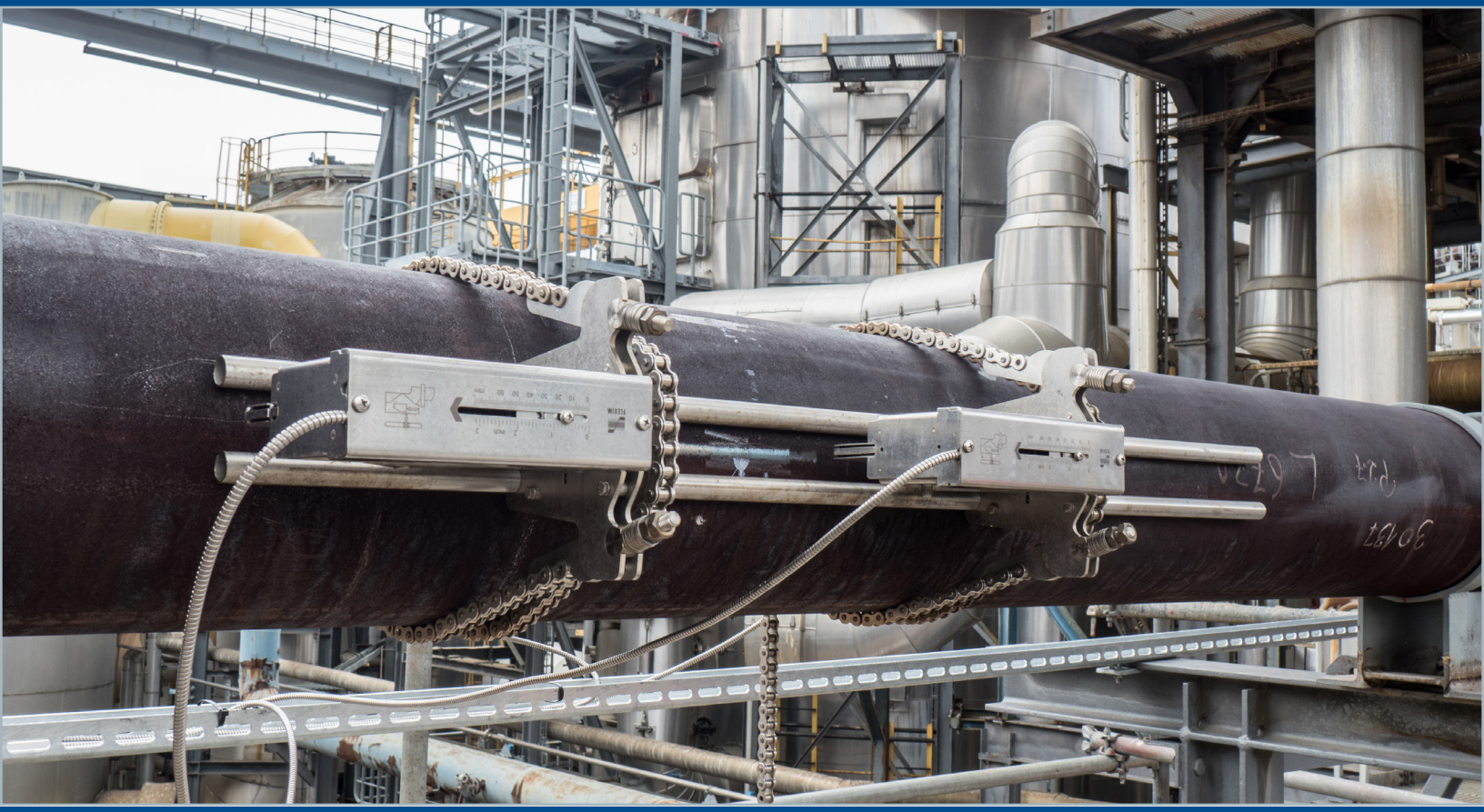
APPLICATION REPORT

STEAM MEASUREMENT AT A SULPHURIC ACID PLANT



“Non-intrusive ultrasonic measurement proves to be particularly advantageous for us in the long term:any maintenance work or calibrations can now take place during ongoing operation and do not reduce the productivity of the system.”

Peter Ankert,
Process Control Technology,
SO2 / SO3-Cluster, BASF SE.

Measuring Task

Flow measurement of steam at over 300 °C at BASF’s sulphuric acid plant in Ludwigshafen for billing when it is fed into the interconnected network

As one of the most important chemical raw materials, sulphuric acid is used in a wide variety of areas and applications by the chemical industry. Today, the industrial production of sulphuric acid takes place everywhere using the contact process that was developed at BASF in Ludwigshafen at the end of the 19th century. The starting material is elemental sulphur, which reacts through combustion to form sulphur dioxide, which is passed over catalysts as hot gas and oxidised to sulphur trioxide. This is then absorbed into sulphuric acid, where it reacts with added water to form more sulphuric acid.

The production process of sulphuric acid is exothermic. In the individual reaction stages, considerable amounts of energy are released at different temperature levels. The heat released must be dissipated in a controlled manner.

BASF’s SO2 / SO3 plant at the Ludwigshafen site has heat recovery systems in which the reaction heat is used to generate steam. The energy from sulphur combustion and contact group is used to generate superheated

steam at a pressure of approximately 50 bar. The heat generated in the acid absorption units is also recovered. It is used to produce low-pressure steam.

The steam generated is fed into the network. The sulphuric acid plant bills the network operator for the quantities of steam produced and delivered. Therefore the quantities must be measured.

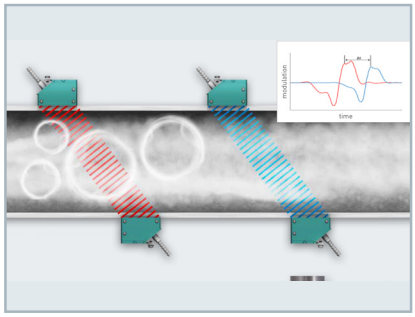
Solution

The conventional instrumentation for this measuring task consists of differential pressure measurements. Measuring orifices were also installed in the transfer lines at the sulfuric acid plant to bill the steam quantities. The traditional technology has proven itself in countless applications of this type, but has a crucial disadvantage: any maintenance work or mandatory calibrations require the line to be opened therefore affecting the availability of the system. In addition, the primary elements the differential pressure measurements cause a pressure loss and thus reduce energy efficiency.

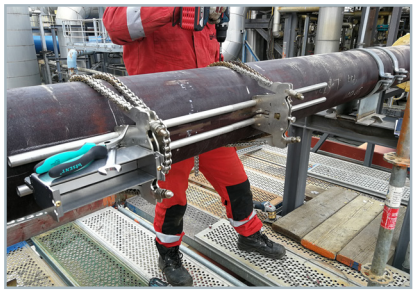
BASF's SO2 / SO3 cluster in Ludwigshafen has had good experiences with FLEXIM's non-invasive measurement technology for decades, especially for measuring particularly challenging media: For example, FLEXIM's clamp-on FLUXUS® ultrasonic flowmeters measure liquid sulfur at around 265 °F in the inlet of the sulfuric acid plant as well as highly concentrated sulfuric acid when it is filled onto tankers. PIOX® S measuring systems are used at various points for non-invasive measurement of flow and concentration of sulfuric acid. As a field sales engineer responsible for supplying Germany's southwest with clamp-on measurement technology made in Berlin, Joachim Cwienk was asked regularly: "What about steam?" For a long time, Joachim Cwienk had to answer: "Unfortunately, we can't measure steam yet." Not yet.

For a number of reasons, steam represented something of the last remaining challenge to non-invasive clamp-on ultrasonic measurement technology. FLEXIM's research and development department has successfully met the challenge with persistence and perseverance. Since 2020, FLEXIM has been supplying the FLUXUS® ST clamp-on ultrasonic systems, the world's only non-invasive flowmeters for steam. Strictly speaking, there are two complementary measuring systems that FLEXIM has developed for steam measurement: FLUXUS® ST-LT measures steam up to a temperature of 360 °F and, like the other flowmeters in the FLUXUS® series, works according to the transit time difference method. For higher temperatures, FLEXIM has developed the FLUXUS® ST-HT superheated steam flowmeter. FLUXUS® ST-HT measures using the cross-correlation method: Two pairs of ultrasonic transducers are mounted on the pipe at a defined distance from each other, thus forming two acoustic measuring barriers.
The ultrasonic signals radiated into the pipe are modulated by the vortices of the turbulently flowing fluid. Since the vortices are carried by the flow, they pass through the two measuring barriers with a time delay. By cross-correlating the modulation signals over time, FLUXUS® ST-HT determines the flow velocity of the steam and calculates the mass flow based on the measuring point geometry and the physical parameters.BASF

Joachim Cwienk, Flexim sales engineer in the field, reading out measurement data from one of the steam test measurements



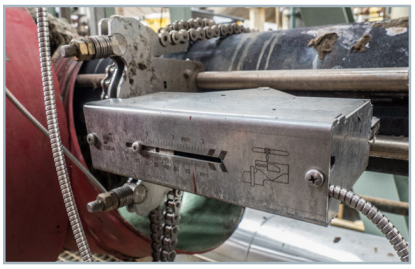
Schematic diagram of non-intrusiveflow measurement using the cross-correlation method.



Installation of WaveInjector® high-temperature transducer mounting devices on the hot pipe.

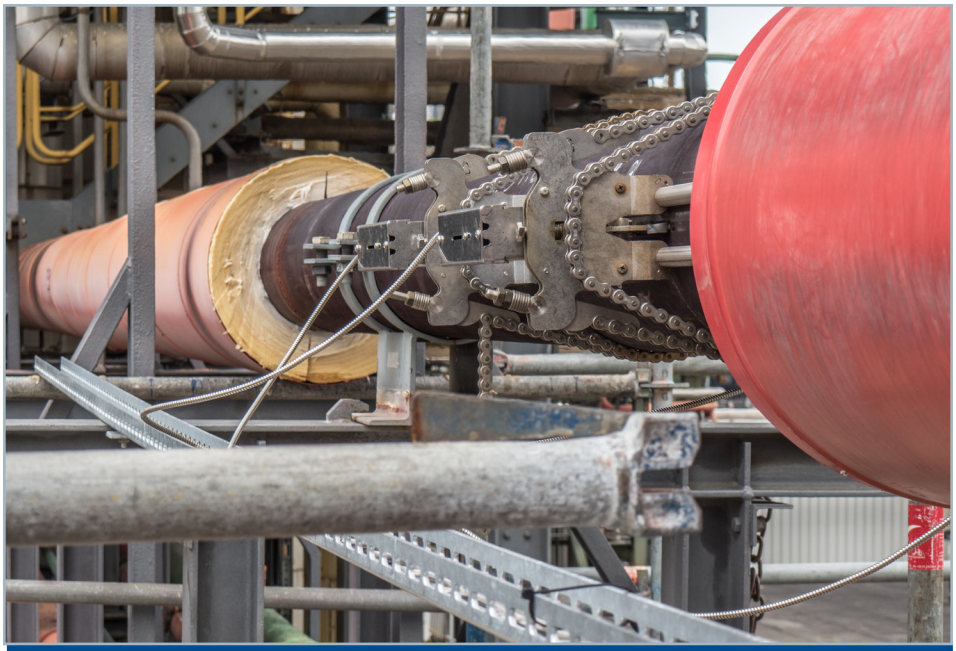
in Ludwigshafen was happy to try out the new measurement technology. A major advantage of non-invasive measurement using clamp-on ultrasonic technology is that it can be tested extensively without ever affecting normal system operation. So a long-term test was initially agreed. Because of the high temperatures of over 570 °F, the ultrasonic transducers were mounted on the patented WaveInjector® transducer attachment device. The WaveInjector® thermally separates the transducers from the hot pipe, but at the same time ensures the best acoustic contact.

During the test phase, the new measuring technology demonstrated its reliability and, in comparison with the installed measuring orifices, its accuracy. BASF has long since acquired the ultrasonic measuring systems and the measuring orifices will be uninstalled the next time the system is shut down



The patented WaveInjector® thermally separates the ultrasonic transducers from the hot pipe and at the same time provides best acoustic contact.

The stationary FLUXUS® G722 ST-HT ultrasonic systems are used as measuring transducers.



Measuring Points and Instrumentation

Pipelines	steel 10“ and 8“, pipe wall thickness 0.3“
Medium	superheated live steam, temperature ~ 570 °F – 750 °F, pressure ~ 725 psi

1 stationary clamp-on ultrasonic flowmeter FLUXUS® G722 ST-HT for superheated steam
2 pairs of clamp-on GDK1N52 ultrasonic transducers
2 pairs of high-temperature WaveInjector® transducer attachment devices

Advantages

- Reliable and accurate steam quantity measurement from the outside
- Installation, possible maintenance and, if necessary, recalibration without any disruption to normal system operation
- No pressure loss and therefore no energy loss
- No pressure equipment directive testing required

For more information, visit
Emerson.com/Flexim

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