Overflash Mass Flow Measurement at 380°C using Ultrasonic Clamp-On Technology

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In petrochemical refineries, a multitude of measuring instruments monitor material transport and conversion. Flow measurement of the Overflash volume, an important indicator for well adjusted and efficient distillation column operation, presents a special challenge. In BP's Emsland Oil Refinery, Lingen, Germany, the amount of HVGO Overflash volume is measured non-intrusively by the Ultrasonic clamp-on flow meter FLUXUS in conjunction with the high temperature WaveInjector mounting fixture.

The many processes running in a refinery form a highly complex system of material and energy flows which can only be managed by means of a dense network of measuring points continuously recording all relevant parameters. In days of rising costs for energy and resources, applied measurement and control technology also has to ensure the collection of data relevant for a continuous improvement of the plants processes. Global competition makes it increasingly important to recognise and utilise all potentials for minimising the required energy and maximising the yield. In the area of crude oil distillation, an important indicator for an efficient column operation is the so called Overflash volume. The properties of the medium – heavy and highly viscous gasoil – as well as the underlying process conditions - low flow velocities and high temperatures of around 380 °C - care for a difficult measurement environment.

The BP Oil Refinery Emsland processes around 4.4 million tonnes of crude oil annually. Most of it is delivered through the north-west oil pipeline coming from oil shipments delivered to the harbour of Wilhelmshaven. But crude oil is not always equal. Its composition, and thus the percentages of light and heavy hydrocarbons it contains, varies depending on its origin. To still care for the highest possible yield of desired products , the refineries process control has to respond with a high degree of flexibility towards these changing conditions. The amount of Overflash volume within the atmospheric distillation is a crucial indicator for a well adjusted and efficient column operation.

Difficult measurement

Usually, refinery plants almost exclusively rely on orifice flow meters due to the high temperatures involved. In Lingen, the Overflash volume is conveyed in a 6" pipe located on the outside of the distillation column. Just by gravitational force, the Overflash volume flows one section downwards back into the column. Flow measurement using the differential pressure method experiences a particular difficulty in measuring the very low flows of 10 t/h (being equivalent to a flow velocity of 0.15 m/s given the small diameter of the Overflash return line) in a satisfactory precision. For a differential pressure measurement to achieve a satisfactory accuracy, the orifice plate inserted has to have a very small diameter. This accordingly results in a significant pressure loss which cannot be compensated with the available hydrostatic height of the Overflash line.

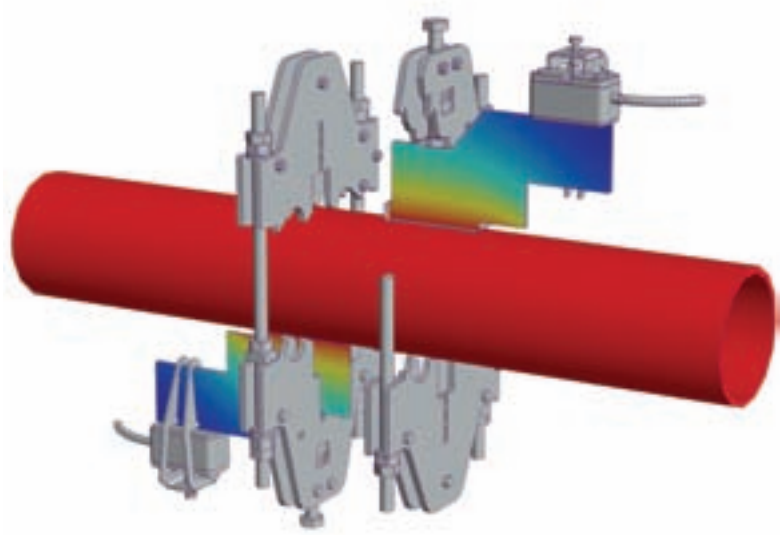
After a test measurement had demonstrated the suitability of FLEXIM's non-intrusive ultrasonic technology for this application, the Berlin based specialist for clamp-on ultrasonic flow measurement installed a FLUXUS® flow meter in conjunction with the high temperature WaveInjector® mounting fixture. FLUXUS® employs the transit time difference principle to measure the volume flow. Since the physical conditions at the measuring point are virtually constant, the flow meter easily calculates the mass flow based on the density curves saved in its internal database and then feeds the data into the process control system, which uses them for various automised process control tasks.

High temperature flow measurement with the WaveInjector®

FLEXIM's patened WaveInjector® extends the possible application range of non-intrusive ultrasonic flow measurement to temperatures up to 400°C and beyond. Its functional principle is of convincing simplicity: The patented system consists of two coupling plates, each connecting a transducer with the pipe, yet keeping both of them a certain distance apart. The surface of these

plates radiates enough heat to keep the temperature at the mounting point of the transducers within the permissible range. Simultaneously, the coupling plates ensure the needed acoustical contact between pipe and transducer. The mechanically robust mounting fixture maintains a high contact pressure. Specially designed metal foils ensure optimal contact and long-term stability.

The WaveInjector® is available in various sizes, each covering different pipe diameter ranges. As the WaveInjector® is a purely mechanical arrangement, it can, in conjunction with the ATEX Zone 1 and FM certified transducers, be used in hazardous areas. It is not required to cut into any pipes to install the transducers - especially for a retrofit of a plant it is the ideal solution as no process shut-downs or complicated approval procedures are needed. The other advantages of FLEXIM's clamp-on flow measurement – such as not being dependent on pressure or media, no wear caused by the medium, the high turndown ration – still apply.



System and process optimisation

The oil refinery in Lingen, which started operation in 1953, was one of the industrial motors behind the economic development of the previously backward Emsland region. With around 600 employees and 75 apprentices, it is one of the most important employers in the region. However,

compared to other national plants, and in particular to international ones, it is rather small. This makes it even more important for the people of the Emsland to optimally use the available capacity. Their success is visible in the figures: In 2007, BP Oil Refinery Emsland achieved a plant availability of 98%, the capacity utilisation amounted to 90%. Especially as far as plant availability is concerned, the ideal solution would be using non-intrusive measuring methods. The measuring unit for determining the overflash volume was installed without interrupting the production process. The measuring point is located in a potentially explosive atmosphere. Thus the explosion-protected FLUXUS® ADM 8027 is used as transmitter.

In addition to unlimited availability of the system components and full utilisation of their capacity, the optimisation of systems and processes is becoming increasingly important. In Lingen, a software for advanced process control has been implemented for this purpose. It varies the process parameters based on mathematical models and the data from the process control system, and optimises the process using iterative learning. An important measuring value for this purpose is provided by the high-temperature ultrasonic flow measurement at the Overflash return line. As reliable data is now available in regard to the quantities that return through the line, standing in distinct relation to the types of crude oil and the way the column is being run, the process can now be optimised to achieve more energy efficiency and yield.

For hot and cold

Ultrasonic flow measurement is a well proven alternative to conventional measuring methods. The WaveInjector® opens up new areas of application for non-invasive clamp-on technology - areas in which reliable and exact flow measurement with a high dynamic range was difficult, if not impossible, until now. Determining the overflash quantities in the distillation of crude oil is only one example. Petrochemical processes typically involve high temperatures and highly viscous media. In this area, non-invasive measurement with the WaveInjector® is very popular, e.g. for flow measurements on tar or bitumen.

The WaveInjector® principle of thermal decoupling is equally effective on the other side of the temperature scale, i.e. for flow measurements at very low temperatures. The WaveInjector® is for example used to measure the flow of coolants in cooling systems, or cryogenic gases. The current boom of demand for liquefied natural gas – LNG – opens up further potential for this innovative measuring technology.