

FH8300 Ultrasonic Flowmeter for Leak Detection System

Background

In 2007, construction began on a new manifold piping system for a Major Oil Company in the Eastern part of Kuwait. The manifold system connected 14 pipelines arriving from different areas throughout the country into a blending system that mixed the oil and then selectively transferred it to two major tank farms (North and South) through 8 large pipelines (4 to each tank farm). The system relied on the pressure generated at the drill head – there are no pumping or lifting stations anywhere to provide increased pressure to the oil process flow so overall system pressure drops had to be minimal resulting in large pipeline sizes and low flow velocities.



Application

A major Engineering, Procurement and Construction (EPC) vendor out of South Korea was selected to provide the design and installation of the system. As part of the design requirements, flow measurement on both the incoming lines to the manifold and the outgoing lines to the 2 tank farms were included. In total, 22 ultrasonic flow meters ranging in size from 10" to 48" were required. In each case, the ability to measure varying types of incoming crude of varying densities and viscosities accurately, with repeatability and with a minimum of pressure loss was required. Some of the installations required reducers installed in front of and after the flow meters to ensure optimum measurement velocities were achieved without pressure loss.

Challenges

The installation required no pumps or methods of increasing line pressure. All 14 incoming lines feed into a manifold where mixing occurs and then depending on requirements, flow is diverted to either the north or south tank farm. Key challenges included :

1. NACE certification
2. Accurate Low flow measurement
3. High ambient temperatures
4. Large line size meters
5. Sand/Wind proof enclosures

The chosen supplier would have to meet all these requirements plus other "normal" start up issues and provide accurate flow measurement of the process flow rates. Faure Herman (La Ferté Bernard, France) was selected as the primary supplier of flow meters for the project. Faure Herman has over 80 years experience in petroleum product flow measurement. The company has supplied ultrasonic liquid flow measurement products to most of the key petroleum companies throughout the world. In order to meet the challenging requirements of the installation, a new 48" meter design was required, a cost effective solution for the NACE requirement would have to be devised and an innovative approach to cooling the electronics in an environment where ambient temperatures could hit 60deg C had to be implemented.

The Solution

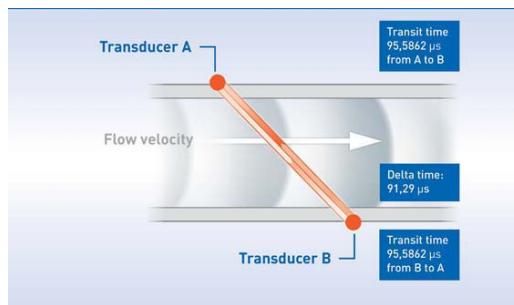
1. NACE compatibility

The engineers at Faure Herman relied on 15 years of experience designing, manufacturing and installing ultrasonic flow meters to develop and manufacture the products used in this installation. In order to address the NACE issue, the internal wetted surfaces of standard meters manufactured of carbon steel were coated with Inconel 625 to ensure that they held up in the corrosive environment.

This created challenges because the meter calibrations were done prior to the coating process. The coating process added wall thickness to the units so a calibration offset had to be calculated to compensate for this reduction in cross sectional area and ensure accuracy/performance of the meter.

2. Low Flow rates

Most ultrasonic flow meters require a minimum flow velocity to perform accurately. Ultrasonic meters rely on the difference between the transit time of an ultrasonic beam across the flow stream in the direction of flow and against the flow. The average flow velocity of the medium in the pipe is proportional to the difference in time taken for the beam to cross with the flow minus the time taken to cross against the flow.



As the flow velocity decreases, the difference between the time taken for an ultrasonic pulse to travel from A to B versus the return trip from B to A becomes so small that it is difficult to measure accurately. Given that there were very tight restrictions in the pressure drops allowed at the measuring points, engineers at Faure Herman had to maximize the performance of the meters under low flow conditions without compromising the overall performance range of the units.

3. High Ambient Temperatures

The meters were to be installed in an environment where the ambient temperatures could be expected to reach over 55C. In order to ensure reliable and continuous operation of the flow meters, special design considerations had to be given to the electronics and how to keep them cool enough to enable accurate and repeatable functioning. A special housing was designed to ensure that the internal temperatures of the electronics housings were maintained at recommended levels for the components used. The housing was designed to shield the electronics from direct sunlight while still allowing air to circulate around the enclosure.

4. Large Line Size Meters

The specification called out several large (48”) diameter meters. These meters presented a challenge, not only due to the weight and requirements to machine, manufacture and support them but also due to the requirement for calibration. There are no facilities in the world set up to handle flow rates and capacities for line sizes that large using hydrocarbons. A decision was made to calibrate the units at Delft in the Netherlands using water and then calculate the necessary offsets in the electronics to ensure that the meters measured the oil flows accurately and precisely.



5. Sand/Wind Proof Enclosures

A special double stainless steel enclosure was required to ensure that sand did not penetrate the electronics housing during high wind/sand storm conditions. Although the meters were installed below grade weather conditions required that special consideration be given to the electronics housings. The engineering team designed a special double stainless steel housing to ensure the integrity of the electronics during severe weather and to make sure that no dust/sand contaminated the system.



The overall manufacturing, calibration, installation and commissioning proceeded without a hitch and the system was installed and commissioned in late 2009. During the commissioning process, one of the meters did not perform correctly and provided erroneous flow rate readings that were not consistent with the process. Using the advanced diagnostic functions available in the FH8300, the engineers were able to determine that the reason for the error was not due to a faulty meter but due to water that had settled in the pipe. The meter had actually been installed in a low spot in the pipeline and entrained water had settled out of the oil and ended up in the lower third of the meter. Due to the flow conditions (flow velocities are extremely low $<.5\text{m/s}$), the water was not being moved out of the pipeline and continued to build up in that area. A drain valve would be required to remove excess water in the area.

The installation and commissioning of the meters was scheduled and completed without any technical difficulties.

The calibrations were performed at Faure Herman (10" to 16" meters) and Delphit (20: to 48" meters) and based on the performance balancing (incoming meter measurements vs outgoing meter measurements) the system achieved the operational accuracy requirements of the customer.

Overall, the new manifold and distribution system installation was a success for Faure Herman, the EPC and the customer.