



# Viscosity-compensated flowmeter improves existing leak detection system

Shortly after the completion of an African pipeline project, its operator decided to upgrade the system by installing additional flow monitoring equipment at two pump stations. The intent was to improve the efficiency of the existing leak detection system by supplementing it with very accurate and repeatable flow readings. The solution was to install an SITRANS FUH1010 viscosity and density-compensated flowmeter from Siemens, providing standard volume and mass measurement for the leak detection system.

The pipeline project, which involved several African countries, included crude oil extraction and production as well as transportation from central Africa to the Atlantic coast through a new pipeline. The project, which was expected to produce 225,000 barrels of oil per day during peak production, was managed by a joint venture between several international oil companies.

## Background

The pipeline project was divided into two major phases. Phase one aimed at developing a field system, which included drilling of some 300 oil wells and erection of associated facilities. Phase two entailed the construction of a 670-mile (1078 km.) 30" (DN 760) pipeline from the oil fields to the loading facilities at the Atlantic coast. Three pumping stations, auxiliary facilities and infrastructure improvements complete the system.

Additional facilities comprise an onshore pressure-reducing station connecting the onshore

pipeline with a subsea pipeline, in which the crude oil is transported to a Floating Storage and Offloading vessel (FSO) located seven miles (eleven km) offshore. From here the crude oil is loaded onto export tankers.

In order to protect the pipeline from damage or sabotage, the entire pipeline is buried below ground. Extra thick pipe walls have been installed at river and road crossing locations and concrete coating has been used in wetlands and at river crossings for additional safety.

Along the pipeline, 48 block valve stations and three pump stations are installed to control the oil flow. The valves are used to isolate parts of the pipeline when maintenance is needed or in case of a rupture or a leak. 16 of these block valves are connected to the pipeline's telecommunication and Supervisory Control And Data Acquisition (SCADA) monitoring system, allowing them to be remotely controlled. This enables instant shut down of a particular

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pipeline section or sections in case of an emergency.

Rather than letting the pumps and generators at pump stations number two and three run on electricity, a portion of crude oil is extracted from the pipeline, refined on-site and used as fuel. Leftover crude oil and naphtha residue from the refining process are returned to the pipeline immediately downstream of the pump stations.

#### The problem

To monitor the entire operation, the operator installed flowmeters on crucial locations along the pipeline. These included the inlet station, pump station one, the pressure-reducing station, the inlet manifold of the FSO and the crude oil take-off lines. As part of a pipeline upgrade project, it was decided to install additional flowmeters at pump stations two and three. Overall, this would allow for better monitoring of the entire pipeline but also supply the existing leak detection system with valuable flow information. In the project description, the pipeline operator specified the need for highly accurate and repeatable flow instruments with a better than 0.5% accuracy.

#### The solution

Siemens won the project with the installation of the SITRANS FUH1010 viscosity-compensated four beam

flowmeters at pump stations two and three. The customer viewed this solution as ideal for several reasons:

Since fluctuating temperature and pressure conditions have an effect on a liquid's viscosity, the Reynolds number that the flowmeter calculates to compute the flow profile compensation, will also be affected. The result is a negative impact on the flow measurement accuracy as well as the pipeline balance. The SITRANS FUH1010 works around this by automatically compensating for such changes.

The input options provided by the SITRANS FUH1010 were an additional positive feature. Since pump stations two and three were already equipped with pressure and temperature transmitters, these were connected to the flowmeter via the 4-20 mA current inputs. This enabled automatic compensation for viscosity changes caused by fluctuating temperature and pressure conditions that have an impact on accuracy.

The SITRANS FUH1010 can also calculate the coefficient of thermal expansion of the pipe. With a length of more than 670 miles (1078 km) the pipeline runs through regions with varying climates and temperatures. These temperature differences make the pipeline expand and contract, affecting the inner diameter of the pipe. Knowing the inner diameter, is a

very important factor in clamp-on ultrasonic flow measurement so if this value is off by only a fraction of an inch compared to what has been entered into the flowmeter, the accuracy will be greatly affected. With the SITRANS FUH1010, however, this can be easily eliminated.

As with any clamp-on flowmeter from Siemens, it is not necessary to cut the pipe or shut down operations to install the SITRANS FUH1010; the transducers are installed on the outside of the pipe, eliminating pressure drops, minimizing maintenance expenses and preventing deposits from forming.

The latter is a particularly important benefit in crude oil pipelines where paraffin wax build-up is very common. To remove this build-up, periodical pigging is required. Since clamp-on transducers are mounted on the outside of the pipe the pig can easily clean the entire pipe. In addition, there is no clogging of the sensors, which could result in meter malfunction as is the case in wetted sensor systems.

Although the upgrade project entailed a challenging installation, the complete package of compensatory features of the SITRANS FUH1010 combined with the added valve and pump monitoring abilities, offered a solution that both enhanced the overall operation of the pipeline as well as the existing leak detection system.

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