Oil Terminal Improves Efficiency with High-Capacity Flowmeter

Production of crude oil in the U.S. is expected to increase dramatically, putting pressure on terminals, tank farms and pipeline distribution facilities. Coriolis flowmeters can handle the increased flow.

By Mark Thomas, Endress+Hauser

According to the U.S. Energy Administration (EIA), the U.S. has passed Russia as the world's biggest producer of crude oil[1]. Due to this increased production, pipeline bottlenecks in Texas and New Mexico are causing increased use of trucks and rail cars to haul oil, leading to potential transport problems.

The massive increase in crude oil production is also causing problems at tank farms, pipeline distribution facilities and even oil terminals (Figure 1). This is because, in addition to the increased production in the U.S., the country still imports a large amount of crude. According to the American Geosciences Institute[2], the U.S. imports 10.4 million barrels of petroleum per day, with the largest amounts coming from Canada (42%) and Saudi Arabia (8%).

One of the main issues at oil terminals, tank farms and pipeline distribution facilities is restrictions in flow caused by conventional flowmeters. In this article, we'll describe how Coriolis flowmeters are better able to handle flows through larger pipes, and how a new oil terminal is using the flowmeters—but first, let's look at the crude oil problem.

Domestic Crude Production

The EIA says that the Permian Basin in West Texas and southeastern New Mexico will double production by 2023[3]. Current production already exceeds pipeline capacity, so several pipeline projects are underway.

The Eagle Ford shale formation in Texas is another huge source of crude. According to the latest report from the U.S. Geological Survey (USGS)[4], the land sits on billions of barrels of untapped oil and natural gas. The USGS estimates these shale fields contain approximately 8.5 billion barrels of oil, 66 trillion cubic feet of natural gas, and 1.9 billion barrels of natural gas liquids.

Figure 1: Oil terminals are processing millions of barrels per day, putting pressure on flowmeters.

In 2018, the USGS[5] recently announced the Wolfcamp and Bonespring formations in West Texas and New Mexico hold the most potential oil and gas resources ever assessed, more than twice as much as previously reported. The Permian and Delaware basins account for roughly a third of all U.S. crude oil production in the U.S. Estimates are now in the range of 46.3 billion barrels of oil, 281 trillion cubic feet of natural gas, and 20 billion barrels of natural gas liquids.

The International Energy Agency[6] said U.S. production of crude oil, condensates, and natural gas liquids will rise to 17 million barrels a day by 2023, up from 13.2 million in 2017. The rising U.S. production means the U.S. may soon become energy self-sufficient, a huge shift from the era not so long ago when the U.S. was the world's largest oil importer.

Someday the U.S. may even be a net crude exporter, something that has not happened in 75 years.

Crude oil imports have remained at 10 million barrels per day since 2015, but instead of importing much of the crude from OPEC countries, the U.S. is importing more from Canada via pipelines, railroad cars and tanker trucks, most of which is bound for Gulf Coast refineries.

The challenge to oil terminals, tank farms and pipelines is they are handling 2.5 MMBPD of crude today, but this will increase to 4.0 MMBPD by 2022. This will require more capacity at all facilities. And one bottleneck for all this increased capacity is the ability of flowmeters to handle the increased flow.

Flowmeter Challenges

Mechanical meters with rotating vanes or gears have been the workhorse of the pipeline flow metering business for decades. Such meters are large, heavy, must have upstream dirt filters, wear out expensive rotating parts, require regular maintenance, don't work with gas, and are not "smart" instruments. Accuracy of such devices is usually around 0.25%.

Figure 2: Promass X Coriolis flowmeter.

All mechanical meters share common limitations:

- Maintenance due to moving parts and other issues
- Reliable with lubricating and clean fluids
- Sensitive to changes in process parameters
- High installation cost

Regular maintenance is required on mechanical meters to replace worn or damaged parts. Parts, such as bearings, must be lubricated, inspected or replaced on a regular basis to ensure the accuracy and performance. Other parts—such as pistons, gears, and turbine blades—must also be checked for damage and replaced over time.

Maintenance is often overlooked on initial investment, but this cost is often the most expensive in the life cycle of a mechanical meter as maintenance requires extensive downtime and constant replacement of sometimes expensive parts. Mechanical meters are also sensitive to changes in process parameters such as temperature, pressure and viscosity. These parameters can affect the accuracy, performance and life of a meter.

More and more terminals are looking for compact flowmeters that can fit in tight areas, are easy to repair and maintain and provide exceptional accuracy, while also looking at multiple parameters and advanced diagnostics features. To address these issues, oil terminals and other midstream facilities are turning to Coriolis flowmeters, as in the following example.

New Oil Terminal Chooses Coriolis

A new large oil terminal located in the Gulf region receives crude oil from the Gulf of Mexico and distributes it to five local refineries via pipelines. The terminal is able to accommodate multiple oil tankers at a time at its numerous unloading piers. It needed reliable and repeatable flowmeters that would work with a wide turndown range and could handle increased flow capacities from 24-inch pipelines. Endress+Hauser and its partners met with the terminal operator and management to discuss options for these high capacity flowmeters. Promass X Coriolis flowmeters were recommended due to their ability to meet high capacity crude oil flow rates, maintain a low pressure drop and remain accurate with a wide turndown ratio.

The two companies started working with a local engineering firm to design unloading skids. The skids were to be installed at the shore end of the piers in an area at low sea level with soft soil, so weight minimization was important. The more weight, the more concrete was necessary for the foundation. By reducing size and weight, the need for additional support structures could be reduced.

The Promass X is a lightweight large capacity mass flowmeter (Figure 2), which helped reduce the skid's weight. It was determined that if each Coriolis meter was installed in a horizontal position with its underside facing up, a departure

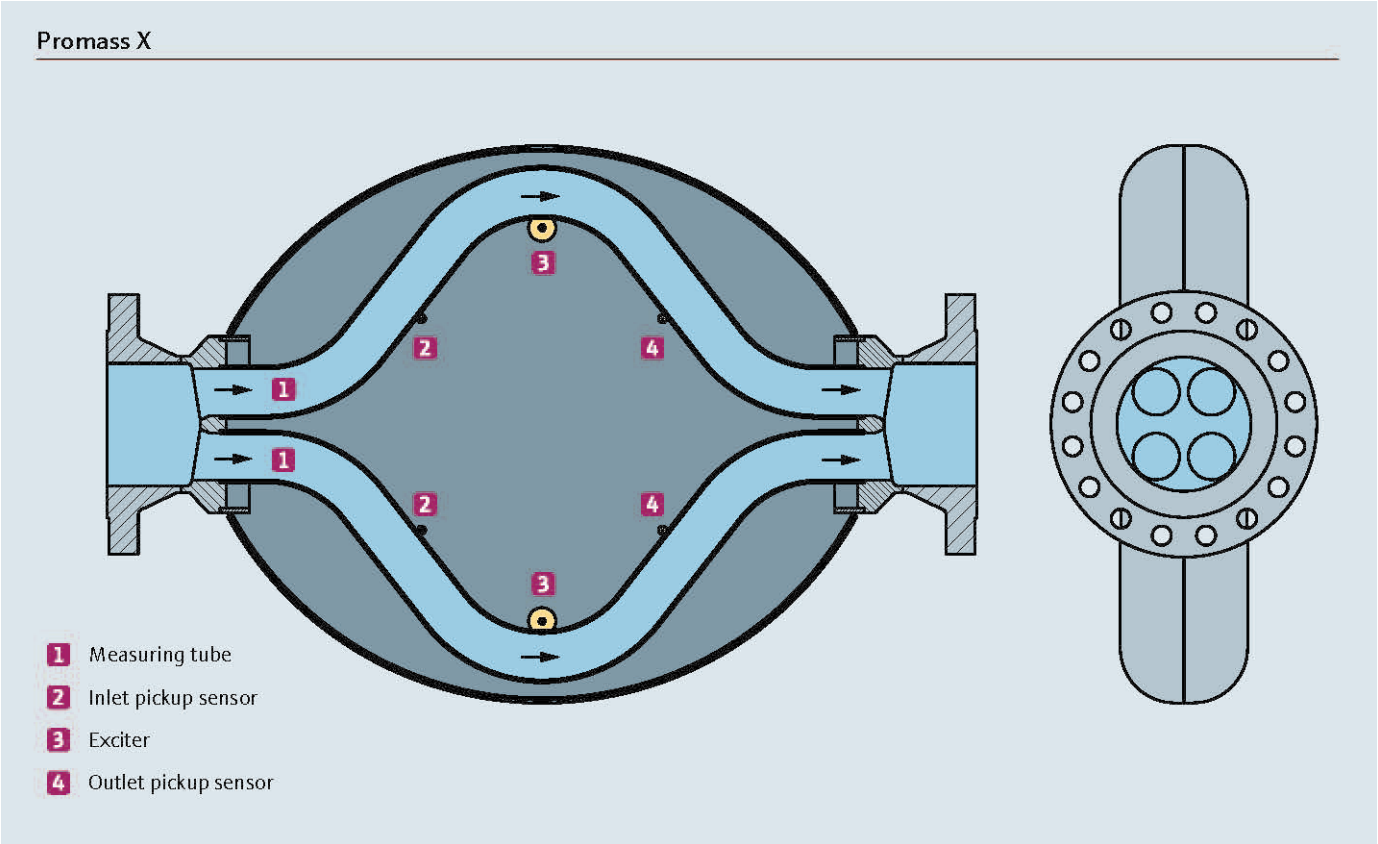

Figure 3: By using four small tubes instead of two large tubes, a four-tube Coriolis meter is lighter and smaller, making it easier to fit on skids.

from the normal vertical mounting, it would reduce the size of the skid by almost 50%.

The project called for ten 12-inch Coriolis flowmeters mounted on five skids to handle crude oil being unloaded from tankers.

By using the Coriolis flowmeters, the customer was able to confidently move and distribute crude oil at high rates, while decreasing the size and weight of the metering skids. The five skids and 10 Coriolis flowmeters are able to handle a total of 167,000 barrels of oil per hour. With the Coriolis meters being used in this high capacity crude application, the terminal can reliably and accurately track the crude entering the facility, as well as allocate oil to local refineries.

Four-Tube Coriolis Flowmeters

The capacity of a Coriolis flowmeter can be increased by making the measuring tubes larger, but larger measurement tubes result in bulky Coriolis devices which can be demanding to install due to the weight and required space. Instead of upscaling an existing two-tube Coriolis design to achieve a higher capacity, Endress+Hauser uses a patented four-tube design. Instead of two large measuring tubes, the Promass X uses four smaller tubes (Figure 3).

By doing so, 68% of the cross-sectional area of the pipe can be used, allowing a more compact design than a two-tube system. Four-tube Coriolis meters are now available in sizes up to 16-inch with a capacity of 720,000 bbl/day and accuracy of 0.05% with repeatability of 0.025%.

Advantages of a four-tube Coriolis flowmeter over mechanical meters include:

- Measurement is independent of density, viscosity and flow profile
- Provides both volume and mass flow rate
- Typically handles higher temperature and pressure
- Better turndown
- No regular maintenance required
- No upstream piping
- Best basic accuracy of any oil field meter
- Patented Reynolds number corrections
- Measurement of density and other fluid quality parameters
- Advanced diagnostics, process monitoring and built-in verification

With these advantages in mind, four-tube Coriolis flowmeters are the measurement technology of choice in midstream oil and gas and other demanding applications.

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WP01113A/24/EN/01.19

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