

# Clamp-on meter provides unique interface detection and flow solution

An internationally oriented oil company operating a Malaysian oil terminal relied on a SITRANS FUH1010 clamp-on ultrasonic flowmeter from Siemens to measure the extremely narrow density difference as well as the flow between two types of unleaded gasoline transported from vessels to land-based storage tanks through a state-of-the-art oil pipeline. The application was considered so unique that one of the only ultrasonic flowmeters capable of handling both interface detection and flow measurement in one unit was manufactured by Siemens.

Being that most oil companies are global players in exploration, production, manufacturing, marketing and transportation of oil and natural gas, they know that process optimization and performance is key. So when an international oil company decided to complement an existing pipeline located at an onshore oil terminal in Malaysia with a new one, it was done with one primary object in mind; to enhance the overall operations efficiency of its storage and distribution facility.

## Background

The 10 mile (16 kilometer) long existing pipeline with an outer diameter of 10" (DN 250) carried three types of refined gasoline with varying specific gravities (S.G.) from vessels to land-based storage tanks:

1. Unleaded gasoline 92 Ron (S.G. 0.729 – 0.7451 kg/cm<sup>3</sup>)

2. Unleaded gasoline 97 Ron (S.G. 0.730 – 0.7762 kg/cm<sup>3</sup>)
3. Automotive diesel (S.G. 0.850 – 0.870 kg/cm<sup>3</sup>)

With only one pipeline to transport the three oil products, the terminal operators had to constantly shift between one oil product, a water displacement interface, another oil product and so forth. At the receiving station, the transmix was discharged into a slop oil system for later treatment while the different oil products were channeled into designated storage tanks.

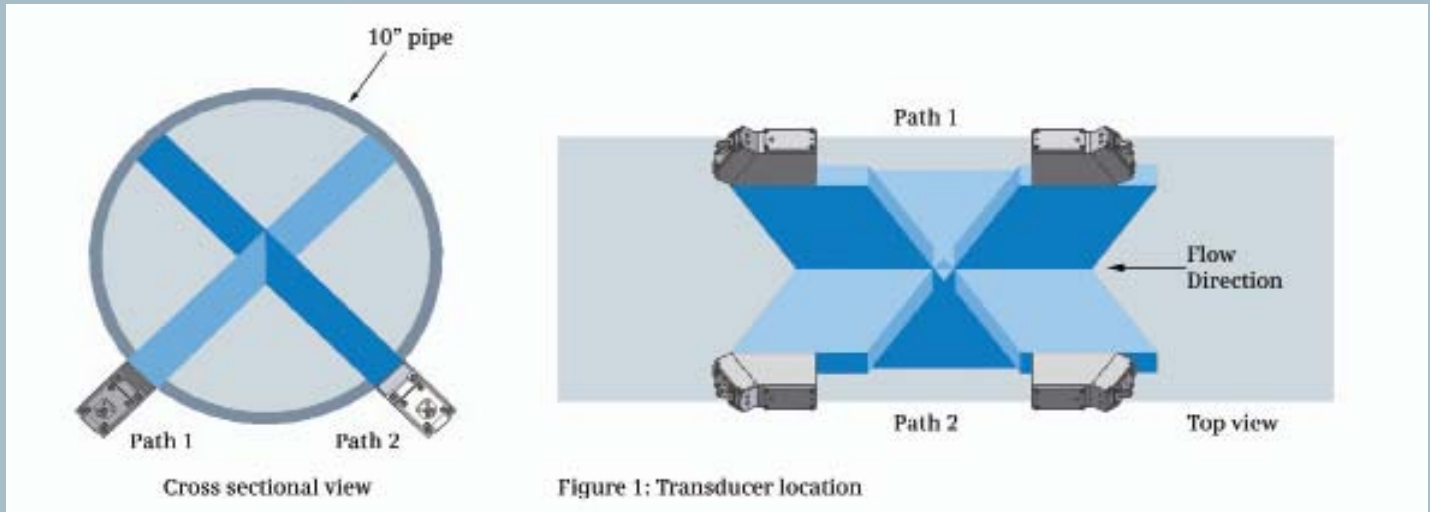
Using such a method has several drawbacks: In order to avoid unnecessary waste, it is first of all required to have a slop oil treatment system for the transmix. Such a system is not only costly it is also characterized by low performance caused by the product separation process which is very time-



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consuming. Secondly, although the water displacement method is very common, it can potentially impact the quality of the gasoline if it is unintentionally mixed with some of the transmix.

To enhance the product quality as well as the overall operations efficiency, the oil company therefore decided to install a new 10" (DN 250) product pipeline to complement the existing line. They wanted to dedicate one pipeline to the automotive diesel while using the other for the two grades of unleaded gasoline. At the same time it was also decided to receive the two grades of unleaded gasoline using the direct displacement method instead of the water displacement method. Making this possible, however, was a big challenge.

### The problem

When using the direct displacement method, equipment is needed that can analyze the density (or specific gravity) of the various oil products running through the pipeline. Since density varies from liquid to liquid it can be used for accurate and reliable liquid identification and hence, interface detection. What made this installation particularly challenging, though, was that the specific gravity spread between the two types of gasoline was extremely small, and in some instances, even overlapping. For this reason, the oil terminal operator had two basic requirements for the measurement equipment to be installed on the pipeline:

- It had to be extremely sensitive and be able to conduct detection of both grades of gasoline without using water or pig displacement.
- It had to be able to measure flow, enabling the terminal operators to precisely determine the amount of gasoline going into each of the storage tanks compared to what was being offloaded from the vessels and to predict when the interface arrives.

### The solution

During the pre-stage planning of the project, several solutions were considered including more traditional ones such as the use of a densitometer or a Coriolis mass flowmeter. These methods detect the interface through measurement of the difference in the density of the gasoline. However, due to the narrow density difference and overlapping of the two gasoline grades Ron 92 and 97, these solutions were not considered precise enough.

Instead, the clamp-on ultrasonic SITRANS FUH1010 multi-function flowmeter from Siemens featuring interface as well as flow measurement capabilities was chosen. Rather than relying solemnly on the liquid density to effectively distinguish between Ron 92 and Ron 97, the FUH1010 flowmeter uses a combination of sonic velocity, rate of change in sonic velocity, temperature as

well as density. This approach is much more sensitive than using a densitometer because the density of the different products flowing through a pipeline is calculated by measuring the liquident (the sonic velocity at standard conditions). Since a liquid's liquident can be compared to a human being's unique finger print, it provides an extremely accurate way to distinguish products that have even very close densities.

The liquident is determined by looking at the liquid's temperature, its sonic velocity and its liquident slope (the sonic velocity of hydrocarbon liquids change linearly with temperature so the linear rate of change is referred to as the liquident slope). Since changes in a liquid's temperature effects its sonic velocity it is imperative that a direct displacement interface detector has an accurate temperature gauge.

This is of particular importance with a system measuring liquids with a narrow density difference, as was the case with the two grades of gasoline that needed to be transported via the new pipeline. As a result, the FUH1010 was mounted with extremely accurate insert resistance temperature detectors (RTDs). As opposed to the clamp-on RTDs, which would have been sufficient if the pipeline had carried only one type of gasoline and several other product types with a wider difference in density or sonic velocity, the

insert temperature sensors are in direct contact with the media.

By taking the temperature changes, the sonic velocity and the liquid into account, the SITRANS FUH1010 was set to identify a rate of change (ROC) in the liquid over 13 feet (4 meters) for every 15 seconds. This means that if the measured liquid changes over 13 feet during a 15 second period, the meter interprets this change as an interface resulting in the meter's relay to energize. The relay sends a signal to the electrical valve that channels the particular gasoline grade directly into the respective product tanks at the receiving station, prompting it to either open or close. Even though the various liquids in the pipe have overlapping densities, as was the case in the Malaysian pipeline, the SITRANS FUH1010 is still able to detect the ROC in liquid, making it a very powerful interface detection meter. In fact, this capability was the main reason for why the SITRANS FUH1010 was chosen over a traditional densitometer.

This Malaysian pipeline with this direct displacement system using the SITRANS FUH1010 has been running for more than 6 years, and the oil company owners as well as the terminal operators have been very satisfied with its consistent and accurate performance. It has greatly enhanced the overall operation of the storage and distribution facility and saved substantial costs in water displacement treatment.

### The product

In terms of interface detection, Siemens has two types of products to offer. One is the independent single or dual beam SITRANS FUH1010 dedicated for interface

detection only. The other meter, which was the one chosen for the new pipeline in Malaysia, is the dual beam SITRANS FUH1010 multiple function flowmeter with both interface and standard volume or mass flow measurement capabilities. This meter has several features that were deemed crucial by the oil company:

- The dual beam version of the FUH1010 was suggested by the Siemens engineers mainly because two pairs of transducers increase the flow measurement accuracy by improving the flow profile averaging. In addition, it can also measure temperature, density and viscosity compensation, making it a perfect choice for flow measurement as well as interface detection using the direct displacement method.
- The FUH1010 can be equipped with either clamp-on or insert resistance temperature detectors (RTDs). For the Malaysian pipeline the 1000 ohm platinum RTD was preferred due to the requirement for high accuracy temperature measurement.
- The RTDs of the FUH1010 are directly connected to the flow transmitter eliminating the need for a separate temperature transmitter.
- The FUH1010 offers the ability to modify the rate of change anytime to fit application conditions, product types and pipeline distances. So if it at some point is necessary to transport an oil product with a different liquid through the pipeline, the meter can easily be adjusted to accommodate these changes.



The SITRANS FUH1010 transducers can be installed in two ways:

- In direct mount the transducers are positioned on opposite sides of the pipe. This position is sufficient and also recommended for pure interface detection.
- For flow measurement, however, reflect mount where the transducers are mounted on the same side of the pipe is recommended.

Reflect transducer mounting method also increases the flow sample area and sends the ultrasonic signals through the liquid twice through the use of only one pair of transducers. In addition, it also enables the meter to compensate for cross flow conditions (see figure 1).

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