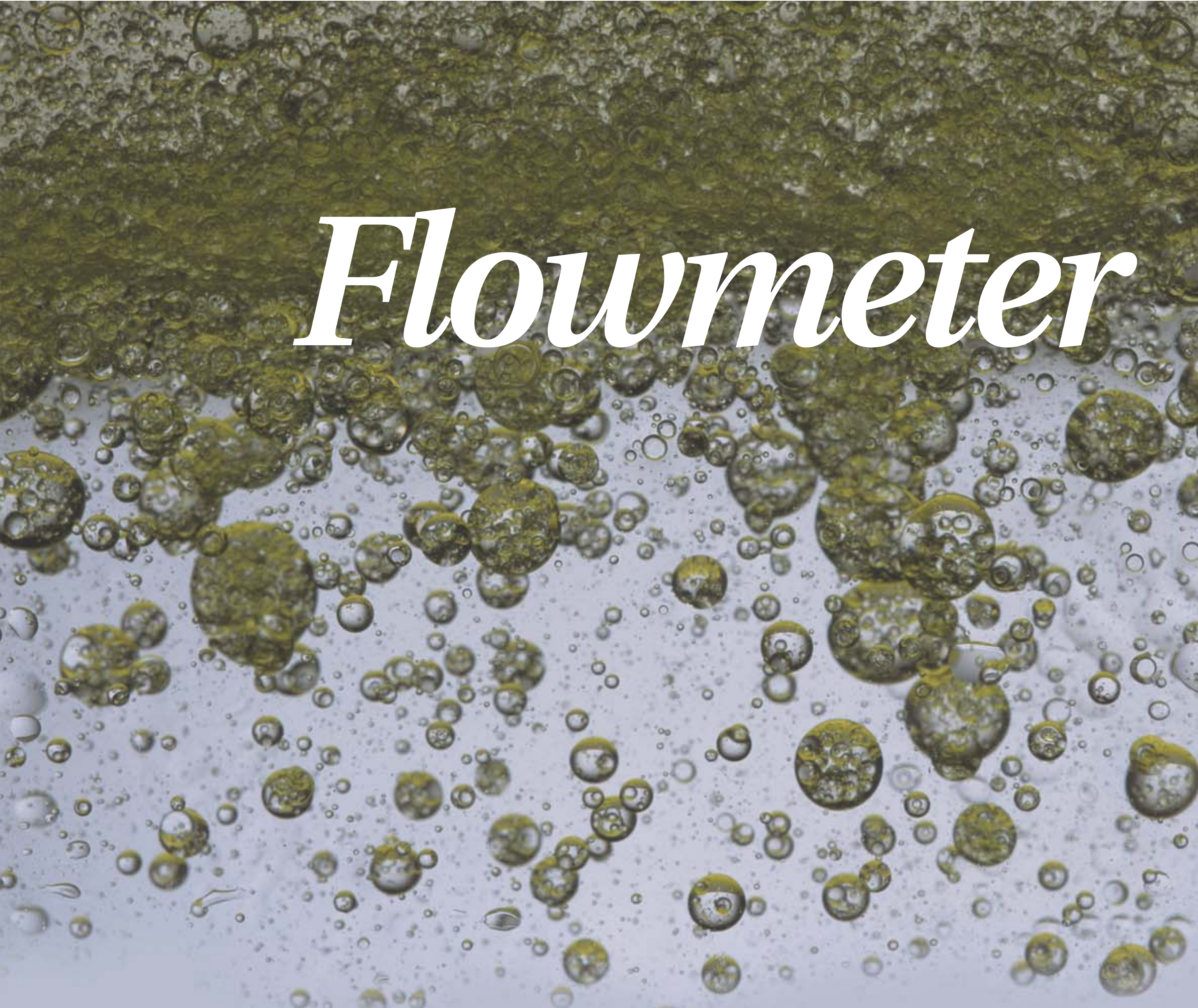


Flowmeter

By Donald Dunn and Michael Klein

Surprisingly, Coriolis metering technology detects oil-water interface with extraordinary precision. However, can the capabilities of Coriolis surprise anyone anymore?

sleuth

The water has got to go! In petrochemical plants and refineries, there is typically water in the unprocessed hydrocarbons. It is imperative to remove this water—the earlier the better.

The longer the water stays in the system, the more problems it will cause, from higher maintenance costs to shortened catalyst life and process rework. It is therefore common practice to try to remove the water quite early in the process.

Normally, we let the hydrocarbons rest in a tank for a time so the hydrocarbons float to the top of the tank and the water sinks to the bottom. Then we decant the water out of the tank and flush it out to the API separator or waste treatment facility.

The decanting process is more difficult than it sounds. A valve needs to open to let the water drain out. At the right moment, the valve must shut again so valuable hydrocarbons are not

FAST FORWARD

- Using a Coriolis meter to detect the interface by means of changes in fluid density is about 1,000 times more accurate than traditional level systems.
- By installing a Coriolis meter inline, underneath the tank, engineering can detect the interface reliably even when there is a rag layer present.
- Density measurement is an area where these Coriolis meters shine.

flushed away with wastewater.

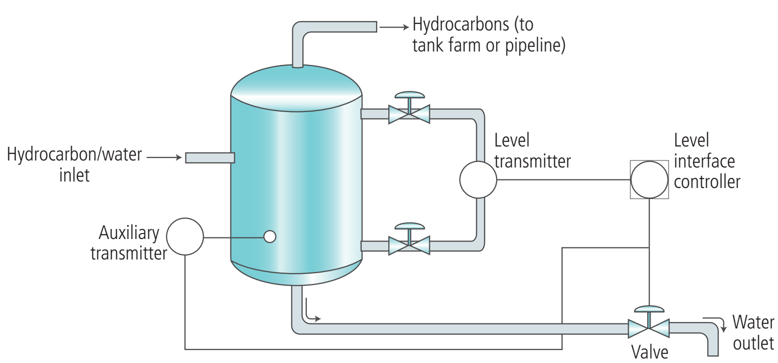
Detecting that change—from water to hydrocarbons—can be a tricky business. The detection of the interface can be further complicated when there is a rag layer (an emulsion between two liquids).

The traditional method of decanting the water out of a tank employs level metering technology (e.g., float, ultrasonic, optical, microwave) to open and close the valve. The tank contents, after a period of time, separate, the valve opens, and as the level instrumentation detects the interface layer between the water and the hydrocarbons, it closes the valve.

Between the main level sensor and the auxiliary sensor, it is possible to detect the interface with a certain degree of accuracy. As soon as detection of the interface happens, a signal transmits to close the wastewater valve.

There are a few nagging problems with this approach. For one, there is enough uncertainty about the measurement that the system may often let hydrocarbons escape down the drain. The possibility of this happening is much greater when a rag layer is present, because many level systems will miss the rag layer completely and only “realize” the problem after spilling a lot of valuable material. Not only is this wasteful, it is problematic from an environmental standpoint as well, as the waste treatment facility can get overloaded.

Oil-water separation mechanism



In many parts of the world, environmental regulations are much tighter than they were in years past. It is not uncommon for government environmental protection agencies to levy severe, non-negotiable fines against companies whose waste is excessively polluting.

Using a Coriolis meter to detect the interface by means of changes in fluid density is about 1,000 times more accurate than traditional level systems.

The accuracy of the measurement devices used to shut off the drain valve therefore has a direct relationship to fines incurred and, consequently, profitability. Most level systems, which have an uncertainty of between 0.5% and 2.0%, are no longer sensitive enough to ensure compliance with local environmental laws.

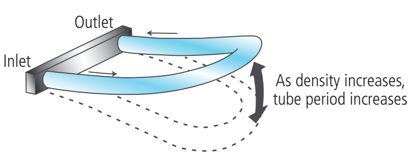
Compensating in the other direction by retaining excess water in the tank does not really help, from a plant profitability perspective. Any water that remains in the system must leave the process eventually, so the problem merely pushes further into the refinement process, where it can be much more expensive to resolve.

Density decline is the time

An alternate way to sense the interface between hydrocarbons and water is to measure the density of the fluid at any point. When the density drops, you have found the interface. One of the reasons engineering has not used the method is the difficulty of obtaining a timely, accurate density measurement.

Density measurement is an area where these Coriolis meters shine. A Coriolis meter works by oscillating a flow tube rapidly. By measuring the time it takes to complete one oscillation (the “tube period”), it is possible to determine the accuracy of a fluid’s density with great precision. In fact, the density measurement is determined directly—the meter does not infer the density from other measurements.

The physics

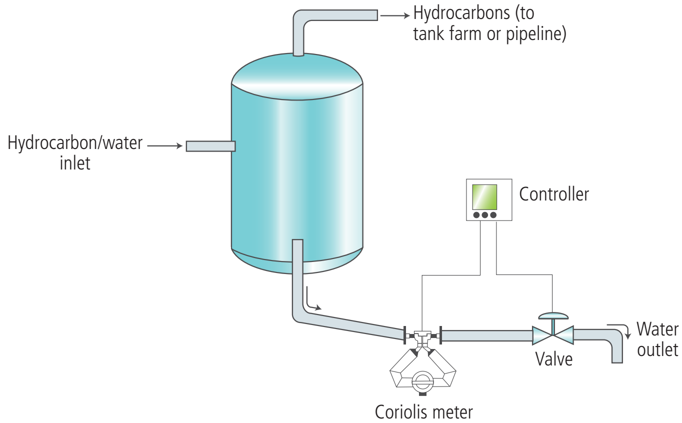


The Coriolis effect causes the tube through which the fluid passes to vibrate.

By installing a Coriolis meter in-line, underneath the tank, we can detect the interface reliably even when there is a rag layer present. The wastewater passes directly through the meter. As soon as the tube begins oscillating more quickly, that is the interface. Immediately a signal can transmit shutting off the valve. Since the oscillations happen in the range of tens of thousands per second, it does not take more than an instant to sense the change in fluid density.

The drainpipe coming from the bottom of the tank should angle slightly downward so the fluid that reaches the meter contains the least possible quantity of hydrocarbons. By

Meter the waste pipe



placing the sensing element directly in the waste pipe, we can keep the maximum amount of hydrocarbons in the tank and the maximum amount of water out of the tank.

Using a Coriolis meter to detect the interface by means of changes in fluid density is about 1,000 times more accurate than traditional level systems. These Coriolis meters have accuracies as precise as a few ten-thousandths of a gram per cubic centimeter.

That kind of precision can go a long way toward ensuring compliance with environmental rules. Even in terms of direct profitability, it is a great benefit: Valuable material is no longer wasting away down the drain, and water removal problems are not carrying over to and entering the refining system.

In fact, this sort of measurement system can deliver such accuracy, responsiveness, and reliability, that unexpected benefits appear, like freeing up operator time for other tasks, thereby increasing overall plant efficiency.

The flow-measurement capabilities of the meter are also of use, of course. The exact amount of water the system decants from the tank is available information, and this can be an important to operations and planning.

ABOUT THE AUTHORS

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Terminology

Decant: To draw off the upper layer of liquid after the heaviest material (a solid or another liquid) has settled

Emulsion: The suspension of one liquid as minute globules in another liquid as, oil dispersed in water

Coriolis effect is an effect whereby a body moving in a rotating frame of reference experiences the Coriolis force acting perpendicular to the direction of motion and to the axis of rotation. On Earth, the Coriolis effect deflects moving bodies to the right in the northern hemisphere and to the left in the southern hemisphere. The Coriolis effect or Coriolis force is a manifestation of inertia that Gaspard-Gustave Coriolis, a French scientist, first described in full in 1835.

RESOURCES

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