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INTERFACE DETECTION IN LIQUID PIPELINES

Class #8065

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The basic concept of interface detection is simple: detect and direct the flow of different fluids, or batches, through pipelines. The implementation, however, can be very complicated. The goal of interface detection is to time the switching or cut of the product in such a way that delivers the maximum quantity of product to customers without downgrading the quality of the product. Inaccurate interface detection leads to an increase in both downgraded product delivery and transmix, which requires storage and additional refining. Both significantly cut into the profit margins on delivered product.

Historically interface detection was facilitated by batching fuels of dissimilar densities against each other in the pipeline. The interface could then be detected using time-based displacement with manual sampling, or density measurements from metering stations and/or add-on sensors.

Time-based displacement requires an educated guess on interface arrival times at switching locations and then manual sampling and/or observation to make the cut. This process depends upon highly dissimilar batching and plentiful man-hours. To ensure the proper quality of delivered materials, operators must cut or switch generously on either side of the interface, creating unnecessary waste and expenses.

A far more common methodology utilizes densitometers. Most metering stations contain an existing densitometer. Measured shifts in product gravity from metering station densitometers combined with flow rate data can be used to make switching decisions downstream. In addition to metering stations, they can be installed on analyzer loops to be used specifically for interface detection.

The most accurate densitometer technology is the vibrating straight tube. In a vibrating straight tube, fluid is passed through or around an oscillating tube. Variations from the calibrated oscillation rate are isolated to the fluid's effect on the vibration rate. This effect is a property of the density of the fluid, meaning that variations in vibration correspond to variations in density that can then be calculated accordingly.

Where Densitometers Fail

Today's specialty fuels such as ULSD, often feature minute differences in density, creating difficulties for interface detection by conventional means. In addition, fluids may be dyed to indicate ownership. In such a case, two batches of diesel might differ in color, but have exactly the same density and be undetectable by conventional means.

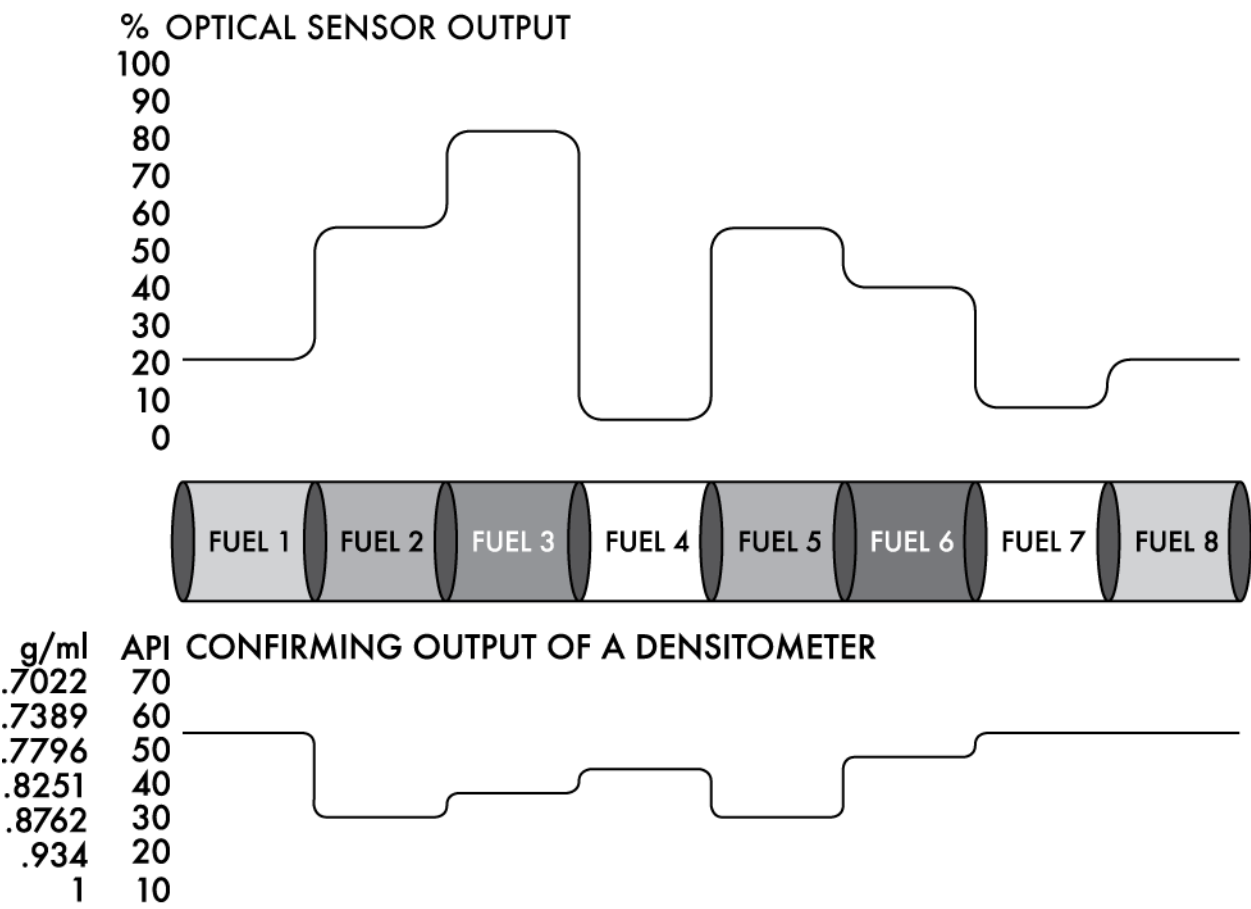
Much like densitometers, ultrasonic wafers measure the speed of sound through fluid. They accurately detect fluids with disparate densities, but require insertion between two flanges, making pigging the pipeline nearly impossible and requiring draining the pipe for installation.

Newer technologies such as optics provide opportunities for more accurate interface detection for all fuels, including specialty and dyed fuels. Optics (refractive index measurement) relies upon the ability of the fluid to absorb light rather than the fluid's density. Typically, these sensors use fiber optic technology to emit light into the fluid. Different fluids will absorb light in different ways. The unabsorbed light is captured in a return fiber optic loop and measured, creating an optical signature for each fluid. Optical sensors are highly sensitive and respond almost immediately to fluid changes. They can be inserted into the main line or on an analyzer loop.

The most sophisticated optical technology for interface detection is colorimetry. Colorimeters are able to detect shifts in color for identical fuels, such as dyed versus clear diesel or dyed batching of refined fuels. They can be used for highly sensitive quality control, such as with jet fuels, in addition to interface detection. Colorimeters emit

multiple lights of different colors into the fluid and, like other optical meters, measure the absorption of each signal. The signals are combined to provide an accurate color for the fluid and can be output on a linear scale or on many industry standard color scales such as ASTM 1500, Saybolt, or Platinum-Cobalt.

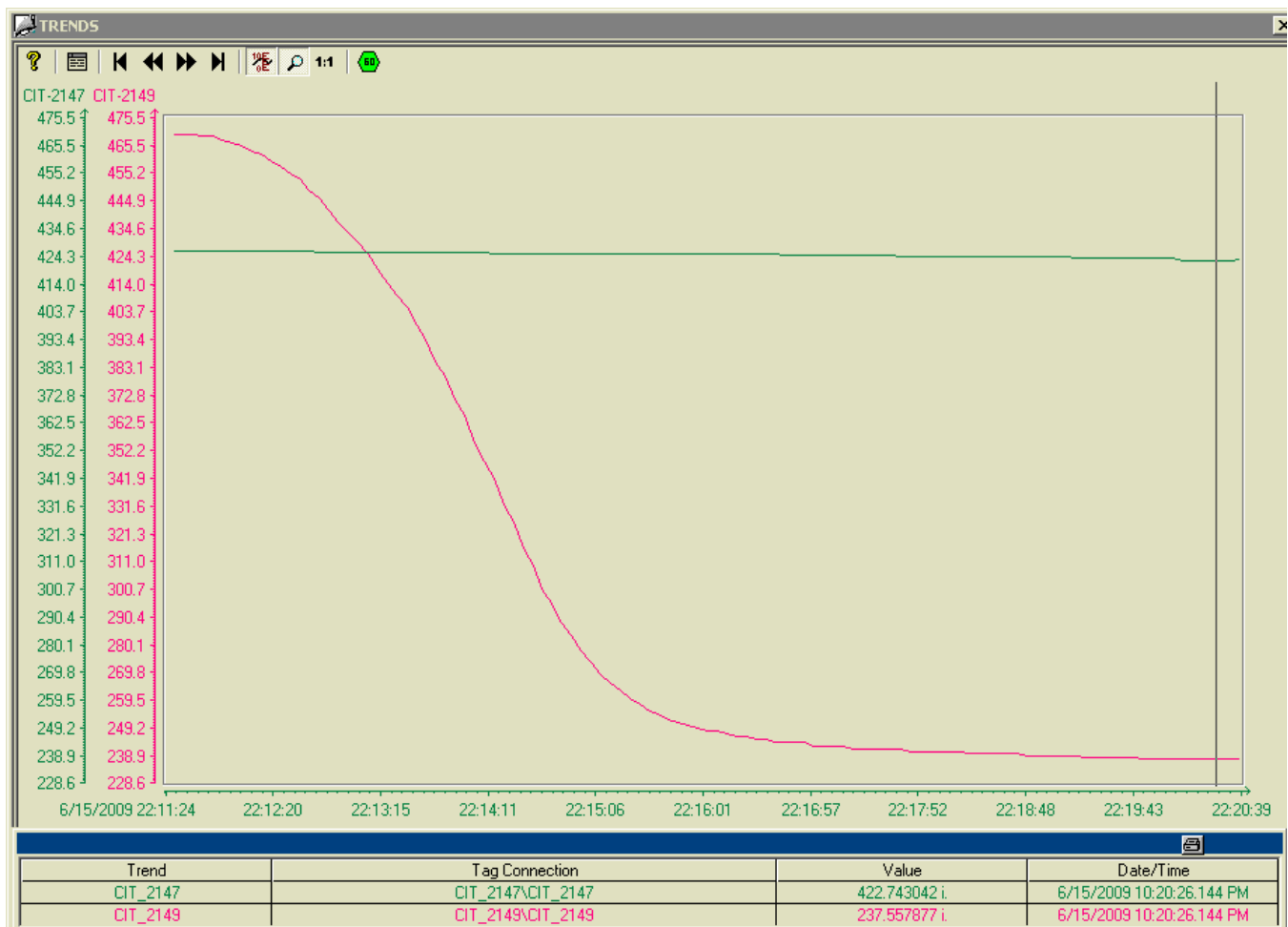
Optical vs. Densitomer



Optical vs. Colorimeter

NAME OF GASOLINE	Colorimeter						Optical Interface Detector			
	SAYBOLT #	ASTM #	HAZE #	X #	Y #	Z #	VDC	mA	Logarithmic Percent Output	Linear Mode Percent Output
#1 DIESEL	1.8	0.5	106.37	95.88	98.7	83.18	1.5520 VDC	17.945 mA	87.2%	77.6%
#2 DIESEL	6.6	0.5	104.97	97.1	99.7	88.54	1.8144 VDC	19.251 mA	95.3%	90.7%
84A	8.5	0.5	99.71	96.96	98.95	88.94	0.4317 VDC	11.805 mA	48.8%	21.6%
84B	9.5	0.5	78.44	95.58	97.09	87.68	0.3834 VDC	11.436 mA	46.5%	19.2%
87A	7.1	0.5	88.79	94.59	96.14	84.88	0.3398 VDC	11.110 mA	44.4%	17.0%
87B	15.1	0.5	99.12	97.43	98.64	92.9	0.1690 VDC	9.081 mA	31.8%	8.5%
PREMIUM	18.7	0.5	90.1	97.84	99.37	97.02	0.0992 VDC	7.803 mA	23.8%	5.0%

A Colorimeter Used in Interface Detection of Dyed Fuels



Which Technology Should You Use?

The determination as to which technology is appropriate for a specific installation depends on a number of factors. These include:

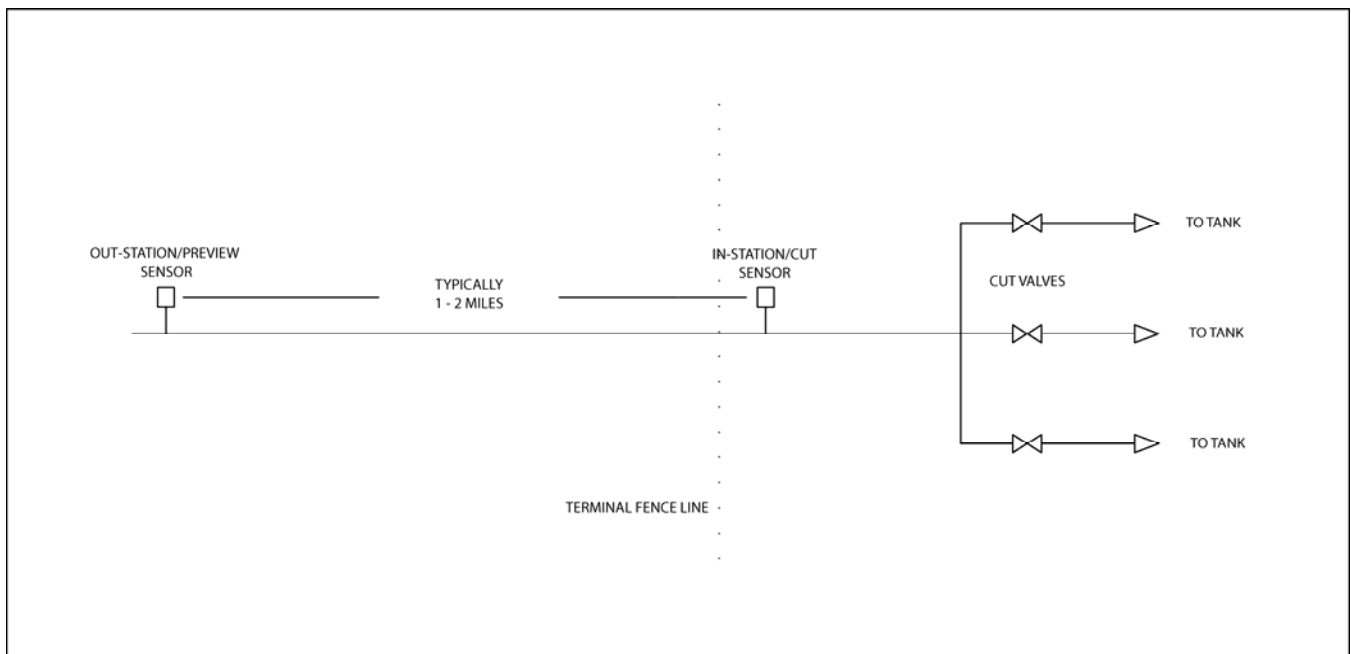
- Initial cost
- Maintenance costs including man-hours
- Systems already in place such as densitometers at metering stations
- Types of fuels in the pipeline
- Training required to implement the technology
- Ability to automate interface detection
- Installation availability, i.e., mainline, analyzer loop, flanges, taps, etc.
- Ability to pig the line without sensor removal

Multiple sensor installations

With the minute differentiations in many of today's specialty fuels, many pipeline operators install multiple sensors to ensure product quality and accurate, timely switching. Having an additional set of eyes in the pipe reduces errors caused by erroneous data, inaccurate readings or operator error.

One of the best ways to do this is with by combining an interface detection sensor (optic or density) with a quality control sensor such as a colorimeter. Colorimeters work similarly to optic sensors, but use multiple fiber optic cables to emit different colors of light into the fluid. Just as with an optic sensor, the changes to the various colors of light are recorded and converted to electronic signals, which can be combined and formulated into a color standard matching various industry scales. Highly accurate, colorimeters can detect extremely small shifts in interface, product quality, or dyed fluids.

Operators may also choose to install multiple sensors of the same type at different locations in the pipeline. By installing a preview sensor one to two miles upstream of the terminal fence line, operators have the data and time to optimize the batch cut at a second, in-station sensor. Similar to using two sensors of different types, this method reduces the potential for error and increases the operator's confidence in their decisions. In addition, it gives the operator the time to resolve any issues that may arise during a critical interface.



Conclusion

Proper interface detection is critical to controlling costs and delivering quality product. Today's specialty fuels complicate the process and increase the need for accurate, informed decision making to ensure product quality and limited waste. In order to determine the best technologies and/or systems for interface detection, operators should carefully evaluate their needs, matching them to the best available technology.