Minimizing Transmix With

FuelCheck®

completely fiberoptic pipeline interface detection

by

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What is Transmix?

Those who have to deal with transmix best answer this question. Below are 2 different perspectives, the first from an engineering consulting firm, and the second from a trans-mix refiner.

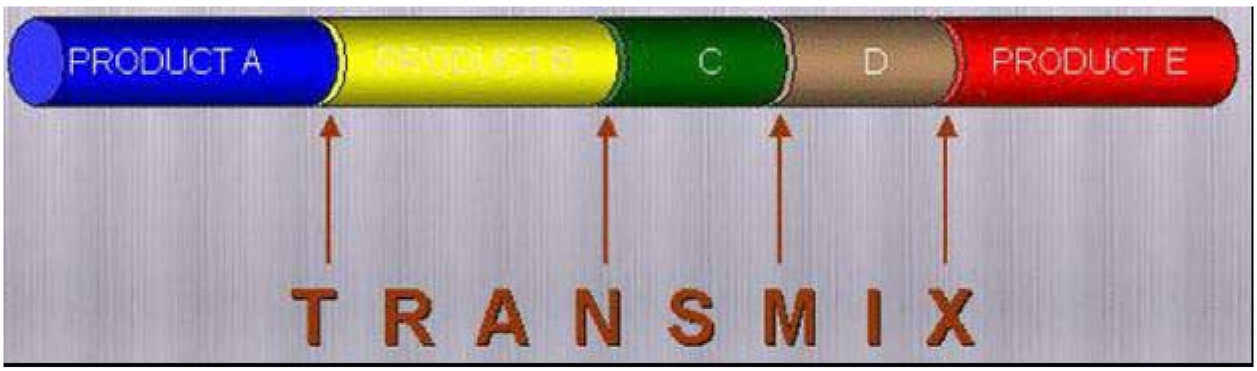

Figure 1

Figure 2 any of a number of products. For example, a pipeline branch linking two major cities may move aviation fuel in the morning, gasoline in the afternoon, and fuel oil in the evening. The question that immediately arises is, how can you transport two dissimilar products in succession without blending the two? The fact is, some blending will occur. However, if plug flow conditions can be maintained between origination and destination points, blended product can be minimized. Undesirable product blending which occurs during transport is commonly referred to as transmix.   A certain amount of transmixing is inevitable. It represents a problem that can cost the pipeline company and the American consumer millions of dollars per year. Transmixing erodes the margin that exists between a premium product and a lower grade and less expensive product. Frequently, a transmixed section of fuels must either be blended into lower grade product streams, or trucked out at a loss to be recycled (re-refined) back into individual product streams. In the case of one South Texas pipeline, transmixing was responsible for approximately $1 MM/month in lost revenues."1

"Millions of barrels of motor gasoline, diesel fuel and jet fuel move daily in batches through pipelines connecting refineries to terminals in major population and distribution centers across the country. Each refiner and marketer shipping these products through the pipelines is responsible for disposing of the interface between batches of the individual products. The interface between different refined petroleum products is a product known as "transmix."

Transmix has been handled in a variety of ways in the past but recent changes in the laws regarding the environment, diesel desulfurization regulations and mandatory oxygen-based additives in motor gasoline have made disposal of this product more troublesome for shippers. The volume of transmix is expected to increase as more kinds of products are shipped as a result of additional regulations. The major refining companies need someone capable of physically removing and paying for large volumes on short notice so that pipeline shipments are not interrupted. Another concern of the shippers is that the transmix be handled by a safe and legal operation and not simply blended back into conventional products sold in the local marketplace."[2]

What IS *FuelCheck®* ?

FuelCheck® is a completely fiberoptic process refractometer used to perform accurate batch cuts in shared product pipelines. ***FuelCheck®*** is comprised of 3 major components; namely, the probe, the fiberoptic interconnect, and the controller. The probe is installed into the pipeline through a 1-inch (or larger) full-opening valve. The probe is normally inserted only until flush with the inside wall of the pipeline so that pigging can be conducted without removing

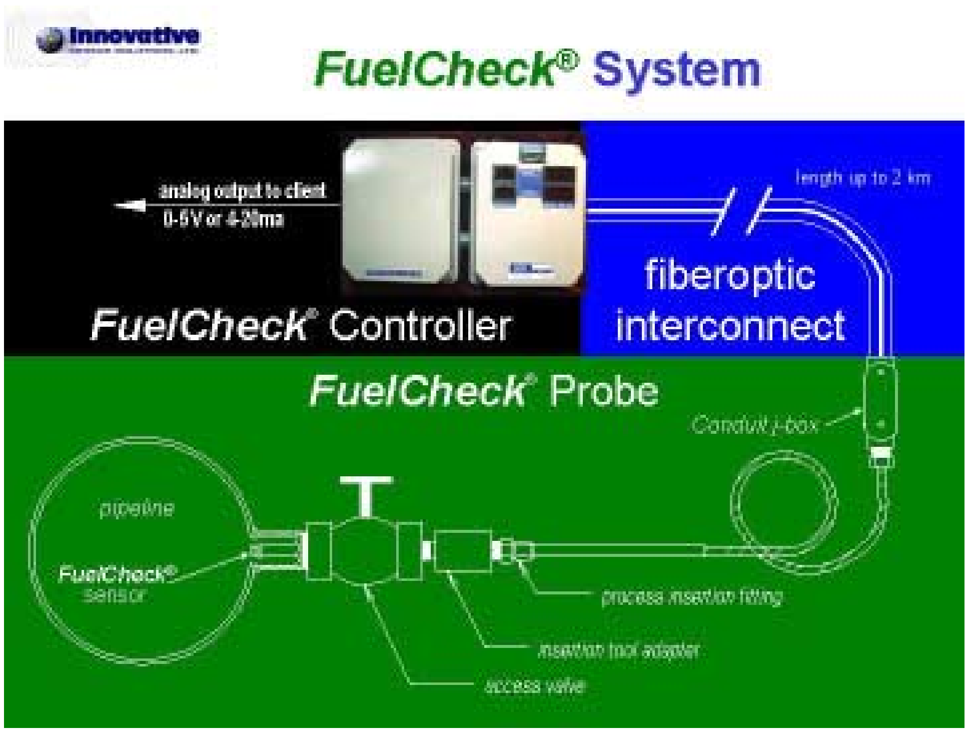

Figure 2

or retracting the probe. The fiberoptic interconnect is used to convey light energy to and from the probe, and consists of a pair of optical fibers packaged in various cable configurations which are selected based on application environment. The controller supplies the light energy to the probe and measures the light intensity returning from the probe, which is then converted into an electrical signal. The controller can be located up to 2 km away from the probes, enabling cost-effective upstream placement of probes without the need for power or special piping. Because the probes are completely fiberoptic, they are immune to lightning and other EMR and are also inherently safe devices.

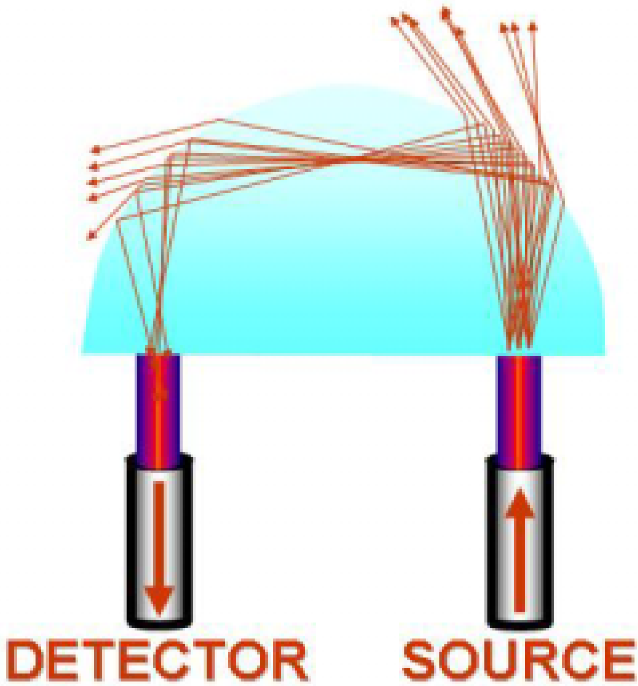

Figure 3

How does *FuelCheck®* work?

The ***FuelCheck®*** sensor (U.S. patent number 5,946,084) is a dual surface critical angle refractometer. Light enters the 5 mm diameter hemispherical sapphire lens through one of the attached optical fibers, reflects twice inside the lens, and leaves the lens via the other optical fiber. Some light is refracted out of the lens into the fluid wetting the lens. The amount of refraction (or loss) is proportional to the refractive index of the fluid. Refractive index is defined as the ratio of the speed of light in a fluid to the speed of light in air; hence, the refractive index of air is 1.0000. Since light travels ⅓ faster in water than in air, its refractive index is 1.3333. Refined products' refractive indices run from about 1.38 to 1.5. With refined products containing no ddi-tives, there is an excellent correlation between refractive index and density. If the fluid temperature correction algorithm (described in the ***FuelCheck®*** Installation & Operation Manual) is applied to the ***FuelCheck®*** output, the system can be calibrated very closely to API gravity or specific gravity.

FuelCheck® is an extraordinarily robust sensing system. The dynamic range between air ($\eta = 1.0000$) and heavy hydrocarbons ($\eta = 1.5000$) is over 40 dB optical. This results in extremely high sensitivity and SNR, enabling easy differentiation of similar products. The charts shown below demonstrate the sensitivity of the ***FuelCheck®*** system.

How are transmix volumes minimized using *FuelCheck®* ?

Too often, terminal operators are forced to rely on little more than experience and intuition when making batch cuts on incoming product streams. Indeed, most batch cuts are performed using sight (color), smell, or a barrel counter. Almost every terminal has a densitometer located somewhere in the terminal; however, these are of little use in conducting batch cuts because of their location and speed. Because most batch cuts are “seat-of-the-pants” operations, unnecessarily large volumes of perfectly good product are diverted to the transmix tank to minimize the risk of contamination.

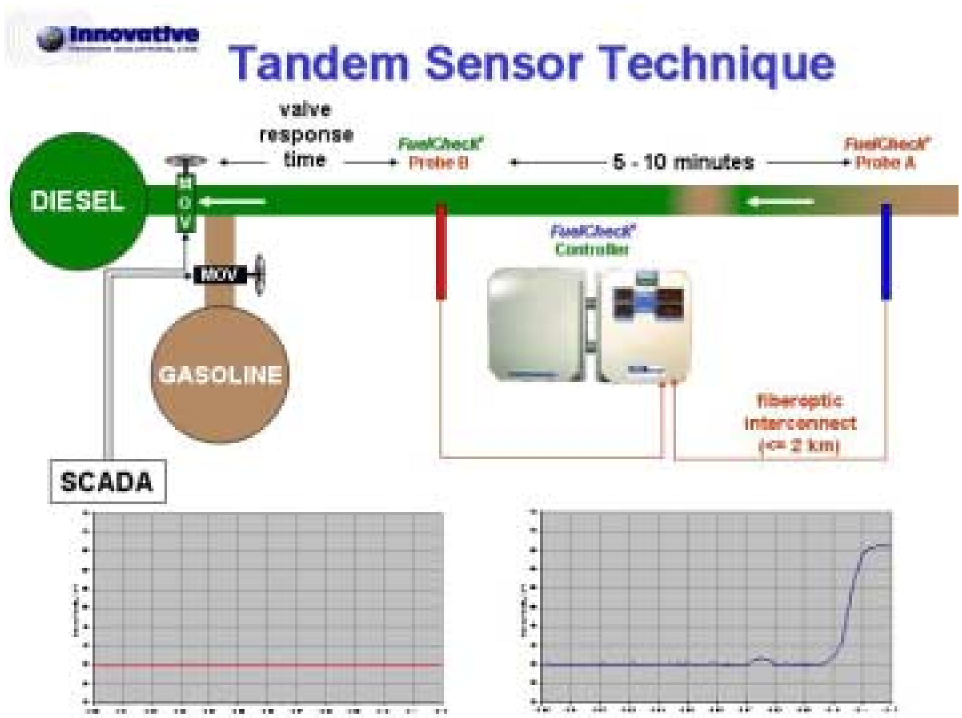

Figure 4

In order to significantly reduce transmix volume, one must be able to perform very accurate batch cuts during pipeline receipt. For example, when switching tanks from diesel to gasoline, one must have the ability to perform the batch cut at the beginning of the interface. A very small amount of low-sulfur diesel contamination in the gasoline tank generally will not cause an “out-of-spec” condition; however, a small amount of gasoline in a diesel tank will almost certainly cause unacceptable contamination.

In order for accomplish highly accurate cuts on incoming batches of products, early detection and definition of the interface is necessary. The best way to accomplish this is to place interface detectors several minutes upstream of the tank manifolds. Because product interfaces are rarely “normal”, early detection and a definition of the interface is critical. In order to do this, an interface sensor must be located sufficiently upstream of the tank manifold so as to allow the operators enough time to identify the interface and decide where within it the batch cut should be performed.

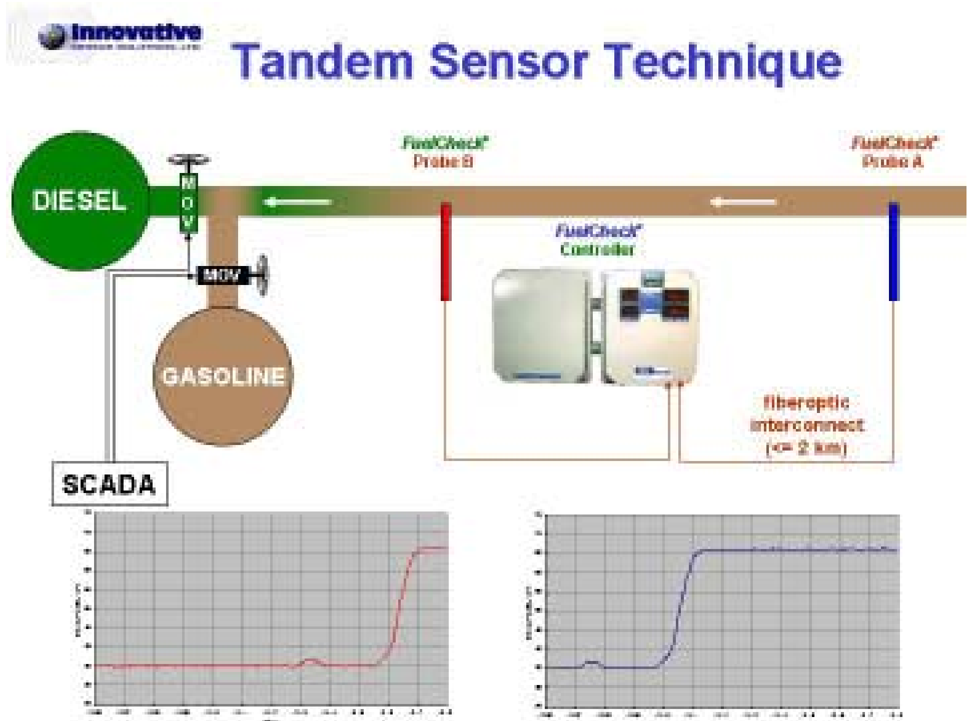

Figure 5

Figure 5 shows the tandem ***FuelCheck***® sensor arrangement frequently implemented to conduct high-accuracy batch cuts in refined product pipelines. In this simplified example, diesel is being delivered to the tank on the left, followed by a batch of gasoline. Because of irregular valve operation at the originating pipeline terminal, or disruption of batch integrity in transit, abnormalities in interfaces such as the one shown in the example are extremely common. When making a batch cut from diesel to gasoline, it is necessary to make the cut early in the interface so as to prevent introducing gasoline into the diesel tank. If, however, only a single sensor located close to the incoming tank manifold is used, it is likely that the batch cut would be performed too early because of the anomalous “blip” just ahead of the actual interface. This could result in the sulfur content of the gasoline being increased above acceptable limits.

When tandem sensors are employed as shown in this example, **Probe A** would provide sufficient time for the operator to properly assess the interface and decide where the batch cut should be conducted when it arrived at **Probe B**.

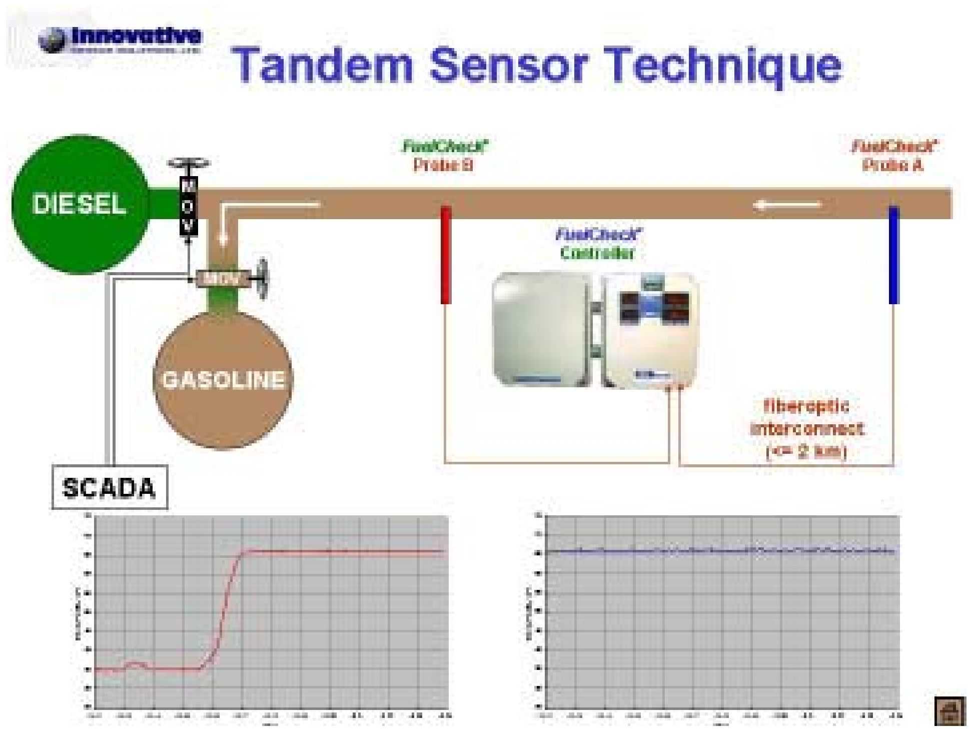

Figure 6

Additional benefits to this system configuration include the ability to save the data onto a computer or data logger and thus provide documentation of the batch changes. Certainly, identical response at 2 identical probes will assure high confidence in sensor integrity. Also, by placing a sensor sufficiently upstream of the terminal, the line could be shut down and samples obtained before the interface arrived at the manifold should an extremely anomalous event be observed.

References

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[1] **Tru Tec Services, Inc.,** Pipeline Transmix Study, World Wide Web, http://www.tru-tec.com/html/body_q2art31998.html

[2] **Petro Source Corporation**, Tonopah Nevada Refinery, Transmix, World Wide Web, http://www.petrosourcecorp.com/Asphalt_Tonopah.htm#Transmix