Float & Tape Tank Gauging

Improving the Level of Accurate Measurement

A Varec, Inc. White Paper

The 2910 FTT is the latest version of Varec's 2900 Float and Tape Transmitter that provides higher accuracy and repeatability when compared to existing transmitter technologies on the market today. The 2910 FTT utilizes an absolute capacitive encoder to convert the mechanical level measurement from the connected Automatic Tank Gauge (ATG). It then transmits the level to the host system for use in inventory calculations, allowing the operator to make sound decisions for asset management.

We have been examining magnetic and capacitance technology for use in level encoding for a number of years. After extensive verification testing, we found capacitive technology to be twice as accurate as magnetic encoders, the industry's current leading technology.

Encoder Technologies

The mechanical float and tape tank gauge has been the mainstay device for bulk petroleum liquid level measurement for almost a century. Due to the small quantities consumed by industry, all manufacturers build the instruments to order by hand. It is in this manual process where quality is won or lost and the foundations for accuracy and repeatability in the field are set. For over 10 years, Varec's manufacturing facility has been ISO 9001 approved for quality, and it is our investment in quality and verification testing that led us to capacitive technology.

For many years, brush encoders were the predominate technology used in level transmitters. This is the least accurate technology and requires the most maintenance as they have a tendency to wear down the bushes and encoder boards. Optical encoders replaced brushes, but they too have their problems. Optical encoders are affected by sunlight during calibration and also the build-up of dust or corrosion on the encoder board during their service life.

More recently, magnetic encoders are being utilized by tank farm, refinery and terminal operators. This technology is more accurate and requires less maintenance than its predecessors. However, the placement of a magnetic encoder on the electronic assembly is critical to the accuracy of measurement obtained by the sensor. The smallest amount of variation in the rotational center of the magnet and the center of the sensor affects the accuracy of the device. Accuracy was seen to be affected even at minute distances and the variation in level encoding is proportional to the accuracy of placement.

Although the accuracy of the magnetic encoder is acceptable and an improvement on previous technologies, we felt we could offer an even better product if we invested a little more development resources and delayed the time to market for our next product refresh. The accuracy of the capacitive encoder is not dependent on alignment between the shaft and the sensor.

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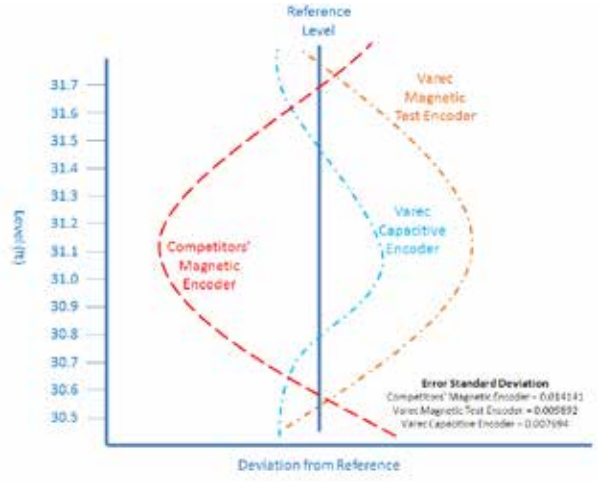
Figure 1 below illustrates the performance of the three transmitters over a sample measurement range and is representative of the entire measurement range.

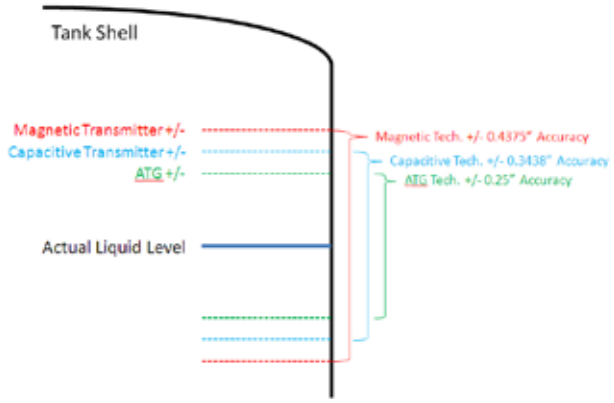


► *Figure 1. Validation test results of standard deviations in level readings by transmitter technology*

As one can observe, the competitor's magenetic technology transmitter and the Varec magnetic encoder test unit exhibit similar periodic deviations in level error, while the Varec capacitive technology transmitter was seen to reduce the deviation by an additional 50%.

How Does this Affect Inventory Management and Accounting

The standard deviation shown in Figure 1 directly equates to level accuracy. Based on the placement of magnetic sensors, the deviation in level reading could vary by an additional ±3/16" (±0.1875"); capacitance technology added only ± 3/32" (± 0.0938") to the variation in measured level. An automatic tank gauge correctly installed promises an accuracy of ± ¼" (±0.25"). The combined variation is demonstrated in *Figure 2* below. Older technologies, such as optical or brush encoders, increase the variation in level measurement accuracy still further. In reality, these errors are very small, but on a large diameter tank they become accountable.



► *Figure 2. Compounded variations in level accuracy based on technology*

On a standard inventory management system, such as FuelsManager® Oil & Gas, displaying level, the customer may not realize the relevance of small variations on large numbers. For example, when displaying only decimal inches on a 100 foot diameter tank at 50ft, 6-1/2", the operator may see a level reading of 606.8438" vs 606.9375" between the two technologies. Even when rounded to 2 decimal places, the large number (606") distracts from the small decimal difference of .84" vs .93". However, when displayed in feet, inches and sixteenths of an inch, the standard operator in the U.S. may start to understand the difference, for example 50 ft, 6" and 14/16" vs. 50 ft, 6" and 15/16" and how 1/16" affects the physical volume calculation. Improving the level measurement accuracy by 1/16" on a standard 100 foot diameter tank equates to a 306 gallon change in volume.

In reality, there are many other factors that affect the application and create uncertainties (no matter what technology is used) in the final level measurement, such as the tank wall movements and ambient conditions. The improvements we are building into our products try to eliminate the elements of error that we can control. If we can do this by 1/16" or 305 gallons at a time, the customer can ultimately account for their inventories with greater consistency and accuracy.

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