Derek Blagg, Varec, USA, discusses options for aligning tank gauging technology with needs and budget.

ACCURACY ASSESSMENT

Tank gauging is a generic name given to the measurement of bulk liquids in storage tanks. This type of measurement uses a variety of gauging devices. Within the oil and gas sector, static measurement of bulk liquids in tanks is used to account for the product stored, as well as track the movement of product in and out of the tank. In the US, most terminal operators account for product inventory based on volume vs weight. As a result, the accuracy of a level-based measurement system is one of the leading specifications that drive tank gauging purchasing decisions.

This article will focus solely on tank gauging for inventory management, and not include custody transfer applications. The latter has specific accuracy levels that require tank gauging technology. For inventory management, organisations should first identify the required level of accuracy needed for terminal operations and compare that to the capital investment budget available to ensure those components align. Often, the capital investment an organisation is willing or able to commit to is less than the amount required to secure technology that supports the highest levels of accuracy.

Accuracy through technology

Advanced tank gauging technologies, such as radar and servo, are well-suited for organisations needing the highest level of measurement accuracy in conjunction with the ability to track other variables. When commissioned correctly, these applications can give terminal operators real time insight into varying levels of detail. However, the

Figure 1. Bulk liquid tank farm.

applications for both gauge types can be costly and require specific commissioning to achieve the stated high accuracy levels. If budget is not an issue, there are great benefits offered by these technologies.

Radar gauges, specifically those designed for inventory control applications in stilling wells and bulk storage tanks, generally provide an accuracy rate of ± 2 – 6 mm (0.08 – 0.24 in.) depending on the gauge. These gauges are suitable for high pressure, high temperature (HPHT) applications. In addition, changes to process conditions typically have no effect on measurement. However, because of the nature of microwave measurement, radar gauges need to be equipped with functions to suppress interference echoes in the tank to prevent these echoes being interpreted as level measurement.

Servo gauges are suitable for atmospheric and high pressure applications, and typically have a level accuracy of ± 0.4 – 0.7 mm (± 0.016 – 0.028 in.) depending on the gauge. Most can also determine the interfaces between multiple liquids, the specific gravity of the liquids, and the tank bottom. This allows the servo gauge to provide spot density measurements, profile the liquid density throughout the tank, or profile the stratified upper layer.

Float and tape tank gauging has been a reliable level measurement technology in the oil and gas industry for over 90 years. Automatic tank gauges generally provide an accuracy level of ± 4 mm (0.2 in.). To accommodate control room integration and volumetric calculations, a transmitter can be retrofitted to the automatic tank gauge. This technology has remained a go-to solution over the years because of the simplicity, reliability, and cost. When budget is a factor, and the highest levels of accuracy are not required, float and tape gauges are a solid choice for terminal operators.

Determining the right solution

The type of measurement can sometimes dictate the required equipment. For instance, some terminals require density measurement or density profiles to accurately account for their product inventories. To meet this requirement, high accuracy tank gauges and ancillary equipment is required as accurate density is dependent on the accuracy of the level measurement. If float and tape gauges are in place at a terminal that wants to obtain density measurement, it is recommended to keep the original gauging in place when adding the advanced gauges. This will allow the float and tape gauge to serve as a backup system in the event of a power outage.

Shifts in communication connections are another factor. Hard-wired connections are still the industry standard, but wireless transmitters are also widely used. The shift is largely driven by the cost advantages of wireless when compared to updating old, hard-wired systems or running new wiring in hazardous areas. Wireless transmitters connect directly to the tank gauge transmitter, and use point-to-point, point-to-multipoint or mesh communications. Nearly all wireless transmitters or gateway devices in the market use a combination of HART® and MODBUS communication protocols. As long as the tank gauge transmitter is capable of outputting data via one of these protocols, it does not matter which brand of transmitter or wireless device is used as they do not have to be from the same manufacturer.

For US-based terminals, operators have to decide how their facilities will meet the redundancy and fail-safe requirements of the American Petroleum Institute (API) standard 2350 for overfill protection. Meeting these requirements does not necessarily mean expensive investments need to be made, but it is important to have technology in place to support the standard. Operators must first clarify their facilities' operational and overfill response procedures. After they identify the tank category, they must then determine which levels of concern need alarm automation and how to support measurement, alarm, redundancy, and fail-safe requirements with existing or new technologies.

Another factor when determining the right solution is the gauging platform itself. The shape of the tank can cause errors in level measurement. This happens because the weight of the liquid product against the side of the tank wall causes the wall to bow, which in turn can cause the roof to flex. If the gauging platform is not stable and free from the effects of tank deformations, it is difficult to guarantee accurate level measurements at all levels within the tank. A stilling well is recommended for high-accuracy radar and servo gauges for this reason. Another benefit of a stilling well is to minimise the effect the product surface conditions, such as turbulence, have on radar and servo readings. It is important to note that in many cases, existing stilling wells in the field are not optimised for radar measurement; the investment to support radar technology may include modifications to the existing stilling well. For example, stilling wells are typically secured to the tank roof for use in hand-dipping or sampling, but in a radar application, they should be fixed to the tank floor and use a vapour seal on the tank roof.

The installation location for tank gauges is also something to consider when evaluating technologies. Operators generally prefer tank-side installation because it makes it easier and safer to commission, service or read the units at the ground level, but this is not an option for all technologies. Float and tape gauges are installed tank-side and do not require power unless a transmitter is also being used. Advanced gauges, such as radar, servo, and magnetostrictive, are installed on tank roofs and require

Figure 2. A 2920 FTT mounted on a 2500 Automatic Tank Gauge.

power at the gaugehead. Cautious operators will set up permanent fall protection systems, such as stairs, guardrails, and tank-top platforms to help protect workers who need to climb a tank to get to the installed gauge. These are additional costs to consider when evaluating advanced gauge technologies.

The last factor to consider is the complete lifecycle cost. This varies depending on the technology used, the current infrastructure in place and the number of tanks in question. Radar gauges, once commissioned correctly, require little ongoing maintenance, thus minimising lifecycle costs. There is, however, a high initial cost associated with purchasing and commissioning these gauges, as noted previously. For some operators, the upfront cost outweighs the lack of maintenance costs, especially if they can achieve their accuracy requirements with a less expensive technology. Float and tape gauges, on the other hand, will incur ongoing costs because they are mechanical devices with moving parts. Over time they will need recalibration, cleaning, and other maintenance, including parts replacement. These costs are generally moderate considering the longevity of these gauges. Owing to the low cost associated with commissioning these gauges, many operators still choose this technology over advanced gauges to support their level measurement needs.

Case study

A large refinery in New Jersey, US, had over 100 tanks and was evaluating new tank gauging hardware. The refinery needed more detailed measurement of its inventory, including real time product movement across its typically large distributed tank farm. The refinery's engineering team also had a mandate to find the most cost-effective solution to provide this level of measurement that would also help improve efficiencies across every aspect of the refinery's ongoing operational and maintenance processes.

The team also sought to reduce in-the-field risk by automating and transmitting comprehensive tank conditions back to the site operations centre and load racks in real time. They considered swapping out existing measurement equipment with radar-based systems offering data transmission capabilities. To fully evaluate this option, the team calculated the man-hours required for installation, infrastructure upgrades, and capital expenditure requirements.

Considering the level of effort, significant cost, and extended return on investment (ROI) timeline needed to swap equipment, the engineering team decided to seek out a more practical, timely and cost-efficient option. It was important to find a solution that would meet the necessary accuracy requirements and support current staff levels.

Solution

The New Jersey-based engineering team met with Varec to learn more about its radar gauges, and in that discussion, Varec suggested its Model 2920 Float and Tape Transmitter (FTT) as an alternative. The transmitter could serve as a 'bolt on' component to the refinery's current tank gauges (Figure 2). The plug and play solution enabled the refinery to eliminate the cost of replacing the extensive number of installed tank gauging equipment, which in many cases included Varec's 2500 Automatic Tank Gauge. The FTTs could be added at a fraction of the cost. In addition to the transmitter's flexible communications protocols, its HART input functionality and digital inputs and outputs integration capabilities made it a suitable choice for meeting API 2350.

Result

Aside from the substantial savings made by installing the FTT over replacing the current tank gauges with radar gauges, there were other immediate benefits. For instance, the refinery was able to utilise the existing field communications infrastructure. Additionally, the 2920 FTT includes an onboard three-wire resistance temperature detector (RTD) input, enabling direct wiring of RTDs and eliminating the need to use a separate temperature probe and transmitter at the tank.

By automating the tank gauging system, the refinery achieved a more accurate and reliable measurement system. Security was improved by adding optional high, high-high, low, and low-low levels alarms to the FTTs.

Conclusion

Several factors can affect the level measurements produced by tank gauges, including the stability of the gauging platform, tank deformations, and surface conditions. When deciding on gauging technologies, it is important to understand the gauge's ability to overcome these issues, or at least be able to minimise them in order to meet API 3.1B requirements.[1]

Reference

1. As per the Manual of Petroleum Measurement Standards Chapter 3 - Tank Gauging Section 1B - Standard Practice for Level Measurement of Liquid Hydrocarbons in Stationary Tanks by Automatic Tank Gauging.