ON THE RIGHT LEVEL

Adam Wishall, Varec, USA, outlines the multitude of benefits that a complete inventory control system can offer tank terminals.

For organisations with bulk liquid storage tanks, visibility and control are vital for a smooth-running operation. In the oil and gas industry, reliable and safe level measurement is critical, but there is much more required to achieve complete inventory control. Tank farms, terminals, and refineries need the ability to monitor inventories remotely, track and manage product movements, account for their assets in real-time, integrate safety features and access controls, as well as set and manage alarms to prevent overfills and leaks.

Facilities need to integrate hardware, such as tank gauges, transmitters, and communication interfaces, with software in order to achieve complete inventory control. The types of hardware can vary based on need. However, the types of gauges and transmitters used generally align with whether the facility is focused on only inventory management or if there is also a custody transfer requirement. Once the hardware solution is determined, how the tank inventory data is relayed back in the control room will depend on the communication interface.

Human machine interface (HMI) software, designed to manage inventory, and supervisory control and data acquisition (SCADA) are needed to support automation and control. The more sophisticated the software is, the greater facilities will be able to automate and manage operational processes through it.

Reliable and repeatable measurement

There are a wide range of oil and gas products stored in bulk liquid storage facilities; therefore, a singular technology is not suitable for every application. Tank types and operating conditions must also be taken into account. For tank gauging, there are two types of measurement methods used – volume or mass. When looking at volume, the level is measured, while in a mass-based system, the measurement of the hydrostatic pressure of the liquid column is directly used. The method selected should be based on how an organisation manages its product inventory, i.e., volume or weight.

Common tank gauging technologies and field devices

- Float and tape gauges – suitable for most liquid storage inventory management applications and tank types with an accuracy range up to ±0.2 in. (±4 mm) depending on model.
- Float and tape transmitters – vary in capability and application, but generally support simple indication of alarms or relays; they also support advanced functionality such as level encoding and temperature measurement integration.
- Radar gauges – suitable for both high accuracy inventory management and custody transfer applications with an accuracy rate up to ±0.02 in. (0.5 mm) depending on model.

Figure 1. Tank detail screen from HMI software showing the current status of the gauge level and position, temperature, water level, density, alarms, product movement, tank volumes and more.

Movement Delivery Ticket - Receipt Gauge

Name:	Pipeline to Tank 3					Date of Record:	09/30/2015 18:23:33		
Order Number:						Comment(s):			
Product:	Jet A								
Start Time:	09/30/2015 12:02:00								
Stop Time:	09/30/2015 18:23:00								
	Node	Status	Product Level	Temp	Water Level	Standard Density	Gross Volume	Net Volume	Net Volume Transferred
From	Pipeline	Opened					1,209,445 gal (US)	2,357,750 gal (US)	
		Closed					1,876,169 gal (US)	3,017,392 gal (US)	-659,642 gal (US)
To	Tank 3	Opened	12.52 ft	86.4 °F	0.00 ft	43.0 °API	363,971 gal (US)	359,116 gal (US)	
		Closed	35.43 ft	85.8 °F	0.00 ft	43.0 °API	1,030,079 gal (US)	1,016,658 gal (US)	657,542 gal (US)
							Discrepancy:	Gauge:	-2,100 gal (US)

Figure 2. Example of a product movement receipt showing product received from the pipeline to a particular tank.

- Servo gauges – suitable for both high accuracy inventory management and custody transfer applications, and also supports the ability to measure level, interface level, density and water bottom with an accuracy rate up to ±0.016 in. (±0.4 mm) depending on model.
- Tankside monitors – generally used in conjunction with advanced tank gauges, i.e., radar and servo, for bulk storage applications to provide convenient monitoring and integration of all tank inventory measurement sensors.
- Temperature sensors – used to calculate accurate inventory volumes by integrating temperature measurement into tank gauging systems, and can vary from single-point to multi-point averaging types.
- Pressure sensors – instrument used to measure liquid and/or vapour pressure in order to be utilised in volume or mass based inventory measurement, and can vary from single to multi-point types.
- Communication interfaces – intelligent devices such as remote terminal units (RTUs) that enable open communications and seamless integration between most tank gauging systems, distributed control system (DCS), programmable logic controller (PLC), or HMI software.

Organisations must balance their operational needs and application of each technology, along with their budget, in order to determine the best solution.

Real-time inventory management

When tank farm measurements are integrated with an HMI software program, facility operators are able to reduce the time spent in the field monitoring the product inventory in tanks. Communication interfaces transmit the data received from the gauges and field devices into the HMI system in the control room, enabling operators to view the status of each tank in real-time.

With this detail readily available, operators can quickly make informed business decisions as they are able to view and monitor measured levels, calculated variables, and alarm statuses. As data is being updated in real-time, the control room displays can be customised to provide the most efficient and pertinent information based on the business needs of each facility. If enterprise capability is supported, individual site data can be rolled up into the hierarchical levels of an organisation. This provides corporate officers the ability to monitor and report on the status of their assets across facilities.

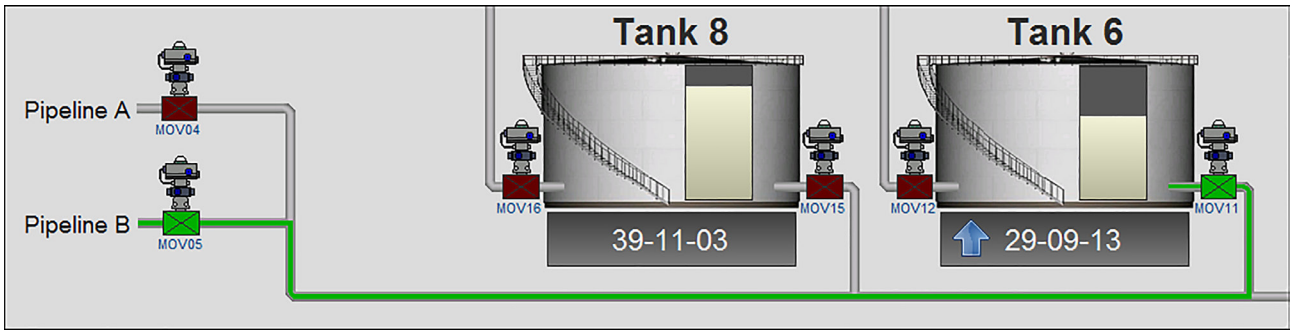

Figure 3. Visual illustration depicting the movement process from pipeline to tank.

Product movements across the tank farm

Tracking and monitoring product movements in real-time is an essential component of a complete inventory control solution. In order to track product receipts and issues from bulk liquid terminals, or transfers between tanks within the same terminal, there needs to be integration between field devices (i.e., tank gauges, RTUs, PLCs, flow meters) and HMI software that includes SCADA as a part of the control system.

With the integration in place, it is then easy to capture, view, and archive data for multiple product movements in real-time and reconcile those movements to identify any discrepancies. The automation and control enables the tracking to automatically initiate when movement starts or stops. The triggers for automation are normally tied to valves opening and closing, a pump starting, or are prescheduled based on planned shipment times. The data collected could then be delivered to other operational systems, such as customer orders, logistics, planning, and yield accounting. It is recommended to track multiple movement types, such as tank-to-tank transfers, charges, shipments, receipts, yields (i.e., rundowns), water drains, and blends.

Daily accounting and inventory reconciliation

Another key aspect of complete inventory control includes automated accounting and reconciliation. When facilities integrate receipts from the pipeline, barge, or load rack with product movements, product inventory levels and bill of ladings from load racks in their HMI software, end-to-end inventory reconciliation is virtually seamless. This assumes there is an accounting ledger as a feature of the HMI to centralise all terminal activities in order to track, manage, reconcile, and report against book and physical inventories by owner, manager, and product. Most often this is a requirement that is needed on a daily basis for facilities with a lot of activity.

One key accounting efficiency that facilities will benefit from with this method is minimising the downtime during closeout periods. By automating end-of-day closeout processes they can also compare book vs physical inventories for additives and co-mingled products for a complete accounting view of all bulk liquid assets. Additional benefits include access to reporting, an audit trail, and the ability to lock down the ledger during closeout periods to ensure the integrity of the data.

Figure 4. Tank farm view of pipes and valves.

Operational safety

Inventory control also helps organisations improve the safety of their facility operations. Automating alarms not only protects personnel, it protects against product loss and helps prevent damage to equipment and the environment. Facilities can program alarm notifications around their desired inventory measurement limits. These types of alarms are generally tied to high level limits to prevent overfill, low level limits to protect pumps, and static limits monitoring for potential leaks or tampering. They are also related to other variables such as temperature or pressure where applicable. Having this monitoring available in the control room reduces the need for operators to climb tanks, an important safety benefit.

Automated alarms also give facilities insight into any potential issues with their flow rates or accurate valve line-ups during filling or emptying. They will have more accurate, real-time information to better understand what their maximum flow rate should be, beneficial information when preparing for pipeline receipts. All said, with this type of data, facilities can increase their storage capacity which in turn increases the amount of inventory they are able to store and sell, while also ensuring they are staying within safety limits.

Customer and resource information management

With a single, integrated system, operators can more easily configure, store, and manage key operational data points, such as customers, company, personnel, and equipment. This level of real-time visibility simplifies tracking, while also enabling activity and security alerts to be automated, another perk available in a complete inventory control solution.

Controlling product throughput automatically helps ensure the accuracy of allocations by supplier, manager, or customer and is based on the organisation's business rules and processes. This type of integrated system also supports the seamless management of resources, including personnel and equipment. Automating training schedules, for example, helps facilities proactively match personnel to the right tasks based on capability and helps ensure any required training activities are completed on time. Similarly, certifications for equipment can be tracked automatically to ensure maintenance schedules are adhered to in a timely manner.

Automation in action

A 50+ tank terminal in East Chicago, Indiana, US, has been benefiting from an inventory control solution for many years. Prior to making the change, it had been utilising a combination of manual processes and a load rack system that had limited functionality. The Varec inventory control solution in place today includes level measurement, inventory management, a movement system, and inventory accounting, in addition to a terminal automation system.

With terminal automation, the preset calculations of each blend is configured in the software during implementation. Having these tolerances built in helps ensure the right blends are created and delivered to the right customer. And if, for any

reason, the percentages per product and blend begin to fall outside the specified tolerances, the system will shut down. This automated shut down helps minimise any potential product loss due to bad blends. Operators are immediately alerted so they can investigate and resolve in real-time.

The terminal sells blended fuels, and before automating this process with the movement system, they had to manually calculate the blend ratios. They also spent a lot of time manually assessing which tanks to move product from in order to provide their customer with a tank of the requested blend. The start and stop for each tank's pumps and valves had to be initiated by hand, and had to be done one at a time so that the movement could be recorded for accounting purposes. With automatic tank gauging updating their inventory management system in real-time, they saved 30 min. on each blend simply by having live data at their disposal. The automated movement system saves additional time per blend as the movements can take place simultaneously. Determining which tanks to move products to and from is seamless and all movement data is recorded automatically based on the preset calculations of each blend. This increase in productivity also improves the capacity levels of available product to sell at any given time.

Another way the facility leverages the movement system is for their pipeline receipts. The movement system's tracking also supports their custody transfers. The validation of movement, and the accompanying documentation, gives operators a tool they can share with customers as there is confidence in the completeness and accuracy of the data. The documentation includes key details of the requested blends by showing what product was moved, when it was moved, and where it was moved. With the movement system data and pipeline receipts stored in the same accounting module, the facility is also able to quickly and accurately perform reconciliation during closeout periods.

The facility's terminal manager also shared that the automated alarms not only help keep the facility safe to work in, but help protect their stored assets. A movement alarm was triggered during normal operations on an idle tank a few years back. He explained that the valve had been opened on the tank, but the movement had not been initiated yet. Approximately 30 min. later, the movement alarm went off. It struck them as odd that an idle tank triggered an alarm so they knew something must be amiss. The operator went to the tank to investigate and found there was a small pipeline leak. The size of the leak was so small that it took around 30 min. to trigger the alarm. Without the automated movement alarm, they do not know how long a leak like that might have gone undetected. It is possible the discrepancy in tank level would not have been noticed until closeout under their prior manual processes. Depending on when that would have occurred, it could have been days later or longer.

For this busy terminal, inventory control has been an integral part of its operations for many years. Removing the manual procedures for inventory management, product movement, terminal automation, and inventory accounting and reconciliation has helped them refine and improve the overall management of terminal operations. This is because facility operators and managers are able to make more informed decisions based on real-time data. T&T