Adam Wishall, Varec, USA, explains the vital role that movement tracking has to play in bulk liquid management.

KEEPING TRACK

Tracking product movement is a recommended best practice for bulk liquid storage terminals. Some facilities choose to utilise a predominantly manual process to validate product movements by comparing pipeline meter data with the level data of the designated tank. For the most part, the manual systems work as long as no human error exists and all the system hardware is in good working order. If a valve does not close tightly, it may allow some product intended for one place to go somewhere else. An automated tracking system should include more than just the designated tank in its analysis in order to eliminate human error.

Automatic movement tracking systems are generally part of a tank farm automation solution that includes tank gauging, inventory management software, and supervisory control and data acquisition (SCADA). It can also be a standalone solution for facilities that do

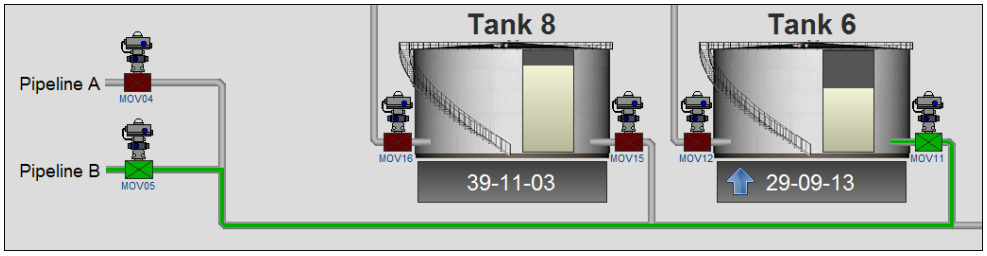

Figure 1. Illustration of movement tracking in process from the pipeline to the tank.

not operate an automation and control system or do not have integrated hardware capable of recording and storing product data. These systems automatically track bulk liquid movement based on valve position, pump status or user command, without needing to be started or stopped by an operator.

As movement tracking systems capture the physical movement of bulk liquids in real time, the system stores a variety of data points, such as beginning level, end level, transfer set points, volume, time stamps, etc., every time a valve is opened or closed on a tank. Typically, all common movement types are captured, such as tank-to-tank transfers, charges, issues, receipts, yields (rundowns), water drains, and blends. For most terminals, movement tracking acts as a passive check and balance to quickly validate inventory data. Once in place, the system is able to capture and archive movement data across all liquid types and tanks, while providing operators with on-demand, real time movement tickets and reports.

Product receipts and issues

For inbound transfers from the pipeline, movement tracking is used to verify the accuracy of pipeline receipts. Pipeline receipts are fairly accurate unless there are unknown issues with the pipeline itself. These receipts are produced based on the meters, but the location of those meters varies from pipeline to pipeline. Tracking the physical inventory as it is received is the fastest way to discover if there is an issue with a particular line or valve from the pipeline or at the receiver's tank farm.

Discrepancies between the tank volume and metered amount calculated by movement tracking can help operators determine how much of the transfer packed the vacant pipeline vs that which filled the tank. If there is a flow meter installed, operators have an added advantage of being able to compare all three data points. They can verify how much product was received in the tank, know how much product passed through the meter, and then compare that to the amount the pipeline receipt says was received.

When issuing product, the movement system provides similar benefits. When product is transferred to another tank, ship, hydrant pump, or load rack, the amount of product leaving the tank is tracked. If a fuel accounting system is also in place, movement tracking helps track ownership and perform reconciliation. From the time product is received and a bill of lading (BOL) is provided, through to the time product exits the tank and is issued, there are several reasons why calculated data may not match the measured physical data. The BOL could simply be wrong or the amount manually entered as received could be wrong due to human error. If there is no automated inventory management software in place, outbound product issues will also be handled manually with a potential for bad data due to human error. There could also be undetected hardware problems from tank gauges, meters, pumps, or valves causing incorrect data readings, system issues, or leaks.

All movement tracking data is captured in real time, making it easier to identify discrepancies between the calculated book inventory and the measured physical inventory during a specified closeout period. With discrepancies easier to detect during reconciliation, more time can be spent determining what happened in order to prevent future occurrences. If source pipeline meter data are not available electronically, operators can still enter the pipeline ticket information into the system for direct comparison to captured data.

Another benefit of having a movement tracking system in place is that it can help detect sealed system leaks. These are hard to detect leaks that occur when valves are not closing properly in the lines between tanks. There are a few questions an operator can ask to help determine if there is a potential sealed system issue at their facility:

- Does the amount of product consistently match the amount indicated by the pipeline receipts?
- Is the amount of product in the allocated tanks at the expected level based on receipts and issues?
- Are inventory levels changing in a tank that did not have any receipts or issues?

Case study

A fuel farm at a major US airport was experiencing inventory level readings that were showing losses on certain tanks periodically. It was difficult to establish why these particular tanks had inventory level discrepancies that did not match pipeline receipts or match the expected calculated levels after product was issued from the tank. Varec's systems engineering team was approached for assistance.

The tank farm has three groups of tanks, and the problems were specific to one group of three tanks.

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 movement tracking receipt.

Figure 3. Illustration of tank detail screen with inventory management and movement tracking.

As operators provided more details, they described the issue with reported levels lower than what the pipeline receipts indicated was received. These were showing up as losses for their receipt reporting. They also occasionally saw level changes in tanks that did not have receipts or issues during the closeout period. More interesting was the fact that when reconciliation was completed across the tank farm, the data did not indicate a loss at the site level. This left operators confused as to how they could have all of these variables happening and still be within tolerance once they ran site-wide inventory closeout reports.

Since there was a movement tracking system in place, Varec engineers decided to dig deeper into the real time trends for the three tanks in question to better understand what was happening whenever product was received or issued. What was uncovered was a unique combination of problems.

The data showed that whenever one of the three tanks was receiving product, and the volume in either of the other two tanks was low, product from the filling tank would leak into the other tank(s). This occurred because some tank valves did not properly close, allowing product from a full tank to trickle into an empty tank. The issue was compounded during pipeline receipts since gain/loss was normal if all of the other tanks were full. The pressure of full tanks prevented blow-by enough that the designated receipt tank was within tolerance.

Alternatively, if a nearly empty tank in the group was issuing product, and another tank in the group was full, the head pressure of the full tank allowed product to creep by an outlet valve that did not seal tight. Collecting data on issues to the airport was difficult. This behaviour made it look like the seeping tank had a leak, but only on occasion.

When the engineers analysed the data and compared the system plumbing, they determined that the tank group had several sealed system leaks. The multiple variables also meant that the problem was due to a combination of inlet and outlet valves. Without the movement tracking in place, it would have been extremely difficult to find these seal system leaks as the problem was not isolated. In the end, the customer decided to replace all the tank inlet and outlet valves in the tank farm, and not just the valves causing the problems. Once the new valves were in place, actual levels measured matched expected levels in that tank group.

Conclusion

This article provides insights and best practices for tank farm and terminal operators looking to deploy accurate, automated inventory management and control systems. However, operational needs vary by facility, therefore it is best to evaluate all options to determine which processes will provide the best results based on needs and budget. T&T