

THE POWER OF AUTOMATION

Murali Krishnan T, Emerson Process Management, Asia Pacific, and Christopher Amstutz, Emerson Process Management, USA, explain how demands for greater throughput, higher reliability and improved safety can be met by automating manual systems and practices.

Driving past or flying over most tank farms leaves a sense of quiet and stability, with all the white storage tanks standing in rows. A casual observer is probably not aware of the activity within those pipes and tanks, and the critical role of the product movement they control in the global hydrocarbon supply chain (Figure 1). Those facilities are important for a variety of reasons:

- From wellhead to final customer, product custody can change numerous times. The fuel in a car's gas tank or the gas heating a home has likely moved great distances, gone through many processing steps, and had multiple owners during its journey.
- The product may have been moved via pipeline, tanker, vessel, railcar, truck or a combination of those. Moving it from one transport mechanism to another can be a complex process.
- The products in those tanks are fuels, and certainly flammable and potentially explosive, so safety has to be paramount at all times.
- Whether in storage or moving from one transport mechanism to another, there is always potential for product contamination or loss. Fuels are valuable, but their worth can be diminished very easily due to improper handling.

- A terminal able to operate efficiently and effectively adds value to the chain, but problems can just as easily hurt profitability. Product spills invite catastrophe, so operators have to be constantly vigilant to avoid causing an environmental incident.

With all these factors, performing terminal operations manually, or even partially automated, is very risky as it depends on near perfect execution by human operators. Given the amount of money constantly in play as products move from transport to tank and back again, automating all or part of a terminal's operations will improve profitability, and help avoid incidents like these.

Avoiding health and safety incidents

Unfortunately, transfer and storage facilities have had their share of incidents, reminding companies and communities of the potential dangers. The following are three examples from the last 10 years:

Buncefield oil storage depot

In December 2005, the Buncefield oil storage depot near London, England, was transferring unleaded gasoline from a supply pipeline into a storage tank. This very routine

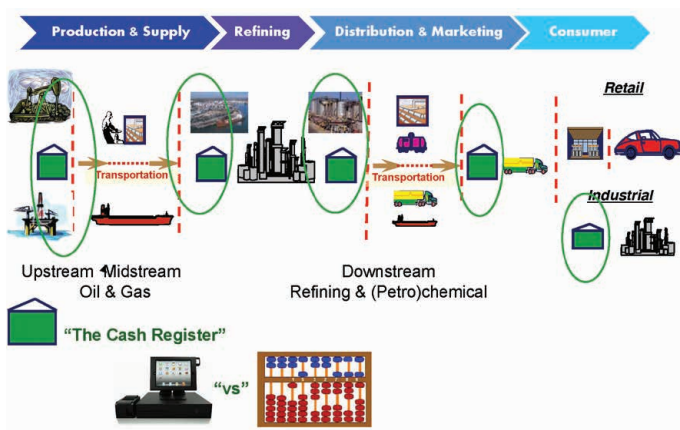


Figure 1. The global hydrocarbon supply chain is arguably the most valuable and pervasive transfer activity in the world. Terminals enter into the process time and time again as product is processed and moves from wellhead to final consumer.

operation was being carried out in the pre-dawn hours of a Sunday. Operators filling the tank did not realise the two level sensors on the tank were both inoperative, nor were they paying close enough attention to realise the tank was reaching its limit. Pumping continued as the tank began to overflow, and leaks in the surrounding retaining bund allowed the gasoline to flow throughout the adjacent tanks. The resulting fire burned for five days and destroyed most of the 194 000 t facility.

Elk River chemical storage facility

In January 2014, residents near Charleston, West Virginia, noticed a strange odour from their drinking water and called local authorities. The odour was caused by 4-methylcyclohexylmethanol leaking from the Freedom Industries chemical storage facility near the Elk River, the source of the drinking water. The chemical, used to clean coal in nearby mining facilities, was leaking out of a 1 in. hole in the bottom of a 40 000 gal. tank. Approximately 7500 gal. escaped, and much of it found its way through the facility's containment system to the nearby river, where it affected the water supply of 300 000 local residents.

Jaipur oil terminal

In October 2009, Indian Oil Corporation was beginning to transfer gasoline from a storage tank to a pipeline at its Sitapura Oil Terminal near Jaipur, India. Operators apparently opened valves in the wrong sequence, resulting in a major discharge that continued for hours. Gasoline accumulated around the tank and created a cloud of vapour making breathing difficult, but the facility had no incident response plan to deal with such a situation. Eventually the vapour found an ignition source and a massive explosion ensued. Ultimately the incident claimed 11 lives and injured more than 150.

Methods for prevention

Each of these situations could have been prevented by effective automation. Buncefield was largely an instrumentation and safety instrumented system (SIS) failure, and the situation was made worse because operators had inadequate operator

interfaces to see what was going on throughout the facility. Appropriately selected level sensors integrated with more informative operator interfaces, and an effective SIS, would have stopped the tank from overflowing, whether the operators were paying attention or not.

Freedom Industries had inadequate leak detection capabilities, so neither its operators nor its safety systems were able to realise the contents of a tank had decreased substantially without any reason. Inventory management capabilities tied to the larger automation system could have detected such changes, and leak detection sensors would have identified the chemical outside its tank.

The Jaipur facility depended on human operators to establish piping lineups, opening and closing manual valves in the correct sequence to direct products to the right locations. With automatic valves controlled by an automation system, the valve lineup procedure would be performed properly every time.

Positive effects of automation

Automation is not simply a defensive strategy to prevent incidents; it can also increase the amount of product a given terminal can handle while reducing costs (Figure 2).

The challenges tank farm and terminal operators face these days can be separated into four main areas:

- Product issues, including inventory loss and contamination: the number of products most terminals have to handle has increased in recent years, increasing the number of changeovers, tank cleanings and line clears.
- Customer demands: terminal users, whether internal or external customers, expect more in the way of product processing capabilities, administrative information and turnaround speed. Data on custody transfer has to be flawless and delivered immediately to facilitate rapid order to cash.
- HSSE demands: every safety and environmental incident at a terminal anywhere in the world seems to drive tighter operational restrictions, and operators must respond.
- Personnel and staffing challenges: terminal operators are not immune from the common industry problem of finding reliable, technically qualified workers. The great shift change affects everyone.

Terminal management

Terminal owners and managers want control of the business aspects of their operations, and these activities centre on inventory tracking and handling speed of both product and information. Moving product through the facility is what generates income, and movements need to be measured very precisely.

- Sophisticated instrumentation, such as the Rosemount 5900S high precision radar gauge, keeps a close handle on product movement, down to proper compensation for changes in volume caused by temperature variations.

- DeltaV automated control driving valve actuators can create lineups in an instant, eliminating the need for operators to walk through and check potentially dozens of valves and segments over thousands of metres.
- Instrumentation can detect spills and determine where other releases are happening in a facility. Spilled product wastes money in addition to creating HSSE issues.

Terminal management covers all activities at a facility:

- Inventory monitoring includes quality and quantity of contents, heating or cooling if necessary, blanketing for fire suppression, and corrosion monitoring to avoid leakage.
- Process control encompasses movements, vapour recovery, in tank actions, blending, and other processes required by customers.
- Asset management monitors the operation, utilisation and condition of equipment including jetties, gantries, piping, pumps, instrumentation and safety devices.

All of these capabilities have to work together flawlessly to keep the operation performing at peak capability. A failed pump motor or a leaking valve can prevent a critical lineup from being implemented, delaying product movement or causing a spill or contamination. Valves not closing fully can allow inventory loss or products to mix, creating contamination issues.

An effective terminal automation system performs two major functions. First, it has to be the terminal's cash register and bookkeeper, recording all flows in and out including custody transfers and product movements. All the data comes from the facility's instrumentation through the process control system.

The second function is process control, monitoring and operating all the valves, pumps, instruments and safety systems. These two main functional areas may be supported on totally separate platforms, but they must be integrated seamlessly because information and data needs to constantly flow from one to the other.

Product transfer and load out

In most cases, a terminal is not a consumer of products it handles, at least not in any significant amounts. It makes money by storing and moving product in and out, sending it on to the final customer or the next processing phase. Some products may be stored on the site for some period of time, but in most cases, the less time in storage, the better.

Many facilities have various pipeline connections going in and out, along with the ability to load and unload bulk carriers such as trucks and railcars, and, if there is access via waterway, tankers and vessels. On any given day product can be moving from any one of those to any other causing a variety of challenges:

- Custody transfer data must be accurate at all times: all the products stored or moving through a facility represent money, so the ability to know exactly how much product is moving and its value is paramount. Without the highest level of measurement accuracy, recognised and accepted by all sides, customers can contest the validity of transactions.
- Effective maintenance to keep pumps and valves at peak performance: condition-based maintenance is a critical part

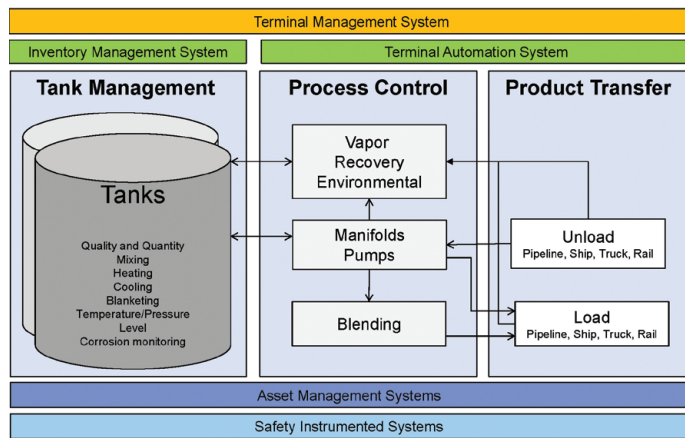


Figure 2. All the elements of a terminal operation, including inventory management, are interrelated and perform best when controlled by a seamlessly integrated terminal management system.

of asset management because it can warn of developing problems while there is opportunity to solve an issue before it becomes an operational issue. Without such an approach, maintenance becomes reactive instead of proactive, either allowing outages to develop at the worst times, or adding to costs due to wasted efforts fixing things when not necessary.

- Accurate and fast lineups permit more throughput while avoiding inventory loss. Consider this example: the contents of a vessel must be unloaded to a tank near a jetty and then transferred to a truck. If the terminal is large, those two places could be several thousand metres apart, and a dozen or more valves may need to be set correctly to establish the proper lineup. With a typical manual procedure, an operator needs to walk through the lineup, checking or changing each valve so it is in the correct position, and reporting on each to the control room by radio. If the operator is conscientious and qualified, this can be an accurate and reliable procedure, but it could easily take an hour or two, and if he or she makes an error in valve identification, the result could be disastrous. When valves are automated, they can be controlled and monitored by the automation system, allowing the correct lineup to be established and verified in minutes. Lineups can be stored in libraries, allowing them to be used whenever needed, and special operations can be verified to avoid safety incidents.
- Broader ranges of products can be handled without contamination: terminal operators frequently cite operational problems caused by increasing numbers of products. As product types increase, so do opportunities for contamination. Keeping product families and grades separate using manual systems adds a level of complexity difficult for operators to manage, whereas the task is much simpler with automation.
- Delays due to equipment failures can be minimised or even eliminated: if a vessel pulls into the dock and needs to be unloaded, the owner expects it to

be carried out promptly so the vessel can move to its next assignment. If the piping manifold extending to the dock is down because of a valve or pump failure, it is a major problem for everyone. An effective maintenance programme using diagnostic information from smart field devices, valve controllers and monitoring sensors helps predict and prevent failures and ultimately unplanned delays.

Moving product out of the facility includes its own set of challenges. Customers wanting specific fuels or chemicals do not make logistical plans for the benefit of the terminal. Trucks and railcars do not always show up at the time scheduled or in the order expected, so the terminal may have to make last minute changes to keep things moving. Some additional considerations for operators are outlined below:

- High accuracy volume measurements: load out is virtually always a custody transfer, so this last outbound measurement has to be precise and unquestioned. Whether by truck, vessel or pipeline, all parties to the transaction must agree on the amount changing hands.
- Clear and immediate transfer documentation and billing: once the product moves, the paperwork, either printed or electronic, should be complete and ready on the spot.
- Fast and positive vehicle identification: the ability to identify a vehicle and its driver is an important element of internal control mechanisms.
- Batch control for final blending: some products are blended as they are loaded. The ability to control this process quickly and accurately ensures deliveries on time with products meeting specification. In-line blending also creates opportunity by freeing up storage that may have been used for in tank blending.

Effective automation can simplify these processes to confirm the right blend of product is delivered at the right time to the right vehicle in every situation. Loading facility time can be scheduled accurately and efficiently to avoid time wasting stack-ups. Deliveries satisfy all the parties to a transaction and all documents, printed and electronic, are included. The ultimate result is a higher load out volume, handled quickly and efficiently with a minimum of labour and confusion.

Automation in action

Say a terminal loading facility could shorten turnaround times, increase throughput, reduce energy consumption and essentially stop vapour emissions entirely – all without adding staff. Is this too good to be true?

A major loading facility at a refinery and chemical processing facility in northern Europe did all those things and more, and automation was a major part of the improvements. A third party, Logistic Services, owns and operates the terminal for the customer, and works with Emerson Process Management to provide advanced automation systems. The customer gave the operator a free hand in the design process, provided it met a list of critical requirements related to performance and environmental considerations. For example:

- Unrecovered hydrocarbon vapour emissions have to be below the customer's standards.
- The operator was liable for penalties if a truck cannot be loaded within a two hour window due to an operational failure.
- The operator was responsible for maintenance, but it has no technicians on the site so Emerson performs most of the actual maintenance and repair work.

So how does this facility operate?

- When a tanker arrives for loading, drivers and plant operators follow an automated series of safety steps.
- Vapours captured by the recovery system are burned to generate all the electricity needed for the terminal.
- Critical scheduling capabilities have reduced the normal turnaround time for a typical tanker truck from three hours to two.

Emerson's SmartProcess TMS (Terminal Management Solution) interfaces with the customer's sales order system and transmits information to the tank farm's automation system. Drivers receive transport requests from the customer's ERP system automatically, providing a time slot at the gantry. All the 'paperwork' is thus electronically prepared before the truck even arrives.

With tight schedule control and a condition-based maintenance planning programme, equipment is kept running and repairs are performed when they will cause the least disruption. The operator requires Emerson to maintain a 99.7% availability level for its equipment, which means over a year there must be fewer than three outages of four hours each. This availability includes gantry automation, gantry electrical controls, slot planning, and communication with the customer's ERP system.

This automation programme has reduced the need for human resources in an area where finding qualified people is a serious challenge. The terminal now has a staff of six operators rather than the 10 on the payroll before the automation system installation. The benefits have also been pushed upstream, as the customer says it now spends about 20% fewer administrative man-hours processing transactions thanks to the more refined information it gets from the automated systems.

Conclusion

The overall oil and gas supply chain is hugely complex, and tank farms and terminals can make or break the profitability picture for customers and operating companies alike. Efficient movement of products, by whatever transport mechanism appropriate, ensures adequate supplies and stable markets. The processes necessary to operate terminals efficiently are not conceptually complex, but they can be difficult to execute manually day in and day out.

Automation systems can handle these functions reliably and easily, and the more the various aspects are integrated, the better the overall performance. Piecemeal automation solutions can exhibit many of the same drawbacks of manual approaches, so the greatest benefit, as the customer realised, is found when using a single supplier capable of deploying a truly integrated approach from the enterprise level to loading gantry. 