



# MODERNISING OLD TANK FARMS TO MEET NEW REQUIREMENTS

## TANK GAUGING IS AT THE FOREFRONT OF WIRELESS NETWORKS

**W**hen most tank farms were built, automation was costly. Therefore most storage tanks have a bare minimum of instrumentation and rely heavily on manual checks. There are now even more stringent safety and environmental directives and new fiscal requirements. Considering operator workload, manual tasks become impractical. Therefore tank farms are now being modernised with more automation.

Accuracy, fidelity, and validity are important for tank gauging. It cannot be achieved with 4-20 mA. Therefore tank gauging systems were on the forefront to abandon analog signals instead using digital communication. Digital signals can be transmitted perfectly, without error, for complete fidelity, and can be repeated and replicated infinitely. Digital signals also have near zero marginal cost, once the investment in the network has been made, many signals can be added at little or no cost. Initially, proprietary communication was used but now standard communications such as Foundation fieldbus is used instead.

Tanks usually have no spare wires available for additional instrumentation. Tank farms are usually located some distance away, they are large and are separated by roads, tracks, drains, and ponds preventing trenching to lay cable. Cable would be costly and risky since digging may damage other cable or piping. Moreover, tank operation downtime is lost revenue. Therefore it is very difficult to modernise tanks using wires. Wireless instruments are easy to deploy because cable and digging is not required, and downtime is minimal.

### THE SMART STORAGE TANK

Most tanks are only fitted with level measurement due to the cost of system I/O cards and running wires for 4-20 mA and on-off signals for additional instruments. Tank farms rely on manual inspection for floating roof pontoons, hydrocarbon leaks and spills, pump vibration, manual valve line-up, and roof water pooling etc.

### INVENTORY MANAGEMENT

Tank modernisation often includes replacing existing level gauges. By using wireless communication for the inventory measurements the existing cable is now freed up and can instead be used for SIL-rated overfill protection signal to a safety system. The two signal paths work in parallel.

A refinery in the US has multiple tank farms across the site. The tank measurements were stranded in each area. Operators spent undue time checking and manually recording readings. Wireless networks were deployed in each tank farm and wireless instruments installed on the tanks. Operators now monitor all tanks from a centralized location reducing man-hours spent on operator rounds. The site planned not only for the instrumentation that was being installed on the current project, but made the gateway easily accessible to instruments installed in the future. The wireless network can easily accommodate new measurements. Several points which had not been monitored in the past are now measured.

### FLOATING ROOF TILT AND WATER POOLING

Leaking pontoons or punctured deck, increased rim seal friction, tank wall abnormalities, or the rolling roof access ladder not moving freely may affect the buoyancy of the floating roof on a storage tank. This may cause vapour releases, potential fire, and explosion. If the roof drain pipe is blocked, rain water or snow will accumulate on the roof and may cause the roof floating too low and tilt. Strong winds may also press the roof down or make it tilt. Visual inspection to check the integrity requires a person to climb and enter tanks on a weekly basis.

Floating roof tilt is detected using three level transmitters. One method has radar level transmitters with wireless adapters mounted on the tank rim measuring the distance to the roof, which also becomes a secondary level measurement for overfill prevention. The other method uses wireless guided wave radar level transmitters mounted on roof nozzles or

hatches measuring the distance to the product surface. As a result, operators get an early warning of tilt, and climbing and entering tanks is minimised, improving personnel safety.

An oil refinery in Germany had to meet new safety and environmental directives. Three WirelessHART vibrating fork level switches were installed on each tank to detect pooling on the roof. The fork frequency distinguishes between oil and water. As a result the EU regulations for tank roof safety were met, manual inspections were minimised, and personnel safety was improved.

### HYDROCARBON LEAK AND SPILL

Leaks from tank bottoms, buried valves, and pumps may not be seen and therefore may go undetected for long periods of time.

Hydrocarbon sensor cable with a WirelessHART transmitter detects the presence of fuel in the soil or collecting in a sump. Sensor cable is installed beneath existing tanks using horizontal boring under the tank bottom to detect leakage through corroded steel floor plates. Alternatively, the sensor cable is placed in a trench around the perimeter of each tank. Valves and flanges can also be monitored. Probes can detect liquid fuel on the surface of water due to leaks or overfill. On floating roofs, a sensor detects fuel accumulating due to failure of ring seal.

### SECONDARY OVERFILL PREVENTION

A Mexican crude oil storage terminal required overfill alarms for 20 crude oil storage tanks in two areas spread along 3 km. A WirelessHART vibrating fork level switch was installed on each tank and integrated with the control system. As a result the risk rating for the terminal was improved, the insurance premium reduced, safety improved, tank operation optimised, and environmental regulations preventing oil spills were met.

### PUMP VIBRATION

Bearings on pumps are checked periodically

with a portable vibration tester. However, since tank farm pumps are operated intermittently the pump may not be running when the technician measures. Developing vibration issues may be missed. WirelessHART vibration transmitters are instead used to measure once an hour. As a result, developing problems are caught early. Since vibration sensors are non-intrusive, pumps can be modernized while in operation. WirelessHART pressure and level transmitters on the seal flush reservoir monitor fluid level and pressure to detect mechanical seal failure.

At a terminal in India the pump lube oil levels were checked manually from sight glasses, which is time consuming and error prone. WirelessHART level switches were installed at each reservoir and integrated with the system for low level alarm. As a result manual inspection is reduced and maintenance gets a quick identification of a problem so action can be taken immediately to prevent damage to pump or cause shutdown.

**VALVE POSITION**

Product movement often requires hand operations of manual valves. Incorrect lineup of valves may cause product to be loaded into the wrong tank resulting in mixing of product or in overflow, fire, and explosion. Manual valves can be fitted with WirelessHART position transmitters to feedback valve position to operators for better situational awareness reducing mistakes, and even used for pump interlocks.

After a fire in a terminal in India caused by a dike valve left open, a committee recommended monitoring of dike valves to notify operators. Another operator in India implemented this at 64 marketing terminals using WirelessHART position transmitters. As a result they comply with the regulation and enjoy greater safety.

**MODERNISING TANK GAUGING SYSTEM**

Mechanical level gauges used in some tank farms have moving parts that wear, fail, and require maintenance.

Many tanks farms are modernised replacing mechanical level gauges with electronic radar gauges which have no moving parts resulting in high reliability and low maintenance cost. The new gauges integrate with existing inventory management system by emulating legacy proprietary protocols making it easy to upgrade and liberate the site from proprietary protocols tank by tank. Modern instrumentation based on standard Foundation fieldbus enable device management such

as configuration, commissioning, diagnostics, and internal variables, which can also be accessed through a WirelessHART adapter. The radar can also be used as an independent overflow prevention device. Local readout displays can be added on the same two-wire bus.

A terminal in China had several tank farms built at different times. Each one used different tank instrumentation with different communication protocols and inventory management software which was hard to manage. Some of the instrumentation did not meet custody transfer standards. The terminal standardised on radar level inventory tank gauging system based on standard fieldbus communication and fitted with WirelessHART adapters and secondary wireless vibrating fork level switches. As a result all tanks are managed centrally.

**MODERNISING VALVE AUTOMATION**

Tank farms have many electric actuators/ MOV. Each MOV has 16 or more control and feedback signals to be connected to fully utilise its capability. However, due to the high cost of 4-20 mA and on-off wiring and I/O cards, only some signals are wired, so many functions are not available. Due to these limitations tank farms are among the first to abandon hardwired signals instead using digital networking to harness the full functionality.

Tanks farms can be modernised with WirelessHART or using Foundation fieldbus for MOVs. This results in MOVs with full functionality free from proprietary protocols. The instrument and control engineers can centrally access MOV diagnostics such as torque and motor temperature.

The same Intelligent Device Management (IDM) software used to manage the radar level transmitters and control valves can also be used to manage MOV and two-wire intelligent on-off valves.

**TANK FARM 4.0**

Tank farm automation has a history of leading with digital networking, first with proprietary protocols, and now with wireless and standard fieldbus. Existing tank farms can be modernized with wireless and fieldbus to meet today's demands, and to be ready to meet future needs. Start with a modernization audit of the tank farm to uncover missing measurements that need to be instrumented to make the storage tanks and tank farm smart, and ready for the Industrial Internet of Thing (IIoT) and Industrie 4.0.



IDM software dashboard for fieldbus MOV rendered from EDDL

**SMART STORAGE TANK**



Higher degree of instrumentation alarm on tank floating roof tilt and water pooling

**SMART PUMP**



An instrumented pump alarms operations when cavitation arises and maintenance if service is required.

**SMART MANUAL VALVE**



Position of manual valves can be seen from the control room

**GAUGE REPLACEMENT**



Instruments send the data to the operator instead of the operator coming to the data

**SMART MOV**



Digitally networking unleashes the full capability of an electric actuator