



Tank Gauging: New Inventory, Safety, Environmental, and Operational Capabilities

One of the most important things to Stockholders, Senior Management, Buyers/Sellers, and others is the value and accuracy of their inventory. This is determined by the Quantity and Quality of the petroleum inventory. The Quantity of petroleum is measured by Volume in most countries within the West Hemisphere, and in some instances by Mass (Chemicals, etc.). The important Quality parameters include density (specific gravity) and water content.

In addition, there are new Safety, Environmental, and Operational regulations or recommended practices that are of great interest for tank owners and operators.

Onward:

There are two traditional methods for determining of Quantity (Volume) of product in storage tanks:

Hybrid Method – is based upon the measurement of Level, Temperature, Density, and Water. The Density in the Hybrid method is measured by a combination of pressure transducers and level measurement. The water measurements are limited to the length of the capacitance probe located at the bottom of the temperature averaging probe (no more than 3ft or 1m).

Hydrostatic Method – is based upon the measurement of up to three pressure points and one temperature point. It does provide calculations of Volume and Mass, as well as average density in the lower portion of the tank. If water is required, then additional instrumentation is needed. Traditional Hydrostatic Tank Gauging systems are composed of multiple instruments, multiple pipe legs (hot taps might be required for installation), block valves, drain valve, heat trace, and tubing are required for mounting & calibration of pressure transducers. Compensation of tank bulging and wind effects must be taken into account. Both Hybrid and Hydrostatic methods require multiple instruments, multiple cable runs, multiple termination points, multiple instrument installations and calibration.

Product Quality is determined not only by the average density and free water, but rather by the density and location and amount of and water within the tank. It is essential to either measure multiple strata or to mix the liquid before inventory or transfer.

There is now advanced Tank Gauge technology that provides all measured and calculated parameters of Hybrid and Hydrostatic Methods, including Volume, Mass, Level, Multi-point spot temperature, Average product temperature, Multi-



strata density, Average product density, total Water (Free, Emulsified, & Entrained), Vapor (pressure, temperature, & density), Ambient (pressure and temperature), and Flow Rate.

The economic, safety, and operational benefits by using advanced tank gauging technology:

An advanced Tank Gauging technology can provide fuel quality sampling data in real-time. The recommended practice for **Fuel Quality** (API RP 1640 and API RP 1543) requires the measurement of density and water to determine product quality. Testing is done by the sampling of fuel (API MPMS 8.1) at the High, Middle, and Low points within the tank before transfer.

In addition, new tank gauge technology has the ability to configure multiple independent tank gauges in one probe. The multiple independent tank gauges can be utilized to address physical tank and operational needs including: Reducing the number of tank mounting entries, providing **tank gauge redundancy**, providing an additional benefit of combined tank gauging data from multiple gauges (virtual gauge). Configurations of multiple gauges within one probe for taller tank heights, critical sensors redundancy configuration, and other applications are achievable.

Overfill Protection in accordance with API Standard 2350 can be achieved with the new tank gauge technology's use of two independent tank gauges within a single probe. One tank gauge for normal operation and the second configured to address Overfill Protection. However, it goes further than the current standards, it addresses **Tank Rupture** by monitoring both tank over pressure and vacuum. In addition, it provides options for low level alarm, operational alarm points, and critical sensor redundancy.

Leak detection capability: Using accurate mass sensitivity for leak detection determination by a tank gauge in above ground storage tanks. Level based systems cannot provide accurate leak detection capabilities for above ground storage tanks. This is because of the extreme dependence on temperature and its effect on Level, which makes leak detection probability too low and false leak detection probability too high for aboveground storage tank. The new tank gauge technology's leak detection capabilities are based on direct mass change sensitivity, which is not dependent on temperature and density variations.

Vapor emission monitoring requires both Vapor and Ambient (Pressure, Temperature and Density) parameters for calculating the emissions from a given tank. New tank gauging technology provides these parameters continuously and in real time.

Pressure Vacuum Relief Vents and Gas Blanket Monitoring: requires both Vapor and Ambient (Pressure, Temperature and Density) parameters for



determining PVRV settings and gas blanket pressure on cone roof storage tank. Thus, provides functional data parameters and minimum / maximum values to monitor operating condition

In tank blending: The advanced tank gauging technology monitors the density (specific gravity), temperature, water, product volume, and available space within the target tank. It also monitors the density, temperature, water, and product volume of the transfer tanks. The monitoring of product quality and volume within available space, allows for optimization of in-tank blending. This could be used for example for benchmark crude preparation, fuel oil optimization, lubricant, and chemical blending.

Water settling. The monitoring of multiple strata for free, emulsified, and entrained water throughout the height of the tank provides a more accurate view of the water settling process, total water / product quantity per strata, settling time, and tank optimization.

Water separation: The advanced tank gauge technology monitors multiple strata for free, emulsified, and entrained water throughout the height of the tank capabilities provides a more accurate view of the water settling process, total water / product quantity per strata. Over time the water may stop descending to the free water layer towards the tank bottom and seemly hold as entrained water in product strata. At this point tank operators could decide whether the percentage of water in product is within specification or do you add de-emulsifiers.

Multiple single points as well as average temperature: Even though multi-point temperature probes are used by multiple tank gauging vendors to provide average product temperature. The ability to utilize single temperature points for operational needs, with advanced tank gauging technologies.

Self-Calibration: The advanced tank gauging technology uses normal tank movement to calibrate its own sensors. As product goes down and exposes a sensor, it is automatically compared to the reference sensor in vapor space and re-calibrated. Every time the tank is cycled (Filled and then emptied), a full re-calibration is achieved.

The advanced tank gauge **Architecture** provides maximum redundancy built into the initial design. A single failure point (sensors, transmitter wing boards, etc.) will not take down the complete gauge in most cases, the system is designed to minimize Mean-time To Repair (MTTR). In the known case of total failure, an optional solution is available and also reduces MTTR to minutes.

Diagnostics and Forecasted Maintenance: The advanced tank gauge technology provides most extensive alarms, warnings and self-diagnostics capabilities down to raw output of every sensor. This information is available continuously through MODBUS register map together with the measurement



data. Not only the system diagnoses and flags any problem, it also may be configured to automatically set a sensor into a maintenance mode to allow system's continuous operation with very insignificant temporary degradation of accuracy due to redundancies embedded with the design. A sensor could be put in maintenance mode manually as well. The collection and database history of sensors from the raw data can be used for forecasting any possible maintenance issues.

Behavioral analysis: The new tank gauging technology provides a great deal of information with every poll. It provides operational information on the tank, product, measured parameters, alarms, diagnostics, and more that can be used by the host system for permanent and continuous view inside the tank process. That in turn gives unique opportunity for behavioral analysis and process optimization, which may lead to significant economic benefits. These benefits include shortening of operational cycle, lessening the personnel workload, increasing target product (blend, settling etc.) accuracy and improve asset management. The data from the modern system are suitable for detailed statistical analysis of every process, which may lead to technology improvements resulting in cost savings.

Should a sensor change be needed, such procedure takes just a couple of hours without taking tank out of operation.

Advanced Tank Gauging Technology changes prospective on what a tank gauge can do for tank operators and tank owners and sets new criteria for in-tank measurements. For more information please visit www.gaugingsysteminc.com

