

New technologies reduce the costs of improving terminal efficiency and safety



Tank gauging requires integrated high performance level, pressure and temperature measurement

An open system architecture makes it easy to install the devices needed today and add or replace units in the future. This flexibility protects users' investments so that refineries and tank farms more easily can become and stay efficient. Additional benefits include lower installation costs, high accuracy and built-in safety functions. One feature with substantial potential to save cost is wireless transmission of measurement values. This enables high precision tank gauging data to be made available anywhere on the plant at a much smaller cost than before

• A modern automatic tank gauging (ATG) system is an integrated high performance measuring and calculation system. It normally includes sensors for measurement of following storage tank data:

- Level
- Average product temperature
- Pressure (if on-line density and mass is required)
- Free water level (if required).

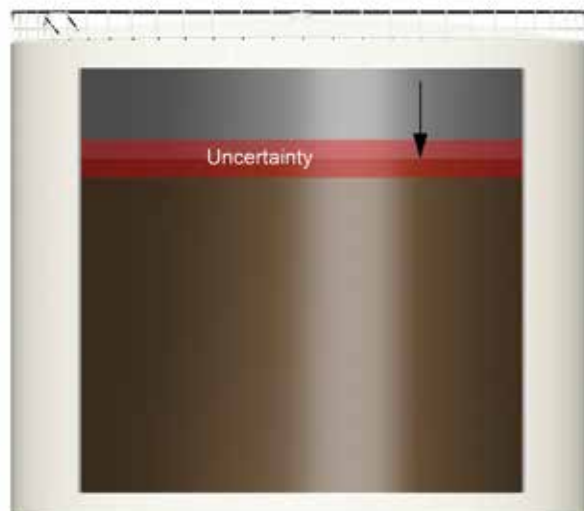
• These data are in most cases used for three main processes handled via a human-machine interface (HMI):

- Tank terminal operations monitoring including overfill prevention
- Inventory management to calculate storage tanks net volumes
- Custody transfer to buy and sell bulk liquids.

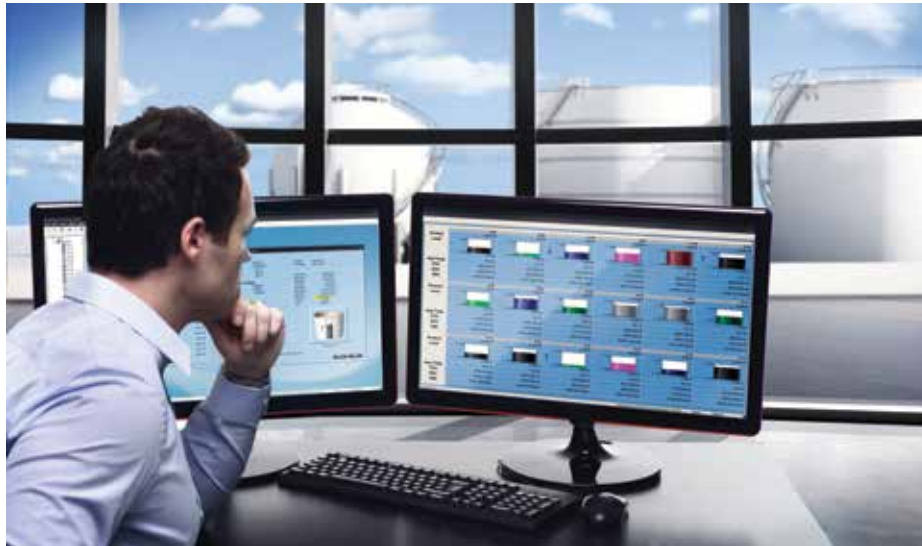
• For inventory and custody transfer purposes, errors and uncertainty in volume measurement can have large

economic implications. A 5 mm level measurement error plus a temperature error of 0.6° C in a large crude oil tank corresponds to around 32m³ of liquid. Considering the amount of transfers this can add up to a value of several tens of thousands of US Dollars for one tank during one year of operation.

A precise calculation of net volumes is consequently the key for useful inventory



Reduction of net volume measurement uncertainty can correspond to large annual values



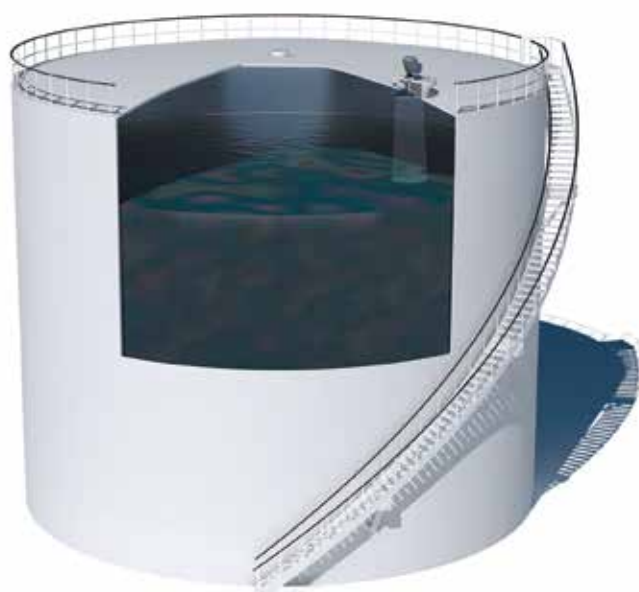
Graphic product movement indication for each tank gives quick summary of tank activity

data required for both internal accounting purposes and external taxation.

Custody transfer based on automatic tank gauging requires in addition very accurate volume measurement of product transfer batches. Many countries have metrological authorities approving gauging systems for legal custody transfer. Most of these authorities accept gauges that are approved and tested by an accredited laboratory according to the Organisation International Metrologie Legal (OIML) requirements. The performance requirement of the OIML standard is approximately 1 mm level accuracy under reference conditions and 2 mm installed accuracy.

Radar level gauging for reduced downtime

Since radar level gauges provide high reliability with no moving parts, and only the antenna/probe is inside the tank, they have become widely used



Free propagation radar with parabolic antenna

both for high accuracy tank gauging and process level measurement.

For radar level measurement, there are mainly two modulation techniques used today:

- Pulse method
- Frequency modulated continuous wave (FMCW).

Using the pulse method means that the radar transmitter measures the time it takes for a pulse to travel to the surface and back. The Time Domain Reflectometry (TDR) technology is a special case, using low power nano-second pulses.

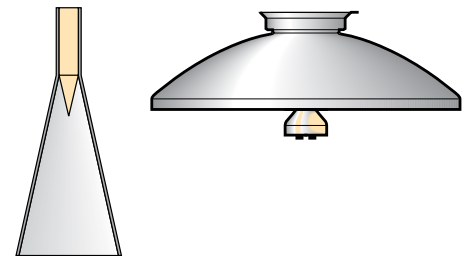
The FMCW method is used by high performance radar level gauges to enable real custody transfer accuracy. The radar gauge transmits microwaves towards the surface of the liquid. The microwave signal has a linear frequency variation. The reflection from the liquid

Digital reference

An FMCW radar gauge needs an internal reference to make the radar sweep linear. Each deviation from the linearity produces a corresponding inaccuracy. To achieve highest precision, the gauge should have an on-line adjustment of transmitter frequency.

Drip-off means less condensation

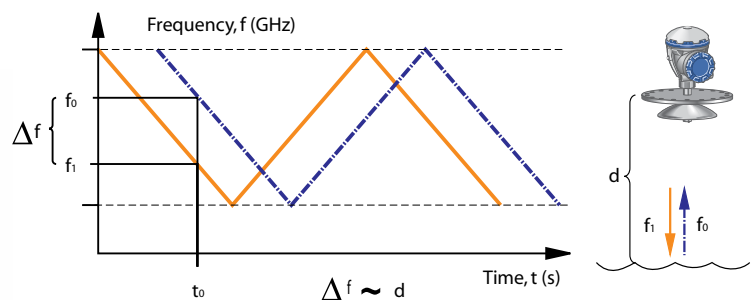
An antenna with an inclined polished PTFE surface where microwaves are emitted will be less susceptible to condensed water or product. The amount of condensation coating the active part of the antenna will be reduced, resulting in a performance increase.



Drip-off antennas

Open and scalable architecture

One way to implement a flexible system architecture is to build the system around a Tankbus connecting all measuring devices on the tank to a 'tank hub', normally located at the tank foot. From the tank hub, a fieldbus, often Modbus based, is

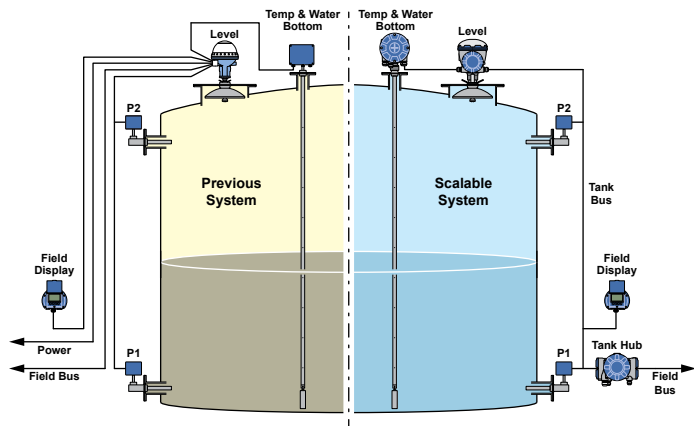


FMCW measuring method

surface has a slightly different frequency compared with the signal transmitted from the antenna when the reflection is received. The difference in frequency is measured, and it is directly proportional to the distance to the liquid surface.

used to transmit data to the control room.

If the Tankbus is based on an open industry standard, Foundation fieldbus, it will allow integration of any device supporting this communication protocol. By making the devices self-configuring startup will be easy requiring no special knowledge of Foundation fieldbus. One system can include a wide range of components to build a small or large customised tank gauging system.



New bus powered scalable 2-wire system means less cabling

Because of the modular design, a system can later easily be expanded/ upgraded and suited to different requirements on accuracy/performance, functionality, or system output.

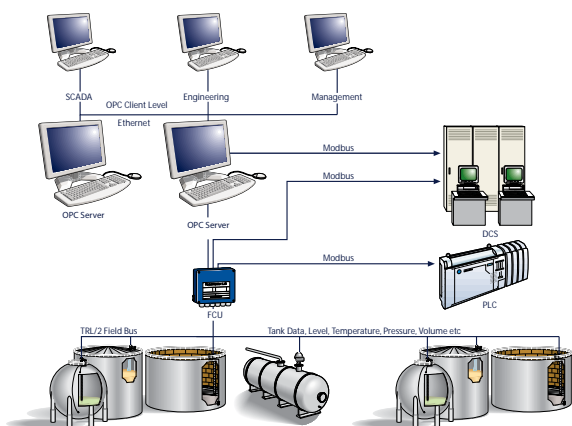
This solution has several advantages as:

- It is safer both at system start-up, and in operation
- Installation costs less, is quicker and easier due to less cabling
- No expensive cable conduits are required.

Networking and remote access

Interoperability and remote access of tank data is necessary for efficient tank farm management. The tank gauging system should be able to connect to all major suppliers of DCS, SCADA systems, plant host computers or terminal automation systems.

The advantage of connecting host computers to a tank gauging system HMI software is that not only the measured values, but also the calculated inventory data can be communicated. Communication to office environment computers and Scada/DCS systems can be made via OPC server or via Modbus.



The HMI software distributes essential inventory tank gauging data

To utilize redundant functionality it is also possible to build a network of several server and client PCs with tank gauging HMI software.

Overfill prevention

All refineries, tank farms and fuel depots have a responsibility to ensure that overfill

incidents do not occur. Depending on the requirements, the tank gauging devices should be certified for overfill protection



Picture caption please

according to IEC 61508-2 and 61508-3. This type of system provides High-High level alarm functionality, based on a separate SIL 2- or SIL 3-rated relay functions. The alarm loop triggers the safety relay output to the Emergency Shutdown System (ESD).

The inclusion of two electronics packages integrated into one transmitter head, a 2-in-1 solution, makes it possible to install a level gauge, and get one primary plus one backup unit, or one primary level gauge plus an independent radar based High-High level alarm. Compared to having two separate gauges, the 2-in-1 solution makes mechanical and electrical installation easier.

Smart wireless tank gauging

Many tank storage facilities that would benefit from modern, non-contacting gauging have obsolete or non-existing signal wiring from the tank storage area. Retrofit of the gauging system in such plants is normally expensive and time consuming as the distance between storage tanks and the control room can be more than one kilometer requiring extensive trenching and cabling.

By connecting a wireless adapter to the tank gauging system, complete tank inventory data can be sent to the control room via WirelessHART communication.

The self organising mesh network ensures uninterrupted data communication also in an environment with large mechanical obstacles such as storage tanks. Wireless tank gauging also means that precise inventory data for remotely located tanks that was previously out of reach can be made available.

Antennas for all storage tank types

To get high precision, radar antennas for level gauges need to have optimised design for various storage tank designs:

The following man types of antennas will cover the need for most bulk liquid storage tanks:

- Parabolic antenna for fixed roof tanks using a 20 inch standard man hole. Installation is made with tank in service in most cases.
- Horn Antenna for fixed roof tanks for smaller nozzles down to 8 inch
- Still-pipe array antenna for floating roof tanks
- LPG/LNG antenna with calibration device for closed tank.

Emulation for step by step upgrades

In order to modernise existing tank gauging system step by step, the new tank gauging system must be compatible with other major tank gauging vendors.

With this compatibility, it is possible to replace old mechanical or servo gauges with modern radar level gauges using the existing tank openings, field cabling, and control system. The gauge is normally installed with the tank in operation. No hot work is required. A gauge seamlessly replaces another device, independent of measurement technology. Data from the integrated radar gauge is displayed as before on the existing inventory management system. By replacing old servo gauges, you can avoid re-calibration and the expenses associated with spare parts and maintenance.