CUSTODY TRANSFER METERING

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ABSTRACT

While performing a flow measurement in a process control, the accuracy of measurement is typically not as important as the repeatability of the measurement. When controlling a process, engineers can tolerate some inaccuracy in flow measurement as long as the inaccuracy is consistent and repeatable. In some measurement applications, however, accuracy is an extremely important quality, and this is particularly true for custody transfer. The money paid is a function of the quantity of fluid transferred from one party to another. Small error in the metering can add up to big losses in terms of money.

Until now, five technologies are used when it comes to custody transfer metering:

1. Differential Pressure (DP) flow meters
2. Turbine meters
3. Positive displacement meters
4. Coriolis meters
5. Ultrasonic meters

Many aspects are taken into consideration when a flow meter is to be selected for custody transfer metering. The accuracy, repeatability, rangeability, availability in higher line sizes etc are some of the factors which suggest why multipath Ultrasonic flow meters are the most preferred in custody transfer metering systems.

Factors affecting accuracy are vital parameters to be studied during designing of a custody transfer metering system. There are meteorological parameters, installation parameters, and external interferences that can disturb the accuracy of the flow meter.

Periodic proving of the flow meter is necessary to confirm or re-establish the performance accuracy of the accounting meter before, during, and after a custody transfer. A flow prover can be installed in a custody transfer system to provide the most accurate measurement possible.

There have been large changes in the instrumentation and related systems used for custody transfer. Meters with intelligence i.e. with modern electronics, software, firmware and connectivity can perform diagnostics and communicate information, alarms, process variables digitally.

KEY WORDS

Custody Transfer, Ultrasonic flow meter, Coriolis meter, Standards, proving

1.0 INRODUCTION

Custody Transfer in oil and gas industry refers to the transactions involving transporting physical substance from one party to another. The term "fiscal metering" is often interchanged with custody transfer, and refers to metering that is a point of a commercial transaction such as when a change in ownership takes place. Custody transfer takes place any time fluids are passed from the possession of one party to another.

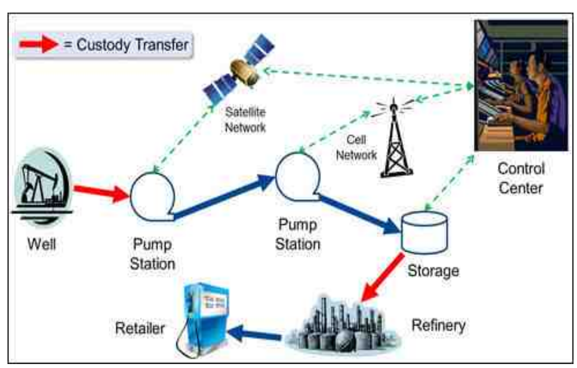

Figure 1-A custody transfer depiction

Measurement errors in custody transfer can be very expensive, hence custody transfer and fiscal metering are regulated in most countries by National Metrology standards and involve government taxation and contractual agreements between custody transfer parties. Custody transfers are also influenced by a number of industry associations and standards organizations such as American Gas Association (AGA), American Petroleum Industry (API), US National Institute for Standards and Technology (NIST), Physikalisch-Technische Bundesanstalt (PTB) in Germany, China Metrology Certificate (CMC), and gosudarstvennyy standard (GOST) in Russia.

Custody transfer applications require more than an accurate flowmeter. There are a number of critical components that comprise a complete metering system including:

- Multiple meter runs with multiple meters in parallel
- Pressure and temperature transmitters
- Flow computers
- Quality measurement
    - For gas energy content, online gas chromatography
    - For liquids, sampling systems and water monitoring
- In-situ calibration using provers or master meters
- Automation

2.0 Custody Transfer Metering Methodologies and Measurement Technologies

While there are many types of flow meters in general industrial use, many of these are not suitable for custody transfer. Generally, five technologies are used for custody transfer measurements.

Differential pressure (DP) flowmeters are the oldest of the technologies and the first to be studied and approved for custody transfer for natural gas. In 1930, the AGA issued Report AGA-1 to cover the use of DP flowmeters with orifice plates for custody transfer applications. Differential pressure (DP) flowmeters are used for the custody transfer of liquid and gas to measure the flow of liquid, gas, and steam. The DP flowmeter consist of a differential pressure transmitter and a primary element. The primary element places a constriction in a flow stream, while the DP transmitter measures the difference in pressure upstream and downstream of the constriction.

In many cases, pressure transmitters and primary elements are bought by the end-users from different suppliers. However, several vendors have integrated the pressure transmitter with the primary element to form a complete flowmeter. The advantage of this is that they can be calibrated with the primary element and DP transmitter already in place.

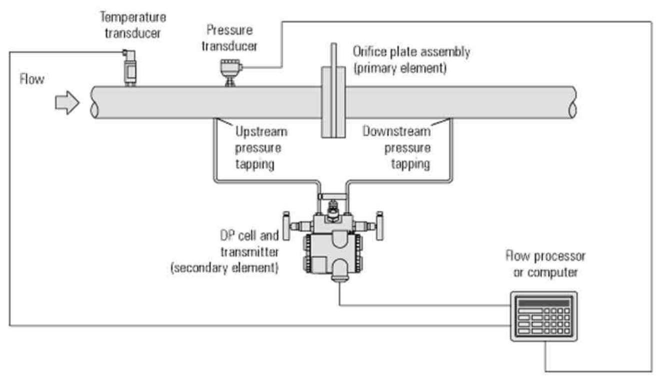

Figure 2-A typical orifice plate steam flowmetering

DP meters can operate in very harsh environments and also feature a high degree of robustness and reliability. A disadvantage of using a DP flowmeters is that they introduce a pressure drop into the flowmeter line. This is a necessary result of the constriction in the line that is required to make the DP flow measurement (fig.3)

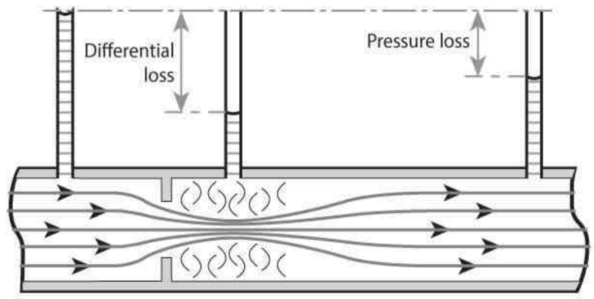

Figure 3-Pressure loss across the DP meter

Turbine meters were approved by the AGA through the AGA-7 in 1981. Turbine flowmeters consist of a rotor with propeller-like blades that spins as water or some other fluid passes over it. The rotor spins in proportion to flow rate. The turbine flowmeter is most useful when measuring clean, steady, high-speed flow of low-viscosity fluids.

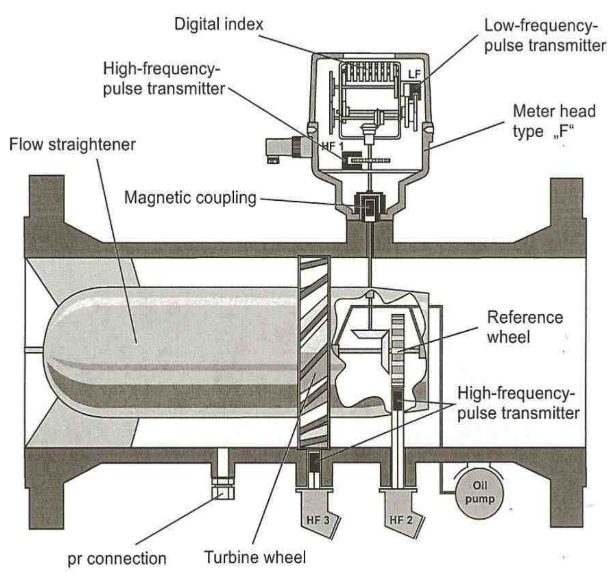

Figure 4-Cross section of a typical turbine meter

In comparison to other flowmeters, the turbine flowmeter has a significant cost advantage over ultrasonic flowmeters, especially in the larger line sizes, and it also has a favourable price compared to the prices of DP flowmeters, especially in cases where one turbine meter can replace several DP meters. During the 1990s, turbine flowmeters began to replace DP flowmeters, especially for gas applications. The main reasons were the higher accuracy of many turbine flowmeters, along with their greater rangeability and cost effectiveness. Turbine meters are also used for custody transfer of petroleum liquids. The disadvantage of turbine flowmeters is that they have moving parts that are subject to wear.

Positive displacement (PD) meters are common for small line size applications. These flowmeters are highly accurate meters that are widely used for custody transfer of commercial and industrial water, as well as for custody transfer of many other liquids. PD flowmeters have the advantage that they have been approved by a number of regulatory bodies for this purpose, and they have not yet been displaced by other applications. It is unusual to find PD meters in line sizes above 10”. PD meters excel at measuring low flows, and also at measuring highly viscous flows, because PD meters captures the flow in a container of known volume. Speed of flow doesn’t matter when using a PD meter. Downsides of PD meters include pressure drop and mechanical moving parts.

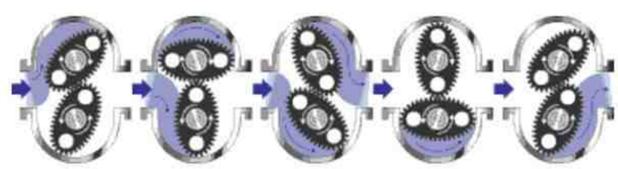

Figure 5-The oval gear positive displacement method

Recent advances in measurement technology have introduced two highly accurate and repeatable flow measurement technologies to custody transfer: Coriolis mass flow meters and multiple-path ultrasonic flow meters.

In oil and gas industry, as in many others, the transition from traditional-technology to new-technology flowmeters is evident not only in custody transfer applications, but also elsewhere in the flowmeter world. However, traditional meters still have the advantage of a large installed base.

It has to be mentioned that any measurement instrument that relies on one measurement principle only will show a higher measurement uncertainty under two-phase flow conditions. Conventional measurement principles, like positive displacement, turbine meters, orifice plates will seemingly continue to measure, but will not be able to inform the user about the occurrence of two-phase flow. Yet modern principles based on the Coriolis effect or ultrasonic flow measurement will inform the user by means of diagnostic functions.

Coriolis Mass Flowmeters

Unlike other meters, Coriolis flowmeters are not volumetric flowmeters, but instead measure mass flow directly. As fluid flows through a Coriolis flowmeter, the measuring tubes twist slightly due to the Coriolis force. The natural vibration frequency of the tubes changes with the mass flow of the fluid (fig.6).

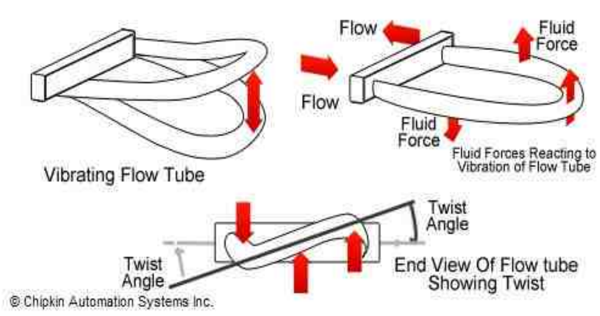

Figure 6-Coriolis principle of operation

Coriolis flowmeters have been around for more than 40 years and are preferred in process industries such as chemical, food and beverage. Coriolis technology offers accuracy and reliability in measuring material flow, and is often considered among the best flow measurement technologies due to direct mass flow, fluid density, temperature, and precise calculated volume flow rates. Coriolis meters do not have any moving parts and provide long term stability, repeatability, and reliability. Because they are direct mass flow measurement devices, Coriolis meters can handle the widest range of fluids from gases to heavy liquids and are not impacted by viscosity or density changes that often effect velocity based technologies (PD, Turbine, Ultrasonic). With the widest flow range capability of any flow technology, Coriolis can be sized for low pressure drop. This combined with the fact that they are not flow profile dependent helps eliminate the need for straight runs and flow conditioning which enables custody transfer systems to be designed with minimal pressure drop.

Figure 7-Actual installation of Coriolis meter

The first Coriolis mass flowmeter was manufactured in the beginning of 1970s. In 2002, the API approved the use of Coriolis flowmeters in custody transfer and fiscal metering (API Chapter 5.6). Coriolis meters are currently supplied for line sizes 1/14" to 16" (1-400 mm).

Flow is measured using Coriolis meters by analyzing the changes in the Coriolis force of a flowing substance. The force is generated in a mass moving within a rotating frame of reference. An angular, outward acceleration, which is factored with linear velocity is produced due to the rotation. With a fluid mass, the Coriolis force is proportional to the mass flow rate of that fluid. A Coriolis meter has two main components: an oscillating flow tube equipped with sensors and drivers, and an electronic transmitter that controls the oscillations, analyzes the results, and transmits the information.

The Coriolis principle for flow measurement requires the oscillating section of a rotating pipe to be exploited. Oscillation produces the Coriolis force, which traditionally is sensed and analyzed to determine the rate of flow. Modern coriolis meters utilize the phase difference measured at each end of the oscillating pipe. While Coriolis flowmeters can have pressure drop and are not available for line sizes above 16" (400 mm), these disadvantages are outweighed by lack of moving parts and significant accuracy improvement over many other flow meters, even those that are temperature and density compensated. In fiscal metering and custody transfer applications, this accuracy is critical.

Ultrasonic Flowmeters for Custody Transfer

User demand for higher accuracy and reliability is causing a shift towards new-technology flowmeters, especially ultrasonic and Coriolis. And in the case of ultrasonic flowmeters, this shift is helped by the number of new products entering the market, particularly for custody-transfer.

The history of ultrasonic flowmeters goes back to 1963, when Tokyo Keiki first introduced ultrasonic flowmeters to commercial markets. In 1972, Controlotron was the first company to introduce clamp-on ultrasonic flowmeters in the United States. In the late 1970s and early 1980s, Doppler ultrasonic flowmeters came to prominence. However, they were not well understood, and as a result often misapplied. This gave ultrasonic flowmeters a bad reputation with some end-users, but by the 1990s ultrasonic flowmeters were being widely used for industrial applications.

Much of the history and success of ultrasonic flowmeters is tied to approvals granted by industry associations. For most custody-transfer applications, end-users select a type of flowmeter for which an industry-approved standard exists. In June 1998, the American Gas Association (www.aga.org) published a standard called AGA-9. This standard lays out criteria for the use of ultrasonic flowmeters, specifically multipath systems, for custody transfer of natural gas. It was updated and reissued in 2007. The publication of this standard gave a boost to the sale of ultrasonic flowmeters, especially those of the multi-path variety.

Ultrasonic flowmeters are volumetric devices that measure the velocity of flowing liquid or gas, and use that velocity to calculate flow rate.

Transit-time ultrasonic flowmeters use a pair of transducers, one pointed upstream and one pointed downstream in the meter body (fig.8). The difference in transit times of the downstream-directed pulses and the upstream-directed pulses is used to determine the average velocity of the fluid. Multiplying velocity by the cross-sectional area of the pipe gives volumetric flow rate (Q=VA). Mass flow can be computed using input from a densitometer.

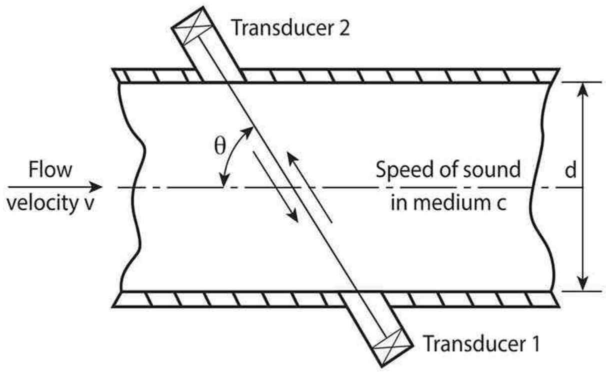

Figure 8-Ultrasonic meter schematic (single path)

Single Path vs. Multipath

Ultrasonic flowmeters often use multiple sets of transducers mounted in the pipe wall. Multi-path meters allow highly accurate readings of average axial velocity, with diagnostic information about flow disturbances which could impact measurement accuracy.

One difference between custody transfer and non-custody transfer applications for ultrasonic flowmeters is that custody transfer applications require three or more measurement paths within the meter. Multi-path ultrasonic meters measure flow velocity at more than one location in the pipe. A path is the route traveled by an ultrasonic signal from one side of a pipe to the other and back.

While ultrasonic meters with two beams could be considered multipath, the term multipath is usually reserved for ultrasonic meters with three or more beams. The best-known ultrasonic flowmeters for custody transfer of natural gas have four, five, or six beams. The jury is still out on what is the optimal number of paths, or the extent to which adding more paths than six offers

improved performance. What is clear is that multipath ultrasonic flowmeters, regardless of the number of paths, typically outperform single or dual-path meters.

Since approval by AGA in 1998, ultrasonic flowmeters have become widely used for custody transfer of natural gas. They are typically available from 2”-line sizes and can handle large natural gas pipelines, which often range from 20 to 42 inches-line sizes. Ultrasonic flowmeters are also used for custody transfer of petroleum liquids – from the oil well through the refinery to the ultimate distribution point.

Advantages of ultrasonic flowmeters include no moving parts, high accuracy and turndown ratio, and virtually no pressure drop. Because there is little or no pressure drop, ultrasonic meters minimize the loss of energy due to friction losses through the meter, and improve the efficiency of pump stations in oil and gas pipelines. They can be used for measurement of crudes, including the heavy crudes found in oil shale and oil sands. Advanced models have sophisticated transmitters and flow computers with full diagnostic suites that make calibration easier and reduce measurement uncertainty. This capability simplifies operations.

Measurement of Liquids

Ultrasonic flowmeters are used to measure both gas and liquid flows. In 1995, the International Organization of Legal Metrology (OIML, www.oiml.org) developed R 117, “Measuring Systems for Liquids Other than Water.” While this is a standard that applies to ultrasonic flowmeters, it applies to other types of flowmeters as well.

After seven years of AGA adopting AGA-9 in 1998, a standard was approved in the United States that was specific to the use of ultrasonic flowmeters for liquid applications. In February 2005, the American Petroleum Institute (API, www.api.org) published a standard for the use of ultrasonic flowmeter for measuring liquid hydrocarbons. Since that time, suppliers have brought out flowmeters that conform to both OIML 117 and the API

Accuracy and Uncertainty

Accuracy is the ability of the meter to measure close to the true value of the flow. Manufacturers usually state the accuracy of their flowmeters. This is often the accuracy of the flowmeter in the calibration lab, but it can be affected by many installation parameters including temperature and density changes, piping configuration, and obstructions in the flow upstream of the flowmeter. Also, vibration (noise) or flow pulsations from nearby rotating equipment can interfere with an ultrasonic sensor's measurement or affect a Coriolis meter.

Total calculated measurement uncertainty of the installed flow meter takes into account: the accuracy of the flowmeter itself, the contribution to inaccuracy of piping and obstructions, and the accuracy of the flow computer and other electronics, including the flow computer's A/D converter. Because of the significant financial risks in custody transfer and fiscal metering applications, close attention must be paid to small details that would be ignored in a process application.

Alignment of the metering tube and the upstream piping is critical. If the misalignment is less than 1/8" (3.2 mm) and the misalignment is concentric, an ultrasonic flowmeter can handle the discrepancy. If the misalignment is eccentric, errors up to 0.2% can be caused. Such an error can result in under- or over-billing of very large amounts over a year's time.

As with process flow applications, upstream obstructions and disturbances in the flow stream must be reduced. However, due to the accuracy requirements of a fiscal metering or custody transfer application, it is even more critical to reduce noise and flow disturbance from control valves, thermowells, elbows, wyes, and tees upstream of the meter.

Where practical, there should be a sufficient straight run of piping upstream and downstream of the flowmeter. Also, control valves and temperature instruments that protrude into the pipe should be located downstream of the flowmeter. Noise and vibration damping devices may be required, especially when using Coriolis and ultrasonic flowmeters.

In many custody transfer installations, multiple meters are installed off a single header. This permits each flowmeter to be operated independently of any other meter, allows one meter to be used as a master meter, and gives the operator and maintenance technician the ability to isolate one flowmeter for repair, calibration and maintenance without shutting off the flow.

It is also important to size headers correctly as header sizing can be critical to the performance of the system. Header sizing is especially important when retrofitting an existing metering skid or metering installation. Care must be taken to ensure that headers are actually built as depicted in the drawings.

Thermowells are challenging, though necessary. AGA 9, for gas metering, recommends installing thermowells at least 2 to 5 pipe diameters downstream of the flowmeter. For bi-directional systems, the standard recommends 3 diameters from the meter. Many flow experts consider these distances to be too close, and add a margin of safety to increase measurement certainty. Vortices shed from thermowells disrupt the flow profile and can reduce installed metering accuracy.

4.0 Proving and calibration

Flow Provers

Each gas or liquid flowmeter can be calibrated against a master meter onsite, or in liquid metering applications, by a stationary or portable prover (Fig 8). For pipe sizes below 42” diameter (1.07 m), on-site provers can be used. Flowmeters in larger pipe sizes must be shipped to a calibration facility capable of handling larger meters, unless another means of volumetric calibration can be found.

Figure 8: A flow prover is installed in a custody transfer system to provide the most accurate measurement possible.

In master meter proving applications, one flowmeter is designated as the flow prover. It must have an accuracy that is better (some claim one order of magnitude better while others claim that four times better is necessary) than the meter to be tested. The master meter must also have been calibrated against a primary standard within the past 12 months.

To prove a flowmeter, that is, to check the calibration, the meter to be tested is valved in series with the master meter prover. The error between the meter under test and the prover or master meter is used to produce a correction factor. This correction factor is programmed into the flow computing system connected to the meter under test. In a multi-run metering system, each flowmeter must be proved in turn. Proving of the meters is done as often as necessary for the particular application.

Good Planning Improves Performance

Selecting the right flowmeter is not enough – for custody transfer, the entire installation must be carefully designed and constructed to reduce measurement uncertainty. The engine of a custody transfer or fiscal metering installation is the flow computer. It is the device that takes the inputs from the measuring devices (flowmeters, pressure sensors, temperature sensors, density sensors, gas chromatographs, and others) and calculates the amount of liquid or gas that has been transferred. These calculations are based on a variety of industry standard flow calculation algorithms.

Many flow computers can handle multiple flow measurement trains. For example, the Daniel S600 flow computer can handle up to 10 meter runs, or six meter runs and a prover. In many applications, flow computation is seen as such a critical function that redundant flow computers are employed to ensure continuous measurement in the event of a single flow computer failure.

Although compact piping is aesthetically pleasing and can consume less real estate at the installation site, it often introduces flow profile distortion and noise. Good planning includes making sure that the appropriate straight runs of pipe with no valves or taps before and after the meter are provided, and that there is sufficient space around the meters to clean them, perform other maintenance, and remove the meter for repair and calibration.

Something that is often forgotten is to provide enough physical access room for service trucks, portable flow provers, and other calibration equipment. The area and the mounting pad must be designed to properly bear the weight of the installation and of any temporary equipment.

The electrical integrity of the system must be maintained, ensuring proper grounding and adequate electrical service to all metering system devices. If the power service is especially noisy, electrical noise filtration must be provided upstream of the connections to the meters and the flow computer to avoid the possibility of noise being introduced into meter and device signals. Other factors become important when a prover is included in the installation. For example, valves should be designed as “double block and bleed.” This prevents bleed-through of fluid past a leaky valve, bypassing the prover and resulting in proving errors. Entrained gas in liquid flow streams must be eliminated as well. Likewise, pockets of gas in a liquid stream can cause metering error and/or damage to some types of liquid meters.

Metering Skids

Because building a custody transfer or fiscal metering system requires special expertise that is often hard to find in-house in a typical end user company, the best solution can often be the purchase of a purpose-built metering skid. If this option is selected, it is important to pick the right supplier. The selected skid builder must have extensive experience and knowledge of flowmeter technologies, flow characteristics, accepted meter proving practices and technologies, government and agency regulations, and much more.

Figure 9: A custody transfer metering system

Many liquid applications must include provisions for proving meters in place under actual operating conditions. That can mean connecting a prover skid directly to the metering station, or making it possible to easily connect a portable prover.

In order to get the correct metering skid, it is important to make sure that your skid builder has the relevant expertise. When a reputed company builds a metering skid, their engineers will need answers to these and other questions:

- What is the area safety classification, and what safety standards are in force?
- What flow measurement standards should be used?
- What are the temperature and pressure parameters?
- What is the flow range? Does it vary? By how much?
- What type and size of meters are needed?
- What mechanical standards apply to the installation?
- Is flow unidirectional or bidirectional?
- Is there ambient and/or electrical noise, and how much?
- Are flow conditioners required?
- Should the meter be horizontal?

Headers, piping, flanges, elbows, and other piping fittings must be properly designed based on meter system design and physical site parameters. If the flow computer and any flow, pressure, and temperature transmitters must communicate with a control system, the interconnections must be specified. If improved performance and modern diagnostics are required, digital connectivity such as HART or Foundation Fieldbus should be considered. Calibration requirements, and the means to meet them both before and after installation, must be taken into account.

Once all the above questions are satisfactorily answered, the skid builder will build the system. During construction, the system and the skid must be subjected to meticulous calibration, quality control and testing. Before the skid is delivered, the site needs to be properly prepared. It must be graded and filled, and the support pad must be poured and cured. Electrical and instrumentation service must be provided, and the skid must have the proper components to hook up to the existing piping at the inlet and outlet.

After installation, the skid builder can commission and startup the system, connect it to the plant control system, perform initial calibration testing if required, and provide whatever training is required to operate and maintain the metering station. Because maintaining a metering skid is a specialized operation, many skid builders provide ongoing technical and complete lifecycle support.

Custody transfer is an exacting science that requires expertise in a number of different areas. For most companies, the best way to procure, install, and operate a custody transfer system is through partnering with an experienced provider. Whether the custody transfer system is built on-site or delivered on a process skid, close cooperation between the owner and the provider will result in the optimal system for the particular application.

5.0 Issues in Calibration of Custody transfer meters:

Orifice Meters:

Calibration of Orifice is deriving coefficient of discharge “Cd”.

The largest contribution to the uncertainty in the measured coefficient is due to the time measurement.

In general, factors associated with orifice installation affect the overall errors in flow measurement. Errors are due to uncertainties in, (a) flow equation, (b) actual physical properties of the flowing fluid, and (c) dimensions of the flow meter.

The flow rate is calculated from a number of variables, the discharge coefficient, expansion factor, differential pressure, bore diameter, pipe diameter, and the fluid density and viscosity, which are derived from temperature and pressure values of the flowing fluid. Therefore, actual fluid properties should be monitored with best possible precision.

The mechanical tolerances are critical for measurement accuracy. The seat gap, sealing material and dimensions, recesses and protrusion, plate flatness and eccentricity, tap location and machining tolerances, etc., must conform to the standard to achieve flow rate measurement within the stated uncertainty of the standard.

Positive displacement Meters:

Caibration of positive displacement needs the meter to be properly filled, air bled and thermally stable before the prover runs are made. It is very critical to maintain the temperature of the meter under test same as that of the master meter. The temperature difference can be minimized by placing the meter under test and the master meter as close as possible.

Turbine Meters:

For turbine meters, the choice of calibration fluid is particularly important. Turbine meters are viscosity sensitive, and the figure below shows some typical calibration results from a turbine meter using water and three petroleum products. Because of this sensitivity to viscosity it is important to calibrate these meters using a fluid as close to the viscosity of working fluid as is practicable. turbine meters, the choice of calibration fluid is particularly important. Turbine meters are viscosity sensitive. Fig10 shows some typical calibration results from a turbine meter using water and three petroleum products. Because of this sensitivity to viscosity it is important to calibrate these meters using a fluid as close to the viscosity of working fluid as is practicable.

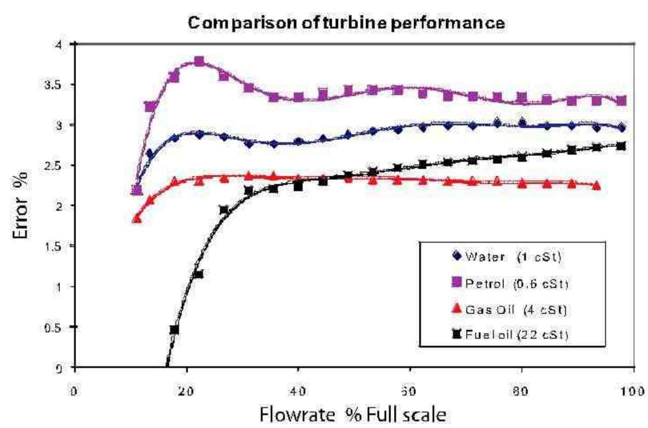

Figure 10. Turbine meter performance

Coriolis Flow meters:

Verification diagnostic techniques have rapidly advanced over the last five to 10 years and are continuing to improve. For example, six meters are used in cavern storage of hydrocarbons in western Canada and were regularly proved, with some random variation in meter factor but no statistical change. More than $175,000 was spent on these provings. As a result of data such as this, Alberta, Canada's energy regulator created Directive 17, which states: If a meter has built-in diagnostics to continuously monitor the condition of the primary element, inspection is not required until an alarm or error is generated by the meter or as recommended by the manufacturer, such as in some types of Coriolis meters. By using meter verification, proving may be extended until the onboard diagnostics advise it is time to prove. This will result in significant savings in proving costs during these extended proving intervals. Some of the meters in this application were upgraded to have modern diagnostics. Several different Coriolis verification methodologies are available. Some are vendor independent, such as the knowndensity method, while others are proprietary. Some require stopping the flow or stopping the process measurement to perform the verification. Others are more time consuming and may require a hot-work permit. Some can be done in situ without stopping flow or the flow measurement.

Verification methodologies can include measuring and trending process measurements, looking at internal parameters such as drive gain and pickoff amplitude, and using additional hardware internal or external to the transmitter to verify flow measurement. The user can perform many of these techniques, and others require a service technician visit by the vendor.

The perfect flow meter — zero calibrations, zero proving, no zeroing, zero worries with powerful diagnostics that can verify meter accuracy and give advance warning of changes — does not yet exist. Coriolis flow meters, however, are largely insensitive to fluid properties. The author predicts that within 10 years, on-board meter verification diagnostics will be a standard expectation in Coriolis technology. Verification will not replace proving or calibration, but it can, and is already, extending intervals. Proving and calibration are often regulated by legal and contractual arrangements. Verification is recognized by a growing number of agencies.

Ultrasonic Flow meters

Multipath ultrasonic gas flow meters are normally flow calibrated at an accredited flow laboratory before installation in order to verify the flow meter's performance and to correct for flow meter offset. The common practice is to install gas flow meters without in-situ calibration arrangement. Many of these flow meters are never recalibrated. It is therefore important to ensure that the flow meters are calibrated properly with the highest degree of confidence to the involved parties.

Preparations: The upstream pipe which will be installed with the flow meter or an identical pipe spool with the same length and inner diameter must be used for the flow calibration in order to provide similar flow profile during calibration as will be expected at the final installation site. If a flow conditioner is part of the final installation, this flow conditioner must also be used during calibration.

The calibration laboratories have limited test runs available with flange type and rating designed for the maximum pressure at the facility. Adapter spools are therefore often required to match the line size and flange type of the flow meter.

The calibration laboratories use their own pressure and temperature transmitters in order to conform to their accredited procedures. The flow meter or the adjacent pipe spools of the same line size should have a pressure tapping to allow for connection of the laboratory's pressure sensor. This is particularly important if the laboratory lines size is different than the flow meter size.
For instance, if a 6-inch flow meter is installed in a 12-inch test pipe, the pressure in the 6-inch flow meter will be lower than the pressure in the 12-inch pipe due to higher gas velocity in the flow meter.
It is also important to supply the bolts and gaskets required for the flow meter, upstream pipe and adapter spools.
Most calibration laboratories will require a pressure test certificate before installing the flow meter and test spools into their laboratory.

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