Advantages of Master Metering Method of Proving Custody Transfer Flows

Chapter 4 of “The American Petroleum Institute Manual of Petroleum Measurement Standards” offers a guide for the design, installation, calibration, and operation of meter-proving systems that are commonly used by petroleum operators around the world. The chapter covers Displacement and Tank provers as well as the use of Master Meters to validate measurement systems for custody transfer. The purpose of this paper is to discuss the advantages of the Master Meter proving method in today’s offshore and onshore custody transfer applications.

In any Greenfield construction project and specially those that are located offshore, space comes at a premium. However, when it comes to custody transfer applications where petroleum product ownership changes hands, operators have limited options as to the type of equipment that can be employed for the verification and proving of flow measurement systems. The API recommendations are specific in the types of equipment suggested for this application. Users have a choice of either Displacement (ball prover), Tank provers or using a master meter to verify the accuracy of the production metering devices.

Why is accurate metering so important? For the operators of the production facilities, there is a significant cost savings involved with the accurate performance of the custody transfer meters. If a typical offshore oil production facility produces 100,000 bpd (barrels per day) and incurs an estimated $8 (random) per barrel cost to extract the product, a meter that has a read error of just 0.01% on total flow will cost the operator over $3MM in revenues assuming an oil price of $50 per barrel (at today’s price of $70+ per barrel), the cost is over $4.5MM. Given that a custody transfer metering station costs around $1.2MM, the payback for it is less than 4 months. While these numbers are eye opening, the primary reason for offshore metering is to measure the output of a typical offshore oil production facility produces 100,000 bpd (barrels per day) and incurs an estimated $8 (random) per barrel cost to extract the product. The accuracy of the prover relies on the proper functioning of all these mechanical processes. Any leakage in the valve seats, stem packing or any damage to the internals of the valve will affect the accuracy and performance of the prover. Also, any coating or scale buildup in the pipe sections will result in a change to the calibrated volume of the unit and therefore the overall accuracy of the system. In order to ensure the proper functioning of the prover, regular scheduled maintenance is required to make sure the system is in perfect working order. This is a labor intensive operation and can be time consuming. Also, how does an operator verify the accuracy of the prover system? If issues are noted (scale, leakage etc) and cleaning or repairs are done, what processes are followed to ensure the system is back and operating accurately? Given the intensive operation and can be time consuming. Also, how does an operator verify the accuracy of the system? In order to ensure the proper functioning of the prover, regular scheduled maintenance is required to make sure the system is back and operating accurately.

Another innovation was the use of pulse interpolation techniques for small volume piston provers. This procedure estimates the part of a full meter pulse that is usually lost at the end of the ball movement. The result is a reduction in the size of the overall prover. This only works however if the duty meter has a uniform pulse output per revolution. This is the case with all turbine meters unless they are damaged or worn in some way. A schematic of a bidirectional prover is shown below.

From the drawing, the one thing that stands out is the number of mechanical parts involved in the product. The accuracy of the prover relies on the proper functioning of all these mechanical parts. Any leakage in the valve seats, stem packing or any damage to the internals of the valve will affect the accuracy and performance of the prover. Also, any coating or scale buildup in the pipe sections will result in a change to the calibrated volume of the unit and therefore the overall accuracy of the system. In order to ensure the proper functioning of the prover, regular scheduled maintenance is required to make sure the system is in perfect working order. This is a labor intensive operation and can be time consuming. Also, how does an operator verify the accuracy of the prover system? If issues are noted (scale, leakage etc) and cleaning or repairs are done, what processes are followed to ensure the system is back and operating accurately? Given the intensive operation and can be time consuming. Also, how does an operator verify the accuracy of the system? In order to ensure the proper functioning of the prover, regular scheduled maintenance is required to make sure the system is back and operating accurately.

The overall installation is significantly more simple and the result is an overall cost reduction in the metering skid of up to 40%. Since the unit is in series with the production meters, the proving run can time can be substantially longer using a larger volume and therefore more pulses from the units. This results in a more accurate calibration of the duty meters. Also, many of the mechanical moving parts are eliminated reducing potential wear points and subsequent maintenance is required to make sure the system is back and operating accurately. Given the intensive operation and can be time consuming. Also, how does an operator verify the accuracy of the system? In order to ensure the proper functioning of the prover, regular scheduled maintenance is required to make sure the system is back and operating accurately.

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inaccuracies) and substantially reducing the maintenance requirements of the overall system. In terms of peak production, the overall capacity of the system can be increased by using the master meter as a daisy meter for limited operational time or during maintenance of the duty meters, the master meters can be used as a spare line. Using a helical blade turbine meter in this application eliminates the issue of viscosity effects on the turbine meters. Using a K-factor calibration on a helical turbine meter eliminates viscosity effects over a wide range of products. This has typically been the source of “commonmode” errors in the past which have generally limited the use of standard turbines in those applications.

The 2 major advantages of a system using a master meter are:
1. The master meter can be periodically removed and sent back to a calibration facility to be checked and recalibrated if necessary. This ensures that the system is running at optimum performance for the operator.
2. The overall size of the metering skid is significantly reduced. In an environment where space is at a premium, having an accurate measurement system that fits into a small footprint is of great value.

Conclusion
The master meter method of proving production flow meters offers significant advantages to offshore production facilities without compromising overall accuracy and performance of the custody transfer metering systems. The helical blade turbine meter is immune to viscosity effects and offers extremely accurate and repeatable measurement of process flows. When used as a master meter, the unit reduces the overall size requirement, reduces overall maintenance of the metering skid and provides an easy way for producers to verify metering skid accuracy. Also, due to the relatively compact design of the helical turbine units, a spare master meter can be stored on site to offer complete system redundancy.

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**ST100 Air/Gas Flow Meter Receives FM and FMc Approval**

The future-ready ST100 Series Thermal Mass Air/Gas Flow Meter from Fluid Components International (USA) has received FM and FMc approval, assuring Fluid Components International’s (FCI) customers that it conforms to the highest international safety standards. The FM APPROVED mark, and Canadian FMc APPROVED mark, assure FCI’s customers that the ST100 Flow Meter has been deemed to perform reliably and safely, backed by independent scientific research and testing. FM Global certifies products to assure customers that they conform to the highest national and international safety standards for loss prevention and risk management. The ST100 Flow Meter has received FM and FMc approvals: Class I, Division 1, hazardous locations, Groups B, C, D; Class II and III, Div 1 Groups E, F, G, Nonincendive Class II Division 2 Groups A, B, C, D, Nonincendive Class I Division 2 Groups A, E, F, G.

The revolutionary ST100 Series Flow Meter sets a new industry benchmark in process and plant air/gas flow measurement instrumentation, offering the most feature-rich and function-rich electronics available today. The leading-edge ST100’s superior flow-sensing performance delivers unsurpassed adaptability and value to meet plant gas flow measurement applications for today and tomorrow.

The ST100 Series Air/Gas Flow Meter was developed in response to discussions with a wide range of instrument, process and plant engineers, who wanted more comprehensive measurement information as well as the flexibility to adapt to future plant and process control technology they might deploy. Beyond continuously measuring, displaying and transmitting the industry’s most extensive array of parameters, the new ST100 is the first thermal mass flow meter with a migration path to tomorrow.

Whether the need is for 4–20 mA analog, frequency/pulse, alarm relay or digital bus communications such as HART, Fieldbus, Profinet or Modbus, the ST100 is a solution. Should a plant’s needs change over time or an upgrade be desirable, the ST100 Flow Meter adapts as necessary with a plug-in card replacement that can be changed out by plant technicians in the field. That takes “never obsolete” to a whole new level in flow measurement instrumentation.

The ST100 Flow Meter’s unique graphical, multivariable, backlit LCD display/readout brings new meaning to the term “process information”. It provides the industry’s most comprehensive information with continuous display of all process measurements and alarm status, and the ability to interrogate for service diagnostics.

The user-friendly ST100 stores up to five unique calibration groups to accommodate broad flowranges, differing mixtures of the same gas and multiple gases, and obtains up to 1000:1 turndown. An optional, patent-pending SpectraCal™ Gas Equivalency calibration method lets users select and switch between 10 common gases. Also standard is an on-board data logger with an easily accessible, removable 2-GB micro-SD memory card capable of storing 21 million readings.

The ST100 Flow Meter has been designed and tested to operate safely in hazardous plant environments will be pleased to learn that the advanced Model F150A Flow Switch/Monitor from US based Fluid Components International (FCI) has received ATEX and IECEx approvals.

Enginners in search of a low-cost flow verification solution for process analyser sampling systems that is suitable for hazardous plant environments will be pleased to learn that the advanced Model F150A Flow Switch/Monitor is suitable for continuous flow verification applications supporting process analyser sampling systems, operating in hazardous plant areas in the European Community and elsewhere worldwide. The ATEX and IECEx approvals specify design criteria for flow meters and other electrically-powered instruments for use in areas where combustible gases may be present. These approvals assure the instrument has been designed and tested to operate safely in these hazardous conditions.

The Model F150A Flow Switch/Monitor represents the next-generation, lowest-cost solution for continuously verifying flows within liquid or gas process analyser sampling systems. It is a small, lightweight instrument featuring superior low-flow sensitivity, a relay alarm trip point, an analog output and an RS232 interface. The F150A advanced electronics and thermal dispersion flow sensing technology provide a superior overall solution to sampling system flow assurance. It is ideally suited for continuous monitoring of analyse sample flows to provide the highest integrity process analysis without interruption.

The breakthrough F150A Analyser Flow Switch Features a precision flow sensor element with no moving parts to foul, clog or maintain, ensuring continuous reliability and requiring virtually no maintenance. Unlike capillary bypass flow meters and controllers, the F150A has no castles, orifices or deadlegs that can trap fluids and lead to contaminated samples, which preserves sample integrity and provides faster system sampling times. The instrument’s wetted parts are corrosion-resistant 316 stainless steel with Hastelloy-C22 sensor tips.

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**Flow Switch/Monitor Receives Zone 2 Approvals**

The future-ready ST100 Series Thermal Mass Air/Gas Flow Meter was developed in response to discussions with a wide range of instrument, process and plant engineers, who wanted more comprehensive measurement information as well as the flexibility to adapt to future plant and process control technology they might deploy. Beyond continuously measuring, displaying and transmitting the industry’s most extensive array of parameters, the new ST100 is the first thermal mass flow meter with a migration path to tomorrow.

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