

GUIDE TO TROUBLE SHOOTING PROBLEMS WITH LIQUID METERS AND PROVERS

Class # 4061

Brian Pierce
Chevron Pipe Line Company
165 Chevron Road
Golden Meadow, LA 70357

Introduction

The purpose of this paper is to familiarize those involved with the Measurement and Troubleshooting of Proving Systems commonly used in the Measurement Industry. Due to the demand and consumption of Hydrocarbon Products, the need to accurately Measure these volumes, is becoming more prevalent by the day. With the high volumes being produced in Deep Water Drilling, and Pipeline Transfers, it's understood by everyone in the Measurement Industry that a small error in volumes of Single Phase Hydrocarbon Measurement can be a significant lost in Revenue. Due to the time allowed for this class, we will discuss Trouble Shooting Problems with Liquid PD Meters and Conventional Bi-Directional Provers in Hydrocarbon Measurement. We will also briefly discuss the importance of designing and installing the LACT components correctly as a measure of trouble shooting problems.

Provers

The purpose of the prover is to provide a known volume for comparison with a meter's indicated volume in order to establish a meter factor. Provers are designed to the desired Operating Flow rates of each particular application or location.

Provers should be designed and operated with the following displacer velocity requirements:
For bi-directional sphere provers, the sphere velocity should operate between 0.5 and 5.0 feet per second.

The prover 4-way or interchange valve will establish complete liquid sealing during operation at maximum flow rate. This should occur before the displacer actuates the first detector switch and have sufficient torque for positive sealing. The prover 4-way or interchange valve should be equipped with a means at the valve to allow visual verification of seal. Bleed valves will be provided at the highest point of the prover piping outside of the pre-run and calibrated sections to assure that air or vapor is completely vented before proving.

Carbon steel provers should be internally coated. 2-inch or greater water draw connections should be provided. For bidirectional provers, the connections located between the 4-way valves Flanges and the prover chambers.

Pipe provers are required to be designed and fabricated in accordance with the following requirements:

- The prover should be designed so that 0.02% repeatability is achieved
- The sphere sized no more than 103% (3% oversized) of the calibrated section internal diameter.
- The pre-run and calibrated sections will be fabricated with seamless pipe.
- All weld surfaces in the pre-run and calibrated sections shall be ground smooth and flush with the internal pipe surfaces.
- Stainless steel spectacle blinds shall be located between the four-way valve and water draw connections.

- Flanges shall be provided in the calibrated section for full visual inspection of the internal coating and surface.
 - Flanges in the calibrated section shall be machine-matched bored, centered, and pinned.
 - Alignment pins shall be uniquely arranged to prevent incorrect mating of flanges.
- Transition reducers located between the launching and receiving chambers and the calibrated section or pre-run shall be the eccentric type and oriented to provide a flat invert in the transition section.
- The internal coating shall be a baked on phenolic applied by the coating manufacturer-approved applicator.
 - It is good practice to require a Calibrated Chart recorder to monitor Temperature, and time to ensure the coating was applied to Manufacturer Specifications.
 - The internal coating should be applied with a minimum of 3 coats, be free of grooves, and have a final thickness of 5-7 mils.
- A quick-opening closure equipped with a pressure-actuated locking device will be provided for sphere loading and unloading.
- The launching and receiving chambers should be designed to accelerate and decelerate the sphere without damage to the sphere or prover.

Mechanically Actuated Detector Switches

The mechanical type of detector switch is used primarily with elastomer sphere displacers. Generally, it is operated when the displacer contacts a stainless steel rod or ball, which protrudes into the prover pipe at the beginning and end of the prover calibrated section. When the displacer contacts this stainless steel rod or ball, a rod containing a magnet will lift and cause an external reed switch to operate.

Detector switches are normally hydraulically balanced and serviceable under pressure. Contact detectors on bidirectional provers should be installed under close tolerance so that the sensing characteristics in one direction are similar to those in the reverse direction.

The electronic sensing elements in contact detectors should be designed so that the detector is not significantly affected by rotation of the mechanical plunger or by mechanical shock of the displacer. Openings through the pipe wall for detectors must be smaller than the longitudinal sealing area of the sphere and on pistons, multiple seals must be provided. The detector switches should be non adjustable type switches.

Launching Chambers

Launching Chambers should be at least two pipe sizes larger than the nominal size of the sphere or loop to allow the sphere to make the transition from the interchange to the calibrated section, and to prevent damage to the sphere and prover.

The launching chambers should provide a method ensuring the sphere launches successfully into the calibrated section of the prover during periods of low flow. If ramps are used, there needs to be enough clearance between the ramp and top of the pipe to allow the sphere to move down the ramp.

Launching chambers shall have smooth transition fittings leading into the prover. Eccentric fittings are preferred.

It is good practice to use horizontal Launch Chambers. In this position you will be allowed to perform thorough internal inspection of the Prover internal coating.

Air Eliminators

The purpose of the air eliminator is to expel entrained air or gas vapors from the flowing liquid before entering the sampling and metering systems. Air eliminators also help in preventing meters from operating without fluid in them, and helping to reduce in unnecessary repair cost to the meter.

Strainers

The purpose of the strainer is to remove materials from the flowing stream that could damage the meter or other equipment.

Divert Valves or System Shutdown

The purpose of the divert valve or system shutdown for conventional platforms is to prevent non-merchantable oil from flowing to the meter.

Sampling Systems

The purpose of the sampling system is to extract and retain a representative composite sample for quality determination. Sampling systems will include a stream-conditioning unit, an isokinetic sample extraction device, sample delivery piping, and a sample container system. The purpose of the stream-conditioning unit is to achieve fluid homogeneity.

Sample Container Systems

The purpose of the sample container system is to collect extracted samples, maintain Sample integrity, and mix the composite sample for quality determination

Meters

The purpose of the meter is to accurately measure the quantity of liquid hydrocarbons being delivered.

Displacement meters can be Smith PD meters, be a double case sliding blade type meter, be equipped with 100% gearing in the stack; be sized to operate at a flow rate between 20 - 80% of meter capacity; display meter registration on a non-resettable mechanical counter at the Meter. Have a reproducibility of + or - 0.25% (0.0025) or less of the meter factor, Have a reproducibility of + or - .25% (0.0025) or less of the meter factor between consecutive monthly proving. Have a repeatability of + or - 0.05% or less between five (5) consecutive proving runs. Be equipped with a pulse generator transmitting the pulse train (1:1 gear ratio) to the flow computer for ticketing and proving operations; Be equipped with a permanently mounted right angle drive (1:1 gear ratio) for troubleshooting purposes

Block and Bleed Isolation Valves

All prover drain valves should be General Twin-Seal, or equivalent, double-block-and-bleed valves configured to allow for leak detection. Block and Bleed Isolation Valves will also eliminate leaks that can allow oil to bypass the prover which will result in a measurement error.

Backpressure

The purpose of the backpressure valve is to maintain a minimum positive liquid head pressure. A properly operated Back Pressure Valve will also keep liquid in the meters to help from starting up without

liquid in them. This can be a great help in maintaining the condition of the meter and save unnecessary cost or repairs.

CONCLUSION

Due to the many components involved in the Design, Construction, and Operation of a Meter Skid, it's important to keep each component in proper working condition. Failure to do so will always result in improperly measured product.

The key to measuring Liquid accurately starts with designing the equipment properly to the application, installing the equipment to Manufacturing Specifications, and maintaining the equipment in proper working conditions.

Maintaining the Equipment will help to eliminate multiple problems when trouble shooting problems with Liquid Meters and Provers.