Pycnometer Installation, Operation and Calibration

Class # 2340

Harold L. Gray
Alyeska Pipeline Service Company
P. O. Box 300
Valdez, Alaska US

Scope

The process of installing Pycnometers for the purpose of calibrating a density meter. The process of field verifying pycnometer calibrations. Experiences in verifying flow through the pycnometer and ways of achieving temperature equalization in both the density meter and the pycnometers.

Introduction

- A discussion of the types of pycnometers and the differences in design.
- A brief discussion on the ways to install the pynometers. The density meter and the way it is installed can and should determine the installation of the pycnometer. Allowances in the piping should given to measure the temperatures in both the density meter and the pycnometer. The same should be integrated for the measurement of pressure as well.
- Safety considerations should govern all designs. And all parts of the calibration process.
- A discussion of the data that is supplied with the Laboratory Calibration
- A very brief discussion on the field verification process in accordance with API MPMS Chapter 14.6 Continuous Density Measurement.
- A step through of the calibration process including the calculations necessary to complete the process.

Extremely Important

Care must be taken to insure that the pressure rating of the rupture disk that is located in the inlet valve of the pycnometer is within the maximum pressure rating of the associated piping and tubing of the density meter and it's connecting piping.
A word about safety: all necessary steps should be taken to insure a safe egress from the area. Never enter a vapor cloud for any reason, automatic shut down systems should be installed for remote shut-in ability.

Recommend a pressure test be performed on the pycnometer while the laboratory is certifying the instrument. Consideration should be given to the environment you enter with the pycnometer
To obtain a liquid filled weight, the pycnometer is in a static condition and pressure will quickly build from temperature increase during this condition.

Pycnometer Types and Design

- A single cylinder pycnometer that consists of a stainless steel vessel with a calibrated volume of approximately 500 cubic centimeters, and fitted with valves at each end and a pressure rating adequate to handle the pressure for its application.
- A single sphere pycnometer is a stainless steel sphere that has a capacity of 1000 cubic centimeters. It is fitted with (2) two valves located on the inlet and outlet of the sphere the out let is desingned with a siphen tube to insure adequat purging of heavy material in the bootom of the vessel. And is designed to handle the pressure of the application.
- A double wall vacuum insulated sphere that is made up of 2 stainless spheres. One inside the other with an annulus that has a volume of approximately 1000 cubic centimeters. This sphere is configured identical to the single sphere. This design prevents any exchange of heat from ambient conditions, and also mitigates moisture build up on the sphere that could hamper the accuracy of the test.

For each type there are common design criteria that must apply to all types.

- The ratio of the pycnometer to the weight of the fluid measured should be kept low to minimize errors in weighing the filled vessel.

- The weight of the liquid filled pycnometer should not exceed 5000 grams.
- The calibrated volume should not be less than 500 cubic centimeters 1000 is desired.
- The shape and materials of construction should be of a safe, easy to clean material. The surface should be polished to allow easy cleaning. The flow pattern should designed to allow for self elimination of entrapped gas pockets, allow for proper purging and not restrict the flow of calibration liquids, for easier temperature equalization
- The valves shall be located at both the inlet and discharge of the pycnometer. The valves should be welded in place to prevent movement that would change the certified volume. The valves should provide positive shut off and leak free service.
- The pycnometer should have a full flow rupture disk installed to prevent over pressuring the vessel. Pycnometer shall have a serial number on each removable piece to prevent an accidental change of volume, due to different displacement from parts.

Pycnometer Installation

Most density meters are of the “slip-stream” type. Therefore the design should incorporate the connections for the Pycnometer.
Some points for consideration:

- The installation shall not induce any separation of the phase (liquid to gas).
- The installation shall provide enough flow for adequate compensation for lags in flow through the density meter and pycnometer.
- The configuration shall not allow for the entrapment of gas bubbles.
- The installation should not allow any fluid pulsation and pressure surges.
- The entire installation of the density meter and pycnometer should all be insulated to allow for a minimum of temperature differential from the meter to the density meter to the pycnometer.
- Allowances should be made for thermowells for making temperature measurements and taps for pressure measurements.
- Pycnometer connections should allow for quick and easy disconnects and reconnects.
- Allowances should be made for venting or flaring of product during connect and disconnect.
- Any pumps should be installed in a configuration to prevent measuring the density at different conditions than the mainline-metered product.
- A flow-indicating device should be installed to measure the flow though the configuration. At certain conditions temperature equaization can occur with little or no flow.

Laboratory Calibration Data

- (Wa) Certified air filled weight
- (WO) Certified evacuated weight
- (PVB) Certified base volume.
- (Ep)Certified coefficient of expansion due to internal pressure of the pycnometer
- (Et) Certified coefficient of expansion due to temperature of the pycnometer

Recertification of Pycnometer should occur when:

- New construction of pycnometer
- Maximum of (2) years since last certification
- The pycnometer has been damaged
- The pycnometer has been disassembled
- Welded on valve parts have been replaced
- The rupture disk has been replaced

Recertification is not necessary if the valve manufacturer can substantiate that there would be no change in pycnometer volume in excess of .02%

Field Verification

The purpose of the field verification test is to determine that there has been no shift in the certified volume of the pycnometer (PBV). And evacuated weight (WO).
An acceptable verification accomplished from (2) consecutive runs repeating within 0.02% for each of the certified values as follows:

- (Wo) certified evacuated weight
- (Wa) certified air filled weight
- (PVB) certified base volume at 14.696 PSIA

This is in accordance with API MPMS 14.6 part 15 Field Verification Procedures for Pycnometers"

Proving Procedure

The following steps are taken when performing a density meter proving.

1. Verify calibration of all test equipment
2. Verify the pycnometer is clean by performing (Wo) verification in field verification procedures.
3. Install the pycnometer
4. Verify that the temperatures and pressures are equalized
5. Remove the pycnometer and weigh, obtaining liquid filled weight.
6. Repeat steps 4 through 7 to achieve 2 consecutive tests within .02%
7. Average 2 runs to arrive at a new DMF

Note: when using (2) pycnometers in series with each other and each pyc run repeats within .02% the process is complete.

References

API MPMS Chapter 14 Natural Gas Fluids Measurement.
Section 6 Continuous Density Measurement