# Pycnometer Installation, Operation and Calibration

Class # 2340

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## Introduction

This white paper will cover the various steps necessary to accomplish a successful density meter proving using the pycnometer test method. This document will include the requirements for certification and the information that must be recorded and present on the associated report. Also included will be a brief overview of critical equipment and recommendations for proper configuration, installation, and maintenance. The information provided is in accordance with API MPMS 9.4 and all standards referenced within that document.

## Density

Pycnometer testing is one of several methods used to determine a corrected density for continuous measurement applications. This method is commonly utilized for its high level of accuracy and low uncertainty, which are crucial in custody transfer applications. Density can serve one or several primary and secondary functions in daily pipeline activity. Typical uses for density include determining gross to net volume calculations, inferred or direct mass measurement, product quality determination, and process control. In many applications the degree of measurement accuracy and frequency of testing required will be dictated by contractual agreement.

The most common devices, densitometers, measure density by monitoring changes in vibration, when flowing product travels through the device. There are many different designs present in the industry, but they all operate on the same basic principle. Each will have some type of vibrating or “driving” element that is calibrated by the manufacturer to establish a low and high setpoint or a “span”. The change in the vibration frequency from the product can then be used to inversely calculate the fluid density. As with any measuring device there are errors due to a variety of factors that can bias the output. The pycnometer test method establishes a Density Meter Factor (DMF) to correct this bias.

## Pycnometer

A vessel whose Prover Base Volume (PBV) and Evacuated weight (Wo) are precisely known and certified. The most common style of pycnometer for hydrocarbon measurement is the double wall vacuum insulated sphere. This design provides the most resistance to ambient conditions and helps to maintain internal stability of the sample collected. A representative sample is captured from the flowing line to calculate a true density of the product.

## Certification

Certification of the pycnometer is a laboratory procedure to determine certain reference values for field use. The methods of calibration are outlined in API MPMS 9.4 Annex C. Certification is required every 2 years or whenever any modification, including changing a valve, is made. This test consists of three consecutive runs at varying pressures across the expected operating range of the pycnometer. The certification should produce the following values:

- Pycnometer Air Filled Weight (Wa)
- Pycnometer Evacuated Weight (Wo)
- Pycnometer Base Volume (PBV)
- Coefficient for the effect of Temperature (Et) and Pressure (Ep)

## Maintenance

Proper maintenance and routine cleaning of the pycnometer will minimize potential measurement errors. The best cleaning method is debatable, but a proven one involves using a mild detergent and warm/hot water to break up possible coatings or grime. Flush with water until it seems to be clear and then completely drain. Next, fill with acetone and agitate the pycnometer for a sufficient amount of time, and drain. Finish with a nitrogen purge to ensure all moisture from the inside is eliminated. Repeat this process for the outside as well.

## Pycnometer Verification

Sometimes referred to as “field” verification, this is the process of verifying the certified values at ambient field conditions. This process takes place prior to installation on the density loop and before introducing any product into the pycnometer. Weigh the pycnometer and record the empty weight and reference the certified weight on the calibration report; the two values should agree within .02% of the certification. Note that a weight heavier than the certified value typically can be resolved by thoroughly cleaning the pycnometer. However, a lighter weight generally requires repair and/or recertification. Adverse climate conditions such as rain or extremely humid environments can induce inconsistencies in the verification and testing procedure. Although these may be unavoidable, steps should be taken to mitigate the effects of environmental influence.

## Equipment

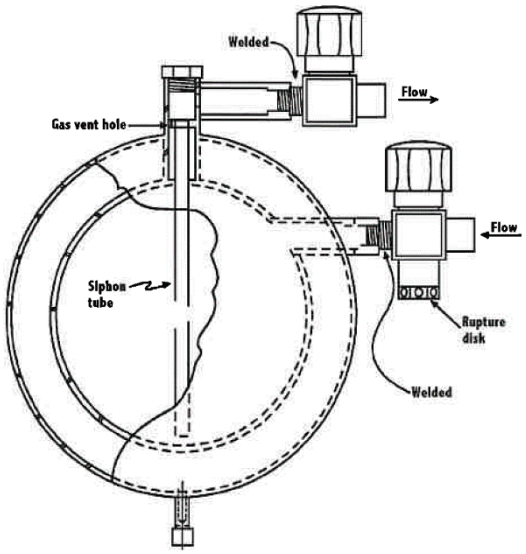
The following items are necessary to determine all the values for calculation of the density meter factor (DMF), also included for each instrument/test measure is the required frequency of recertification.

- Certified Pycnometer and Calibration Report – 2 years
- Certified Electronic Thermometer – 1 year
- Certified Electronic Pressure Gauge – 1 year
- Certified Weigh Scale – 2 years
- Certified Test Measures – 2 years

## Installation

To introduce the flowing product into the pycnometer correctly a density measurement system or “density loop” should be installed. There are typically two methods used for implementing density loops, parallel and in series. This indicates the pycnometer location in relation to the densitometer.

A method known as “slipstreaming” is required to achieve sufficient flow through the density loop. This method relies on generating differential or “back” pressure to force flow through the density loop. Pycnometer connections are typically located downstream of the densitometer but should be located as closely to the densitometer as possible. Install the densitometer securely via the provided connections but be careful not to overtighten connection fittings. Common connection tubing is typically 3/8” or 1/2”.




**Densitometer Proving by Pycnometer**

After installation, flow should be established through the density loop and allowed to stabilize. Before opening the pycnometer, briefly purge both up and downstream connection tubing to remove any contaminants. Open the upstream fill valve to the pycnometer followed by the upstream pycnometer valve. Allow the fill chamber to equalize then open the downstream pycnometer valve and the downstream fill valve. Next close the bypass valve to divert 100% flow through the densitometer and pycnometer. Flow indication is ideal for this method but not required; monitor and adjust your flowrate to obtain stable temperatures and pressures. Allow enough time for conditions to maintain stability and record the following values:

- Densitometer Temperature and Pressure
- Pycnometer Temperature and Pressure
- Densitometer Density Reading
- Ambient Temperature

Temperature readings must be no more than ±0.2 °F between the mainline, densitometer and the pycnometer. Likewise, pressure may not deviate more than 1 psi between the same 3 points.

Partially open the bypass valve and then close the downstream pycnometer valve followed by the upstream pycnometer valve. Close the up and downstream fill valves and purge the associated tubing. Remove the pycnometer and record the weight. Reinstall and repeat these steps until 3 consecutive runs that meet the repeatability requirements, usually .05%, are obtained. The runs should be averaged to determine the DMF.

**Conclusion**

The method of calibrating a density meter using a pycnometer can be quite tedious. It is a careful process that requires close attention to detail as well as relatively stable process conditions. Adhering to the steps outlined in this document will result in better measurement accuracy, lower testing uncertainty and maximize reproducibility.