INSTALLATION AND OPERATION OF DENSITOMETERS

John V. Bailey
Supervisor, Liquid Balance
Enterprise Products
1100 Louisiana
Houston, Texas USA

Introduction

A densitometer is a dynamic device used to measure the density of a flowing stream. A densitometer is used to measure the density of liquid hydrocarbons and finished products like propane, gasoline and liquid mixtures such as, Y-grade natural gas liquids (NGL). This article addresses on-line liquid density measurement. There are several applications in the oil and gas industry where measured density is an important and foremost component of total liquid measurement. The major use of densitometers is to determine the mass-volume that has passed through the flow meter. This quantity may be determined either through mass or volumetric measurement techniques.

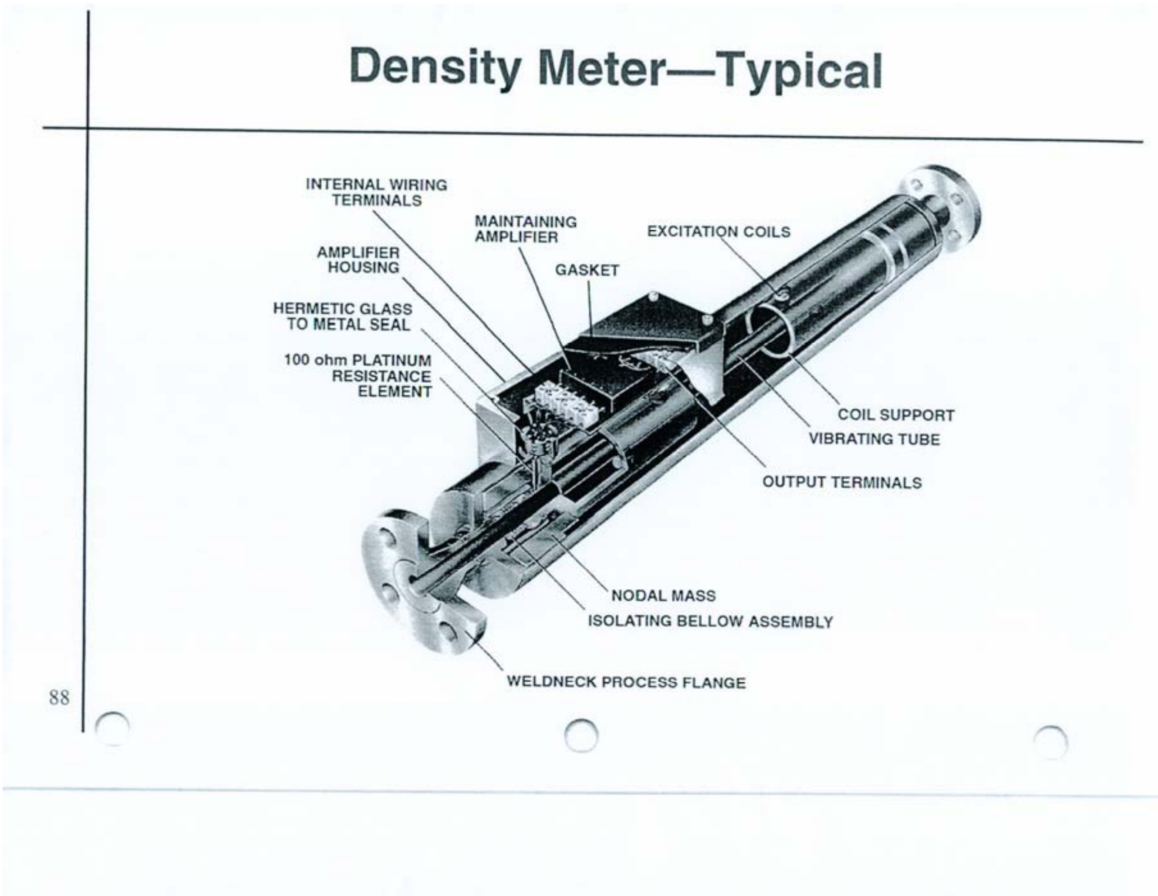
A secondary use of a densitometer is to detect a pipeline product interface. One of these is the "plug" of liquid between two dissimilar products shipped in the same pipeline. Continuous density measurement provides a pipeline operator with the ability to monitor the density change from one batch to the next. This will allow for the appropriate valve changes to correctly route products to their proper destinations. Measured density provides critical data for quality monitoring of finished products and other fluids. This article centers on the installation and operation of densitometers in dynamic systems for custody transfer. Principles detailed in this paper can be applied to installing and operating densitometers for mass-volumes, liquid interface, and quality & commercial monitoring.

Densitometer

Densitometers come in many forms, shapes, and configurations. Commonly used types are:

- Vibration:
- Buoyancy:
- Nuclear:
- Acoustic:

Each of these base principles has advantages and disadvantages. The selection of the densitometer type usually depends on the application, performance requirements, and budget. In this article, we will restrict our discussions to the products that utilize the vibration principle. These are typically the vibrating tube type densitometers that are widely used today.



Installation

The performance accuracy depends largely on how well the density meter is installed. The densitometer installation should be carefully arranged to be free from, but not limited to the following:

- Gas or air bubbles
- Severe vibrations
- Contaminants
- Turbulence from pumps
- Temperature effect from ambient environment due to insufficient insulation

The cost of designing an accurate density measurement installation is insignificant in comparison to the potential loss resulting from an error in density measurement.

Loop System Characteristics

Different types of loop systems involve the following:

- Sampling Pumps:
- Up & Down Stream taps across a control valve:
- Scoops, sampling, or pitot tubes that are installed as a pair
- Orifice plates on the main line

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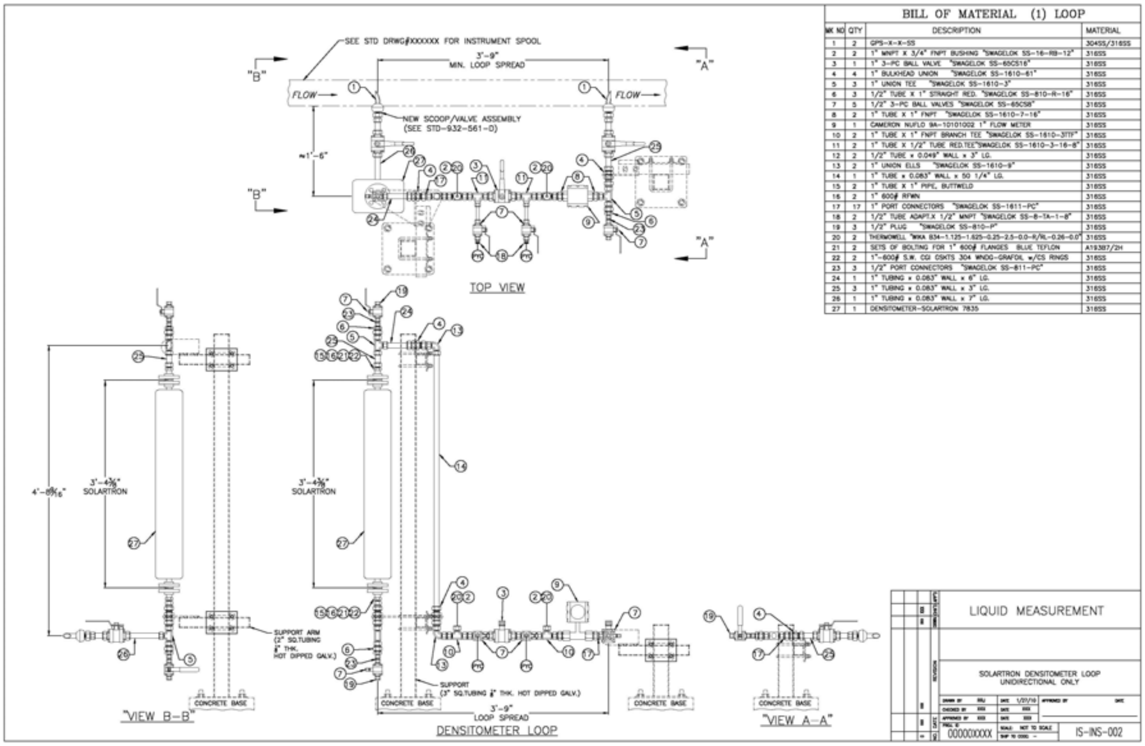

Performance of a "PYC"

To assure the accuracy of the densitometer, a calibration of sorts must be performed. This can be achieved through several methods, for this discussion we will deal with the most common type use, that of a pycometer. The pycometer or "pyc" is a sphere or ball of calibrated volume and a designated tare weight. The use of the pyc allows for the weight of a specific volume of product thus giving an exact representation of the density.

• Density = mass/volume

Therefore, with a good proving of the flow meter, the mass flow can be determined. The key to this is the procedure of the pyc itself.

Items needed for a good pyc are:

1) Certified pyc ball with documentation of the tare weights
2) A good vacuum pump that can go down below -15 psig.
3) A certified digital scale with a accuracy range to 0.001
4) A set of good digital thermometers & a liquid couplant
5) A steady working platform for handling the scale & vacuum pump
6) Wind & air movement protection

To perform a pyc, the pyc ball must be clean and free of any debris, inside & out. The ball is weighed on the scale at atmospheric pressure and compared to the certification documents. Then the ball is attached to the vacuum pump to achieve a full evacuated ball, which is a -15 psi. The ball is then weighed again on the scale and verified to the certification documents. Once the tares are compared and verified equal to the certifications, the ball is then connected to the system. Install the pyc on line with the densitometer in either series or parallel for proving (calibration). Proceed with the densitometer calibration procedure in accordance with API Chapter 14, Section 6 on "Continuous Density Measurement" to obtain two repeatable provings.

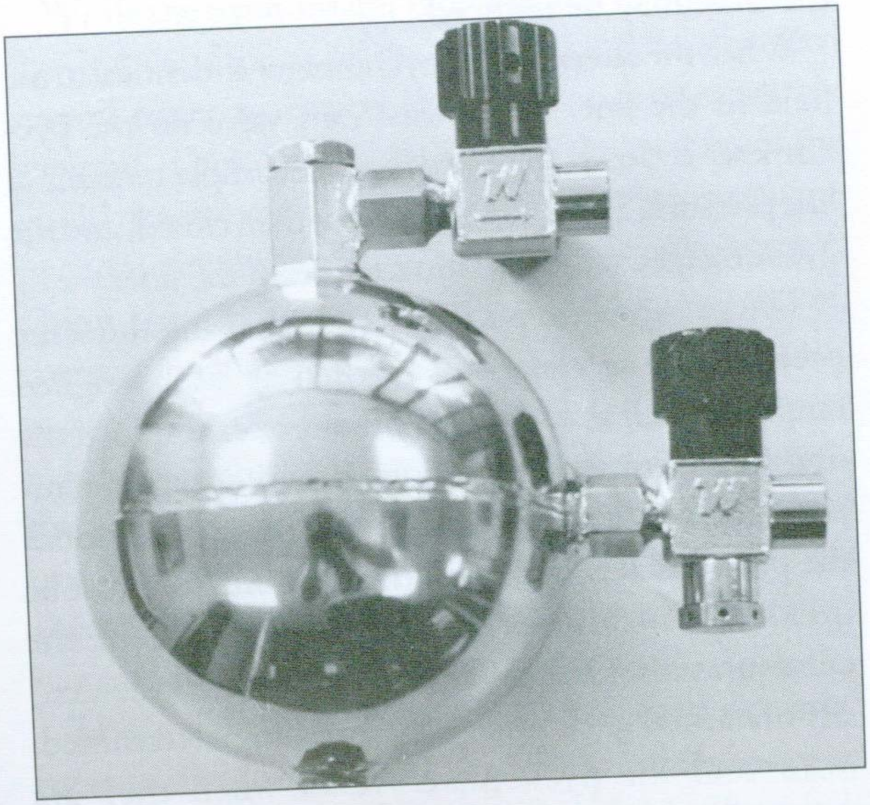

FIGURE 6.3. PRESSURIZED PYCNOMETER

Then proceed with the following iteration"

A. Take the average of the two Pycnometer test densities and subtract the average of the two indicated densities from the density meter.
B. Add the deviation from Step "A" above to the coefficient "K_o" as a zero offset adjustment. Replace the old "K_o" with the new "K_o" in the Flow Computer.

FORMULA

$K_{o\ NEW} = K_{o\ OLD} + Avg.\ Dev.$

Example: Field Calibration from Density Coefficient Ko		
$K_{o\ OLD}$ = -1.34923		
	Run No. 1	**Run No.2**
D_{D625} = Density from D625 Density Meter [g/cc]	0.56791	0.56825
D_{pyc} = Pycnometer Test Density [g/cc]	0.56762	0.56794
Deviation (D_{pyc} - D_{D625})	-0.00029	-0.00031
Average Deviation = [(-0.0029)+(-0.00031)]/2 =		**-0.00030**

<u>Solve for the new Ko</u>

K_o = (-1.34923) + (-0.00030) = -1.34953