Application Notes

Variable Area Gas Flow Meter Calibration Procedure Using Metrology Series Primary Piston Provers

Introduction

The flow measurement professional is responsible for calibrating and/or verifying the accuracy of various flow measurement devices, such as variable area gas flow meters (variable area flow meters).This costly, time-consuming process typically involves sending variable area meters out for calibration or verifying them in-house. As the leader in primary gas flow measurement, Mesa has developed a simple calibration procedure that combines the precision and high-speed of our Metrology Series of primary piston provers with carefully-selected instruments and gauges to enable accurate calibration of variable area flow meters.

Flow Corrections:

Each variable area flow meter is designed to operate under a certain set of conditions which include the temperature, pressure and the type of gas. Usually, these conditions are documented directly on the tube enclosure of the variable area flow meter, with the flow rate scales referenced in mm (millimeter). A reference table is provided to enable you to match the millimeter readings against the equivalent flow rates at the specified standard temperature and pressure. Otherwise, direct scale variable area flow meters indicate the flow rates directly on the tube enclosure. When calibrating variable area flow meters using a primary piston prover, correction must be applied to the indicated flow measurements in order to take into account the difference between the actual temperature, pressure and gas used versus the variable area flow meter's specified temperature, pressure, and gas requirements.

To properly calibrate variable area flow meters, refer to the following formula:

Variable Area Flow Meter's Corrected Flow = Variable Area Flow Meter's Indicated Flow X Correction Factor, Where: Correction Factor = $\sqrt{(A \times B \times C)}$

Where:

A = The Specific Gravity of the calibration gas as specified by the variable area flow meter / The Specific Gravity of the calibration gas

B = The operating Pressure in PSIA during calibration / Pressure in PSIA as specified by the variable area flow meter

C= Temperature in ^{o}K as specified by the variable area flow meter / Temperature in ^{o}K during calibration

Equipment required:

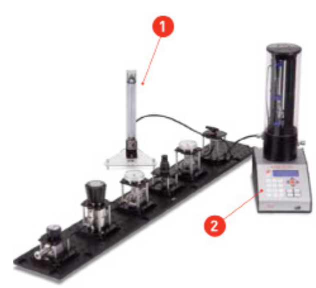
1. DryCal Gas Flow Delivery System (part number 100-030)
2. Mesa Metrology Series primary piston prover (models DryCal 800, DryCal 500 or Definer 220)

The DryCal Gas Flow Delivery System features an on/off valve, precision pressure regulator, high-side and low-side pressure gauges, needle valve, A-B switch (three-way valve), "quick connect" with male and female connectors, and breadboard.

Installation:

Step 1

Connect and/or verify all device connections. The Gas Flow Delivery System comes with in-series, ¼" tubing connection of the on/off valve, pressure regulator, high-range pressure gauges, needle valve and A-B switch, as well as a "quick connect" with male/female connectors for connection of the on/off valve to the gas cylinder/ compressed air.



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Step 2
Connect one end of the A-B switch to the inlet fitting of the variable area flow meter and the other end to the inlet fitting of your DryCal unit.

Step 3
Using the quick connect, connect the on/off valve to the gas cylinder/compressed air. Gas inlet pressure should be approximately 80 to 100 psi.

Procedure:

Step 1
Close the needle valve, open the on/off valve and set the gas pressure by adjusting the pressure regulator to above 30 psi.

Step 2
If the variable area flow meter contains a built-in needle valve, open its needle valve fully for unrestricted gas flow.

Step 3
Turn on your DryCal primary piston prover. Through its Setup menu, set the pressure unit to 'psi' and its flow readings to 'Vol' (Volumetric). For other flow measurement options (such as Continuous readings or the number of readings in the average), consult your DryCal product manual.

Step 4
Press your unit's Read button in order to record the ambient pressure and temperature.

Step 5
Flip the A-B switch to the variable area flow meter and gradually begin to open the needle valve.

Step 6
Set the variable area flow meter's flow at the desired level using the needle valve. The flow rate is indicated by the point on the printed scale where the float's center stabilizes.

Step 7
Wait one to two minutes for the float to stabilize. To ensure a particular flow point, flip the A-B switch back and forth a few times to check if the float returns to the previous scale point. If it needs adjustment, adjust the flow using the needle valve.

Step 8
Record the low range pressure gauge's pressure reading (in psia).

Step 9
If you are not using a direct scale variable area flow meter, record the reflected flow rate reading from the reference flow table against the floating point.

Step 10
Refer to "Flow Corrections" in order to correct the variable area flow meter's indicated flow for the operating temperature, pressure and the type of gas.

Step 11
Flip the A-B switch to your DryCal unit. Begin taking flow measurements with your DryCal unit.

Step 12
Determine the full scale accuracy of the variable area flow meter using the following formula:
% Accuracy = (DryCal's Flow Measurement - Variable Area Flow Meter's corrected flow reading)*100 / Variable Area Flow Meter Full Scale %

Application Notes:
- We recommend taking a minimum of ten flow measurements in an average. The more measurements in the average, the better the calibration results
- Allow the DryCal unit to stabilize before beginning a calibration
- When calibrating a variable area flow meter, it's best to use its specified calibration gas (calibrating with a surrogate gas can add greater uncertainty). If a surrogate must be used, we recommend using one with specific gravity similar to the gas the variable area flow meter is designed for

An Alternative Method of Calibrating Variable Area Flow Meter at Rated Temperature and Pressure Using MetLab Series Primary Piston Prover

Introduction:

The previous Mesa method recommends calibration of a variable area flow meter (rotameter) by applying a correction factor to the DryCal's indicated flow reading for temperature and pressure, without subjecting the rotameter to the pressure specified for the variable area flow meter. This procedure is recommended as an alternative method for rotameter calibration where it will be subjected to its rated pressure using the Mesa back pressure module. The back pressure module consists of a back pressure regulator and a pressure gauge.

Flow Corrections:

Each variable area flow meter is designed to operate under a certain set of conditions which include the temperature, pressure and the type of gas. Usually, these conditions are documented on the tube enclosure of the rotameter. A reference table is provided to match the millimeter readings against the equivalent flow rates at the specified temperature and pressure. Otherwise, direct scale variable area flow meter indicates the flow rates directly on the tube enclosure.
When calibrating a rotameter using a DryCal piston prover, a flow correction factor (FCF) must be applied to the DryCal's indicated flow measurement in order to take into account the difference between the actual temperature versus the rotameter's rated temperature.
In this procedure, no correction is applied for the pressure as the equipment set up is designed to calibrate the rotameter at rated pressure. Correction is applied to the DryCal's indicated flow measurement only when the actual gas temperature differs to its rated temperature.
Flow correction factor, $FCF = 1/ \sqrt{(\text{calibration temp in 0F} + 460)/(\text{operating temp in 0F} + 460)}$

Setup Diagram:

On/ off valve → Pressure regulator → Pressure gauge → Needle valve → VA Meter → Pressure gauge → Back pressure regulator → DryCal

Equipment required:

1. DryCal Gas Flow Delivery System, consists of on/off valve, pressure regulator, pressure gauge, needle valve
2. Back pressure regulator and pressure gauge
3. Mesa Metrology series Primary Piston Prover (Models DryCal 800, DryCal 500, or Definer 220)

Installation:

Step 1
Connect all the devices as per the set up diagram. Connect tubing from the back pressure regulator to the inlet of the DryCal and leave the outlet open to atmosphere.

Step 2
The gas flow delivery system comes with a 'Quick-Connect' with male/female connector that connects the on/off valve to gas cylinder/compressed air. Connect the 'Quick-connect' to the gas flow source. Gas pressure should be approximately 80 to 100 psi.

Procedure:

Step 1
Turn on the DryCal unit. Through its set up menu, set the flow reading type to 'STD' and Temp Correction Factor to rated temperature of the rotameter.

Step 2
Through the set up menu, enter the calculated flow correction factor (FCF) as a Sensor Factor in your DryCal if the actual gas temperature differs to the rated temperature of rotameter. Otherwise, set its value to default 1.00.

Step 3
Close the needle valve, open the on/off valve, and set the gas pressure by adjusting the pressure regulator to 30 psi above the rotameter's rated pressure.

Step 4
If the rotameter contains a built-in needle valve, open its needle valve fully for unrestricted gas flow.

Step 5
Open up the needle valve and adjust the back pressure regulator until the pressure gauge before the back pressure regulator indicates the rotameter's rated pressure.

Step 6
Set the variable area flow meter's flow at desired level using the needle valve. The flow rate is indicated by the point on the printed scale where the float's center stabilizes.

Step 7
If you are not using a direct scale rotameter, record the reflected flow rate reading from the reference flow table against the floating point.

Step 8
Press 'Measure' or 'Read' on the DryCal and begin taking readings.

Step 9
Determine the full scale accuracy of the variable area flow meter using the following formula:
% Full scale accuracy = (MetLab's flow reading – VAF's indicated flow reading)/ VAF's full scale %.

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