Application Notes

Orifice Calibration:
Setup and Procedure for the Calibration of Orifi Used in the Field for Ambient Air Monitoring Equipment

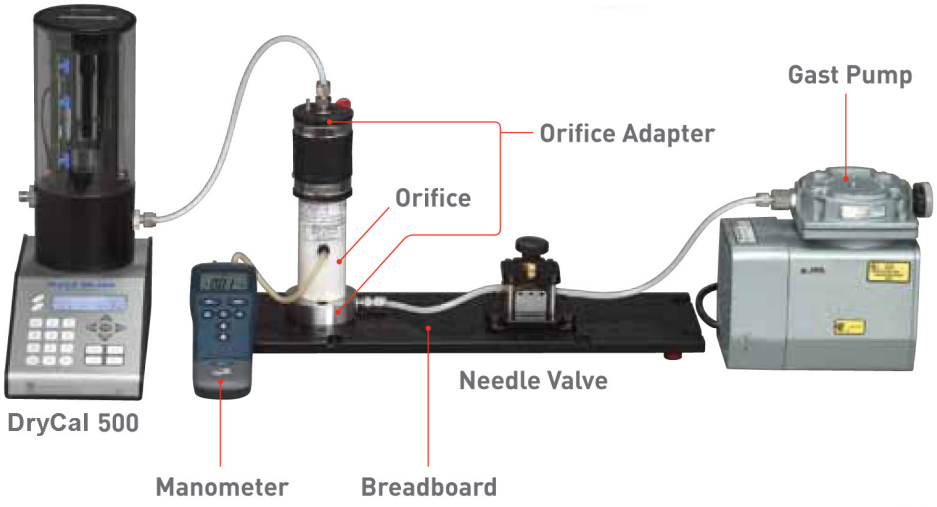
Introduction

The environmental professional uses an orifice to calibrate common air monitoring equipment in the field, such as PM samplers, TEOMS and FRMs. An orifice is a flow transfer standard (FTS) that determines flow by measuring the pressure drop across the orifice, in conjunction with the ambient temperature, pressure and calibrated orifice coefficients. An example of an orifice is the Definer™ 110 or the Chinook Engineering Streamline FTS™. Bios has developed a procedure to help you to perform accurate, defensible laboratory calibrations of your fleet of orifi. Our orifice calibration procedure involves the use of a DryCal Metrology Series piston prover as the designated primary standard.

Equipment required:

- DryCal 500 primary piston prover, with High flow cell (model 44)
- Manometer (digital)
- Suction flow source
- Tubing
- DryCal Excel spreadsheet

Mesa Labs offers the FTS Calibration Station (part number 100-029, pictured below) as a pre-packaged orifice calibration solution for our environmental customers; please contact Mesa for details (note: DryCal 500 system not included).



Mesa Labs
10 Park Place
Butler, NJ USA 07405

Tel: +1-973-492-8400
Toll Free: 800.663.4977
Fax: 973.492.8270
www.MesaLabs.com

Rev. 06.15.2016

Application Notes

Installation:

Step 1
Place the orifice you wish to calibrate onto the holder mounted on the calibration station (or, "flow bench").

Step 2
Place the adapter with the pressure tap onto the inlet of the orifice unit. If you're using the Definer™ 110 orifice, unscrew its windscreen before installing the adapter.

Step 3
Your calibration station has a precision needle valve. Connect your tubing from one side of the needle valve to the orifice holder and on the other side to the pump.

Step 4
Place your DryCal 500 upstream of the orifice. Connect the DryCal 500's outlet to the orifice's inlet adapter.

Operation:

Step 1
Power on your DryCal 500 and set it to take volumetric flow measurements.

Step 2
Without running gas flow to your DryCal 500, press its Read button. This will give you the ambient pressure condition, or Pamb. Record the Pamb in mmHg.

Step 3
From the manometer, connect its positive side to the pressure tap in the orifice inlet adapter and its negative side to the pressure tap in the orifice. This enables you to measure the pressure drop (ΔP) across the orifice.

Step 4
Turn on the pump and begin taking flow measurements with your DryCal 500. Using the DryCal 500 flow measurements as reference, adjust the pump's flow rate using the needle valve to the first desired flow rate calibration point.

Step 5
Step 5a, using the manometer to measure the pressure drop $\Delta P_{orifice}$: Cap the orifice pressure tap and connect the negative side to the pressure tap of the inlet adapter, while leaving the positive side open to ambient. This pressure drop is used to determine the orifice inlet pressure $P_{orifice}$.
OR
Step 5b, using the DPI pressure indicator to measure pressure drop $\Delta P_{orifice}$: Connect a digital pressure indicator to the pressure tap of the inlet adapter to determine the orifice inlet pressure $P_{orifice}$.

Mesa Labs
10 Park Place
Butler, NJ USA 07405

MesaLabs

Tel: +1-973-492-8400
Toll Free: 800.663.4977
Fax: 973.492.8270
www.MesaLabs.com

Application Notes

Step 6

Record the following data for entry into your DryCal Excel spreadsheet. The spreadsheet calculates the m and b orifice calibration constants and displays the transfer orifice standard error at the calibration points with the currently calculated m and b values.

- ΔP (pressure drop across the orifice, in inches H2O, as measured by the manometer)
- $\Delta P_{orifice}$ (pressure drop at the orifice inlet to ambient, in inches H2O, as measured by the manometer)
- T_{amb} (orifice inlet temperature, in ºC, as measured by the DryCal 500)
- QML (calibration flow rate, in liters per minute, as measured by the DryCal 500)

Step 7

Repeat Steps 1 through 6 at alternate flow rates within the orifice flow range (a minimum of seven calibration points is recommended).

Application Notes:

- This procedure is only valid in suction (vacuum) mode.
- For best results, all calibrations should be performed in a thermally-stable environment. You can thermallystabilize your orifice calibration setup by turning on the pump, adjusting the flow to the first calibration point, then waiting at least 15 minutes before recording the first data point.
- Your DryCal 500 should not be taking measurements while recording the pressure drop ΔP and orifice inlet pressure.
- Use the shortest length of tubing possible between all system components for best accuracy.
- The pump should not produce pressure variations.
- The DryCal spreadsheet performs a least square fit of the calibration data points. The calibration curve follows Y=mx+b, where "Y" represents the flow rate Qa, and where "x" represents $\sqrt{(\Delta P * T_{amb}/P_{amb})}$ from the flow equation for the orifice: $Qa=m*\sqrt{(\Delta P * T_{amb}/P_{amb})}+b$.

Mesa's Butler, N.J. manufacturing facility (pictured above) is the only NVLAP accredited ISO 17025 laboratory serving the occupational health and safety industry. With the lowest gas flow measurement uncertainties of any commercial laboratory, Mesa provides you with the legal protections and peace of mind valued in today's litigious business environment.

Mesa Labs
10 Park Place
Butler, NJ USA 07405

MesaLabs

Tel: +1-973-492-8400
Toll Free: 800.663.4977
Fax: 973.492.8270
www.MesaLabs.com