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 Bios Definer™ 110 or the Chinook Engineering Streamline FTS™.

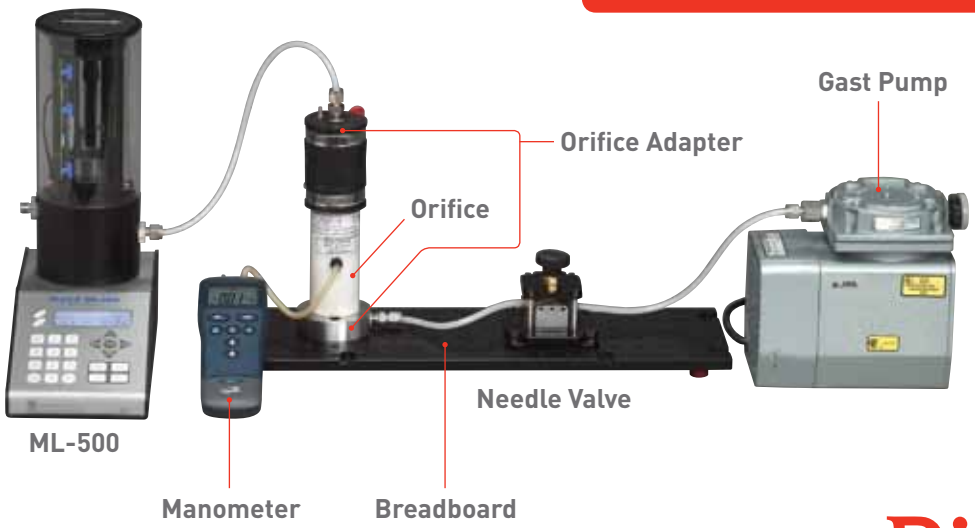
Bios has developed a procedure to help you to perform accurate, defensible laboratory calibrations of your fleet of orifi. Our orifice calibration procedure involves the use of a Bios Met Lab® Series piston prover as the designated primary standard.

Equipment required:

- **Bios Met Lab® ML-500 primary piston prover, with High flow cell (model 44)**
- **Manometer (digital)**
- **Suction flow source**
- **Tubing**
- **Bios Excel spreadsheet (downloaded via myBios at www.biosint.com)**

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

Bios FTS Calibration Station



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Driving a Higher Standard in Flow Measurement℠

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 Bios 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 ML-500 upstream of the orifice. Connect the ML-500's outlet to the orifice's inlet adapter

Operation:

Step 1

Power on your ML-500 and set it to take volumetric flow measurements

Step 2

Without running gas flow to your ML-500, press its Read button. This will give you the ambient pressure condition, or P_{amb}. Record the P_{amb} 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 ML-500. Using the ML-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 $P_{orifice}$

Step 6

Record the following data for entry into your Bios 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 ML-500)
- QML (calibration flow rate, in liters per minute, as measured by the ML-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 thermally-stabilize 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 ML-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 Bios 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: $Qa=m*\sqrt{(\Delta P * T_{amb}/P_{amb})}+b$

About Bios

Bios is a recognized leader in primary gas flow measurement. We provide products, services and solutions for professionals in diverse disciplines, including environmental protection, occupational health and safety, industrial process control, research and development and calibration laboratories.

Our Butler, New Jersey facility is one of the world's most accurate gas flow measurement laboratories. Since 2004, we've been accredited to the calibration laboratory quality and proficiency standards set forth by ISO 17025, ANSI Z-540 and NIST Handbook 150, through the National Voluntary Laboratory Accreditation program (NVLAP) of the National Institute of Standards and Technology (NIST), the national lab of the United States.

We're pleased to state that our Scope of Accreditation uncertainty is ±0.071% of reading for gas flow measurements from 5 to 50,000 scc per minute. A current copy of our accreditation certificate and scope may be found on our website, at **http://www.biosint.com/pdf/NVLAP-accreditation.pdf.**

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