FLOW DYNAMICS
NVLAP-accredited Laboratory

PDCL Calibrators

Installed in metrology and production calibration laboratories around the world

Primary Standard, Positive Displacement Flow Calibrator

Flow Dynamics' Positive Displacement Calibrators, Liquid (PDCL) offer the highest precision obtainable for flowmeter calibrations. The PDCL 10, 60 and 400 primary standard liquid flow calibrators meet all the requirements for correlation and proficiency testing. The NIST fluid flow measurement laboratory uses these precision calibrators in their liquid flowmeter lab.

The PDCL is the world's most advanced primary standard, positive displacement flow calibrator.

Application

The world's most advanced primary standard flow calibrator, the PDCL is capable of performing flow calibrations on various types of flowmeters, including turbine, differential pressure orifice plate, variable area, coriolis and other types of special meter designs. Flow Dynamics uses the same equipment it manufactures; therefore, the evolution of upgrades over the years has produced a quality design with excellent user interface software.

Many of our calibrators are located in government metrology laboratories around the world. Known for their precision, low maintenance and small footprint, they have proven to provide quality calibrations for decades. Also, being used in OEM calibration laboratories in daily production environments testifies to the reliability and long service life of the PDCL calibrators.

Description

The PDCL is a positive displacement measurement system. A primary cylinder is used to measure a precise volume of fluid displaced through the flowmeter under test. Temperature sensors determine fluid viscosity and density, as well as effects on the diameter of the measurement cylinder. Measuring all these variables allows for extremely high precision and calibration repeatability. PDCL calibrators have an uncertainty of <± 0.05% of reading.

FM78587
AS9100 Rev. 6 and
ISO 9001:2000

NVLAP
NVLAP Lab Code 200668

Flow Dynamics is a NVLAP-accredited primary standard flowmeter calibration laboratory

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Positive Displacement Calibrator, Liquid

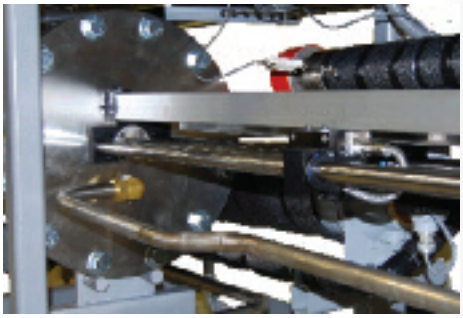
Principle of Operation

The PDCL consists of a precision-honed and polished cylinder assembly, with a piston mechanically connected with a displacement shaft. The travel of the piston is measured with a high-resolution linear encoder. One side of the piston is actuated pneumatically, while the other side is displacing a controlled amount of fluid through the meter under test.

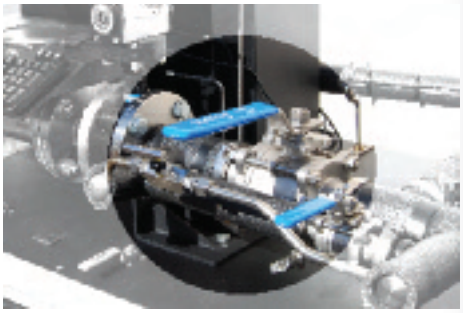
The flow is regulated by three control valves—course, medium and fine - to obtain the exact flow rate required. The fluid is collected in a reservoir tank and returned to the cylinder, bypassing the meter under test. A temperature control system maintains the fluid temperature to create the desired calibration conditions. This process can be fully automated to allow automatic flowmeter calibration.

The PDCL's low fluid usage supports the need to reduce hazardous fluids, while keeping fluid costs to a minimum. Blending fluids is made easy with a built-in pump for fluid removal and a cycling feature for mixing the fluids. A telescoping test section adjusts to enable installation of different size flowmeters. The calibrator's drain pan incorporates a drain pump and filter system to return the fluid to the reservoir. The piping loop has been designed to facilitate draining fluids out of the system.

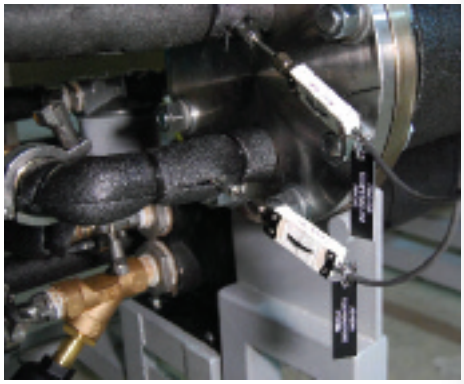
The electronic output from the calibrator's encoder, temperature sensors, and the meter under test are signal conditioned and collected with a computer data acquisition system. The computer uses Flow Dynamics' Windows-based "Flo-Cal" software to graph and produce calibration data reports. The software graphics display visual aids and real-time calibration data. Calibration files are automatically stored for easy comparison and to maintain calibration history.



Piston shaft and linear encoder



Three precision control valves

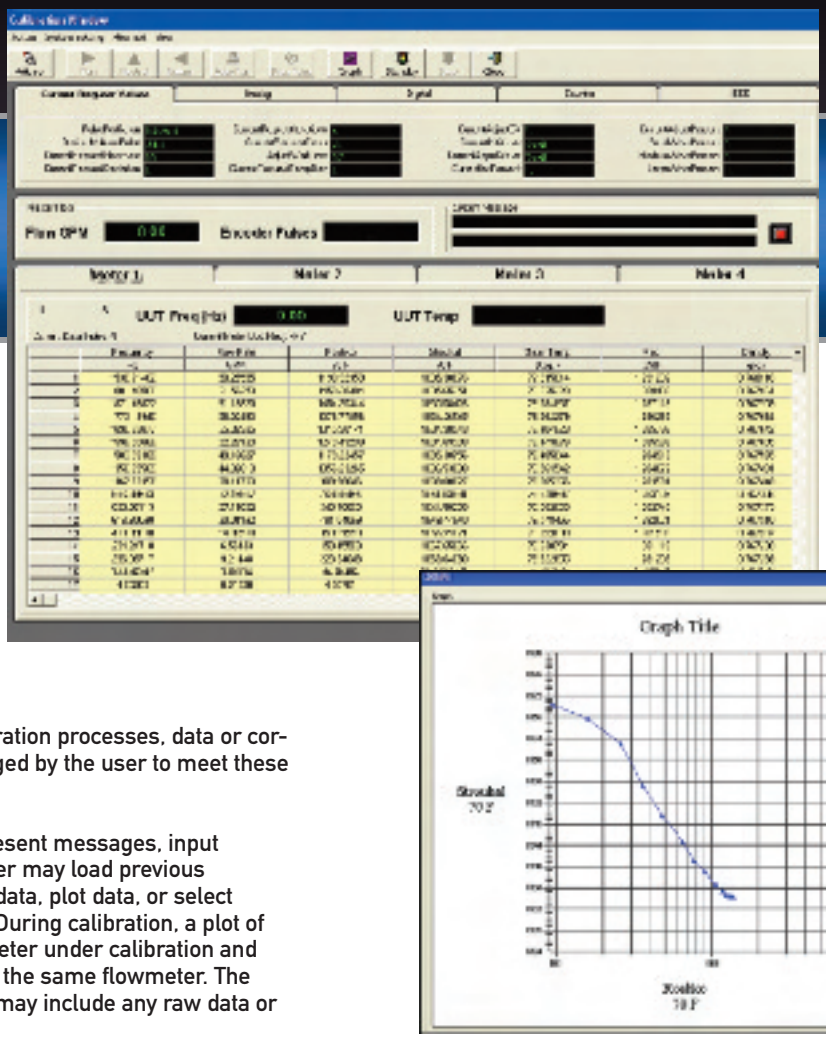


Temperature sensors for the PD cylinder and Temperature Control System

Features

- **Fluid Volume:** The precision cylinder on the PDCL ensures ample volume to capture stable data at max flow rate.
- **Temperature Sensors:** The PDCL has separate temperature sensors for the cylinder and test section to correct for changes in volume as recommended by NIST.
- **Test Section Length:** PDCLs have long test sections that can accommodate two turbine flowmeters with flow straighteners in tandem. This is the recommended set-up for a NIST inter-laboratory comparison test.
- **Flow Meter Inputs:** The PDCL comes standard with frequency, voltage and current inputs.
- **Test Section Isolation Valves:** The PDCL has isolation valves in the test section, which reduce the amount of fluid loss when meters are installed or removed.
- **Flow Rate Control Valves:** The PDCL has three rate control valves for course, medium and fine flow rate control.
- **Test Section Fluid Return:** The PDCL provides a filtered pump to return fluid from the test section pan to the reservoir.
- **Fill and Drain:** An internal pump is provided to simplify filling and draining the calibrator.
- **Fluid Temperature Conditioning:** The PDCL provides automatic temperature control using a fluid heater plus connections for a chilled water flow loop.
- **Run and Return Valves:** The run and return valves are activated automatically by software commands.
- **Automatic fluid cycling:** The system automatically cycles the fluid for mixing of fluids.
- **Software:** The PDCL PC includes the full Microsoft® Office Suite, automatically exporting the data to be stored in Access and to data sheets created in Word® or Excel®.

Flo-Cal© software provides a friendly user interface with pull-down menus and calibration data plotting.



Data Acquisition

An integral part of the PDCL system is the "Flo-Cal" Windows-based software program, which collects, reduces, plots, prints and stores calibration data. This program allows the user to change screen displays, data sheet formats and data reduction equations, on line, without using source code and compilers. As new requirements for calibration processes, data or correlations arise, the program may be changed by the user to meet these requirements.

Flo-Cal uses a Windows-style menu to present messages, input screens and other user interfaces. The user may load previous calibrations, start a new calibration, print data, plot data, or select calibrator utilities submenus at any time. During calibration, a plot of the data taken may be displayed for the meter under calibration and compared against previous calibrations of the same flowmeter. The parameters to plot are user-selected and may include any raw data or computed parameters.

Typical parameters that can be displayed on the screen, plotted and printed include, but are not limited to: flow rate, frequency, K-factor, frequency / kinematic viscosity, density, viscosity (absolute or kinematic), Strouhal Number, Roshko Number, Reynolds Number, or Temperature. The user may create and implement equations to reduce or correlate the data in ANY desirable manner or unit set.

Software functions are provided to calibrate turbine meters, variable area meters, positive displacement meters, and any other type of meter that has a visual, pulse, or analog output.

Calibration management / data acquisition software is designed to:

- Display graphical plots of calibration
- Maintain a historical database of all calibrations
- Maintain a database of all flowmeters to be calibrated
- Provide spreadsheet displays of a calibration during process
- Maintain math formulae for all types of flowmeters to be calibrated
- Provide a printed calibration certificate with actual calibration values
- Provide non-dimensional value analysis of performance (Strouhal, Roshko, K-Factor, etc.)

Operator is initiating Flo-Cal data acquisition system utilizing a user graphical interface. Flo-Cal controls the calibration process, both manually and automatically. It is also a diagnostic tool to present a graphic representation of the calibration, allowing for comparison of the previous calibration with the current calibration.

Primary Standard, Positive Displacement Flow Calibrator

This custom PDCL features a fully-automated calibration capability. The calibrator automatically sets the desired flow rates and collects all calibration data. This calibrator also incorporates a quick fixture clamping stage for OEM meter calibration.

Specifications

Model Number	Flow Range GPM (LPM)	Dimensions L-W-H Inches (m)	Weight (less fluid) Pounds (kg)	Displacement Volume Gallons (liters)	Fluid Capacity Gallons (liters)
PDCL 10	0.01 to 10 (0.04-37.9)	108x26x67 (2.7x.066x1.7)	1100 (499)	2 (7.6)	5 (19)
PDCL 60	0.06 to 60 (0.189-227)	164x31x70 (4.2x0.78x1.8)	1900 (862)	8.0 (30)	16 (60.5)
PDCL 400	0.1 to 400 (0.38-1514)	164x31x98 (3.4x0.78x2.5)	1600 (726)	23.5 (89)	40 (151.4)

Muliple flowmeter calibrations, up to 4 flow meters depending on stack length limitations
Power: 100/115 VAC (208 VAC 3 phase power required for heater)
Ambient Operating Temperature: 60° F to 90°F
Fluid Operating Temperature: 40°F to 140°F
Operating Pressure: Up to 120 psig
Fluid Types: Hydrocarbon Oils or Water
Viscosity Range: 0.5 to 1000 Cstks
Density Range: 0.500 to 0.9999 SGU
Input:
- Analog: 0-10 Vdc or 4-20 mA
- Resolution: 12 Bit
- Frequency: 0 to 20 kHz
- 2.5 to 10 Vdc (devices may require amplifiers)
- 2 ea. square wave pulse amplifiers for magnetic and RF inputs
- Interfaces: Analog (0 - 10 Vdc and 4 - 20 mA)
- Visual: Rotameters, etc.
- Signal Conditioners: Temperature

Uncertainty: Flow Rate: <± 0.05% of Reading
Reading Temperature: ± 0.1° F
Repeatability: Flow Rate: ± 0.01% of Reading

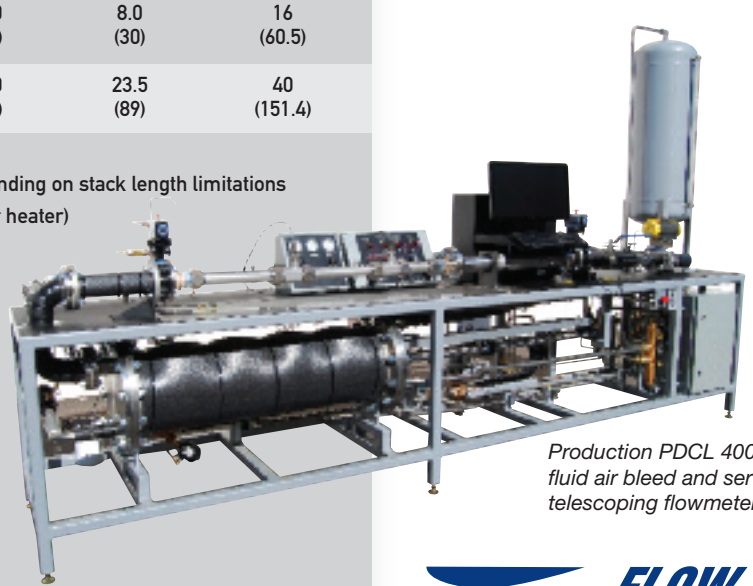
These specifications are for standard calibrators and subject to change without notice. Please consult with factory at time of quotation to confirm your configuration specifications.

On-site Annual Certification

Flow Dynamics offers on-site service to maintain and certify the calibrators. This service consists of:

1. Visually check cylinder condition and measure the diameter with NIST-traceable standard
2. Measure encoder constant over a known distance using NIST-traceable Doppler laser
3. Check temperature using NIST-traceable standard
4. Check time / frequency using NIST-traceable standard
5. Check system analog inputs (voltage/current) using NIST-traceable standard
6. Replace piston seals
7. Leak test system
8. Check flow accuracy with check standards using NVLAP-accredited, NIST-traceable facility
9. Provide calibration certificate and uncertainty analysis

Annual agreements are available along with additional services to include operator calibration training, measurement uncertainty classes and liquid / gas flowmeter classes.



Production PDCL 400 with automatic fluid air bleed and servo driven telescoping flowmeter fixturing

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