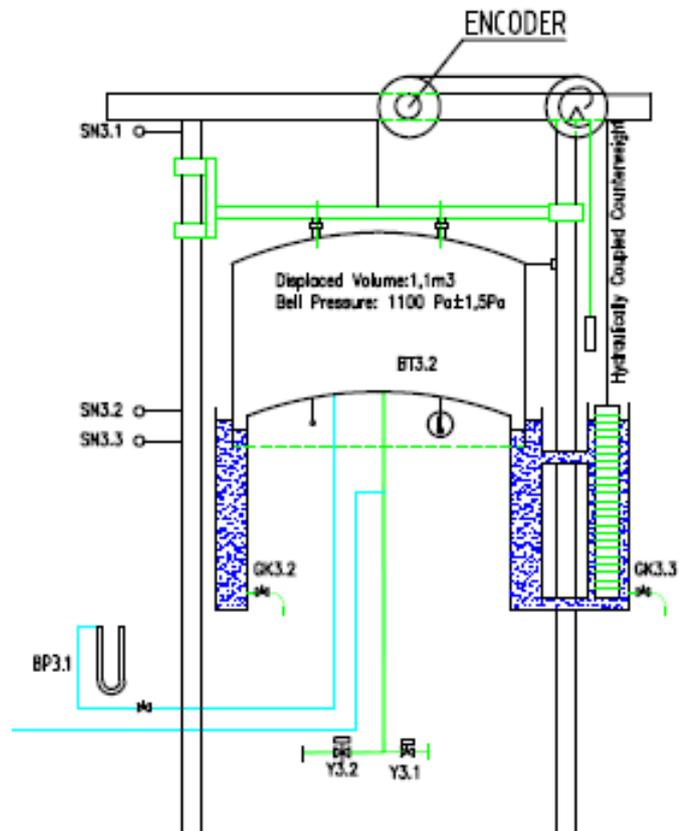


BP1100 - Bell Prover Gas Calibration System

1. Theory of Operation

The BP Bell Prover operates as follows. As gas is displaced through the meter under test, the bell contains it. This causes the bell to rise and as the bell rises, the flow rate is calculated using information supplied by a rotary encoder and pressure and temperature sensing devices.



The computer and interface circuitry which are part of the system provide for various flow meter inputs. Once flow range and specific test meter information are input, the computer prompts the user to set a flow rate. Utilizing a precision valve stack, the operator sets the flow rate. Flow is directed into the bell after the desired flow rate is set. As flow is diverted into the bell, a rotary encoder produces pulses proportional to the linear movement of the bell. Each pulse represents an extremely small, but precise volume of gas displaced through the meter.

At the end of the bell travel, a diverter valve opens allowing the gas to be evacuated from the bell. As the gas is exhausted, the bell returns to the bottom of its travel to the standby position. The system is immediately ready for another calibration run. The design prevents the gas from passing through the flow transducer in a reverse direction.

The volume of gas displaced during the calibration run can be accurately determined by knowing the volume of the bell. This is determined by physical measurement of the bell which is accomplished by a strapping method. This is precise and repeatable to better than $\pm 0.2\%$.

The variable of gas temperature, gas pressure and pulses generated by both encoder and flow transducer are stored in the computer. Immediately after the calibration run, computations are displayed on the computer screen along with the raw data.

The calibrator hardware and software are capable of calibrating other frequency generating Flowmeters (Turbines, Vortex Shedding, etc.), Analog output generating flowmeters (Thermal mass, Differential producers, etc.) or visual flowmeters (Variable Area, etc.).

See separate document for additional software specifications and description of CFlow+ software.

Our Bell prover as well as all other calibration equipment utilizes the CFlow+ calibration software.

2. Model BP Bell Prover Description

Interface electronics are provided to measure displaced volume and time over which the volume is displaced so that a precise flow rate can be determined. To calibrate a gas flowmeter, it must be installed upstream of the bell so that all gas flowing through is captured by the calibrator.

2.1 Mechanical Features

The system consists of a vertical inner tank surrounded by an outer shell. The annular space between the inner tank and the outer shell is filled with sealing liquid (oil). An inverted tank, called the bell, is placed over the inner tank with the wall of the bell riding in the annular space filled with sealing liquid. The liquid provides a bubble tight, frictionless seal which allows for smooth linear movement of the bell at essentially zero pressure drop.

2.1.1 Precision bearing system

A precision linear rod and roller bearing system is utilized.

2.1.2 Hydraulically Coupled Counter Weight

The counterweight used to balance the weight of the bell (so that minimal pressure is required to move the bell up) is machined so that its cross sectional area exactly matches the cross sectional area of the bell. As the bell moves out of the sealing liquid, the counterweight moves into the liquid so that the level of the sealing liquid remains constant. This allows for a more accurate/repeatable calibration since the varying liquid level is no longer an influence.

2.1.3 Small Counter Weight Involute Cam

A small counterweight hanging from an involute cam is used to compensate for buoyancy and other linear effects experienced by the bell as it moves along its stroke. The involute cam compensates for changes in buoyancy that the bell encounters during its stroke. As the bell rises, the torque arm of the cam becomes larger, providing more counterweight compensation.

2.1.4 Precision Machined Pulley

The bell is a precision cylinder so that linear movement of the bell is proportional to displaced volume. A rotary encoder is coupled to the pulley shaft and produces pulses proportional to the linear displacement of the bell. To insure that the pulley is precisely concentric to the shaft of the encoder, the pulley is precision machined. The chain drive is rigidly staked to the pulley.

2.1.5 Temperature and Pressure Transducer Located In Bell

The gas condition in the bell is monitored by temperature and pressure transducers mounted inside of the bell chamber.

2.1.6 Automated Three Way Valve

An automated three way valve (diverter valve) is integrated into the system. This valve opens automatically when the operator desires to begin a new calibration sequence allowing the bell to move to the top of its stroke. The valve closes as soon as the bell has reached its highest position.

2.2 Electrical Features

The proven mechanical hardware of the model BP1100 Bell Prover serves as the platform for installation of our state-of-the-art electrical hardware and software (see CF+ software description in the appendix). The bell is equipped with a high-resolution rotary optical encoder, all the required interface electronics, and a PC host computer. These electronics are interfaced to the rotary encoder, temperature and pressure transmitters, and the diverter valve to provide automatic data acquisition and low level control over the system. The host PC allows user interaction to provide high level control of the system and to manipulate and display data.

2.2.1 Automated Data Collection

The PC controls the entire operation of the bell data collection once initiated by the operator. In operation, the test variables are acquired by the PC, calculations are made, and data is stored. Upon completion of the pre-selected number of calibration points, the data can be viewed on the PC screen in tabular or plotted form, thereby affording the operator the opportunity to immediately view and approve the test results.

The completed calibration data is stored on the PC and can be used to generate hard copy printouts. The software also provides real time data display of all transducer operations and diagnostic routines for system trouble shooting and calibration. See Appendix for the CF+ software description.

3. Specifications

Bell prover type	BP 250	BP 500	BP 1100
Bell volume [dm ³]	250	500	1100
Flow rate range [m ³ /h]	0.1-30	0.22-70	0.5-130
Maximal extended uncertainty U (kU=2) [%]	0,1 ÷ 0,2		
Shortest time limit (max. Q)	30s		
Energy – compressed air	6 bar (not included in delivery)		
Protection	IP43		
Supply	3 x 400V / 230V, 2000VA		

Bell material:	Stainless steel
Wetted materials:	Stainless steel and sealing oil
Dimensions:	1.35Lx1.7Wx3.4H meters
Weight:	Approximately 1600 Kg dry
Operating Temperature:	18 to 24 C
Calibration gases:	Any instrument quality, inert gas, compatible with the materials of construction and filtered to 10 microns.
Diverter valve supply air:	7 bar
Test meter capabilities:	Any type of gas flowmeter including: Gas Turbine meters Rotameters Laminar flow elements Mass flow meters Bubble meters Sonic nozzles
Test meter signal inputs:	Pulse, Visual (Rotameter), Analog (4-20mA or 0-10 VDC)
Data collection:	Automatic upon manual setting of flow rate when used with CFlow+ software.
Unit selection:	Volumetric and Mass selectable when used with CFlow+ software.
Density compensation:	Automatic for bell and meter under test when used with CFlow+ software.
Real time Data:	Bell temperature and pressure Test meter temperature and pressure Test meter frequency
Temp. Transducers:	Included (2 required)
Pressure Transducers:	Included (one absolute and one differential required)