Metrological differential pressure balance - Model CPB6000DP

DH Desgranges & Huot

Applications

- High level Primary standard.
- Test and calibration of differential sensors and transmitters.
- Positive or negative differential pressure.
- Cross-floating for piston cylinder effective area determination.

Special Features

- Static pressure effect down to 1 ppm (see p.3).
- Calibration certificate as a standard from our Cofrac accredited laboratory..
- Static line pressure up to 800 bar.
- ΔP from 10 Pa up to 800 bar.

Model CPB6000DP differential pressure balance

Description

The CPB6000DP consists of **dual gas operated** pressure balances.

These are designed for differential pressure calibration at high static line pressure. A CPB6000DP balance is the **combination of two CPB6000-PX balances:**
- Integrated into one common housing to facilitate operation and improve measurement.
- Built-in pressure controls are provided.
- One side of a CPB6000DP can also be used as a CPB6000-PX for gauge pressure calibrations.

Operating principle
The CPB6000DP defines differential pressures on a single piston-cylinder assembly. The second piston-cylinder is used as a memory for the zero condition. The later operation requires that a piston-cylinder has good geometry and one is using the repeatability factor not the absolute accuracy. This makes possible **very accurate measurement of differential pressures**.
The operating procedure is to apply the same static pressure to both piston-cylinder assemblies with the measuring element floating. Tarring masses are then applied to the comparison-memory element so that both pistons are balanced in their mid position.

The comparison element is then isolated and the mass equivalent to the differential pressure increment required is added to the measuring piston. The pressures on both sides are adjusted using the variable volume. Note that this procedure compensates for any diaphragm movement within the instrument under test.

The exceptional intrinsic characteristics of high quality piston-cylinders allow the static pressure to be set and maintained with precision much greater than the absolute accuracy on either piston-cylinder effective area.
The cross float consists of adjusting the mass load on one of the pistons until both pistons float together in equilibrium at the common static pressure.
Due to the sensitivity of Desgranges & Huot's piston cylinder this equilibrium can be realized within a tolerance of 1 ppm.
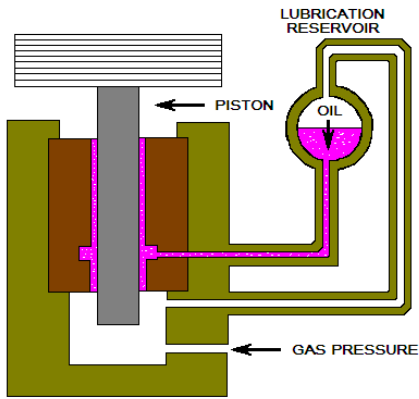
Accuracy
As with all D&H pressure balances, this is defined as the difference between the measured pressure and the true value, and includes all possible sources of uncertainty.

The accuracy with which the differential pressure may be defined depends upon three separate terms:
- Function of a pressure element range: sensitivity at the minimum value of the pressure element that has been determined in D&H laboratories.
- Contingent error on the equilibrium between the comparison and measuring piston. This term is a function of the static pressure.
- Uncertainty on the effective area and masses on the measuring element.

Note that the first two terms are worst-case conditions and after some time in service they may be statistically reduced according to operational experience.

WIKA

Part of your business

Pneumatic Circuit

1 – Gas Inlet quick connecting head
2 – Inlet valve
3 – Exhaust valve
4 – HP isolation valve
5 – LP isolation valve
6 – Pressure manifold / Sump
7 – Variable volume
8 – Visible level lubricant reservoir
9 – Pressure gauge
10 – Filter
11 – Measuring post (static P+DP)
12 – Comparison post (static P)
13 – HP pressure connection
14 – LP pressure connection

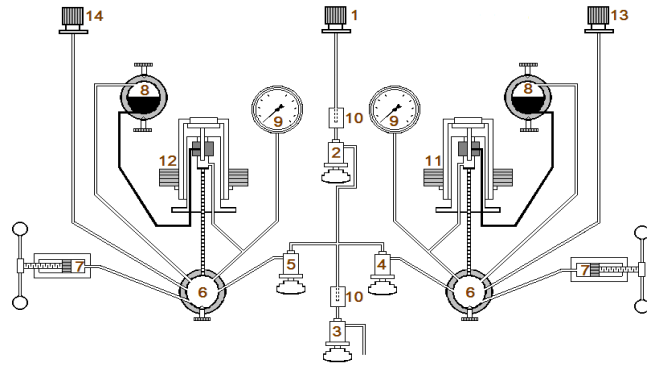## Stability of the differential pressure

Today's sophisticated differential transmitters and transducers offer resolution that makes it possible to observe the stability with which a floating piston controls a pressure. The **"noise"** in the two pressures defined by the two pistons of a CPB6000DP pressure balance may appear large relative to the differential pressure even though it is extremely small relative to the static pressure.

Indeed, controlling a differential pressure of 10 mbar at 100 bar with a stability of 10 Pa means controlling two independent pressures (nominally 100 bar on the low side and 100.01 bar on the high side) **within 1 part per million**.

Generally, when the pistons of a CPB6000DP pressure balance are rotating freely **the noise on the differential pressure will be less than the static pressure effect's contribution to the accuracy statement**.

This "noise", however, will be cyclical and consistent in nature at roughly the same frequency as the rate of rotation of the pistons except when the piston drive mechanism gives the piston an impulse. The piston drive mechanisms can be removed and the pistons rotated by hand but experience has shown that it is more metrological and preferable to isolate and ignore the occasional spikes coming from the drives than to tolerate the distraction and inconsistencies of hand rotation. If the cyclical noise from free piston rotation is averaged and the spikes from the piston drives discarded, precision well inside the accuracy statements can be obtained. When calibrating high resolution test instruments with rapid integration times, users that follow these recommendations report that the achievable precision is three to four times greater than the accuracy claimed.

Available Ranges

Piston Kn	Range with				Static pressure effect *
	1kg	**20 kg**	**30 kg**	**40 kg**	
1 bar/kg	0.1 MPa	2 MPa	1.5 MPa	4 MPa	10 Pa + 1 ppm Static P
20 psi/kg	20 psi	400 psi	600 psi	800 psi	10 Pa + 1 ppm Static P
2 bar /kg	0.2 MPa	4 MPa	6 MPa	8 MPa	10 Pa + 1 ppm Static P
50 psi/kg	50 psi	1000 psi	1500 psi	2000 psi	10 Pa + 1 ppm Static P
5 bar/kg	0.5 MPa	10	15	20 MPa	10 Pa + 1 ppm Static P
100 psi/kg	100 psi	2000	3000	4000 psi	0.002 psi + 1 ppm Static P
10 bar/kg	1 MPa	20	30	40 MPa	40 Pa + 1 ppm Static P
200 psi/kg	200 psi	4000	6000	8000 psi	0.008 psi + 1 ppm Static P
250 psi/kg	250 psi	5000	7500	10 000 psi	0.009 psi + 1 ppm Static P
20 bar/kg	2 MPa	40	60	80 MPa	80 pa + 1 ppm Static P
300 psi/kg	300 psi	6000	9000	12 000 psi	0.010 psi + 1 ppm Static P

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* The accuracy on a differential pressure is calculated by summing the static pressure effect and a percentage of the differential pressure value depending upon the accuracy of the piston-cylinder and mass set used.
When one side of the CPB6000DP is used alone to define gauge pressures, the uncertainties can be as low as **20 ppm** of reading.

General Characteristics

Dimension (mm)	620 x 500 x 510
Weight (in kg)	45 kg
Ranges	From 0.2 bar up to 800 bar
Mass set	Up to 40 kg
Material	AISI316 austenitic, non magnetic stainless steel
PCA material	Tungsten Carbide
Piston-cylinder mounting system	Liquid lubricated gas type (re-entrant).
Piston position monitoring	Dual mechanical (electronic as an option).
Test medium	Any non-corrosive gas.
Lubricating fluid	Drosera as standard. Krytox ^{TM} as an option if oxygen compatibility is required*.