



Industrial Range

DEAD-WEIGHT TESTERS



An
introduction
to
Dead-Weight
Testers.



DH·Budenberg

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PRINCIPLES OF OPERATION

Pressure is defined as force per area, where force is defined as mass multiplied by the acceleration acting on that mass:

$$P = F/A$$

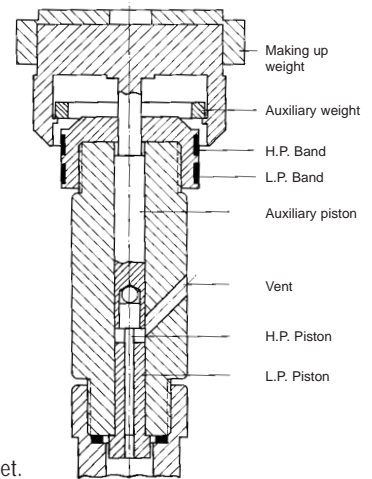
$$F = M \times \text{accel}$$

Dead weight pressure testers use these principles to generate a very stable and accurate pressure, by use of a series of weights which can be loaded on to a piston unit which is housed inside a cylinder. In principle, the components of the above equations are as follows:

A is the effective cross-sectional area of the piston unit

M is the mass of the weights loaded on top of the piston unit in addition to the mass of the piston unit itself

accel is the gravitational acceleration acting on the piston and mass set.



PISTON-CYLINDER UNITS

There is a small gap between the piston and the cylinder to allow the piston to rotate freely, with the pressure medium itself forming a "bearing", thus eliminating frictional forces on the piston. Any viscous forces are circumferential and do not act in a vertical direction on the piston. If the gap between the piston and cylinder is too small, the piston will not spin freely at low pressures. If the gap between the piston and cylinder is too large, there will be excessive leakage of the pressure medium and the piston will fall in the cylinder. DH-Budenberg piston-cylinder units are carefully made so that at low pressures the piston will spin for a reasonable length of time, and at high pressures the piston will float for a reasonable length of time. DH-Budenberg piston-cylinder assemblies are also fitted with a mechanical stop to prevent the piston leaving the cylinder housing if the applied pressure is excessive.

In practice, the effective area of the piston unit is described as the average of the areas of the piston cross-section and the internal cross-section of the cylinder. The manufacture of piston-cylinders is all carried out on-site by highly skilled operatives, thus allowing total control over the tolerances in effective area on each and every DH-Budenberg piston-cylinder unit. To give some appreciation of the processes and quality control involved, a variation of one ten thousandth of a millimetre would cause a change in area of a 1/80th in² piston-cylinder unit by 63 parts per million.

WEIGHTS

As with the production of piston-cylinder units, weights are manufactured in-house from raw materials, allowing total control over product quality. Weights are manufactured from series 300 austenitic stainless steel, reducing effects of corrosion and magnetic permeability to a minimum. As a standard principle, DH-Budenberg weights are manufactured to such a specific set of tolerances that they can be marked with the nominal pressure value that they will generate when used with the associated piston cylinder unit to an accuracy of 0.015% under all nominal conditions. With more accurate knowledge of local conditions, and with individual certification of mass values and piston-cylinder effective areas, the overall uncertainty of DH-Budenberg Dead-Weight Testers can be better than 30ppm. A further advantage of DH-Budenberg's policy of in-house manufacture and quality control, is that for a given piston-cylinder unit, weight sets of different denominations are completely interchangeable and will still produce the given nominal accuracy. Finally, when determined to be necessary by the end-user, DH-Budenberg will manufacture specific weight sets to mass values other than the standard nominal values, allowing weights to be marked with pressures compensated to local gravity conditions.

TESTERS

The third element of a complete dead-weight tester or pressure balance, is the unit required to generate the pressure which is then applied to the piston-cylinder and the instrument under calibration. This unit is generally called the dead weight tester base. DH-Budenberg dead-weight tester bases come in two basic forms, hydraulic for calibration of instruments with liquid as the pressure medium, or pneumatic for calibration of instruments with gas as the pressure medium. Hydraulic dead-weight tester bases are supplied with an in-built pressure generation device called a screw-press or variable volume unit, and in the large majority of cases, this screw-press is a patented dual-area axially located device providing a light, compact and stable base for the piston-cylinder and mass set. Pneumatic dead-weight testers are typically supplied with an incoming port allowing connection of the device to a clean dry non-corrosive source of gas such as a nitrogen cylinder.

GENERAL

All DH-Budenberg dead-weight testers are supplied with an in-house certificate of accuracy which is traceable to National/International Standards. We have, within the DH-Budenberg organisation, UKAS, COFRAC and DKD accredited laboratories, and can issue certification under these accreditations.



For further information on products and accessories, contact us at DH-Budenberg and ask for a Data sheet.