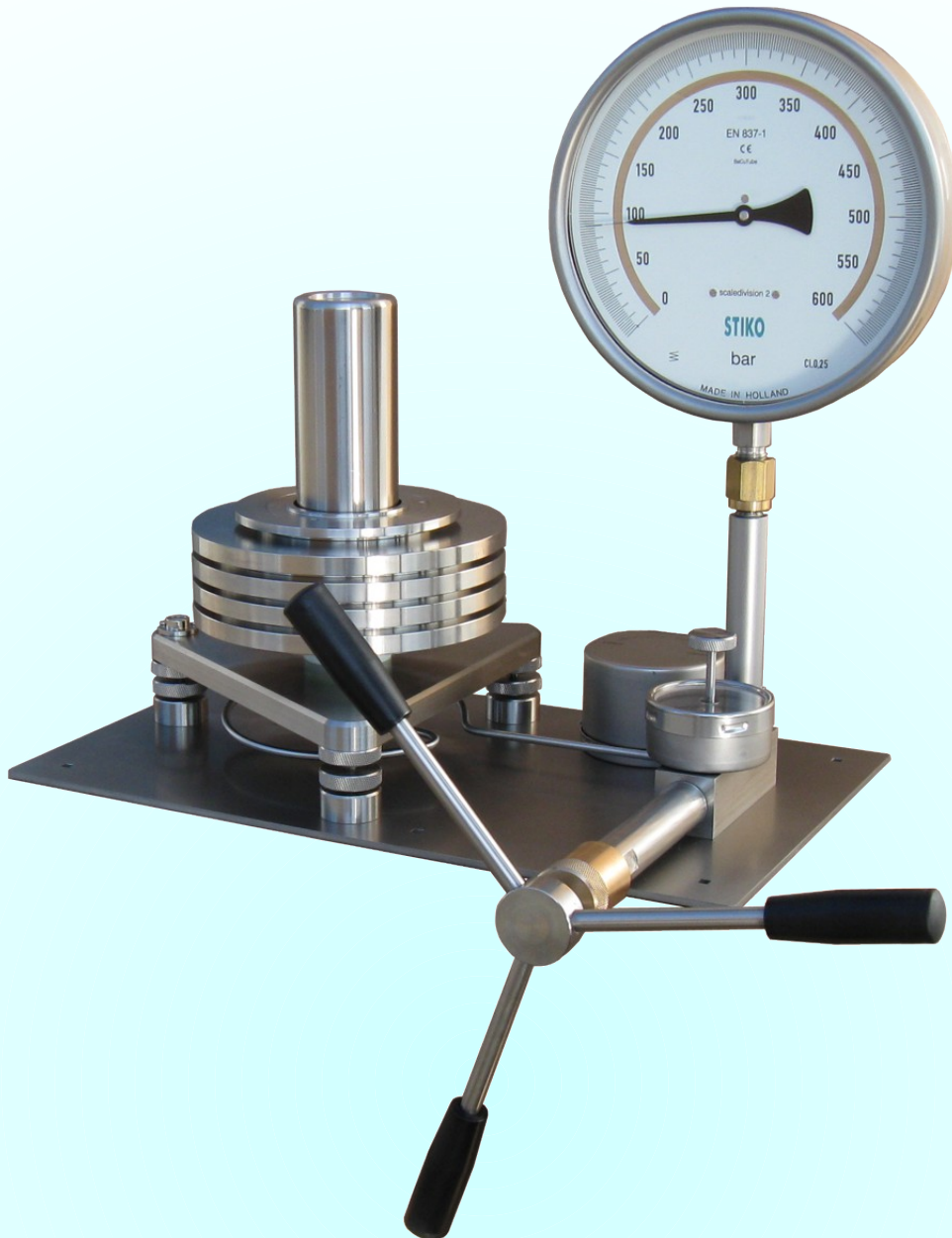


Pressure calibration equipment



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*A pleasure
to measure!*

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to measure!*

Introduction

Stiko has more than 40 years experience in pressure equipment and calibrations and offers a complete line of pressure calibration equipment such as deadweight testers, comparison test pumps and a variety of accessories.

Deadweight testers

Deadweight testers are used as the basic primary standard and its principle is world-wide accepted for the most accurate pressure measurement.

No other piece of equipment for pressure measurement can match the stability, repeatability and accuracy of the deadweight tester. It is ideal for calibrating pressure transducers, pressure gauges, transfer standards, recorders, digital calibrators, etc. and can also be used to measure directly the pressure in systems and processes where precise measurements are important.

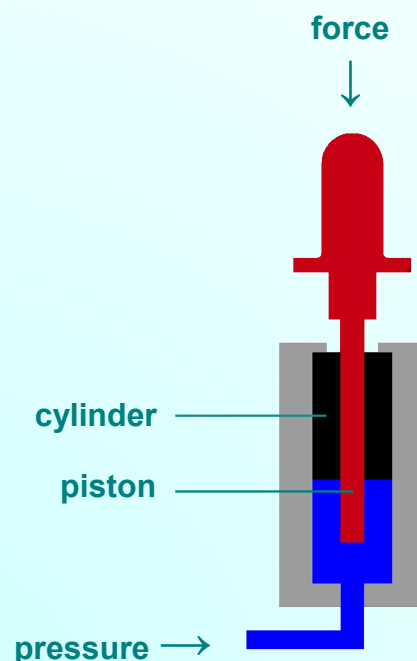
Basic principle of deadweight tester

A deadweight tester is based on a high accurate manufactured piston and cylinder assembly. This cylinder is mounted in a column. The piston can rotate and move freely up and down. Accurate calibrated masses are loaded on top of the vertical mounted piston. A pressure is applied on the bottom of the piston to lift the piston with masses. This creates a balance between the force made by the masses (downwards) and the force made by the pressure (upwards) and the effective area of the piston cylinder assembly.

In formula:

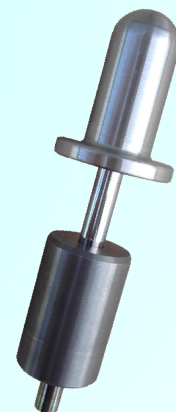
$$p = \frac{F}{A}$$

p : pressure
 F : force
 A : area (of the piston)



Piston cylinder assembly

The piston cylinder assembly is the heart of the deadweight tester and responsible for its high accuracy. Stiko manufactures piston cylinders with accuracies from 0.015% up to 0.008% of reading. To give an idea of the manufacturing skills the space between the piston and the cylinder is in the μm range and can only be measured in a climatic room. To guarantee excellent metro-logical characteristics all pistons and cylinders are made of tungsten carbide. Because of the extreme hardness of this material the pressure distortion (expansion) coefficient is negligible. The low friction coefficient provides minutes of turning just with a little swing.



Effective area

For all deadweight testers the effective area is determined by cross floating with a known reference primary standard deadweight tester. The exact pressure can be calculated. In the formula compensation factors are listed for air buoyancy, local gravity, surface tension of the used oil and temperature and pressure expansion of the piston cylinder assembly.

$$p_e = \frac{m_c \cdot (1 - \rho_a / \rho_m) \cdot g_l + \tau \cdot \pi \cdot d}{A_{20,0} \cdot (1 + (\alpha_p + \alpha_c) \cdot (t - 20)) \cdot (1 + \lambda \cdot p_{nom})}$$

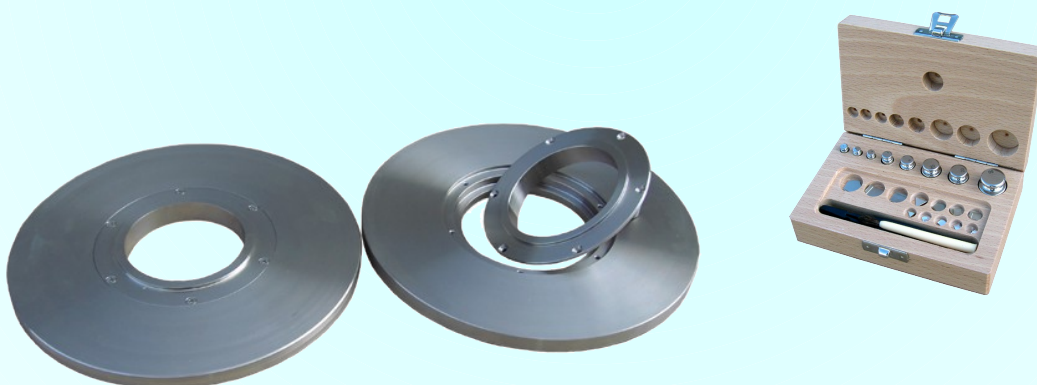
where:

p_e	: gauge pressure at reference level	[kPa]
m_c	: conventional mass	[kg]
$1 - \rho_a / \rho_m$: air buoyancy correction (= 0,99985)	[-]
g_l	: local gravity	[N/kg]
$\pi \cdot d$: piston circumference	[m]
τ	: surface tension oil (=0,031)	[N/m]
$A_{20,0}$: effective area at 20 °C / zero pressure	[m ²]
$\alpha_p + \alpha_c$: thermal expansion coefficient piston + cylinder	[°C ⁻¹]
t	: piston cylinder temperature	[°C]
λ	: pressure distortion coefficient piston +cylinder	[MPa ⁻¹]
p_{nom}	: nominal working pressure	[MPa]

All necessary data are listed in the calibration certificate provided with all deadweight testers.

Mass set

The masses of the Stiko deadweight tester are made of non magnetic stainless steel. They are laser marked with a serial number and mass or the equivalent pressure. The weights are tared out to add stainless steel to an internal chamber. This is easy for recalibration or adjustments for gravity compensation. The mass of all weights are listed in the certificate. For small pressure steps a box with small weights from 1 gram up to 50 gram is available as an option.



Pressure generating and control

The oil operated deadweight testers are supplied with a hand screw pump. This pump has a large displacement of 26cc, therefore a priming pump is not necessary. The pump is made of stainless steel as well as most other parts. The oil reservoir is combined with the vent valve and has a transparent cover to check easily the oil level. The vent valve has an easy to replace O-ring sealing. Because all used O-rings are listed in the manual it is possible to buy them at Stiko as well locally.



Accuracy

Stiko manufactures deadweight testers with an accuracy from 0.015% up to 0.008% of reading. Without additional costs they can be calibrated according to the local gravity instead of the standard gravity of 9.80665 N/kg.

Certification

Deadweight testers with accuracy 0.015% of reading (model DOS0015) are delivered with a Stiko calibration certificate which is traceable to national and international standards. For the higher accuracies of 0.01 and 0.008% of reading a third party *EA* certificate¹ is provided by Minerva Meettechniek B.V. Also certification by other national or international accredited laboratory are available to additional costs. We recommend a recalibration every 2 to 3 years depending on the amount of use.

Construction

All Stiko deadweight testers are of a simple well proofed rugged construction. Most used material is stainless steel, and therefore a long life of the calibration standard is guaranteed.

Scope of delivery

All deadweight testers are delivered fully operational with a stainless steel mass set in carrying cases.

The delivery includes:

An English operating manual;

A calibration certificate;

1/8", 1/4", 3/8", 1/2" BSP female adapters;

Spare multiseal for the pressure connection;

A bottle of deadweight tester oil;

A dust cover and bolts for mounting on a bench for type DOS001; DOS0008; DGS001, and DGDP001;



¹ European Accreditation, see <http://www.european-accreditation.org>

DOS series

oil deadweight testers

DOS0015

The oil operated deadweight tester DOS0015 has an accuracy of 0.015% of reading. This is a typical deadweight tester for industrial use and the weight set is transferred into a pressure unit. A traceable certificate is standard and a RVA certificate is possible as an option. The certificate shows the effective area as well as a list of the weight of each mass. The deadweight tester can be leveled with adjustable feet. An extra set of adjustable feet are included for fixing the deadweight tester to a bench. Five different pistons are available to cover ranges from 0.25 – 25 bar up to 10 – 1400 bar. Also ranges in psi, kPa, MPa and kg/cm² are available.



Ranges

A list of masses corresponding with the ranges is listed below.

bar	Piston number and measuring range					equivalent of mass in bar										
mass set	No. 1					0.25	0.025	0.05	0.25	0.5	2.5	5				
			No. 2			0.5	0.05	0.1	0.5	1	5	10				
					No. 3		1	0.1	0.2	1	2	10	20			
							No. 4		5	0.25	0.5	2.5	5	25	50	
									No. 5		10	0.5	1	5	10	50
kg	Range [bar]	Range [bar]	Range [bar]	Range [bar]	Range [bar]	carrier	number of masses									
20	0.25 - 25	0.5 - 50	1 - 100	5 - 250	10 - 500	1	1	4	1	4	1	4				
24	0.25 - 30	0.5 - 60	1 - 120	5 - 300	10 - 600	1	1	4	1	4	1	5				
28	0.25 - 35	0.5 - 70	1 - 140	5 - 350	10 - 700	1	1	4	1	4	1	6				
32	0.25 - 40	0.5 - 80	1 - 160	5 - 400	10 - 800	1	1	4	1	4	1	7				
36	0.25 - 45	0.5 - 90	1 - 180	5 - 450	10 - 900	1	1	4	1	4	1	8				
40	0.25 - 50	0.5 - 100	1 - 200	5 - 500	10 - 1000	1	1	4	1	4	1	9				
44	0.25 - 55	0.5 - 110	1 - 220	5 - 550	10 - 1100	1	1	4	1	4	1	10				
48	0.25 - 60	0.5 - 120	1 - 240	5 - 600	10 - 1200	1	1	4	1	4	1	11				
52	0.25 - 65	0.5 - 130	1 - 260	5 - 650	10 - 1300	1	1	4	1	4	1	12				
56	0.25 - 70	0.5 - 140	1 - 280	5 - 700	10 - 1400	1	1	4	1	4	1	13				

psi	Piston number and measuring range					equivalent of mass in psi										
mass set	No. 1					5	0.5	1	5	10	50	100				
			No. 2			10	1	2	10	20	100	200				
					No. 3		20	2	4	20	40	200	400			
							No. 4		100	5	10	50	100	500	1000	
									No. 5		200	10	20	100	200	1000
kg	Range [psi]	Range [psi]	Range [psi]	Range [psi]	Range [psi]	carrier	number of masses									
22	5 - 400	10 - 800	20 - 1600	100 - 4000	200 - 8000	1	1	4	1	4	1	3				
28	5 - 500	10 - 1000	20 - 2000	100 - 5000	200 - 10000	1	1	4	1	4	1	4				
33	5 - 600	10 - 1200	20 - 2400	100 - 6000	200 - 12000	1	1	4	1	4	1	5				
39	5 - 700	10 - 1400	20 - 2800	100 - 7000	200 - 14000	1	1	4	1	4	1	6				
44	5 - 800	10 - 1600	20 - 3200	100 - 8000	200 - 16000	1	1	4	1	4	1	7				
50	5 - 900	10 - 1800	20 - 3600	100 - 9000	200 - 18000	1	1	4	1	4	1	8				
55	5 - 1000	10 - 2000	20 - 4000	100 - 10000	200 - 20000	1	1	4	1	4	1	9				

DOS series

oil deadweight testers

DOS0015 Dual Piston

The oil operated deadweight tester DOS0015 dual piston has the same features as the normal DOS0015. By using two different size of pistons a larger measuring range is achieved. The pistons can be inter changed easily within minutes. A wooden box is used to safely store the piston and cylinders.



Ranges

Both pistons cylinders could be used on one weight set. The piston cylinders are made in such a way that the same weight creates for instance for the low range 10 bar and for the high range 100 bar.

For each combination of pistons the table gives a list of masses corresponding with the ranges.

Piston number	No. 1	No. 2	No. 3	No. 4	No. 5	
Ratio	1:	1	2	4	10	20

Example

If a deadweight tester is needed for 0.5 up to 1000 bar a dual piston can be used.

See the table on page 5:

mass set of 40 kg (first column)

piston no. 2 gives 0.5 ... 100 bar

piston no. 5 gives 10 ... 1000 bar

Above table gives the piston ratio.

piston no. 2: ratio 2

piston no. 5: ratio 20

The ratio between both pistons is 2:20 or 1:10. This means that a weight (in this example the largest weight. See table on page 5 the the most right column) for piston no. 2 is 10 bar and the same weight makes 100 bar for the piston no.5

Transport cases



Aluminum case



Flight case

DOS series

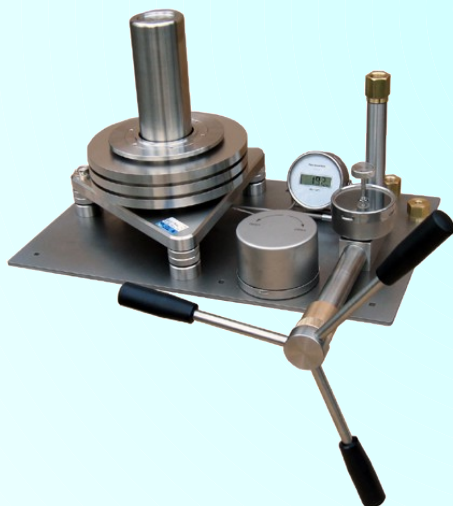
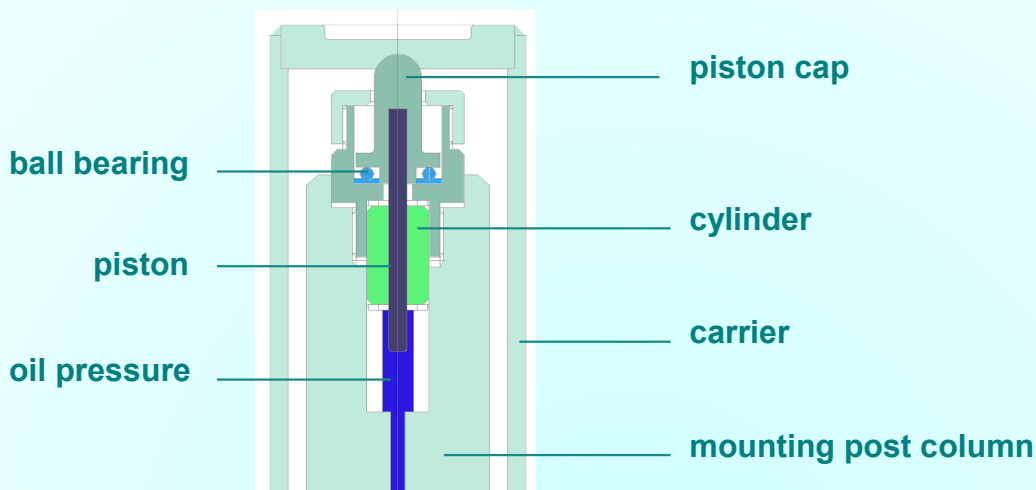
oil deadweight testers

DOS001

The oil operated deadweight tester DOS001 has an accuracy of 0.01% of reading. The weight column and pump are mounted on a stainless steel base plate. A triangle frame is used to make a steady and firm base for the weight column and can be leveled out by a spirit level. The weight carrier is of a hanging type and therefore insensible for any negative influences like friction of a support piston. The picture below shows the design of a DOS001. An EA RVA certificate by an accredited third party is standard. The certificate shows the effective area as well as the weight of each mass.



Design of DOS001/DOS0008



DOS0008

The oil operated deadweight tester DOS0008 has an accuracy of 0.008% of reading. The design is similar to the DOS001, but the piston cylinder assembly is even more accurate. To correct the temperature influence a PT100 with LCD display is applied.

Mass set for DOS001 and DOS0008

The oil deadweight tester DOS001 and DOS0008 can be ordered with different mass sets. Mostly it is delivered in kg. With the mentioned formula and the data listed in the certificate the best accuracy is achieved. By ordering the mass set in a pressure unit (for instance bar, psi or kg/cm²) the deadweight tester can be used without using the formula. In this case the disagreement is larger then by using the formula. The weight set can be adjusted to the local gravity to increase the accuracy.

Ranges

The table gives a list of masses corresponding with the ranges. Five different diameter of pistons are available to cover a wide pressure range. For small pressure steps a box with small weights from 1 gram up to 50 gram is available as an option.

bar	Piston number and measuring range					equivalent of mass in bar										
mass set	No. 1					1.25	0.025	0.05	0.25	0.5	2.5	5				
			No. 2			2.50	0.05	0.1	0.5	1	5	10				
					No. 3		5	0.1	0.2	1	2	10	20			
							No. 4		12.5	0.25	0.5	2.5	5	25	50	
									No. 5		25	0.5	1	5	10	50
kg	Range [bar]	Range [bar]	Range [bar]	Range [bar]	Range [bar]	carrier	number of masses									
16	1.25 - 20	2.5 - 40	5 - 80	12.5 - 200	25 - 400	1	1	4	1	4	1	3				
24	1.25 - 30	2.5 - 60	5 - 120	12.5 - 300	25 - 600	1	1	4	1	4	1	5				
32	1.25 - 40	2.5 - 80	5 - 160	12.5 - 400	25 - 800	1	1	4	1	4	1	7				
40	1.25 - 50	2.5 - 100	5 - 200	12.5 - 500	25 - 1000	1	1	4	1	4	1	9				
48	1.25 - 60	2.5 - 120	5 - 240	12.5 - 600	25 - 1200	1	1	4	1	4	1	11				
56	1.25 - 70	2.5 - 140	5 - 280	12.5 - 700	25 - 1400	1	1	4	1	4	1	13				
64	-	-	-	-	40 - 1600*	1	1	4	1	4	1	15				
72	-	-	-	-	40 - 1800*	1	1	4	1	4	1	17				
80	-	-	-	-	40 - 2000*	1	1	4	1	4	1	19				

* DOS001 high: modified design

psi	Piston number and measuring range					equivalent of mass in psi										
mass set	No. 1					20	0,5	1	5	10	50	100				
			No. 2			40	1	2	10	20	100	200				
					No. 3		80	2	4	20	40	200	400			
							No. 4		200	5	10	50	100	500	1000	
									No. 5		400	10	20	100	200	1000
kg	Range [psi]	Range [psi]	Range [psi]	Range [psi]	Range [psi]	carrier	number of masses									
16	20 - 300	40 - 600	100 - 1200	200 - 3000	400 - 6000	1	4	1	4	1	1	2				
22	20 - 400	40 - 800	100 - 1600	200 - 4000	400 - 8000	1	1	4	1	4	1	3				
28	20 - 500	40 - 1000	100 - 2000	200 - 5000	400 - 10000	1	1	4	1	4	1	4				
33	20 - 600	40 - 1200	100 - 2400	200 - 6000	400 - 12000	1	1	4	1	4	1	5				
39	20 - 700	40 - 1400	100 - 2800	200 - 7000	400 - 14000	1	1	4	1	4	1	6				
44	20 - 800	40 - 1600	100 - 3200	200 - 8000	400 - 16000	1	1	4	1	4	1	7				
50	20 - 900	40 - 1800	100 - 3600	200 - 9000	400 - 18000	1	1	4	1	4	1	8				
55	20 - 1000	40 - 2000	100 - 4000	200 - 10000	400 - 20000	1	1	4	1	4	1	9				
61	-	-	-	-	500 - 22000*	1	1	4	1	4	1	10				
66	-	-	-	-	500 - 24000*	1	1	4	1	4	1	11				
72	-	-	-	-	500 - 26000*	1	1	4	1	4	1	12				
77	-	-	-	-	500 - 28000*	1	1	4	1	4	1	13				

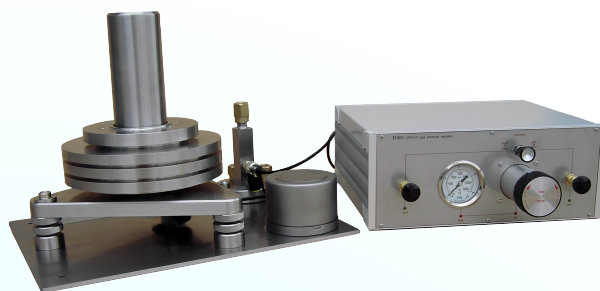
* DOS001 high: modified design

DGS series

gas deadweight testers

DGS001

The gas operated deadweight tester DGS001 has an accuracy of 0.01% of reading. The piston cylinder assembly is made of tungsten carbide which is extremely hard and wear-resistant. The weight column is mounted on a stainless steel base plate. A triangle frame is used to make a steady and firm base for the weight column and can be leveled out by a spirit level. The weight carrier is of a hanging type and therefore insensible for any negative influences like friction of a support piston. An EA RVA certificate by an accredited third party is standard. The certificate shows the effective area as well as the weight of each mass.

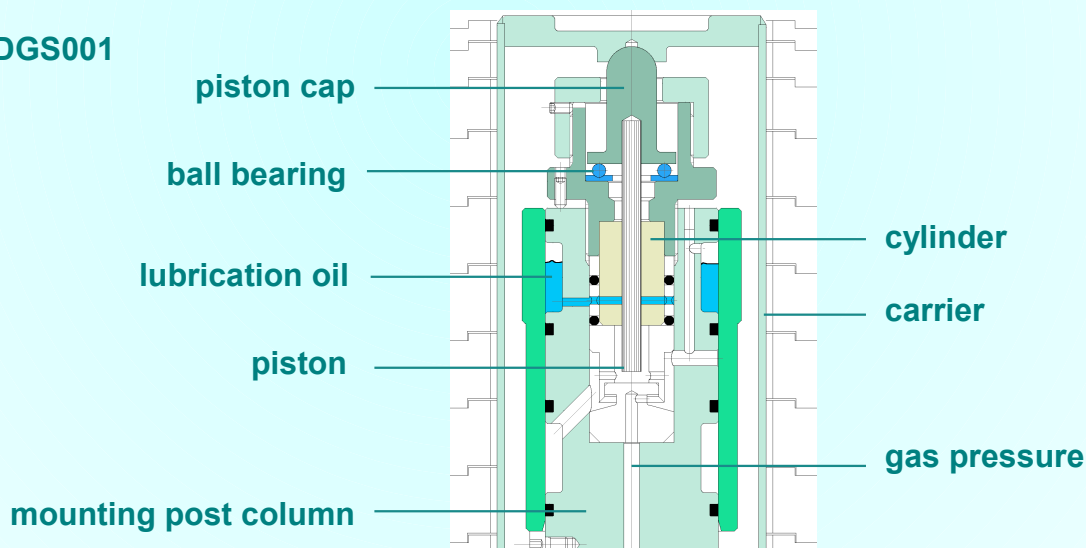


Oil lubricated / gas operated

The oil lubricated / gas operated piston of the DGS series is specially designed to have superior performance at higher gas pressures without the problems of gas lubricated / gas operated pistons cylinders. They have better sensitivity than oil lubricated pistons, however the natural drop rate is much higher at high line pressure. Which makes them very difficult to operate. Oil lubricated pistons have no significant drop rate as the oil acts as a seal. There are a lot of deadweight tester manufacturers who claim oil lubrication / gas operation, but they use a traditional oil / oil piston and an oil-gas interface. The biggest and obvious disadvantage of this solution is that the surface level of the oil-gas interface precisely has to be known. The added uncertainty especially in high line pressure applications make this solution not ideal. The piston cylinder assembly of the DGS series is really different. The oil is lead to the gap between piston and cylinder by means of an oil reservoir around the cylinder. As the oil surface is slightly higher than the entrance bore in the cylinder the oil pressure is also slightly higher than the gas pressure ensuring enough lubrication between piston and cylinder. The benefits of this design are:

- excellent turning time of the piston;
- very small fall rate (also at higher pressures);
- excellent leak rate, because the oil acts as a seal;
- the oil avoids dirt and dust entrance between piston and cylinder.

Design of DGS001



Ranges

The table gives a list of the masses corresponding with ranges. Three different piston cylinders are available. For small pressure steps a box with small weights from 1 gram up to 50 gram is available as an option.

bar	Piston number and measuring range			equivalent of mass in bar						
mass set	No. 1			1.25	0.025	0.05	0.25	0.5	2.5	5
	No. 2			2.50	0.05	0.1	0.5	1	5	10
			No. 3	5	0.1	0.2	1	2	10	20
kg	Range [bar]	Range [bar]	Range [bar]	carrier	number of masses					
16	1.25 - 20	2.5 - 40	5 - 80	1	1	4	1	4	1	3
24	1.25 - 30	2.5 - 60	5 - 120	1	1	4	1	4	1	5
32	1.25 - 40	2.5 - 80	5 - 160	1	1	4	1	4	1	7
40	1.25 - 50	2.5 - 100	5 - 200	1	1	4	1	4	1	9
48	1.25 - 60	2.5 - 120	-	1	1	4	1	4	1	11
56	1.25 - 70	2.5 - 140	-	1	1	4	1	4	1	13

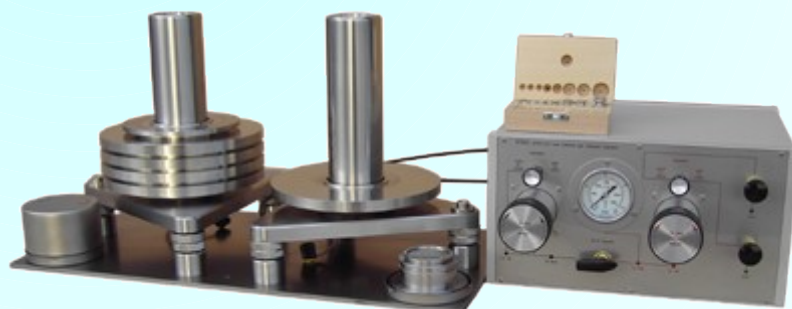
psi	Piston number and measuring range			equivalent of mass in psi						
mass set	No. 1			20	0,5	1	5	10	50	100
	No. 2			40	1	2	10	20	100	200
			No. 3	80	2	4	20	40	200	400
kg	Range [psi]	Range [psi]	Range [psi]	carrier	number of masses					
16	5 - 300	10 - 600	20 - 1200	1	4	1	4	1	1	2
22	5 - 400	10 - 800	20 - 1600	1	1	4	1	4	1	3
28	5 - 500	10 - 1000	20 - 2000	1	1	4	1	4	1	4
33	5 - 600	10 - 1200	20 - 2400	1	1	4	1	4	1	5
39	5 - 700	10 - 1400	20 - 2800	1	1	4	1	4	1	6
44	5 - 800	10 - 1600	-	1	1	4	1	4	1	7
50	5 - 900	10 - 1800	-	1	1	4	1	4	1	8
55	5 - 1000	10 - 2000	-	1	1	4	1	4	1	9

DGS0008

The gas operated deadweight tester DGS0008 has an accuracy of 0.008% of reading. The design is similar to the DGS001, but the piston cylinder assembly is even more accurate. To correct the temperature error a PT100 with LCD display is applied.

Differential deadweight tester type DGDP001

The gas operated deadweight tester is also available in a differential pressure model. The DGDP001 combines the benefits of the oil lubricated piston cylinder assembly with the need to calibrate at a specific static pressure. This deadweight tester allows you to make differential pressure from 1.25 mbar up to the maximum pressure of 200 bar with static pressures from 5 bar up to 200 bar. It can be used to calibrate differential pressure transmitters with accuracies of 0.1 or 0.05%. The accuracy of the DGDP is 0.01% of reading. A differential regulator is used to set the line (static) pressure and to add the differential pressures.



GPR series

gas pressure regulators

Gas pressure regulators are used to control and fine regulate gas pressures. They are necessary in combination with gas deadweight testers, but can also be used for other calibration purposes. All regulators must be connected to a bottle of compressed nitrogen or any other gas. The maximum inlet pressure is 200 bar. All regulators are equipped with minimess flexible tubing.

GPR120 S

This gas pressure regulator is an easy to use max. 120 bars regulator with a fine to adjust inlet and vent valve. The reference and instrument under test can be mounted direct on top of the housing. Adapters with 1/8", 1/4", 3/8", 1/2" BSP female thread are included as well as minimess tubing to connect it to a nitrogen filled bottle.



GPR200

This gas pressure regulator is a regulator with an extreme fine to adjust variable volume. It is specially designed to work with the gas driven deadweight tester DGS001. Minimess tubing is included to connect it to a nitrogen filled bottle.



GPR200D

This gas pressure regulator is a double GPR200 regulator. It is specially designed to combine with the gas driven differential deadweight tester DGDP001. A by-pass valve is used to isolate the high and low regulators. Minimess tubing is included to connect it to a nitrogen filled bottle.

GPR200 SP

This gas pressure regulator is a GPR200 with built in pressure reducer. By reducing the pressure just above to required pressure an even better adjustment of the needed pressure is achieved. Minimess connections are situated at the back as well on the front of the housing.



COP series

comparison test pumps

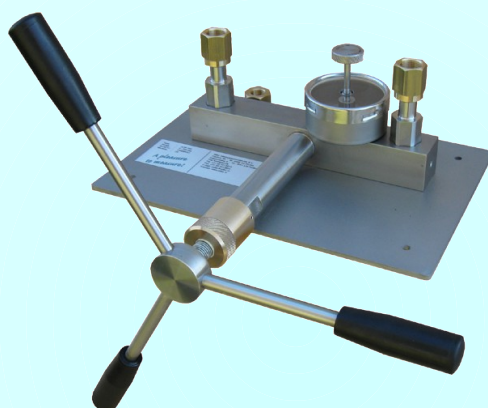
These pumps are used for checking pressure instruments against a master test gauge or transducers. They are portable and rugged. A stainless steel bottom plate with mounting holes is applied for stable bench mounting.

COP700/1400

This large volume (26cc) comparison test pump is easy to operate. The oil reservoir is combined with the vent valve and has a transparent cover to easily check the oil level. The vent valve has an easy to replace O-ring sealing. Because all used O-rings are listed in the manual it is possible to buy them at Stiko as well locally. All pumps are delivered with adapters to $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ " BSP female thread. Aluminum cases or flight cases are available for transport: see page 6.

A variety of models are available:

Model	Medium	Pressure	Option
		bar	
COP700	oil	0 - 700	Skydrol
COP1400	oil	0 - 1400	-
COP700 water	water	0 - 700	Oxygen cleaned
COP1000 water	water	0 - 1000	Oxygen cleaned



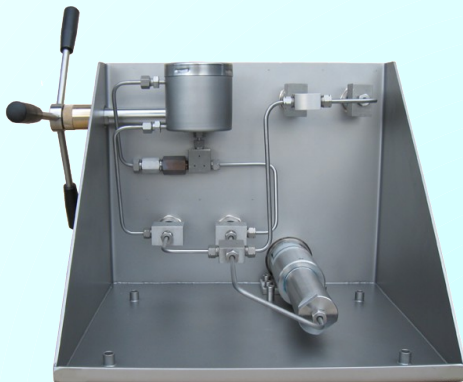
COP series

comparison test pumps

COP4000 / COP7000

This ultra high pressure comparison test pump makes a maximum pressure of 4000 bar for COP4000 and 7000 bar for the COP7000 model. All components are mounted in a strong rugged stainless steel frame to protect the operator at any time. All handles and valves can be operated from the front. Therefore the operator is safe at any time.

A priming pump of 26cc is applied to prime the system and to operate up to 700 bar. The large high pressure hand pump is used to obtain the maximum pressure. A large oil reservoir of 0.7 liter with transparent cover is applied to check the oil level. All ports can be shut off by high pressure valves to isolate a specific circuit.

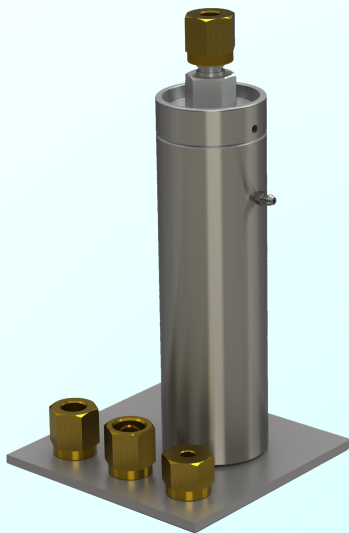
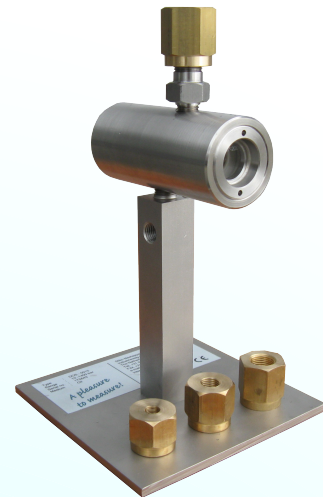


All tubing is made of stainless steel 316 and M16x1.5 or 9/16"x18 UNF high pressure connections are used.

*A pleasure
to measure!*

Dirt / moisture trap (max. 200 bar)

This stainless steel dirt / moisture trap is used to protect pneumatic calibration systems from dirt and oil. Any dirt and moisture can be seen through the inspection glass. The maximum allowable pressure is 200 bar. It is delivered with a free standing frame and a 1/8", 1/4", 3/8", 1/2" BSP female adapter set. The unit can be supplied with a filter unit which is easy to drain by means of a drain plug.

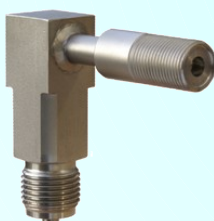


Oxygen tester (max. 700 bar)

Oxygen devices have to be absolutely free from oil and grease. Also many other devices have to be kept clean. They have to be tested on air, water or other suitable liquids. This oxytester (oil-water separator) guarantees an absolute separation between reference liquid of the calibration equipment and the device under test liquid. The separator is sometimes used to prevent a tester from being contaminated by solids or liquids from gauges being calibrated. It is delivered with a free standing frame and a 1/8", 1/4", 3/8", 1/2" BSP female adapter set.

Instrument stand

This stainless steel instrument stand is used to connect pressure gauges, transducers and other pressure equipment. The instrument stand is supplied with a 1/8", 1/4", 3/8", 1/2" BSP female adapter set and a minimess quick tubing connection. The maximum pressure is limited by the minimess tubing. With capillary or tube higher pressures can be achieved.



Adapters

A large variety of adapters can be supplied like angle adapters and adapters with a special thread i.e. autoclave or other high pressure connections. For instruments under test with NPT thread a 1/8", 1/4", 3/8", 1/2" NPT female and for metric thread: M10, M12, M14, M20 adapter set is available. Also adapters in stainless steel can be supplied.

