HARLEX

Diaphragm-type accumulator

Type HAD

Component series 1X and 2X
Nominal capacity 0.075 to 3.5 liters
Maximum operating pressure 350 bar

Features

- Hydraulic accumulator according to Pressure Equipment Directive 97/23/EC
- Diaphragm material for different applications

HARLEX HRL MACHINERY

Ordering code

Capacity	Permissible max. operating pressure	Component series	Certification Acceptance
0.075	250	1X	BA
0.16	250	1X	BA
0.35	210	1X	BA
0.5	160	1X	BA
	250	2X	
0.7	100	1X	BA
	180	1X	
	250	1X	
	350	2X	
1.0	200	1X	BA
1.4	140	1X	CE
	250	1X	
	350	2X	
2.0	100	1X	CE
	250	1X	
	350	2X	
2.8	70	1X	CE
	250	1X	
	350	1X	
3.5	250	1X	CE
	350	1X	

HAD	–	–	/		–		1		–	– *

Component series
Component series 10 to 19 = **1X**
Component series 20 to 29 = **2X**
(unchanged installation and connection dimensions)

Precharge pressure
0 to 250 bar
E.g. 10 bar = **10**

Connection size for hydraulic fluid [1)]

M14x1.5	= **Z04**
M18x1.5	= **Z06**
M22x1.5	= **Z08**
G 1/4	= **G02**
G 3/8	= **G03**
G 1/2	= **G04**
G 3/4	= **G05**
G 1	= **G06**
3/4 – 16 UNF	= **U04**
1 1/16 – 12 UNF	= **U06**
3/8 NPTF	= **F02**
1/2 – 14 NPTF	= **F08**

Type of mounting (form of oil connection)

Mounting cavity	= **A**
Mounting cavity with hexagon	= **C**
Stud ends with female thread	= **E**
Stud ends	= **F**
Stud ends M45x1.5 with female thread	= **E5**

Special variants on request

Further details in clear text e.g. special variants

Certification (acceptance)
CE = Acceptance according to 97/23/EC
BA = Operating instructions

Surface of the connection side
1 = Steel
2 = Galvanized steel

Surface of the tank interior
1 = Steel
2 = Galvanized steel

Tank material
1 = Steel

Diaphragm material
N = NBR
E = ECO
I = IIR
F = FKM

Form of gas connection
1 = Standard variant
2 = Gas valve
4 = Not re-chargable, gas side welded

[1)] Further connection sizes on request

For standard types, see pages 12 to 18

Operating instructions and conformity declarations

Series
Up to 1.0
1.4/140
1.4/250
1.4/350
2.0/100
2.0/250
2.0/350
2.8/70
2.8/250
2.8/350
3.5/250
3.5/350

Function, section, symbol

General

One of the main tasks of hydraulic accumulators is, for example, to absorb a certain volume of a pressurized fluid from a hydraulic system and return it to the system when required.

Because the fluid is pressurized, hydraulic accumulators are regarded as pressure vessels and must be rated for the maximum operating pressure taking account of acceptance standards valid in the country of installation.

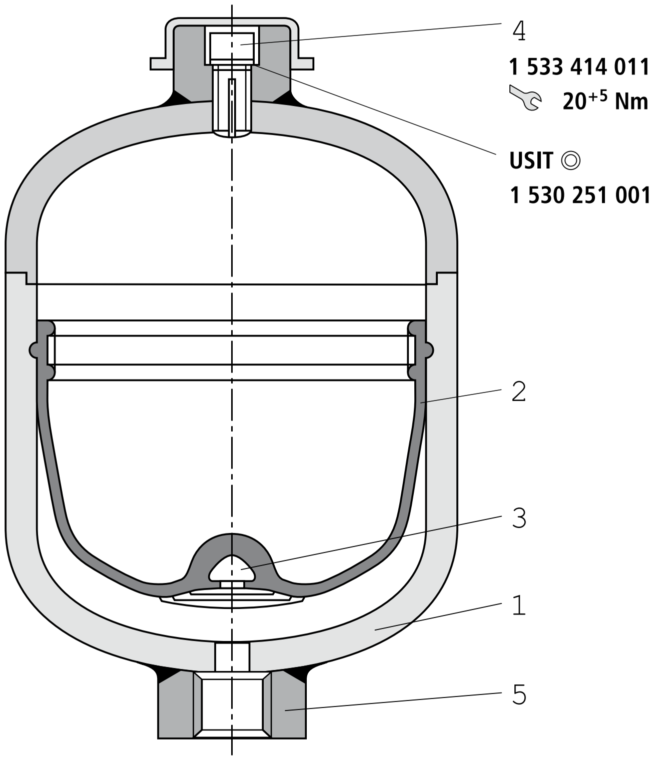
In most of the hydraulic systems, hydropneumatic (gas-charged) accumulators with separating element are used.

Depending on the design of the separating element, we distinguish between bladder-type, piston and diaphragm-type accumulators.

Hydraulic accumulators basically consist of a fluid and a gas section with a gas-tight separating element. The fluid section is connected with the hydraulic circuit. As the pressure rises, the gas is compressed and fluid gets into the hydraulic accumulator. As the pressure falls, the compressed gas expands and displaces the accumulated fluid into the circuit.

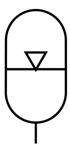
Diaphragm-type accumulators

Diaphragm-type accumulators consist of a pressure-tight steel vessel (1), which is, in most of the cases, of spherical to cylindrical shape. A diaphragm (2) made of an elastic, flexing material (elastomer) with closing poppet (3) and plug screw (4) is provided as separating element in the interior of the accumulator. These elements comply with Directive 97/23/EC.



1 Vessel
2 Diaphragm
3 Closing poppet
4 Plug screw
(gas filling screw)
5 Fluid connection

Symbol



Technical data (for applications outside these parameters, please consult us!)

General

Weight	kg	See tables on pages 11, 17, 18
Design		Diaphragm-type accumulator, welded
Installation position		Optional, preferably fluid connection piece pointing downwards
Type of mounting		With clamps or threaded connection
Ambient temperature range	°C	−15 to +65 [1]
Pipe connection		Female thread

Hydraulic

Capacity	l	0.075	0.16	0.35	0.5	0.7	1.0	1.4	2.0	2.8	3.5
Effective gas volume	l	0.075	0.16	0.32	0.48	0.75	1.0	1.4	1.95	2.7	3.5
Permissible max. flow	l/min	10				40			60		60
Permissible max. operating pressure p	bar					100				70	
				210	160	180		140	100		
		250	250	207	207	250	200	250	250	250	250
					250	350		350	350	350	350
Permissible max. pressure fluctuation width Δp dyn.	bar					93				50	
				90	90	93		80	65		
		150	120	120	120	140	115	140	140	130	130
					100	130		130	130	130	130

Operating pressures and useful capacity		See Calculation on pages 5 to 10
Hydraulic fluid		Hydraulic oil to DIN 51524; other fluids on request!
Hydraulic fluid temperature range Others on request	°C	−10 to +80 (NBR diaphragm) [1] −35 to +80 (ECO diaphragm) [1]

Pneumatic

Charge gas	Use only nitrogen!
Charge pressure p_0	See Standard types on pages 12 to 18

Usable hydraulic fluids

When selecting the accumulator variant, observe the following non-binding notes with regard to hydraulic fluid, bladder or diaphragm material, and the permissible temperature range.

Hydraulic fluids	Temperature range	Material
Mineral oils	−10 to +80 °C −35 to +80 °C	NBR ECO
HFA, HFB [2]	+5 to +50 °C	NBR
HFC	−10 to +60 °C	NBR, IIR
HFD [3]	−10 to +60 °C −10 to +80 °C	IIR FKM
Water [2]	+5 to +50 °C	NBR
Diesel, fuel oil	−10 to +50 °C	NBR
Heavy fuel oil	−10 to +100 °C	FKM
Regular-grade gasoline	−10 to +40 °C	NBR
Premium gasoline	−10 to +40 °C	FKM
Kerosene	−10 to +40 °C	NBR

No warranty claims may be derived from these recommendations.

In the case of other hydraulic fluids and temperatures, please consult us.

NBR Acrylnitrile butadiene rubber (Perbunan)
FKM Fluorine rubber
IIR Butyl rubber
ECO Epichlorhydrin rubber

[1] The permissible temperature specified in the tank test is also revant

[2] Special variants of tank and connection parts may be required

[3] Please consult us stating the detailed specification of the hydraulic fluid

Application, operating principle

Applications

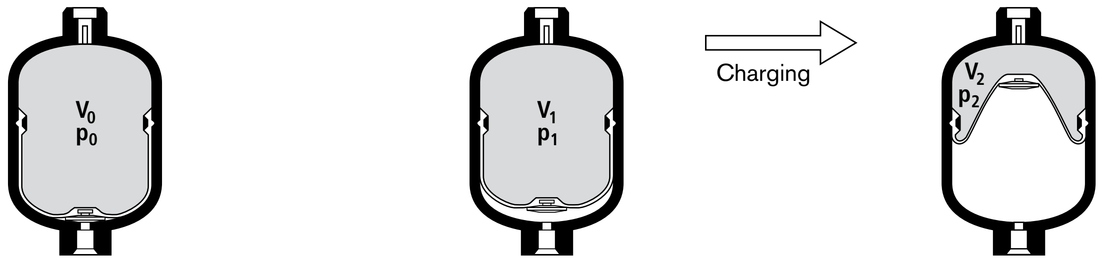
Hydropneumatic accumulators can be used in a wide variety of applications:

– Energy storage for saving pump drive power in systems with intermittent operation.
– Energy reserve for emergency cases, e.g. in the event of a hydraulic pump failure.
– Compensation for losses due to leakage.
– Impact and vibration damping in the case of periodic oscillations.
– Volume compensation in case of changes in pressure and temperature.
– Suspension element on vehicles.
– Shock absorption in the case of mechanical impact.

Operating principle

Fluids are almost incompressible and can therefore not store pressure energy. In hydropneumatic accumulators the compressibility of gases is utilized for storing fluids. Only neutral gases may be used, usually class 4.0 “nitrogen”.

N_2	99.99 % by volume
O_2	50 vpm
H_2O	ca. 30 vpm.



Calculation

Pressures

For the calculation of an accumulator, the following pressures are of significance:

p_0 = gas precharge pressure at room temperature and drained fluid chamber

p_{0T} = gas precharge pressure at operating temperature

p_1 = minimum operating pressure

p_2 = maximum operating pressure

(p_m = average operating pressure)

To achieve the best possible utilization of the accumulator capacity and a long service life, it is recommended that the following values be adhered to:

$$\boxed{p_0, t_{max} \approx 0.9\, p_1} \quad (1)$$

The highest hydraulic pressure should not exceed the quadruple of the precharge pressure; otherwise, the elasticity of the diaphragm is overstressed and excessive variations in the compression result in strong heating up of the gas.

The smaller the difference between p_1 and p_2 the longer is the service life of the diaphragm. However, this also reduces the degree of utilization of the corresponding maximum accumulator capacity.

Diaphragm-type accumulators

$$\boxed{p_2 \leq 4 \cdot p_0} \quad (2)$$

On request

$$\boxed{p_2 \leq 8 \cdot p_0}$$

☞ **Note!**

Filling piece in diaphragm-type accumulators

To achieve an increased pressure ratio ($p_0 : p_2 > 1 : 4$) in the accumulator, a filling piece can be installed on the gas side of the accumulator.

This reduces the usable gas volume V_1, but the diaphragm is protected against impermissible deformation.

Calculation

Oil volume

Pressures $p_0 \ldots p_2$ determine gas volumes $V_0 \ldots V_2$.

Here, V_0 is also the nominal capacity of the accumulator.

The available oil volume ΔV corresponds to the difference be- ween gas volumes V_1 and V_2:

$$\boxed{\Delta V \leq V_1 - V_2} \quad (3)$$

The gas volume, which is variable within a pressure differential, is determined by the following equations:

a) In the case of **isothermal changes of state** of gases, that is, when the gas buffer changes so slowly that enough time is available for a complete heat exchange between the nitrogen and its surroundings and the temperature therefore remains constant, the following is valid:

$$\boxed{p_0 \cdot V_0 = p_1 \cdot V_1 = p_2 \cdot V_2} \quad (4.1)$$

b) In the case of an **adiabatic change of state,** that is, with a rapid change of the gas buffer, in which the temperature of the nitrogen changes as well, the following is valid

$$\boxed{p_0 \cdot V^{\chi}{}_0 = p_1 \cdot V^{\chi}{}_1 = p_2 \cdot V^{\chi}{}_2} \quad (4.2)$$

χ = ratio of the specific heat of gases (adiabatic exponent) for nitrogen = 1.4

In practice, changes in state rather follow adiabatic laws. Charging is often isothermal, discharging adiabatic.

Taking account of equations (1) and (2), ΔV is 50 % to 70 % of the nominal accumulator capacity. The following can be ap- plied as a rule of thumb:

$$\boxed{V_0 = 1.5 \ldots 3 \text{ x } \Delta V} \quad (5)$$

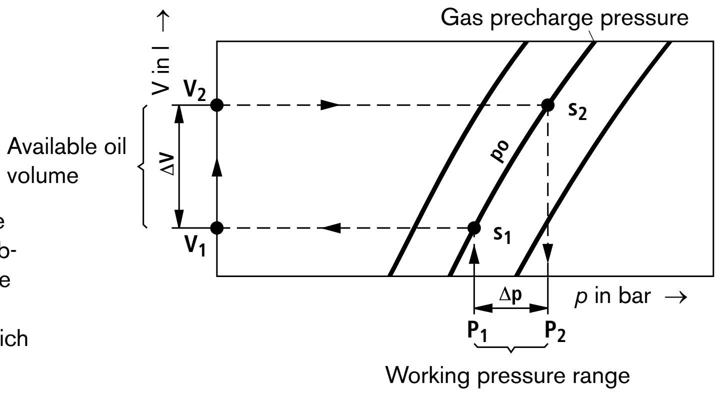
Calculation diagram

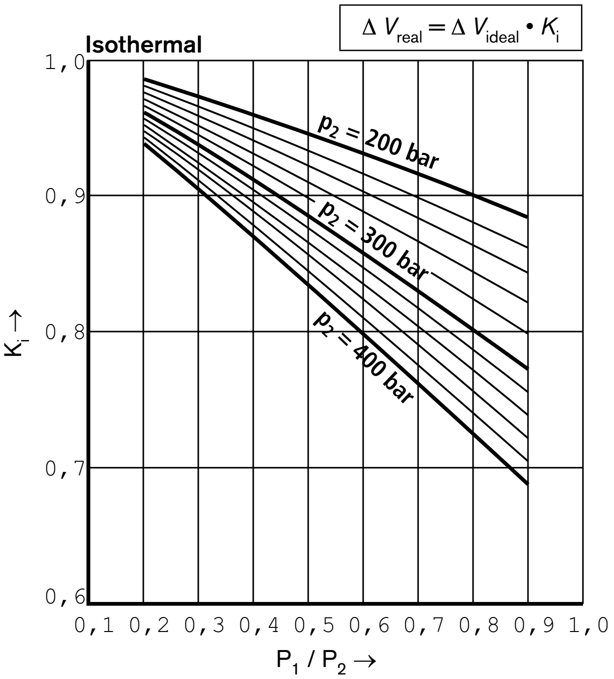
To allow a determination on the basis of a graphic representation, the formulas (4.1) and (4.2) were translated into diagrams on pages 7 to 10. Depending on the task at hand, the available oil volume, the accumula- tor size or the pressures can be established.

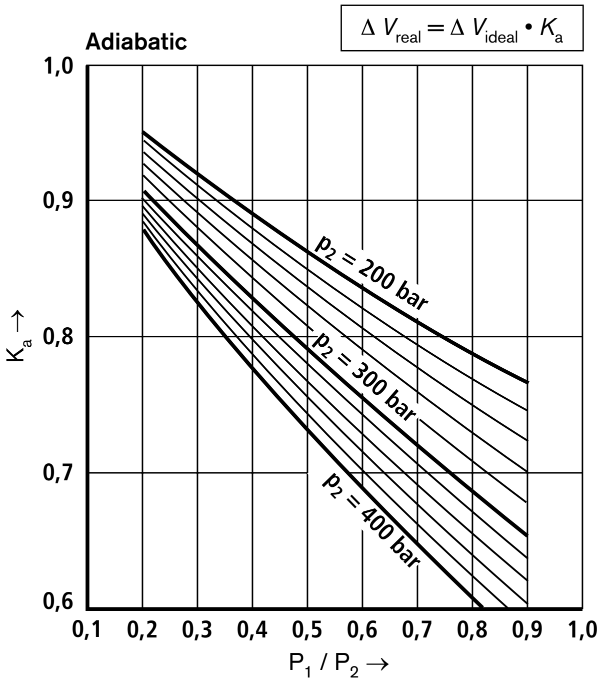
Correction factors K_i and K_a

Equations (4.1) and (4.2) are only valid for ideal gases. In the characteristics of real gases, significant deviations can be ob- served at operating pressures above 200 bar, which must be taken into account by applying correction factors. These are shown on the following diagrams. The correction factors which are to be multiplied by the ideal withdrawal volume ΔV are within the range of 0.6 … 1.

Application of the calculation diagrams





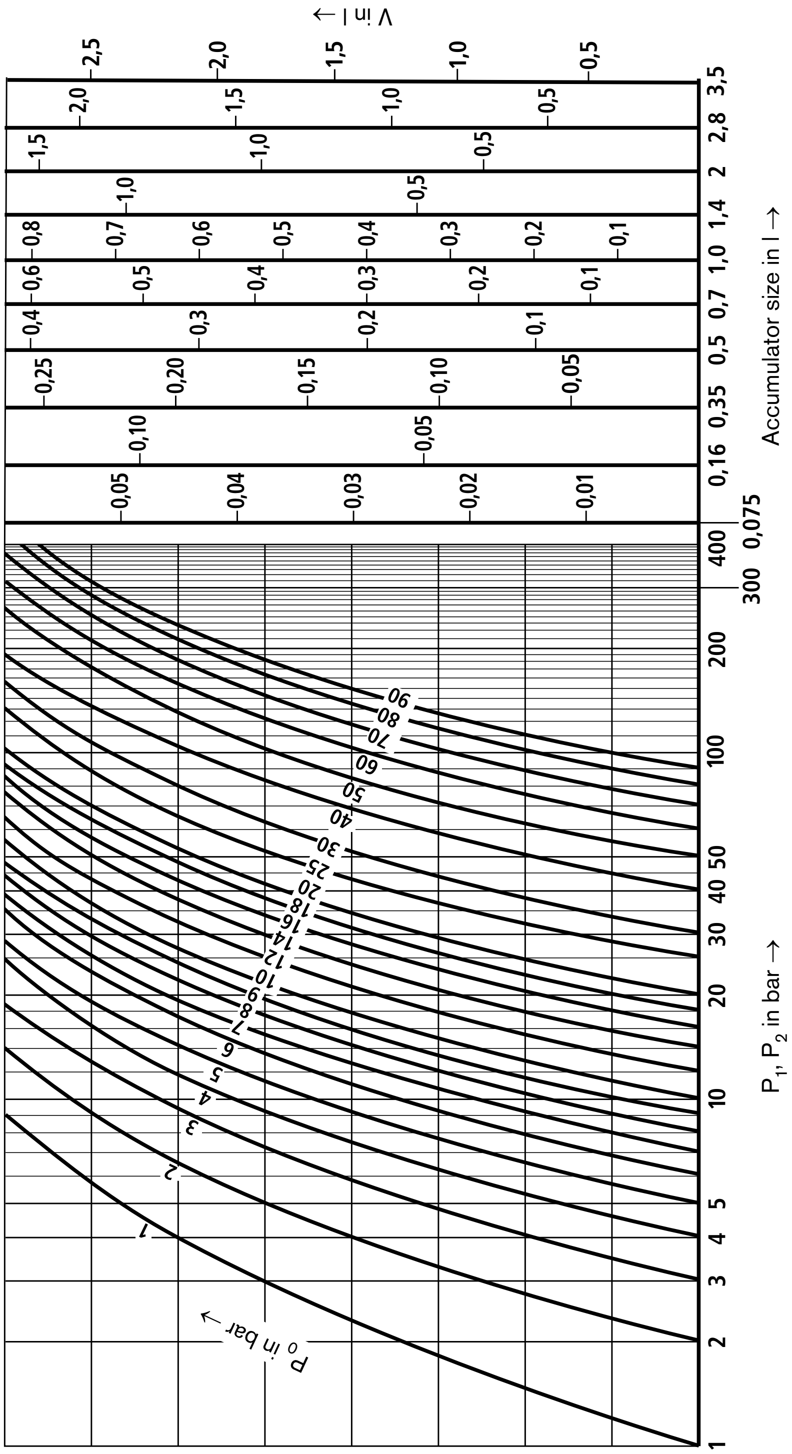


HARLEX
HRL MACHINERY

Calculation

Isothermal changes of state

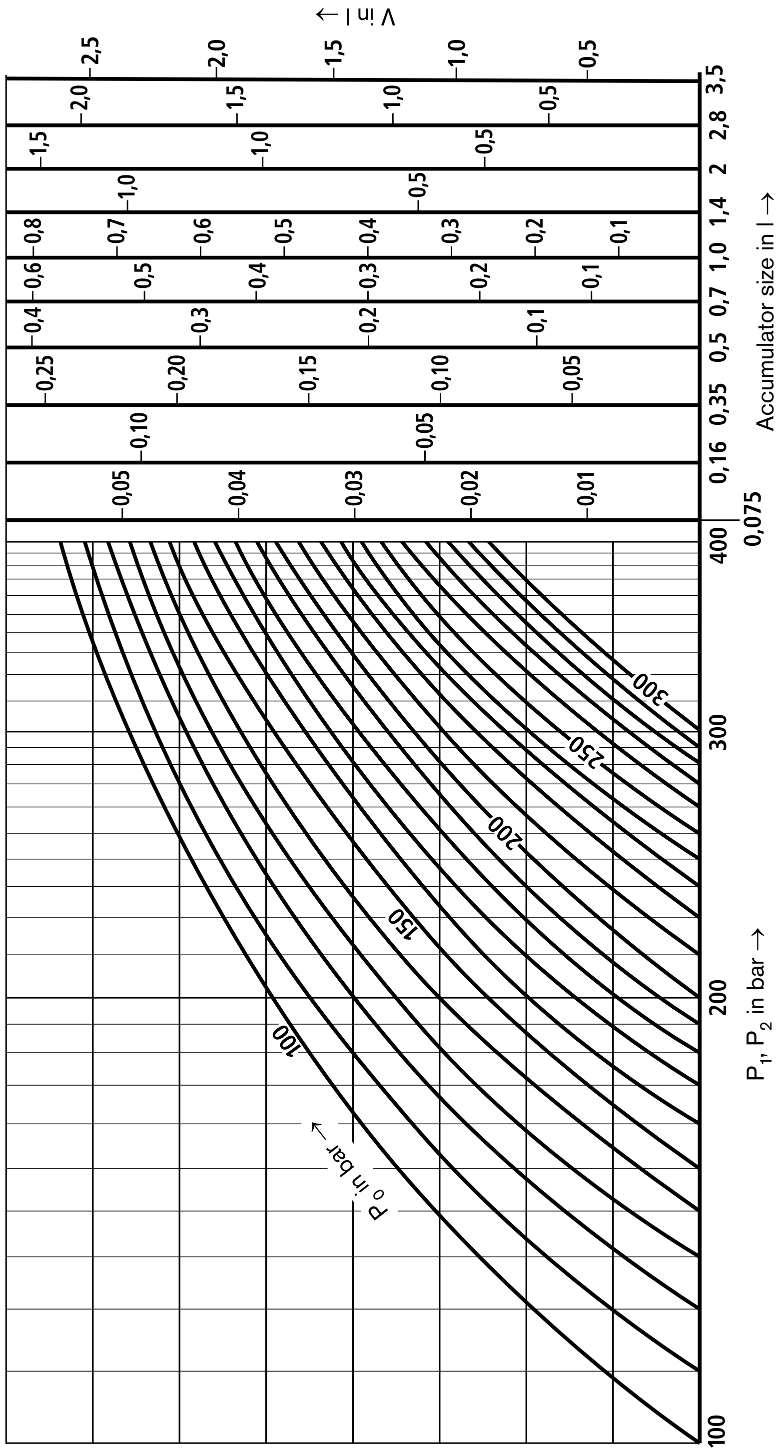
p_0 = 1 to 90 bar



Calculation

Isothermal changes of state

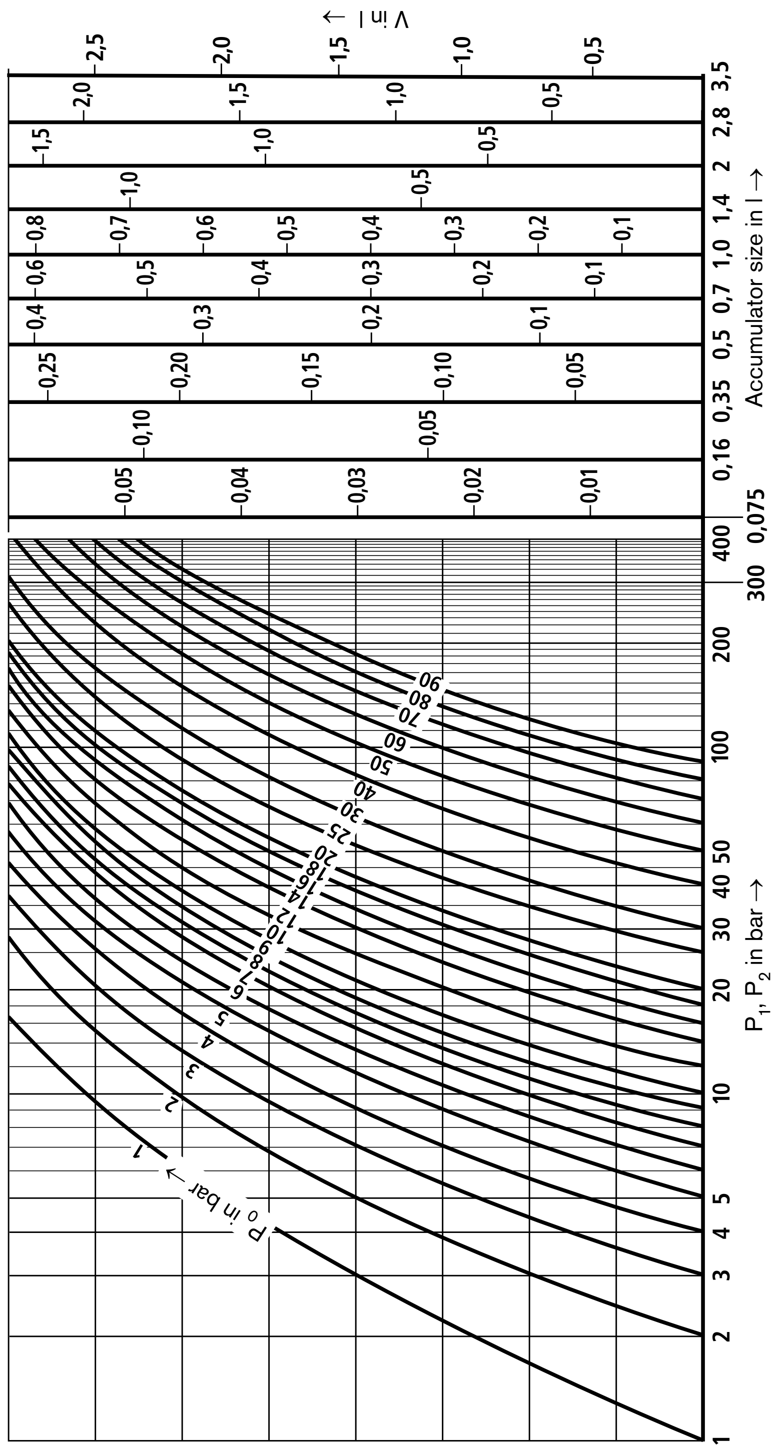
p_0 = 100 to 300 bar



Calculation

Adiabatic changes of state

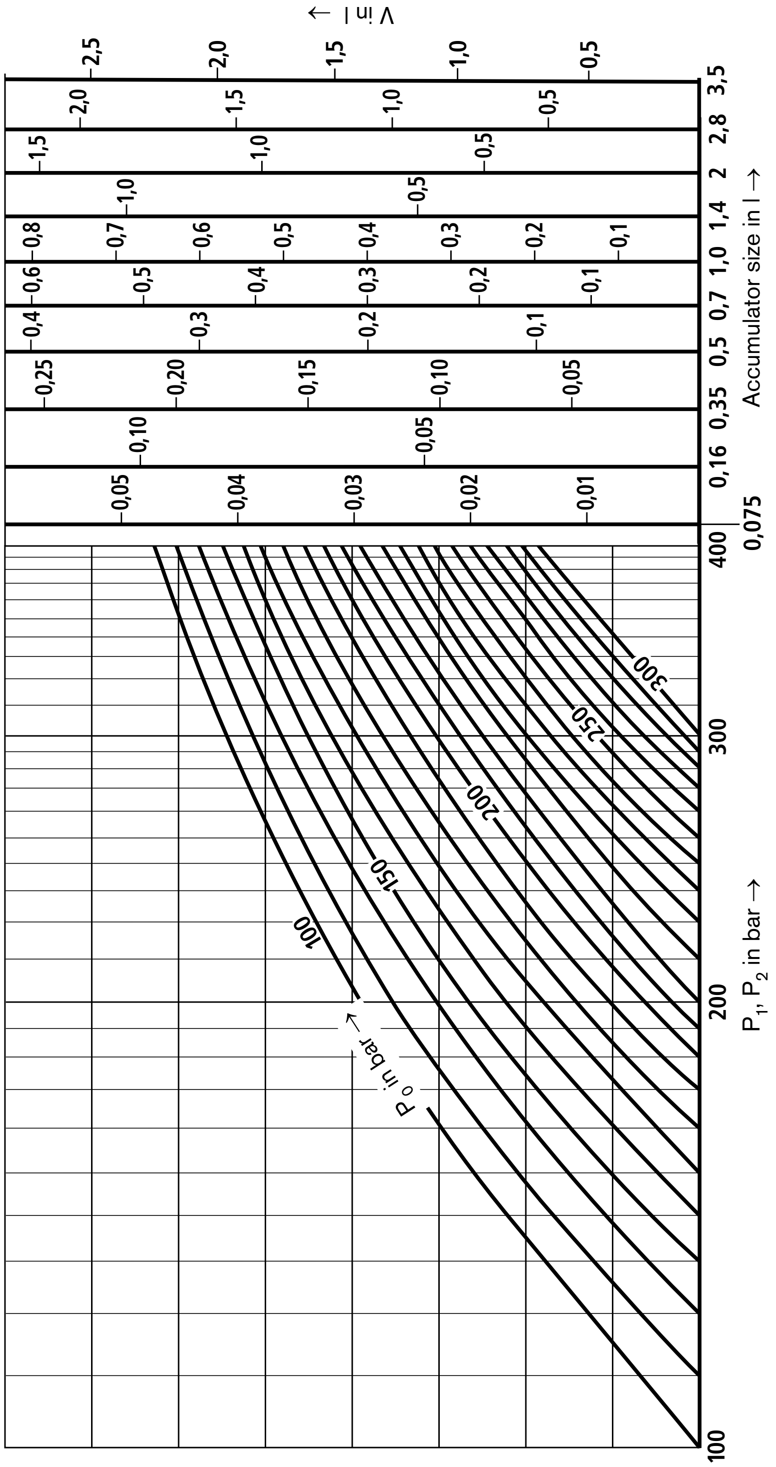
$p_0 = 1$ to 90 bar



Calculation

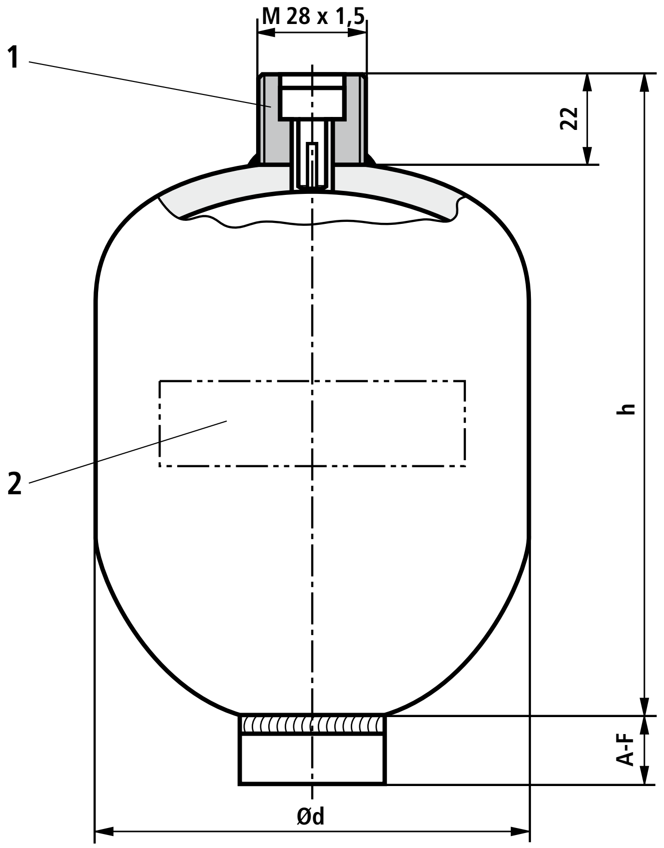
Adiabatic changes of state

p_0 = 100 to 300 bar

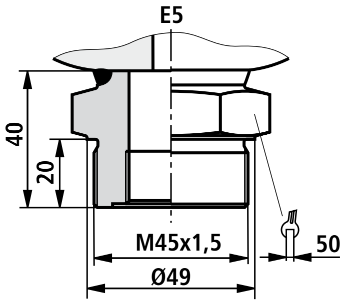


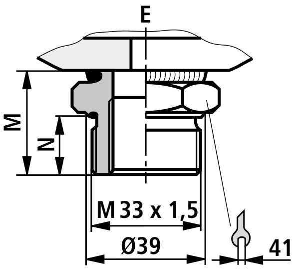
Unit dimensions: 70 to 250 bar (dimensions in mm)

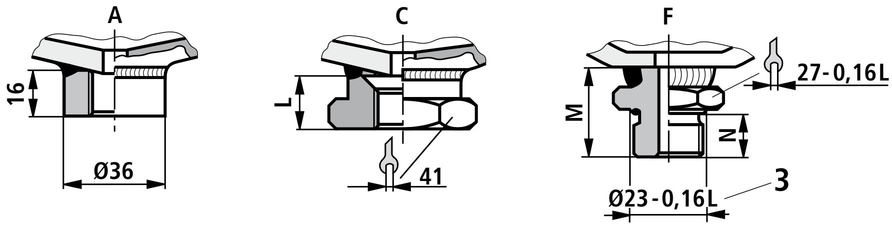
1 Gas connection form "1"
2 Lettering



Mounting type

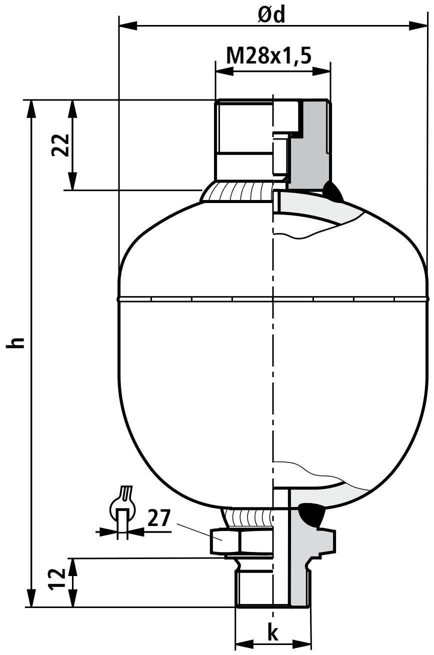




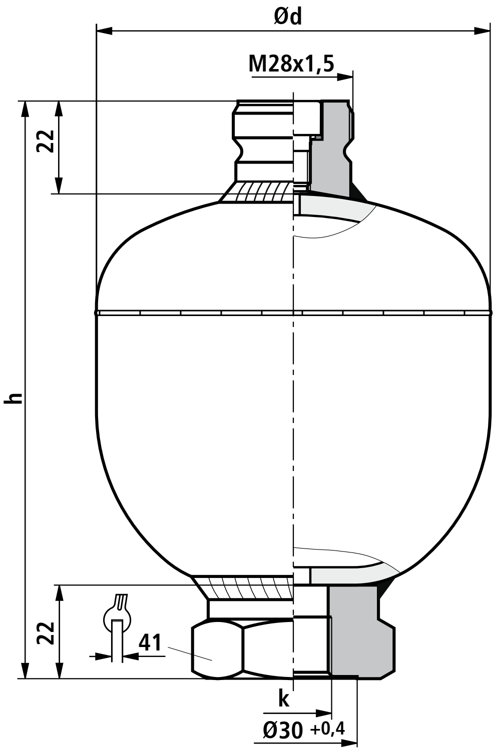


Type/V in liters	p_{max} **in bar**	**Ød**	**h**	**L**	**M**	**N**	**Weight in kg**
HAD0.075	250	64	91	20	21.5	12	0.65
HAD0.16	250	75	99.5	20	24	12	1.0
HAD0.35	210	92	114	22	33	18	1.3
HAD0.5	160	103	127	22	–	–	1.6
	250	106	130	20	27	12	2.0
HAD0.7	180	121	144	22	33	18	2.6
	250	123.6	144	22	33	18	3.2
HAD1.0	200	136	158	22	33	18	3.5
HAD1.4	140	147	169	22	33	18	4.9
	250	152	173	22	33	18	6.2
HAD2.0	100	144	218	22	33	18	4.0
	250	155	229	22	33	18	9.5
HAD2.8	70	160	247	21	33	18	5.5
	250	174	247	21	33	18	10.0
HAD3.5	250	174	285	21	33	18	14.0

Unit dimensions of standard types: 160 to 250 bar; 0.075 to 0.5 liters (dimensions in mm)

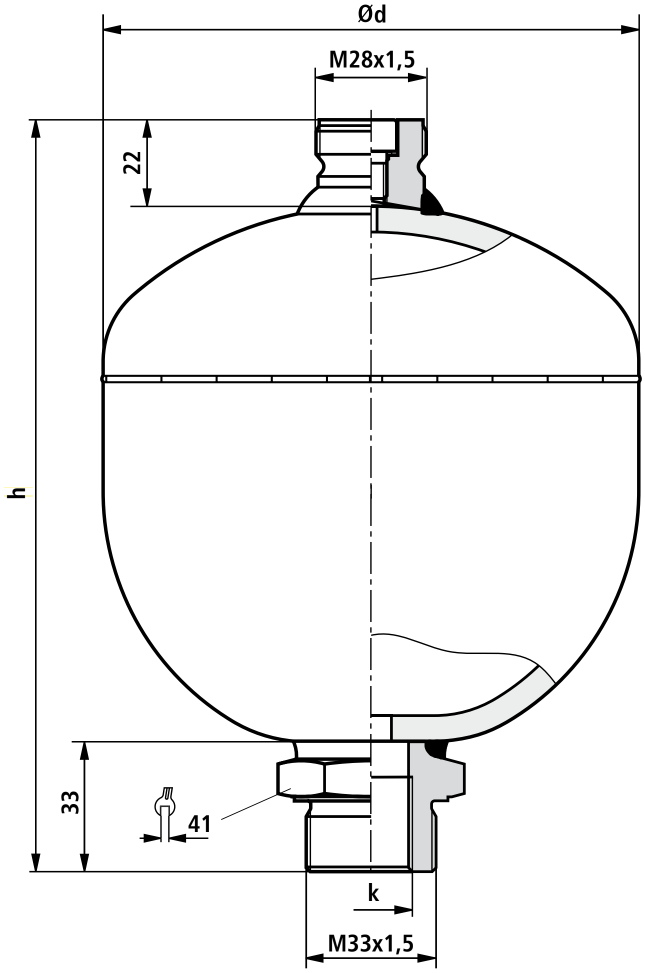


Ordering code / type	Volume in liters		h	Ød	k
HAD0,075-250-1X/2Z04F-1N111-BA	0.075		112.5	65.5	M14x1.5
HAD0,16-250-1X/2Z06F-1N111-BA	0.16		123.5	76.5	M18x1.5



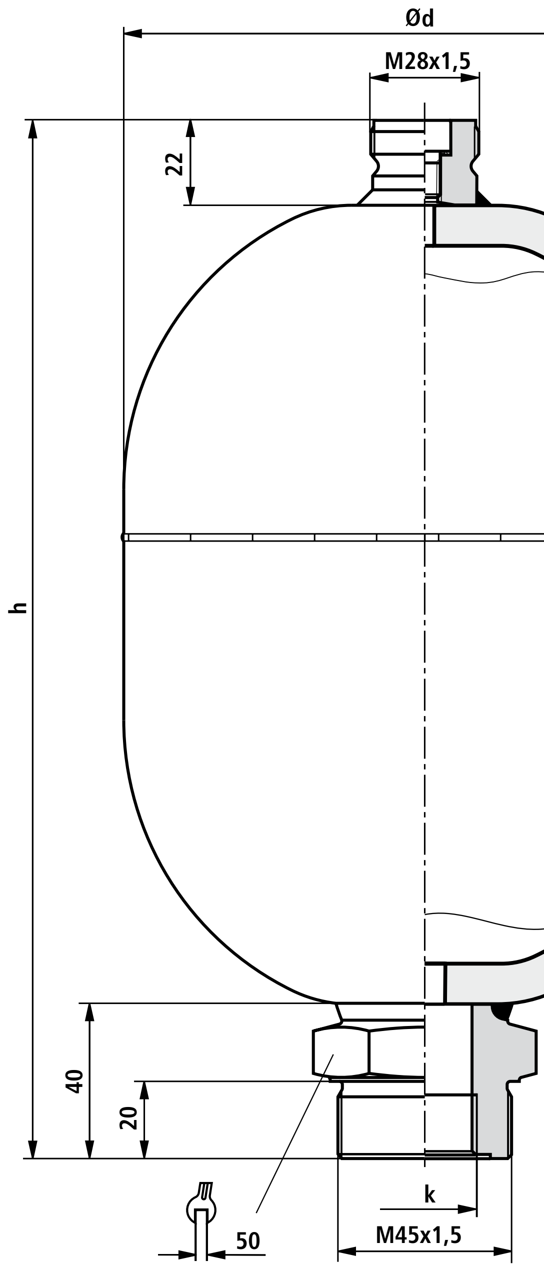
Ordering code / type	Volume in liters		h	Ød	k
HAD0,35-210-1X/2Z06C-1N111-BA	0.35		136	94.3	
HAD0,5-160-1X/2Z06C-1N111-BA	0.5		149	104.8	M18x1.5
HAD0,5-250-2X/2Z06C-1N111-BA	0.5		152	108.5	

Unit dimensions of standard types: 100 to 250 bar; 0.7 to 1.4 liters (dimensions in mm)



Ordering code / type	Volume in liters		h	Ød	k
HAD0,7-100-1X/2G04E-1N111-BA	0.7		172	118.8	G 1/2“
HAD0,7-210-1X/2G04E-1N111-BA	0.7		177	123.5	
HAD1,0-200-1X/2G04E-1N111-BA	1.0		191	138.5	
HAD1,4-140-1X/2G04E-1N111-CE	1.4		202	149.6	
HAD1,4-250-1X/2G04E-1N111-CE	1.4		206	152	

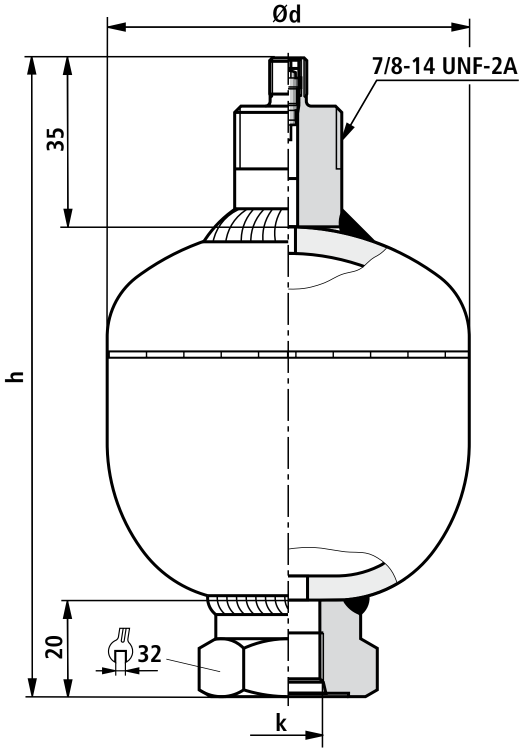
Unit dimensions of standard types: 100 to 250 bar; 2.0 to 3.5 liters (dimensions in mm)



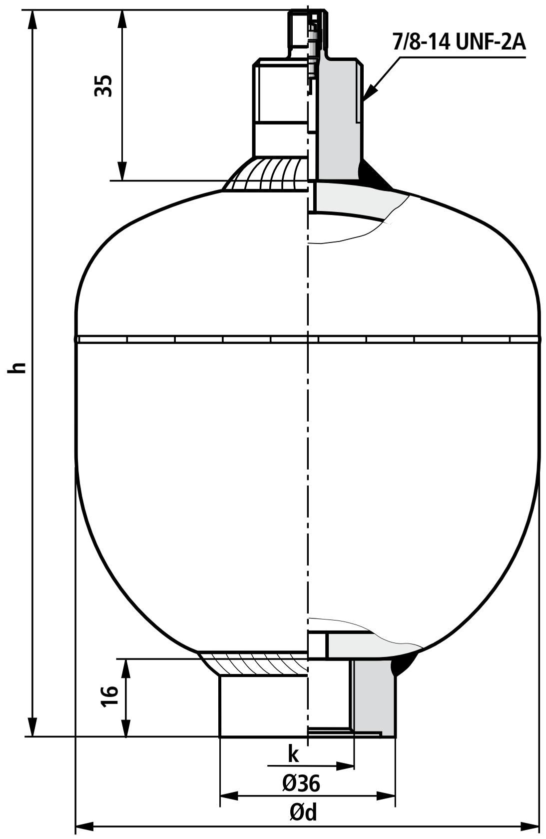
Ordering code / type	Volume in liters		h	Ød	k
HAD2,0-100-1X/2G05E5-1N111-CE	2.0		258	147.2	G 3/4“
HAD2,0-250-1X/2G05E5-1N111-CE	2.0		269	158.6	
HAD2,8-250-1X/2G05E5-1N111-CE	2.8		286	177.5	
HAD3,5-250-1X/2G05E5-1N111-CE	3.5		325	177.5	

HARLEX HRL MACHINERY

Unit dimensions of US standard types: 207 to 250 bar; 0.075 to 0.35 liters (in mm)



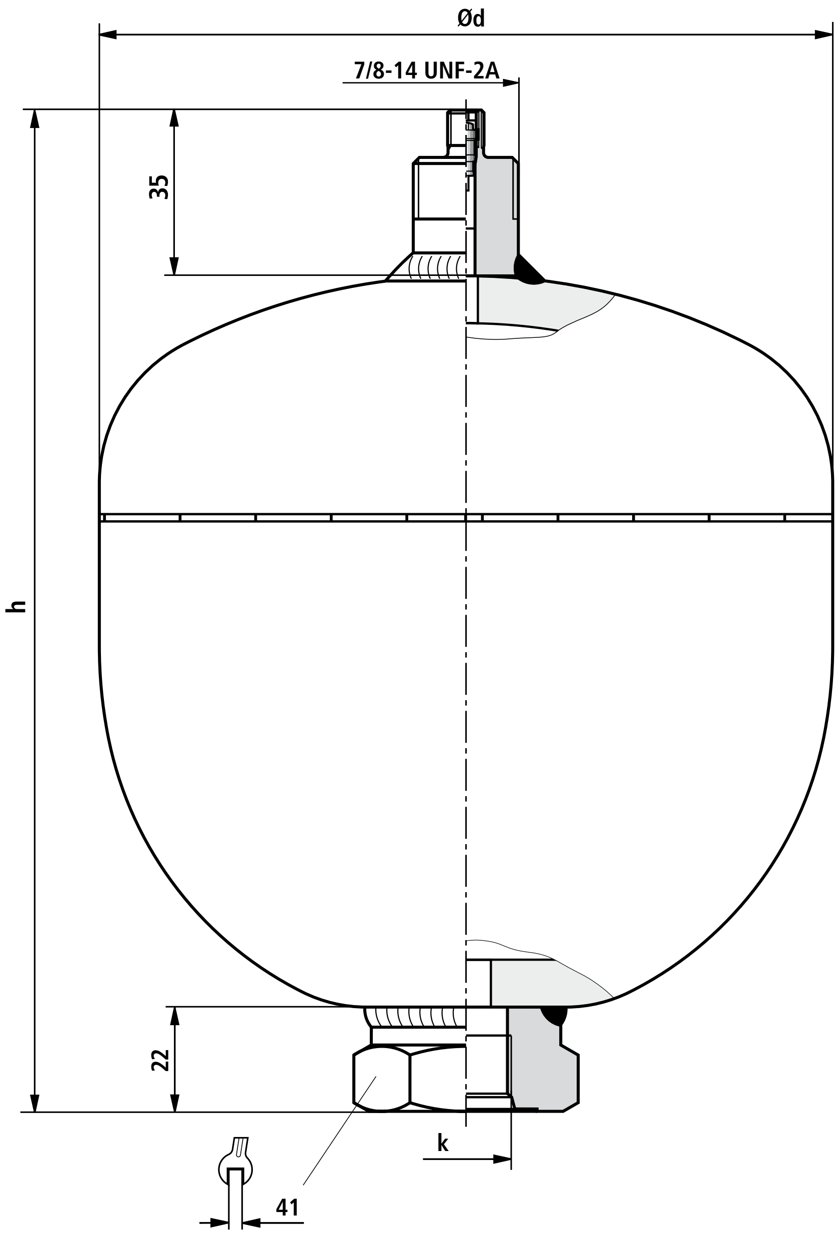
Ordering code / type	Volume in liters		h	Ød	k
HAD0,075-250-1X/0U12C-2N111-USA	0.075		125.8	65.5	9/16-18 UNF-2B
HAD0,16-250-1X/0U12C1-2N111-USA	0.16		132.3	76.5	



Ordering code / type	Volume in liters		h	Ød	k
HAD0,35-207-1X/0U04A-2N111-USA	0.35		150.5	96.5	3/4-16 UNF-2B

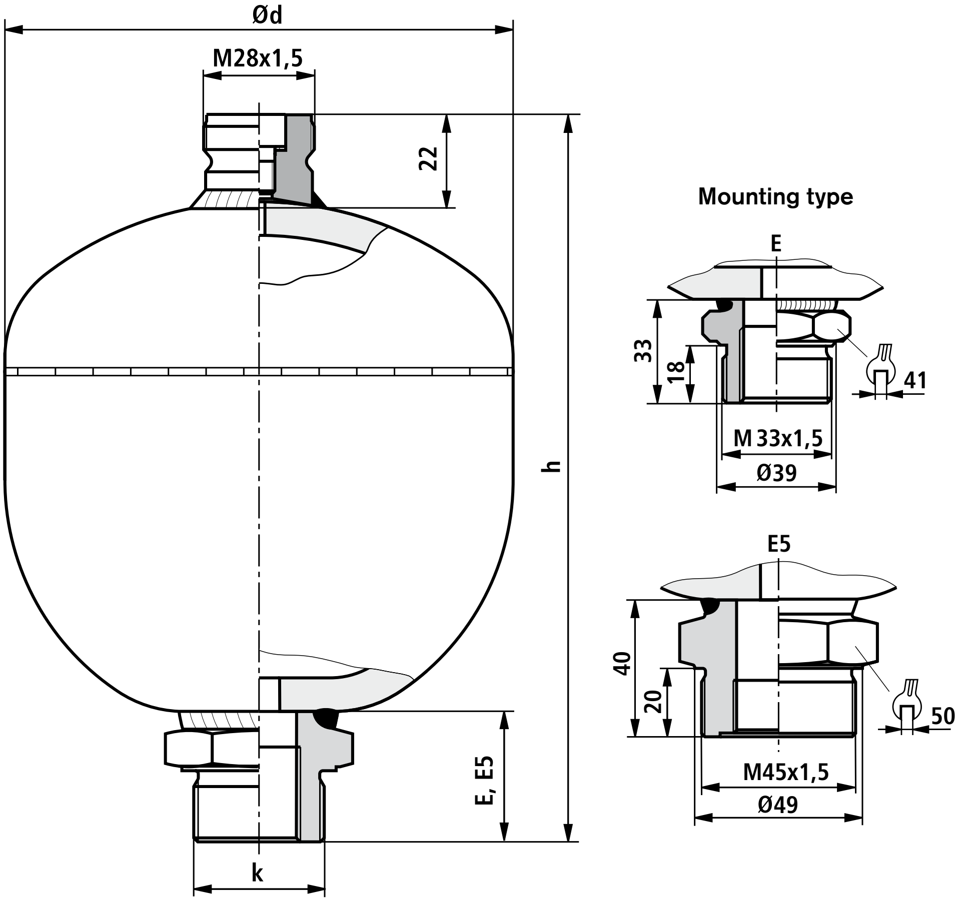
HARLEX HRL MACHINERY

Unit dimensions of US standard types: 207 bar; 0.07 to 2.8 liters (dimensions in mm)



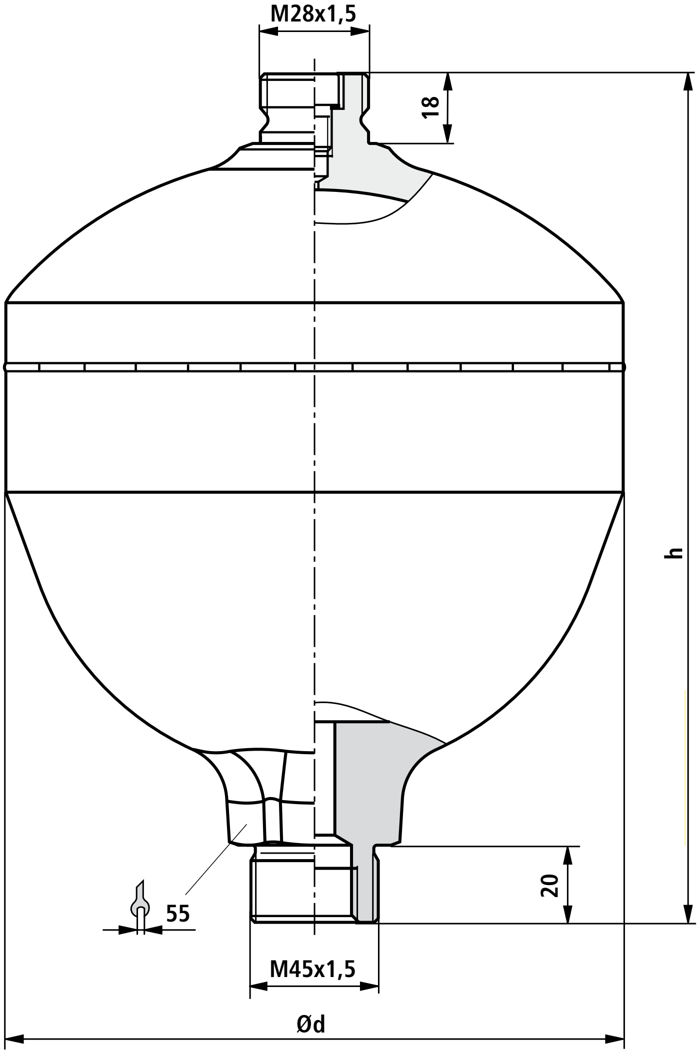
Ordering code / type	Volume in liters		h	Ød	k
HAD0,7-207-1X/0U04C-2N111-USA	0.7		186	128.5	3/4-16 UNF-2B
HAD1,4-207-1X/0U04C-2N111-USA	1.4		212.8	156.5	
HAD2,0-207-1X/0U04C-2N111-USA	2.0		265.8	156.5	
HAD2,8-207-1X/0U04C-2N111-USA	2.8		282.5	175.5	

Unit dimensions of standard types: 350 bar; 0.7 to 2.0 liters (dimensions in mm)



Ordering code / type	Volume in liters		Ød	h	k	Weight kg
HAD0,7-350-2X/2G04E-1N111-BA	0.7		128.5	184	E	4.0
HAD1,4-350-2X/2G04E-1N111-CE	1.4		156	209	E	7.0
HAD2,0-350-2X/2G05E5-1N111-CE	2.0		156	269	E5	9.5

Unit dimensions of standard types: 350 bar; 2.8 and 3.5 liters (dimensions in mm)

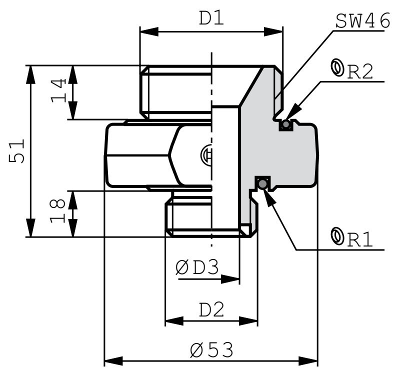


Ordering code / type	Volume in liters		Ød	h	Weight kg
HAD2,8-350-1X/2G05E5-1N111-CE	2.8		180	285	13.0
HAD3,5-350-1X/2G05E5-1N111-CE	3.5		180	325	16.0

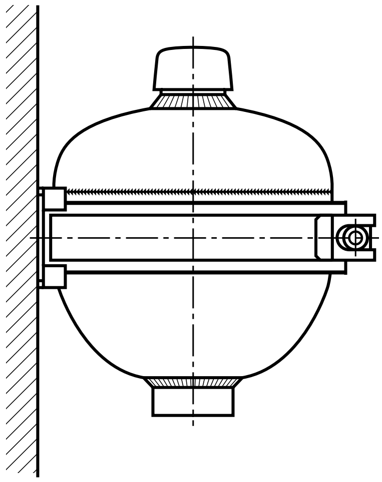
Accessories (dimensions in mm)

Adapter for size 20 blocks
Connection A (accumulator)

Accumulator D1	Block D2	ØD3
M 22 x 1.5	M 33 x 2	12
M 18 x 1.5		8
G 1/2 ISO 228		8



Holding clamps, selection table



Type	Clamp type
HAD0,075	HY/VGBKS 62– 65
HAD0,35	HY/VGBKS 92–97
HAD0,50	HY/VGBKS 101–111
HAD0,75	HY/VGBKS 119–128
HAD0,7	HY/VGBKS 128–136
HAD1,0	HY/VGBKS 135–145
HAD1,4	HY/VGBKS 145–155
HAD2,0/100	HY/VGBKS 135–145
HAD2,0/250	HY/VGBKS 145–155
HAD2,8/70	HY/VGBKS 160–170
HAD2,8–3,5	HY/VGBKS 170–180

Charging and test device

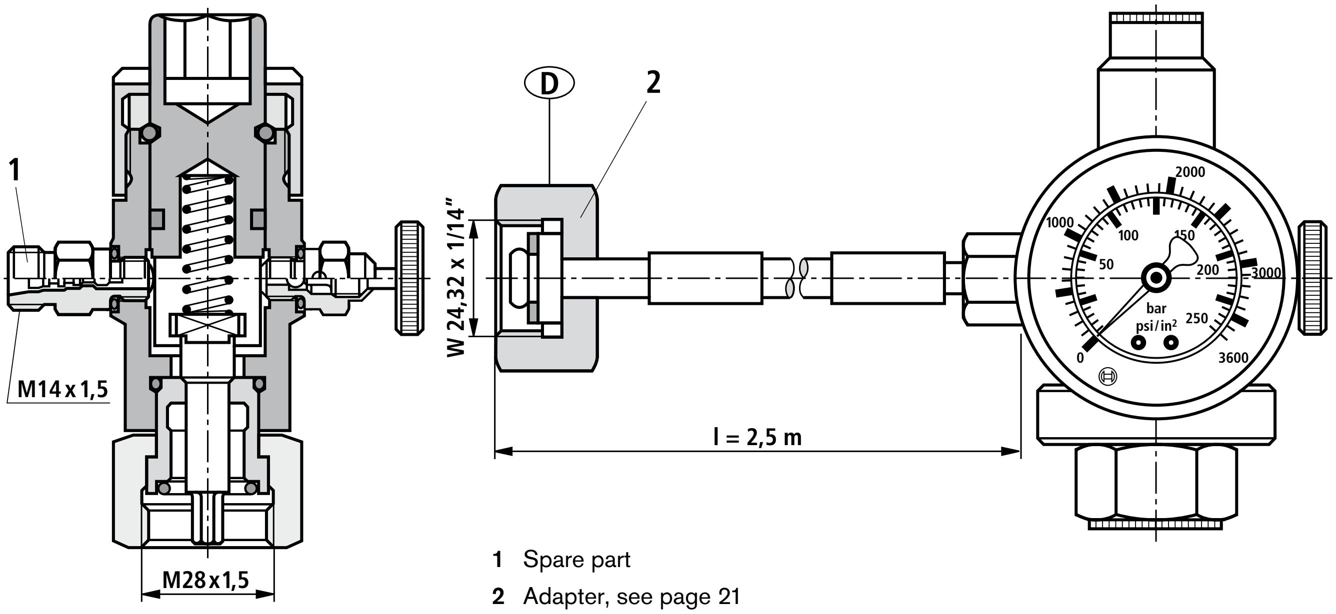
Test case, complete	
Bladder	
Diaphragm	
Bladder and diaphragm consisting of: Case	
Charging and test valve	Bladder
	Diaphragm
Pressure gauge 0 to 250 bar	
Hose l = 2,5 m with adapter piece form D	

Accessory parts to be ordered separately
Pressure gauge 0 to 25 bar
Pressure gauge 0 to 60 bar
Pressure gauge 0 to 400 bar
Adapter piece Form F
Form GB
Form USA
Form COR
Form JAP
Form GUS
Hose l = 5 m with adapter piece form D

Accessories (dimensions in mm)

Dimensions of charging and test valve

1 valve body with check valve,
discharge valve, pressure gauge connection,
and gas hose connection.



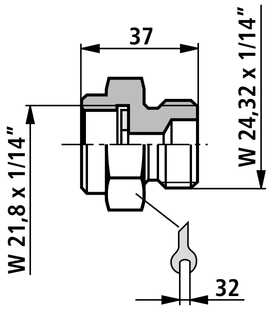
1 Spare part

2 Adapter, see page 21

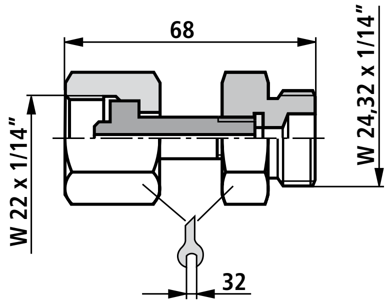
Accessories (dimensions in mm)

Adapter from nitrogen bottle to cap nut

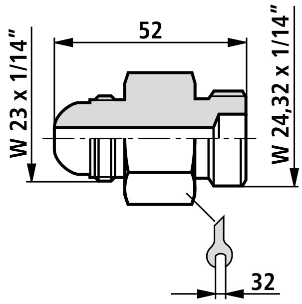
1 533 391 010



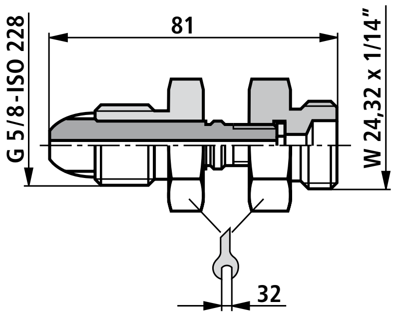
1 533 391 014



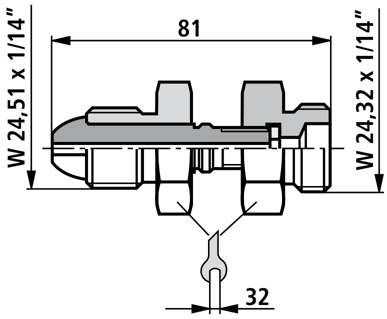
1 533 391 013



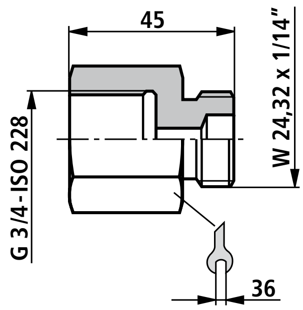
1 533 391 011



1 533 391 012



1 533 391 015



Country						
Brazil	x					
Bulgaria	x					
France		x				
Greece	x					
Great Britain	x					
India	x					
Japan				x		
Canada			x			
Korea North					x	
Korea South					x	
Malaysia	x					
Romania		x				
Russia						x
Spain	x					
Saudi Arabia		x				
Singapore	x					
Turkey	x					
USA			x			
Other countries on request						

Safety notes on hydraulic accumulators

Before commissioning and during operation of hydraulic accumulators, observe the regulations valid at the place of installation.

The operator is solely responsible for observing applicable regulations.

General notes on hydraulic accumulators in hydraulic systems can be found in EN 982.

Documents included in the scope of supply must be properly kept; they are required by the surveyor for recurring inspections.

⚠ **Warning**

Never carry out any welding, soldering or mechanical work on the accumulator vessel!

– Risk of explosion during welding and soldering!

– Risk of bursting and loss of the operating permission in the case of mechanical working!

Never charge hydraulic accumulators with oxygen or air. Risk of explosion!

Before carrying out any work on hydraulic systems, depressurize the system and secure it against restarting!

Improper mounting can lead to severe accidents!

Commissioning must exclusively by carried out by qualified personnel.

Legal stipulations

Hydraulic accumulators are pressure vessels and are subject to the national regulations and ordinances valid at the place of installation.

In Germany, the Health and Safety at Work Regulations (BetrSichV) must be complied with.

Special rules must be observed in the fields of shipbuilding, aircraft construction, mining, etc.

Dimensioning, manufacture and testing must be carried out in line with the codes according to AD 2000. Rules with regard to the erection, equipment and operation are laid down in the "Technische Regeln Druckbehälter" (TRB) (technical rules for pressure vessels.

Vessel categories and tests/inspections in Germany

According to these German regulations, pressure vessels are categorized according to their capacity in ***L***, the permissible operating pressure in bar, and the product of pressure and capacity $p \times L$. Depending on the category, specific inspections are compulsory.

An overview is given in the following table:

Vessel class	Initial test at the manufacturer's end	Acceptance test at the operator's end	Recurring inspections		
			Internal	Pressure	External
II $p > 25$ bar; $p \cdot L \leq 200$	○	○	○	○	○
III $p > 1$ bar; $p \cdot L > 200 \leq 1000$	X	X	○	○	○
IV $p > 1$ bar; $p \cdot L > 1000$	X	X	X 5 [1)] / 10 [2)]	X 10 [1)]	X 2 [1)]

[1)] Years

[2)] Years in the case of non-corroding fluids

X By surveyor

○ By a technical expert

Note!

All vessel categories must be protected by means of a pressure relief valve in accordance with Directive 97/23/EC.

Legal stipulations

Classification societies

Initial inspections/tests, approvals and acceptances are carried out by **surveyors.** These are representatives of the following classification societies in the individual countries:

D TÜV	GB LRIS	F D.R.I.R.E.
B APRAGAZ	USA LRIS	NL Stoomwezen
I ISPESEL	PL UDT	CH SVDB

Shipbuilding and offshore:
- LRS = Lloyd's Register
- DNV = Det Norske Veritas
- GL = Germanischer Lloyd
- ABS = American Bureau of Shipping

These bodies are registered with the EU in Bruxelles and, being "notified bodies", carry out the tests/inspections according to the Pressure Equipment Directive.

CE accumulators are shipped together with a declaration of conformity and operating instructions.

Technical experts

They are appointed by the plant of the operator and must be qualified accordingly.

In Germany, corresponding training courses are offered by classification societies.

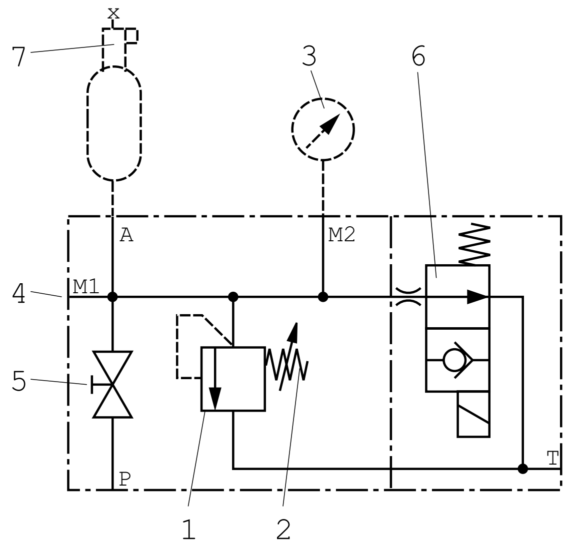
Safety equipment

These specify the following safety equipment:

1 Features against excessive pressure (type-tested)
2 Unloading features
3 Pressure measuring instruments
4 Test pressure gauge connection
5 Shut-off feature

Option:

6 Electromagnetically operated unloading device
7 Safety device against excessive temperatures These safety devices are combined in a compact safety and shut-off block.



Commissioning, maintenance

Notes on commissioning

Precharge pressure

Diaphragm-type accumulators are usually delivered ready for operation. The precharge pressure (p_0) is embossed on the accumulator shell.

Charging gas

Hydraulic accumulators may only be filled with purest class 4.0 nitrogen, N2 99.99 % by volume.

Permissible operating temperature

In the "standard variant", hydraulic accumula-tors are suitable for operating temperatures from −10 to +80 °C. In the case of differing temperatures, please consult us.

Installation position

Diaphragm accumulators can be installed in optional orientation. For the test and charging device, a free installation space of 200 mm must be provided above the gas valve.

Mounting

The accumulator is to be mounted so that any forces caused, e. g., by application-related vibrations or accelerations, can be absorbed safely. If there are multiple fasteners, mechanical stresses caused by operation-related, elastic deformations or thermal expansions of the structure are to be avoided offers corresponding holding clamps.

Commissioning, maintenance

Charging of the accumulator

Use the filling and test device for charging the accumulator (see pages 19, 20).

Observe the relevant notes in operating instructions.

Note

The precharge pressure changes as the gas temperature changes. After charging or discharging nitrogen, wait until the temperature has balanced before you check the gas pressure.

Maintenance

General

After having been charged with gas, accumulators are largely maintenance-free.

To ensure trouble-free operation and a long service life, the following maintenance work must be carried out:

- Check the gas precharge pressure
- Check safety equipment and fittings
- Check pipe connections
- Check mounting of accumulator.

Checking the gas pre-charge pressure

Inspection intervals

After commissioning of the accumulator, the charge pressure must be checked at least once in the first week. If no loss of gas is detected, the second inspection must be made after 3 months. If the pressure is still unchanged, you can check the pressure once a year.

Measurements on the fluid side

Connect a pressure gauge to the accumulator by means of a line. Alternatively, the pressure gauge can be connected directly at the vent point.

Proceeding:

- Fill hydraulic fluid into the accumulator.
- Close shut-off valve (5).
- Let the hydraulic fluid drain slowly (temperature balancing) by opening discharge valve (2).
- Observe pressure gauge (3) during the draining process. As soon has the charging pressure is reached in the accumulator, the pointer abruptly falls to zero.

If deviations are measured, first check whether:

- pipes and fittings are leak-free,
- these deviations can be traced back to differing ambient and gas temperatures.

Only when no faults are detected here is an inspection of the accumulator required.

Symbol