# Hydraulic dampers

## 1. DESCRIPTION

### 1.1. FUNCTION

The pressure fluctuations occurring in hydraulic systems can be cyclical or one-off problems due to:

- flow rate fluctuations from displacement pumps
- actuation of shut-off and control valves with short opening and closing times
- switching on and off of pumps
- sudden linking of spaces with different pressure levels.

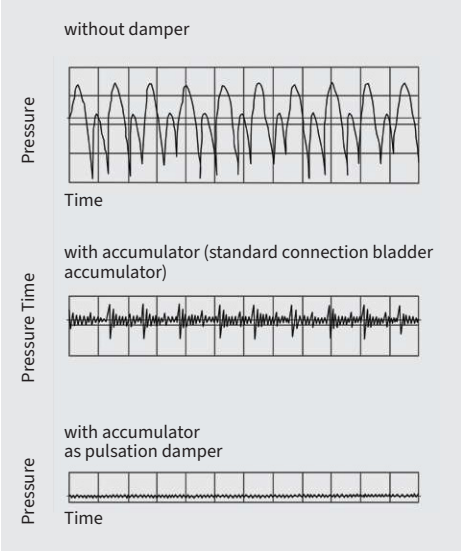
HYDAC hydraulic dampers are particularly suitable for damping such pressure fluctuations.

Selecting the most suitable hydraulic damper for each system ensures that

- vibrations caused by pipes, valves, couplings etc. are minimised and subsequent pipe and valve damage is prevented
- measuring instruments are protected and their performance is no longer impaired
- the noise level in hydraulic systems is reduced
- the performance of machine tools is improved
- interconnection of several pumps in one line is possible
- a pump rpm and feed pressure increase is possible
- the maintenance and servicing costs can be reduced
- the service life of the system is increased.

## 2. APPLICATION

### 2.1. PULSATION DAMPING TYPE SB...P / SBO...P




2.1.1 General
The HYDAC pulsation damper

- prevents pipe breaks caused by material fatigue, pipe oscillations and irregular flow rates,
- protects valves, control devices and other instruments,
- improves noise level damping.

2.1.2 Applications
The pulsation damper is particularly suitable for hydraulic systems, displacement pumps, sensitive measurement and control instruments and manifolds, e.g. in process circuits in the chemical industry.

2.1.3 Mode of operation
The pulsation damper generally has two fluid connections and can therefore be fitted directly inline.

The flow is diverted in the fluid valve so that it does not flow straight. This causes direct contact of the flow with the bladder or diaphragm which, in an almost inertia-less operation, balances the flow rate fluctuations via the gas volume.

It particularly compensates for higher frequency pressure oscillations. The charge pressure is adjusted to individual operating conditions.

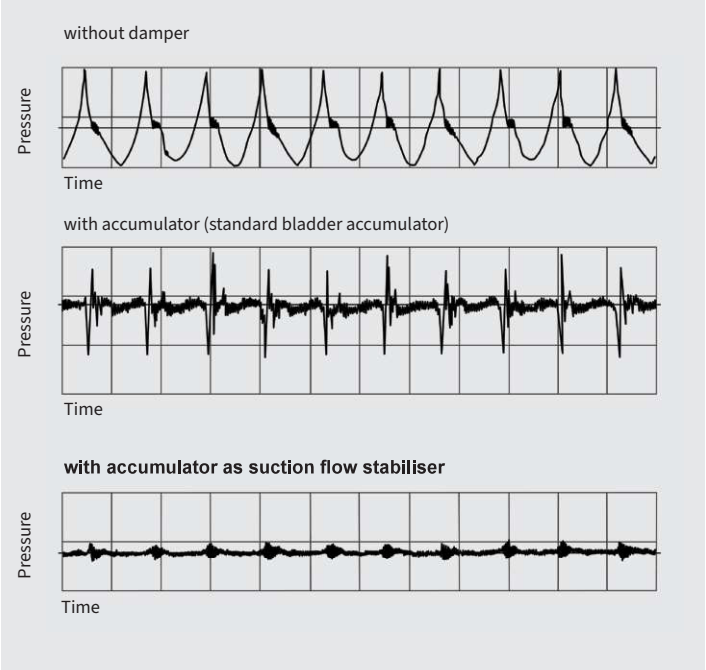
2.1.4 Design
The HYDAC pulsation damper consists of:

- the welded or forged pressure vessel in carbon steel; available with internal coating or in stainless steel for chemically aggressive fluids.
- the special fluid valve with inline connection, which guides the flow into the vessel (threaded or flange connection).
- the bladder or diaphragm in various elastomers as shown under section 4.2.

2.1.5 Installation
As close as possible to the pulsation source. Mounting position preferably vertical (gas valve pointing upwards).

Preferred and alternative installation positions are shown in schematic form in section 3.

## 2.2. SUCTION FLOW STABILISER TYPE SB...S




2.2.1 General

The HYDAC suction flow stabiliser

- improves the NPSH value of the system
- prevents cavitation of the pump
- prevents pipe oscillations.

2.2.2 Applications

Main application areas are piston and diaphragm pumps in public utility plants, reactor construction and the chemical industry.

2.2.3 Mode of operation

Trouble-free pump operation is only possible if no cavitation occurs in the pump suction and pipe oscillations are prevented.

A relatively high fluid volume in the suction flow stabiliser in relation to the displacement volume of the pump reduces the acceleration effects of the fluid column in the suction line. Also an air separation is achieved due to the extremely low flow rate in the suction flow stabiliser and the deflection at a baffle.

By adjusting the bladder gas pressure to the operating conditions, the best possible pulsation damping is achieved.

2.2.4 Design

The HYDAC suction flow stabiliser consists of a welded vessel in steel or stainless steel.

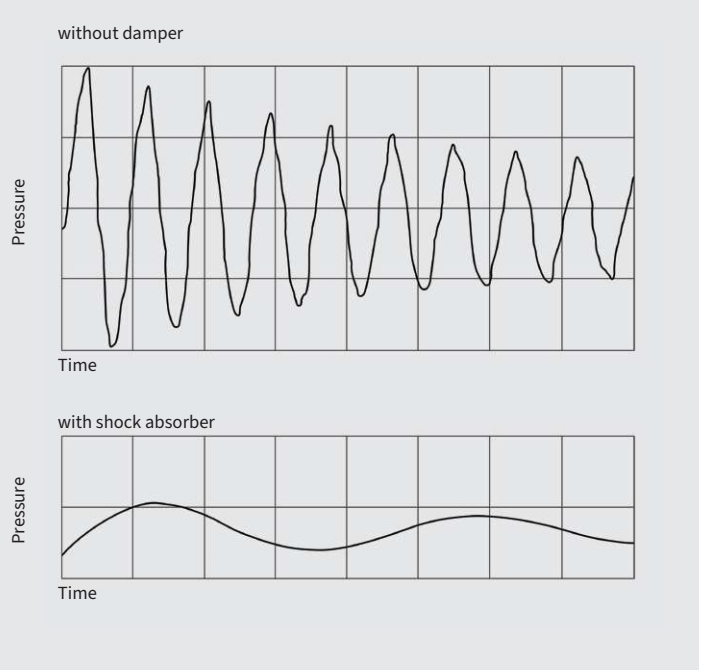
Inlet and outlet are on opposite sides and are separated by a baffle.

The upper part houses the encapsulated bladder. In addition, there is an air bleed screw in the cover and a drainage facility on the bottom.

2.2.5 Installation

As close as possible to the suction inlet of the pump. Mounting position vertical (gas valve pointing upwards).

## 2.3. SHOCK ABSORBER TYPE SB...A




2.3.1 General

The HYDAC shock absorber

- reduces pressure shocks
- protects pipelines and valves from being destroyed.

2.3.2 Applications

The accumulators are particularly suitable for use in pipelines with quick-acting valves or flaps and whilst pumps are being switched on and off.

They are also suitable for energy storage in low pressure applications.

2.3.3 Mode of operation

Sudden changes in pipeline flow, such as those caused by pump failure or the closing or opening of valves, can cause pressures which are many times higher than the normal values.

The shock absorber prevents this by converting potential into kinetic energy and vice versa. This prevents pressure shocks and protects pipelines, valves, monitoring instruments and other pipe fittings from destruction.

2.3.4 Design

The HYDAC shock absorber consists of:

- the welded pressure vessel in carbon steel with or without corrosion protection or in stainless steel.
- the connection including perforated disc which prevents the flexible bladder from extruding from the vessel, and the flange.
- the bladder in various elastomer qualities as shown under section 4.2 with built-in gas valve, which is used for charging pressure $p_0$ and for possible monitoring activities.

2.3.5 Special version

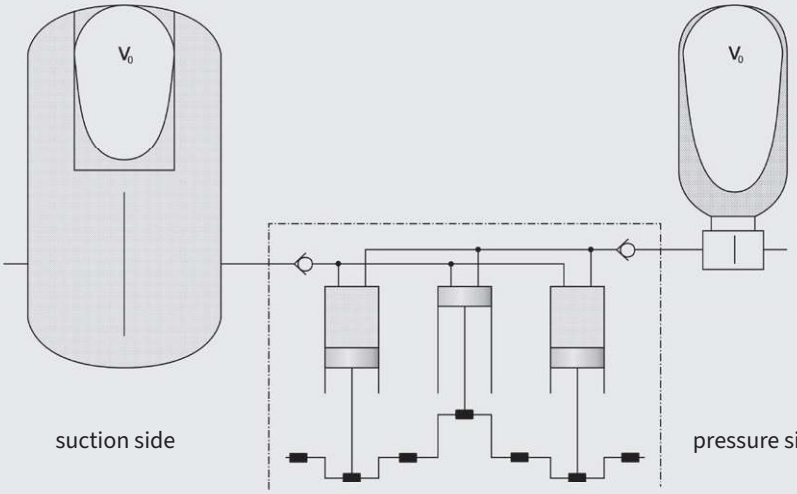
Shock absorbers can also be in the form of diaphragm or piston accumulators. Available on request.

2.3.6 Installation

As close as possible to the source of the erratic condition. Mounting position vertical (gas valve pointing upwards).

# 3 SIZING

## 3.1. PULSATION DAMPER AND SUCTION FLOW STABILISER




On the suction and the pressure side of piston pumps almost identical conditions occur regarding irregularity of the flow rate. Therefore the same formulae for determining the effective gas volume are used for calculating the damper size. That in the end two totally different damper types are used is due to the different acceleration and pressure ratios on the two sides.

Not only is the gas volume $V_0$ a decisive factor but also the connection size of the pump has to be taken into account when selecting the pulsation damper.
In order to avoid additional variations in cross-section, which represent reflection points for vibrations, and also to keep pressure drop to a reasonable level, the fitting cross-section of the damper must be the same as that of the pipeline.

The gas volume $V_0$ of the damper is determined with the aid of the formula for adiabatic changes of state.

By giving the residual pulsation or the gas volume, the damper size can be dimensioned with the aid of the HYDAC software ASP (Accumulator Simulation Program).

Designations:

$\Delta V$ = fluctuating fluid volume [l]

$\Delta V = m \cdot q$

q = stroke volume [l]

$q = \frac{\pi \cdot d_\kappa^2}{4} \cdot h_\kappa$

$d_k$ = piston diameter [dm]

$h_k$ = piston stroke [dm]

m = amplitude factor

$m = \frac{\Delta V}{q}$

z = no. of compressions/ effective cylinders per revolution

x = residual pulsation [ ± %]

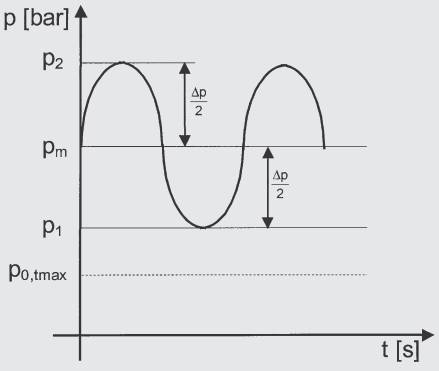
$\kappa$ = isentropic exponent

$\Phi$ = pressure ratio of pre-charge pressure to operating pressure [0.6 ... 0.9]

$\Phi = \frac{p_0}{p_m}$

$\Delta p$ = cyclic test pressure

$\Delta p = p_2 - p_1$ [bar]




Formulae:

$$V_0 = \frac{\Delta V}{\left[\frac{\Phi}{1-\frac{x}{100}}\right]^{\frac{1}{\kappa}} - \left[\frac{\Phi}{1+\frac{x}{100}}\right]^{\frac{1}{\kappa}}}$$

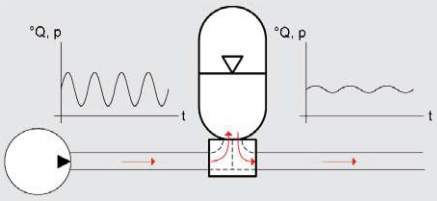
$$\Delta V = m \cdot q$$

$$x\,[\pm\%] = \left|\frac{p_1 - p_m}{p_m} \cdot 100\right|$$

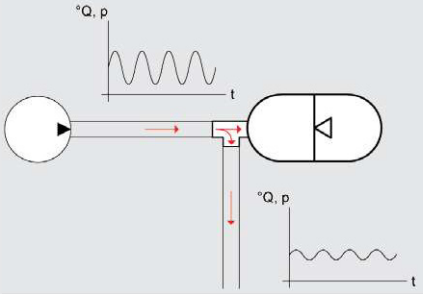
$$= \left|\frac{p_2 - p_m}{p_m} \cdot 100\right|$$

Diagram of mounting options:

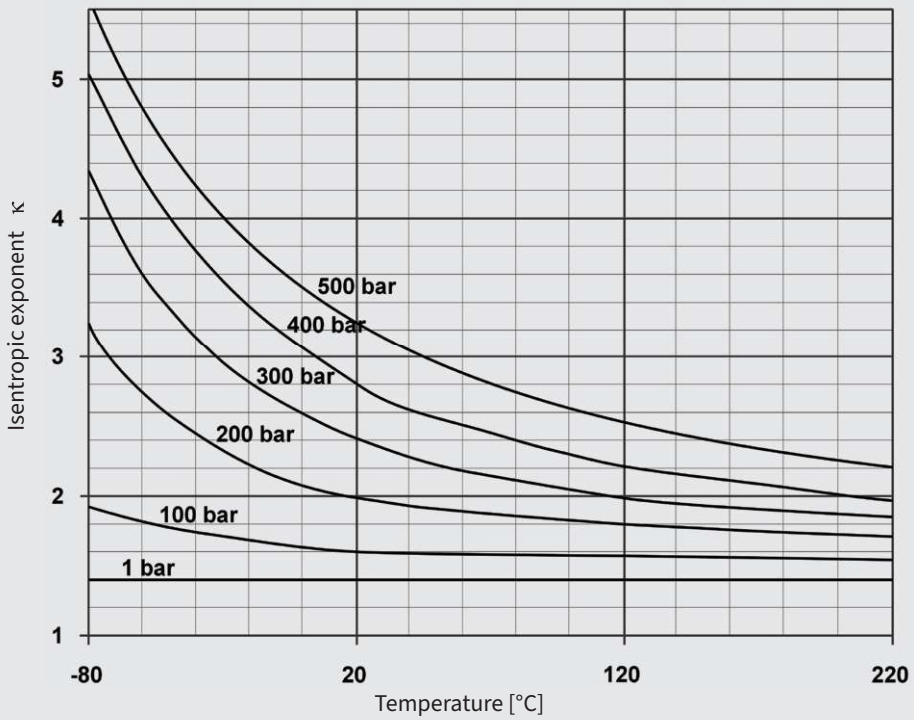
Preferred installation configuration
with maximum damping effect




Alternative installation configuration
using standard accumulator with a
T-piece with reduced damping effect



Isentropic exponent dependent on pressure and temperature:




Amplitude factor (m) for piston pump:

| | m value | |
|---|---|---|
| z | single acting | double acting |
| 1 | 0.548 | 0.206 |
| 2 | 0.206 | 0.042 |
| 3 | 0.035 | 0.018 |
| 4 | 0.042 | 0.010 |
| 5 | 0.010 | 0.007 |
| 6 | 0.018 | 0.005 |
| 7 | 0.005 | |
| 8 | 0.010 | |
| 9 | 0.001 | |

others on request

3.1.1 Calculation example

Given parameters:

Single-acting 3-piston pump

| | |
|---|---|
| Piston diameter: | 70 mm |
| Piston stroke: | 100 mm |
| Drive speed: | 370 rpm |
| Flow rate: | 427 l/min |
| Operating temperature: | 20 °C |
| Operating pressure | |
| – pressure side: | 200 bar |
| – suction side: | 4 bar |

Required:

a) Suction flow stabiliser for a residual pulsation of ± 2.5%

b) Pulsation damper for a residual pulsation of ± 0.5%

Solution:

a) Determining the required suction flow stabiliser

$$V_0 = \frac{\Delta V}{\left[\frac{\Phi}{1-\frac{x}{100}}\right]^{\frac{1}{\kappa}} - \left[\frac{\Phi}{1+\frac{x}{100}}\right]^{\frac{1}{\kappa}}}$$

$$V_0 = \frac{0.035 \cdot \frac{\pi \cdot 0.7^2}{4} \cdot 1.0}{\left[\frac{0.6}{1-\frac{2.5}{100}}\right]^{\frac{1}{1.4}} - \left[\frac{0.6}{1+\frac{2.5}{100}}\right]^{\frac{1}{1.4}}}$$

$V_0 = 0.54$ l

Selected: SB16S-12 with 1 litre gas volume

b) Determining the required pulsation damper

$$V_0 = \frac{\Delta V}{\left[\frac{\Phi}{1-\frac{x}{100}}\right]^{\frac{1}{\kappa}} - \left[\frac{\Phi}{1+\frac{x}{100}}\right]^{\frac{1}{\kappa}}}$$

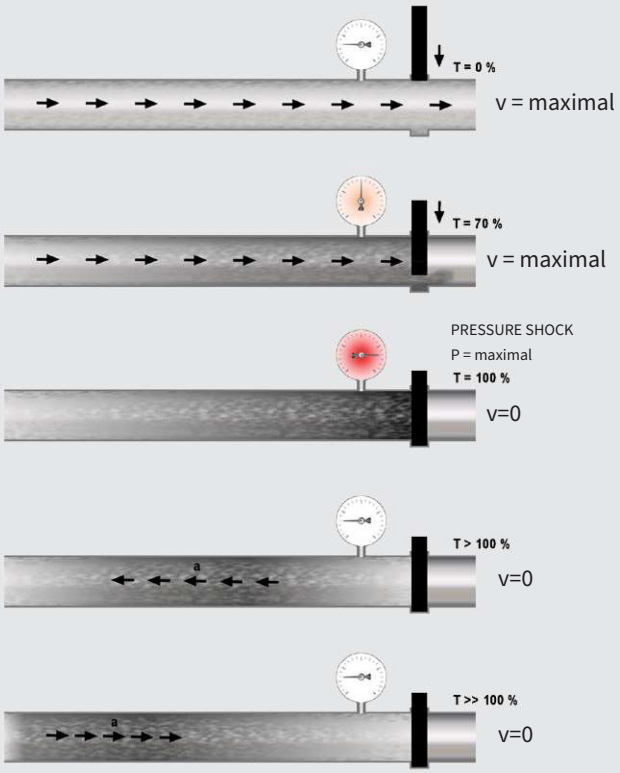
$$V_0 = \frac{0.035 \cdot \frac{\pi \cdot 0.7^2}{4} \cdot 1.0}{\left[\frac{0.7}{1-\frac{0.5}{100}}\right]^{\frac{1}{2.0}} - \left[\frac{0.7}{1+\frac{0.5}{100}}\right]^{\frac{1}{2.0}}}$$

$V_0 = 3.2$ l

Selected: SB330P-4

## 3.2. SHOCK ABSORBER

Pressure shock produced when a valve is closed without a hydraulic accumulator




**Simplified pressure shock calculation for the closing of a valve**

Estimate of Joukowsky's max. occurring pressure shock

$\Delta p[N/m^2] = \rho \cdot a \cdot \Delta v$

$\rho$ [kg/m³] = fluid density

$\Delta v = v - v_1$

$\Delta v$ = change of fluid velocity

v [m/s] = fluid velocity before the change in its condition

$v_1$ [m/s] = fluid velocity after the change in its condition

a [m/s] = propagation velocity of pressure wave

$$a\ [m/s] = \frac{1}{\sqrt{\rho \cdot \left[\frac{1}{K} + \frac{D}{E \cdot e}\right]}}$$

K [N/m²] = compression modulus of the fluid

E [N/m²] = module of elasticity of pipeline

D [mm] = internal diameter of the pipeline e [mm] = wall thickness of the pipeline

The pressure wave runs to the other end of the pipeline and will reach the valve again after time t (reflection time), whereby:

$$t\ [s] = \frac{2 \cdot L}{a}$$

L [m] = length of the pipeline

T [s] = eff. operating time (closing) of the valve

If T < t then:

$p_{max} = p_1 + \Delta p$

If T > t then:

$p_{max}$ $t = p_1 + a\ v\ T$ $\rho \cdot \Delta \cdot$ ——

Determining the required damper size

The accumulator must absorb the kinetic energy of the fluid by converting it into potential energy within the pre-determined pressure range. The change of state of the gas is adiabatic in this case.

$$V_0 = \frac{m \cdot v^2 \cdot 0.4}{2 \cdot p_1 \cdot \left[\left[\frac{p_2}{p_1}\right]^{1-\frac{1}{\kappa}} - 1\right] \cdot 10^2} \cdot \left[\frac{p_1}{p_0}\right]^{\frac{1}{\kappa}}$$

m [kg] = weight of the fluid in the pipeline

v [m/s] = change in velocity of the fluid

($p_1$ bar) = zero head of the pump p

[$p_2$ bar] = perm. operating pressure p

$_0$ [bar] = pre-charge pressure

A special calculation program to analyse the pressure curve is available for dimensioning during pump failure or start-up and for manifolds.

3.2.1 Calculation example Rapid closing of a shut-off valve in a re-fuelling line.

Given parameters:

Length of the pipeline L:
2000 m

Size of pipeline D:
250 mm

Wall thickness of pipeline e:
6.3 mm

Material of pipeline:
Steel

Flow rate Q:
432 $m^3/h = 0.12\ m^3/s$

Density of medium ρ:
980 $kg/m^3$

Zero feed height of pump $p_1$: 6 bar

Min. operating pressure $p_{min}$:
4 bar

Eff. closing time of the valve T:
1.5 s
(approx. 20% of total closing time)

Operating temperature:
20 °C

Compression modulus of the fluid K:
$1.62 \times 10^9\ N/m^2$

Module of elasticity (steel) E:
$2.04 \times 10^{11}\ N/m^2$

Required:

Size of the required shock absorber, when the max. pressure ($p_2$) must not exceed 10 bar.

Solution:

Determination of reflection time:

$$a = \frac{1}{\sqrt{\rho \cdot \left[\frac{1}{K} + \frac{D}{E \cdot e}\right]}}$$

$$a = \frac{1}{\sqrt{980 \cdot \left[\frac{1}{1.62 \cdot 10^9} + \frac{250}{2.04 \cdot 10^{11} \cdot 6.3}\right]}}$$

$$a = 1120\ m/s$$

$$t = \frac{2 \cdot L}{a} = \frac{2 \cdot 2000}{1120} = 3.575\ s\ *$$

* since T < t the max. pressure surge occurs and the formula as shown in section 3.2. must be used.

$$v = \frac{Q}{A}$$

$$v = \frac{0.12}{0.25^2 \cdot \pi/4} = 2.45\ m/s$$

$$\Delta_p = \rho \cdot a \cdot \Delta v$$

$$\Delta_p = 980 \cdot 1120 \cdot (2.45\text{-}0) \cdot 10^{-5}$$

$$= 26.89\ bar$$

$$p_{max} = p_1 + \Delta_p$$

$$p_{max} = 6 + 26.89 = 32.89\ bar$$

Determining the required gas volume:

$$p_0 \leq 0.9 \cdot p_{min}$$

$$p_0 \leq 0.9 \cdot 5 = 4.5\ bar$$

$$V_0 = \frac{m \cdot v^2 \cdot 0.4}{2 \cdot p_1 \cdot \left[\left[\frac{p_2}{p_1}\right]^{1-\frac{1}{\kappa}} - 1\right] \cdot 10^2} \cdot \left[\frac{p_1}{p_0}\right]^{\frac{1}{\kappa}}$$

with $m = V \cdot \rho = \frac{\pi}{4} \cdot D^2 \cdot L \cdot \rho$

$$V_0 = \frac{\frac{\pi}{4} \cdot 0.25^2 \cdot 2000 \cdot 980 \cdot 2.45^2 \cdot 0.4}{2 \cdot 7 \cdot \left[\left[\frac{11}{7}\right]^{1-\frac{1}{1.4}} - 1\right] \cdot 10^2} \cdot \left[\frac{7}{4.5}\right]^{\frac{1}{1.4}}$$

$$V_0 = 1641\ l$$

Selected:

4 x shock absorbers
SB35AH-450

# 4. SPECIFICATIONS

## 4.1. EXPLANATIONS, NOTES

4.1.1 Operating pressure see tables (may differ from nominal pressure for foreign test certificates).

4.1.2 Nominal volume see tables

4.1.3 Effective gas volume
see tables, based on nominal dimensions. This differs slightly from the nominal volume and must be used when calculating the effective fluid volume.

For diaphragm accumulators, the effective gas volume corresponds to the nominal volume.

4.1.4 Effective volume
Volume of fluid which is available between the operating pressures $p_2$ and $p_1$.

4.1.5 Permitted operating temperatures
-10 °C ... +80 °C

standard design, others on request

4.1.6 Gas charge
Hydraulic accumulators must only be charged with nitrogen.
Never use other gases.
Risk of explosion!

In principle, only use nitrogen of at least Class 4.0 (filtration <3 µm).
If other gases are to be used, please contact HYDAC for advice.

When supplied, the accumulator is only pre-charged for storage purposes. Higher pre-charge pressures are possible by arrangement.

4.1.7 Permitted pressure ratio
Ratio of maximum operating pressure $p_2$ to gas pre-charge pressure $p_0$. See catalogue section:

- HYDAC Accumulator Technology No. 3.000

4.1.8 General safety instructions
On no account must any welding, soldering or mechanical work be carried out on the accumulator shell.

After the hydraulic line has been connected it must be completely vented.
Work on systems with hydraulic dampers (repairs, connecting pressure gauges etc.) must only be carried out once the fluid pressure and the gas charge pressure have been released.

The operating instructions must be observed!

- Bladder Accumulators No. 3.201.BA
- Diaphragm Accumulators No. 3.100.BA
- Piston Accumulators No. 3.301.BA

4.1.9 Working temperature and operating medium
The permitted working temperature of a hydraulic damper is dependent on the application limits of the metal materials and the separation element. Outside this temperature range, special materials must be used. The operating medium must also be taken into account.
The following table displays a selection of elastomer materials including max. temperature range and a rough overview of resistant and non-resistant fluids. Please contact us for help in selecting a suitable elastomer.

| Materials | | Materialcode [1] Accumulatortype | | Temperature range | Overview of the fluids [2] | |
|---|---|---|---|---|---|---|
| | | | | | Resistant to | Not resistant to |
| NBR | Acrylonitrile butadiene rubber | 2 | SB, SBO | -15 °C ... + 80 °C | ● Mineral oil (HL, HLP)<br>● Flame-resistant fluids from the HFA, HFB, HFC Synthetic<br>● ester (HEES) Water<br>●<br>● Sea water | ● Aromatic hydrocarbons<br>● Chlorinated hydrocarbons (HFD-S)<br>● Amines and ketones<br>● Hydraulic fluids from the group HFD-R<br>● Fuels |
| | | 5 | SB, SBO | -50 °C ... + 50 °C | | |
| | | 9 | SB, SBO | -30 °C ... + 80 °C | | |
| ECO | Ethylene oxide epichlorohydrin rubber | 3 | SB | -30 °C ... +120 °C | ● Mineral oil (HL, HLP)<br>● Flame-resistant fluids from the group HFB Synthetic<br>● ester (HEES) Water<br>●<br>● Sea water | ● Aromatic hydrocarbons<br>● Chlorinated hydrocarbons (HFD-S) Amines and<br>● ketones<br>● Hydraulic fluids from the group HFD-R<br>● Flame-resistant fluids from the groups HFA and HFC<br>● Fuels |
| | | | SBO | -40 °C ... +120 °C | | |
| IIR | Butyl rubber | 4 | SB | -50 °C ... +100 °C | ● Hydraulic fluids from the group HFD-R<br>● Flame-resistant fluids from the group HFC<br>● Water | ● Mineral oils and mineral greases<br>● Synthetic ester (HEES) Aliphatic,<br>● chlorinated and aromatic hydrocarbons Fuels<br>● |
| | | | SBO | -50 °C ... +120 °C | | |
| FKM | Fluorine rubber | 6 | SB, SBO | -10 °C ... +150 °C | ● Mineral oil (HL, HLP)<br>● Hydraulic fluids from the group HFD<br>● Synthetic ester (HEES)<br>● Fuels<br>● Aromatic hydrocarbons<br>● Inorganic acids | ● Amines and ketones<br>● Ammonia Skydrol and<br>● HyJet IV Steam<br>● |

[1] see section 4.2. Model code, material code, accumulator bladder/diaphragm

[2] others available on request

## 4.2. MODEL CODE

**Pulsation damper, suction flow stabiliser, shock absorber**

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SB330 P – 10 A 1 / 112 U – 330 Al

Series

SB... = with bladder
SBO... = with diaphragm

Type code

A = shock absorber
AH = high flow shock absorber
P = pulsation damper
PH = high flow pulsation damper
S = suction flow stabiliser

Nominal volume [l]

Fluid connection

A = threaded connection
E = threaded connection for weld type construction (diaphragm accumulators only)
F = flange [1]

Type code

1 = standard model (not for screw type diaphragm accumulators or shock absorbers)
2 = back-up type [2]
6 = standard model for screw type diaphragm accumulators type SBO...P-...A6
7 = M28x1.5 gas valve screwed in (only for SB16/35)

Material code dependent on operating medium standard model = 112 for mineral oils

Fluid connection

1 = carbon steel
2 = high tensile steel
3 = stainless steel [3]
4 = chemically nickel-plated (internal coating) [2]
5 = low temperature steel
6 = other materials

Accumulator shell

0 = plastic (internal coating) [2]
1 = carbon steel
2 = chemically nickel-plated (internal coating) [2]
4 = stainless steel [2] [3]
6 = low temperature steel
7 = other materials

Accumulator bladder [4] / diaphragm

2 = NBR [5]
3 = ECO
4 = IIR
5 = NBR [5]
6 = FKM
7 = other materials (e.g. PTFE, EPDM, ...)
9 = NBR [5]

**Certification code**

U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Connection

Al = ISO 228 (BSP), standard connection
Bl = DIN 13 to ISO 965/1 (metric) [1]
Cl = ANSI B1.1 (UNF thread, sealing to SAE standard) [1]
Dl = ANSI B1.20 (NPT thread) [1]

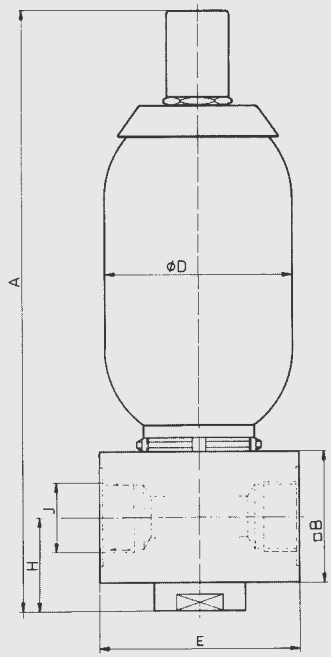
SBO250P-0,075E1 and for SBO210P-0,16E1:
AK = ISO 228 (BSP), standard connection

[1] specify full details of version
[2] not available for all versions dependent
[3] on type and pressure level
[4] [5] when ordering a replacement bladder, state diameter of smallest shell port observe temperate ranges, see section 4.1.9

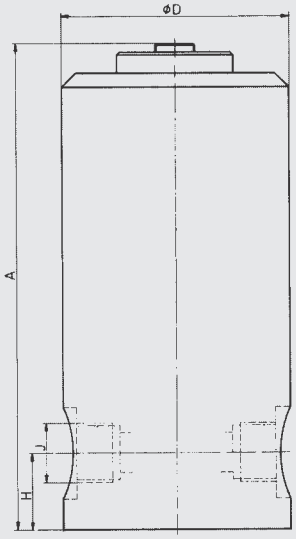
# 4.3. DIMENSIONS AND SPARE PARTS

## 4.3.1 Pulsation dampers bladder accumulator

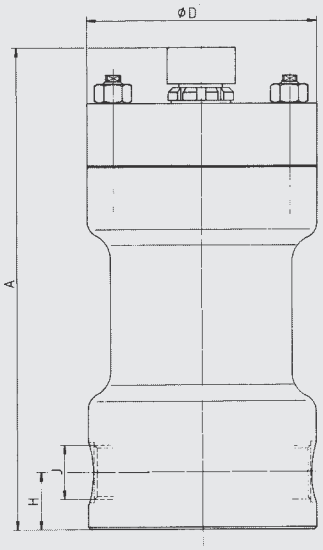
SB330/550P(PH)-...




SB800P-...




SB1000P-...



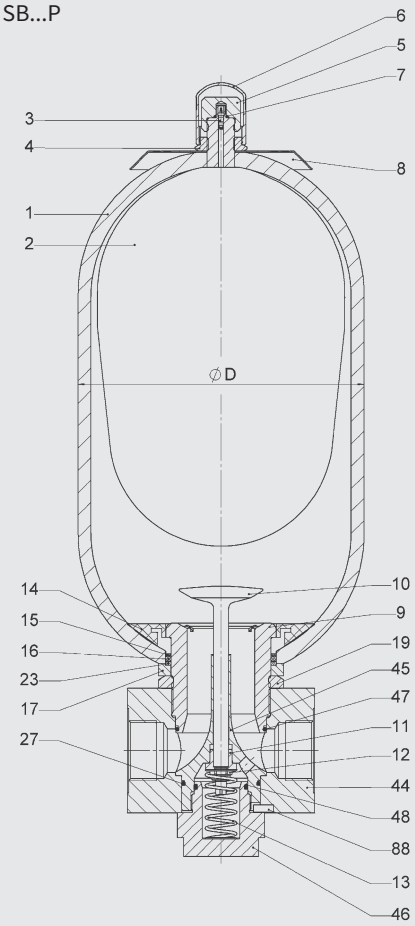

Dimensions SB

| Nominal volume [l] | Series | Max. operating pressure (PED) [bar] | Part no. Carbon steel | Part no. Stainless steel | Eff. Gas volume [l] | A [mm] | □ B [mm] | ØD [mm] | E [mm] | H [mm] | J 2) Thread ISO 228 | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SB330P | 330 | 296114 | 3123952 | 1 | 365 | 80 | 118 | 120 | 57 | G 1 1/4 | 11 |
| | SB550P | 550 | 3435597 | 3132888 | | 384 | 70 | 121 | | 53 | | 13 |
| 1.5 | SB800P | 800 3) | – | – | 1.3 | 346 | – | 160 | – | 55 | | 36 |
| | SB1000P | 1000 3) | – | – | | 414 | – | 215 | – | 49 | 1) | 94 |
| 2.5 | SB330P | 330 | 3078967 | 3108889 | 2.4 | 570 | 80 | 118 | 120 | 57 | G 1 1/4 | 16 |
| | SB550P | 550 | 3576155 | 3096755 | 2.5 | 589 | 70 | 121 | | 53 | | 20 |
| 4 | SB330P | 330 | 3121155 | 3112225 | 3.7 | 455 | 80 | 171 | | 57 | | 18 |
| | SB330PH | | – | – | | 491 | 100 | | 150 | 85 | G 1 1/2 | 26 |
| 5 | SB550P | 550 | 4313259 | 3136856 | 4.9 | 917 | 70 | 121 | 120 | 53 | G 1 1/4 | 26 |
| 6 | SB330P | 330 | 3140558 | 3251391 | 5.7 | 559 | 80 | 171 | | 57 | | 20 |
| | SB330PH | | – | – | | 593 | 100 | | 150 | 85 | G 1 1/2 | 28 |
| 10 | SB330P | | 3082257 | 3114689 | 9.3 | 620 | | 229 | | | | 40 |
| | SB330PH | | – | – | | 652 | 130x140 | | | 100 | SAE 2" - 6000 psi | 50 |
| 13 | SB330P | 330 | 2107871 | – | 12 | 712 | | | | 85 | G 1 1/2 | 48 |
| 20 | SB330P | | 3084825 | | | | | | | | | 70 |
| | SB330PH | | – | – | | 952 | 130x140 | | | 100 | SAE 2" - 6000 psi | 80 |
| 24 | SB330P | 330 | 3152980 | 3986– | 23.6 | | 100 | | | 85 | G 1 1/2 | 82 |
| 32 | SB330P | | 3121154 | – | 33.9 | 1445 | | | | | | 100 |
| | SB330PH | | – | – | | 1475 | 130x140 | | | 100 | SAE 2" - 6000 psi | 110 |

1) M56x4, high pressure connection DN 16, others on request
2) standard connection code = AI, others on request
3) special design, on request

Spare parts

SB...P




| Description | Item |
|---|---|
| Bladder assembly consisting of: | |
| Bladder | 2 |
| Gas valve insert* | 3 |
| Retaining nut | 4 |
| Seal cap | 5 |
| Protective cap | 6 |
| O-ring | 7 |
| Seal kit consisting of: | |
| O-ring | 7 |
| Washer | 15 |
| O-ring | 16 |
| Support ring | 23 |
| O-ring | 27 |
| O-ring | 47 |
| O-ring | 48 |

* available separately
Accumulator shell (item 1) and company label (item 8) not available as a spare part

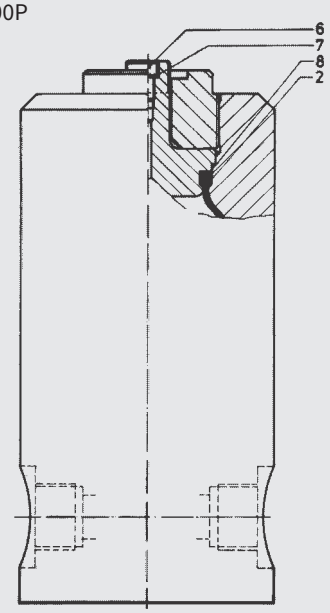
| Description Connection assembly consisting of: | Item |
|---|---|
| Oil valve body | 9 |
| Valve plate | 10 |
| Damping bush | 11 |
| Lock nut | 12 |
| Spring | 13 |
| Anti-extrusion ring* | 14 |
| Washer | 15 |
| O-ring | 16 |
| Spacer | 17 |
| Lock nut | 19 |
| Support ring (only for 330 bar) | 23 |
| O-ring | 27 |
| Connector | 44 |
| Guide piece | 45 |
| Cap | 46 |
| O-ring | 47 |
| O-ring | 48 |
| Locking key | 88 |

* available separately

NBR, carbon steel
Standard gas valve

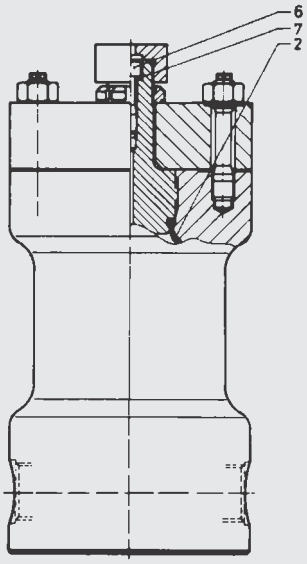
| Volume [l] | Bladder assembly | Seal kit | |
|---|---|---|---|
| | | SB330P/SB400P | SB550P |
| 1 | 237624 | 357055 | 2106402 |
| 2.5 | 236171 | | |
| 4 | 236046 | | |
| 5 | 240917 | | |
| 6 | 2112097 | | |
| 10 | 236088 | 357058 | 357061 |
| 13 | 376249 | | |
| 20 | 236089 | | |
| 24 | 376253 | | |
| 32 | 235335 | | |

SB800P




| Description | Item |
|---|---|
| Bladder | 2 |
| Charging screw | 6 |
| Seal ring U 9.3x13.3x1 | 7 |
| Support ring | 8 |

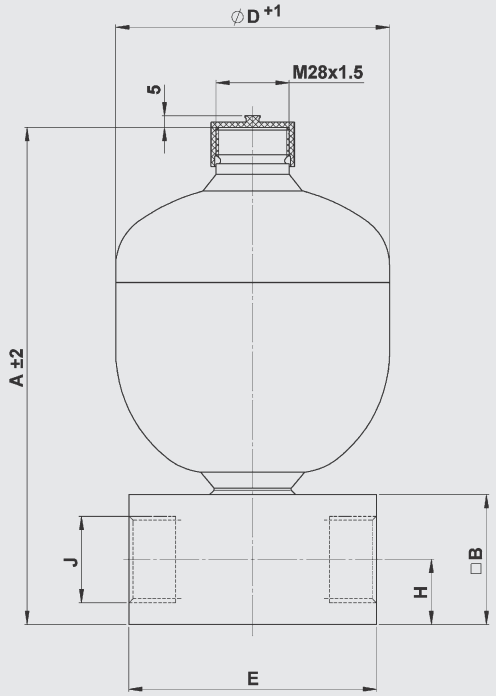
SB1000P



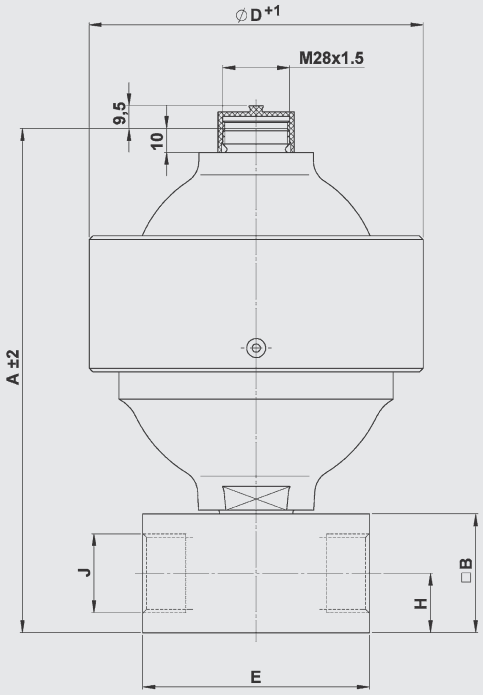

| Description | Item |
|---|---|
| Bladder | 2 |
| Charging screw | 6 |
| Seal ring | 7 |

## 4.3.2 Pulsation dampers diaphragm accumulator

SBO...P...E (welded)




SBO...P...A6 (screwed)



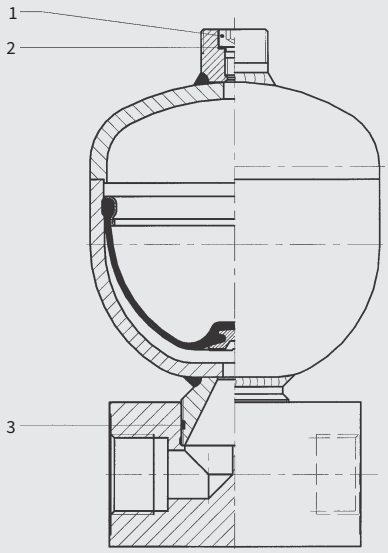

Dimensions SBO

| Nominal volume [l] | Series and connection type 1) | Max. operating pressure (PED) Carbon steel [bar] | Max. operating pressure (PED) Stainless steel [bar] | A [mm] | □ B [mm] | ØD [mm] | E [mm] | H [mm] | J Thread ISO 228 | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.075 | SBO250P-...E1...AK | 250 | – | 131 | – | 64 | hex. 41 | 13 | G 1/4 | 0.9 |
| 0.16 | SBO210P-...E1...AK | 210 | 180 | 143 | – | 74 | | | | 1 |
| 0.32 | SBO210P-...E1...Al | | 160 | 175 | 50 | 93 | 80 | 25 | G 1/2 | 2.6 |
| 0.5 | | | – | 192 | | 105 | | | | 3 |
| 0.6 | SBO330P-...E1...Al | 330 | – | 222 | 60 | 115 | 105 | 30 | G1 | 5.6 |
| 0.75 | SBO210P-...E1...Al | 210 | 140 | 217 | | 121 | | | | 5.1 |
| 1 | SBO200P-...E1...Al | 200 | – | 231 | | 136 | | | | 6 |
| 1.4 | SBO140P-...E1...Al | 140 | – | 244 | | 145 | | | | 6.2 |
| | SBO210P-...E1...Al | 210 | – | 250 | | 150 | | | | 7.7 |
| | SBO250P-...E1...Al | 250 | – | 255 | | 153 | | | | 8.2 |
| 2 | SBO100P-...E1...Al | 100 | 100 | 261 | | 160 | | | | 6.3 |
| | SBO210P-...E1...Al | 210 | – | 267 | | 167 | | | | 8.9 |
| 3.5 | SBO250P-...E1...Al | 250 | – | 377 | | 170 | | | | 13.5 |
| 4 | SBO50P-...E1...Al | – | 50 | 368 | | 158 | | | | 7.9 |
| | SBO250P-...E1...Al | | 180 | 377 | | 170 | | | | 13.5 |
| 0.25 | SBO500P-...A6...Al | 500 | 350 | 162 | 50 | 115 (125) | 80 | 25 | G 1/2 | 5.2 (6.3) |
| 0.6 | SBO450P-...A6...Al | 450 | 250 | 202 | 60 | 140 (142) | 95 | | G1 | 8.9 (9.1) |
| 1.3 | SBO400P-...A6...Al | 400 | – | 267 | | 199 | 105 | 30 | | 13.8 |
| 2 | SBO250P-...A6...Al | 250 | 180 | 285 | | 201 | | | | 15.6 |
| 2.8 | SBO400P-...A6...Al | 400 | – | 308 | | 252 | | | | 24.6 |
| 4 | | | – | 325 | | 287 | | | | 36.6 |

1) standard connection code = AK or Al, others on request
( ) brackets indicate different dimensions for stainless steel version

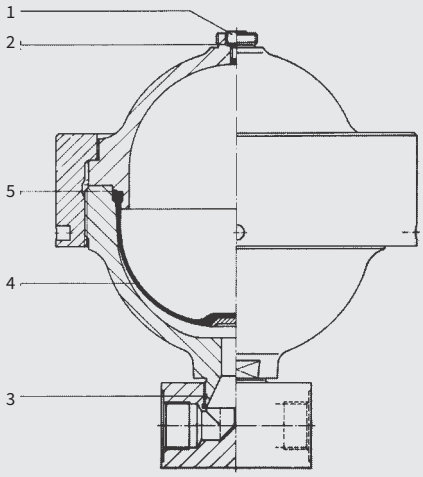
Spare Parts

SBO...P...E




| Descriptions | Item |
|---|---|
| Charging screw | 1 |
| Seal ring | 2 |
| Seal ring | 3 |

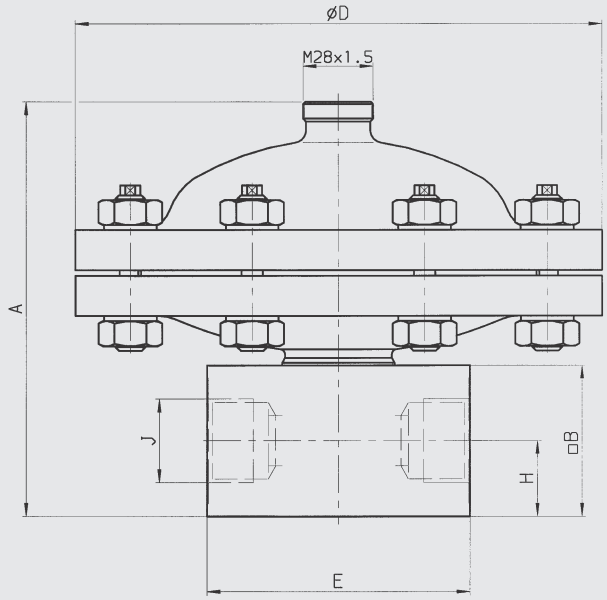
SBO...P...A6




| Descriptions | Item |
|---|---|
| Charging screw | 1 |
| Seal ring | 2 |
| Seal ring | 3 |
| Diaphragm | 4 |
| Support ring | 5 |

## 4.3.3 Pulsation damper for aggressive media

SBO...P-...A6/347...(PTFE)




Pulsation damper in stainless steel with PTFE-coated diaphragm. Also available without connection block.

Permitted operating temperature:
-15 °C ... +80 °C

Permitted pressure ratio $p_2 : p_0 = 2 : 1$

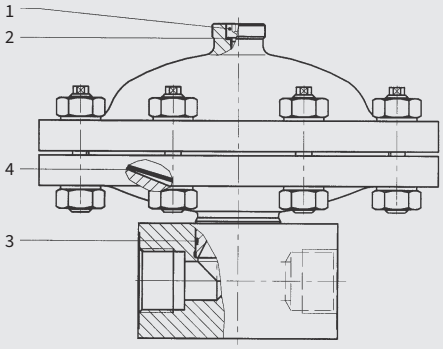
Dimensions

| Nominal volume [l] | Max. operating pressure (PED) [bar] | Part no. | A [mm] | □ B ØD [mm] | [mm] | E [mm] | H [mm] | J 1) Thread ISO 228 | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|
| 0.2 | 40 | 4328332 | 140 | 60 | 210 | 105 | 30 | G1 | 11 |
| | 250 | 4328333 | | | 230 | | | | 27 |
| 0.5 | 40 | 3091224 | 165 | | 210 | | | | 12 |
| | 250 | 3091221 | 200 | | 230 | | | | 26 |

1) Standard connection code = AI, others on request

## Spare Parts

SBO...P-...A6/347...(PTFE)




| Description | Item |
|---|---|
| Charging screw | 1 |
| Seal ring | 2 |
| Seal ring 3 | |
| Diaphragm | 4 |

SBO...(P)-...A4/777... (PVDF/PTFE)

Figure 1

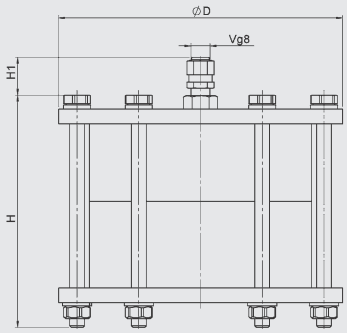
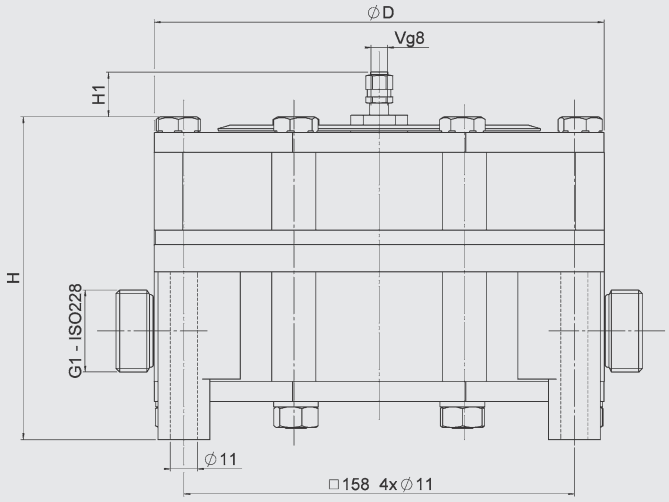



Figure 2




Pulsation damper in PVDF with PTFE-coated diaphragm.

Permitted operating temperature:
-10 °C ... +65 °C

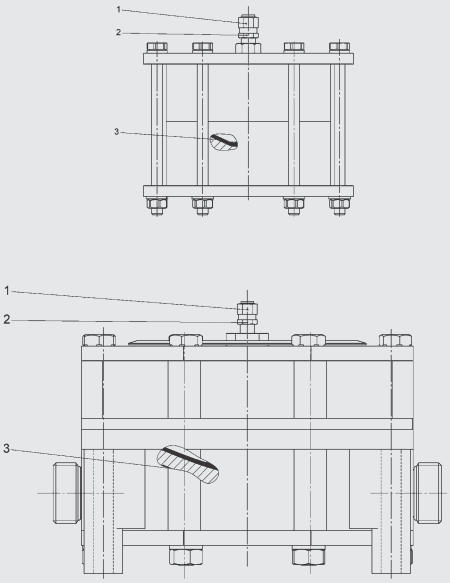
Permitted pressure ratio $p_2 : p_0 = 2 : 1$

Dimensions

| Nominal volume [l] | Max. operating pressure (PED) [bar] | Part no. | ØD [mm] | H [mm] | H1 [mm] | Weight [kg] | Figure |
|---|---|---|---|---|---|---|---|
| 0.08 | 12 | 3655864 | 115 | 94 | 15 | 1.5 | 1 |
| 0.2 | 10 | – | 182 | 128 | 20 | 5.7 | 2 |
| | 16 | – | | 130 | 18 | 6.4 | |
| | 25 | 3357658 | | | | | |
| 0.5 | 10 | – | | 168 | 20 | 6 | |
| | 16 | – | | 170 | 19 | 6.8 | |
| | 25 | 3357657 | | | | | |

Spare parts

SBO...(P)-...A4/777... (PVDF/PTFE)

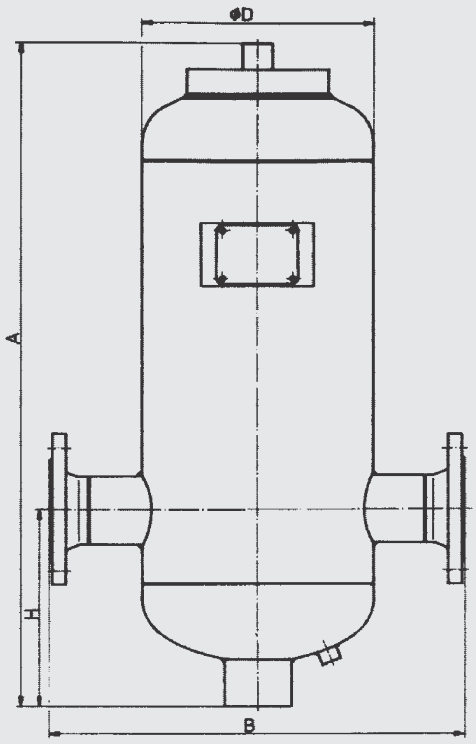



Descriptions Item Gas valve assembly 1 Gas valve insert brass / stainless steel 2 Diaphragm 3

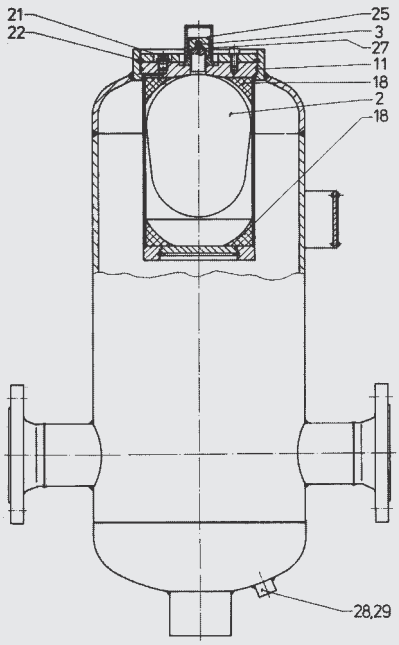
Relevant operating instruction is available on request.

## 4.3.4 Suction flow stabiliser

SB16S




Spare parts




Dimensions

SB16S – permitted operating pressure 16 bar (PED)

| Nominal volume [l] | Fluid volume [l] | Eff. gas volume [l] | A [mm] | B [mm] | ØD [mm] | H [mm] | DN* | Weight [kg] |
|---|---|---|---|---|---|---|---|---|
| 12 | 12 | 1 | 580 | 425 | 219 | 220 | 65 | 40 |
| 25 | 25 | 2.5 | 1025 | | | | | 60 |
| 40 | 40 | 4 | 890 | 540 | 300 | 250 | 80 | 85 |
| 100 | 100 | 10 | 1150 | 650 | 406 | 350 | 100 | 140 |
| 400 | 400 | 35 | 2050 | 870 | 559 | 400 | 125 | 380 |

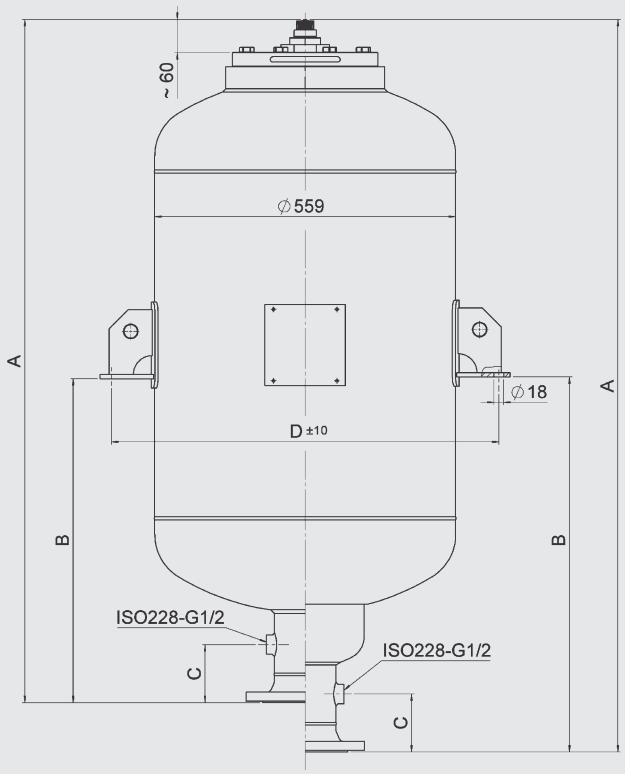
further pressure ranges 25 bar, 40 bar; others on request
other fluid volumes on request

* to EN1092-1/11 /B1/PN16

| Description | Item |
|---|---|
| Bladder | 2 |
| Gas valve insert | 3 |
| O-ring | 11 |
| Insertion ring, 2x | 18 |
| Screw plug | 21 |
| Retainer ring | 22 |
| Cap nut | 25 |
| O-ring | 27 |
| Seal ring | 28 |
| Screw plug | 29 |

4.3.5 Shock absorber

SB16/35A SB16/35AH




Dimensions

SB16/35A

perm. operating pressure 16/35 bar (PED)

| Nominal volume [l] | Eff. gas volume [l] | SB16A Part no. Carbon steel | Stainless steel | A [mm] (approx.) | B (approx.) [mm] | C (approx.) [mm] | D ±10 [mm] | Weight Carbon [kg] | SB35A Part no. Carbon steel | Stainless steel | A [mm] (approx.) | B (approx.) [mm] | C (approx.) [mm] | D ±10 [mm] | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 | 149 | 4108288 | 4108241 | 1044 | | | | 127 | 4108339 | 4108306 | 1076 | 578 | | | 171 |
| 200 | 203 | 4108290 | 4093557 | 1275 | 691 | | | 149 | 4108341 | 4108307 | 1318 | 699 | | | 208 |
| 300 | 288 | 4108291 | 4108242 | 1644 | 920 | 108 | 720 | 178 | 4108342 | 4108308 | 1701 | 937 | 121 | 728 | 261 |
| 375 | 374 | 4108292 | 4108243 | 2020 | 1063 | | | 214 | 4108355 | 4108312 | 2086 | 1083 | | | 315 |
| 450 | 453 | 4108294 | 4108244 | 2361 | 1234 | | | 244 | 4108357 | 4108314 | 2436 | 1258 | | | 364 |

Flange to EN1092-1/11 / DN100 / PN16 or PN40
others on request

SB16/35AH

perm. operating pressure 16/35 bar (PED)

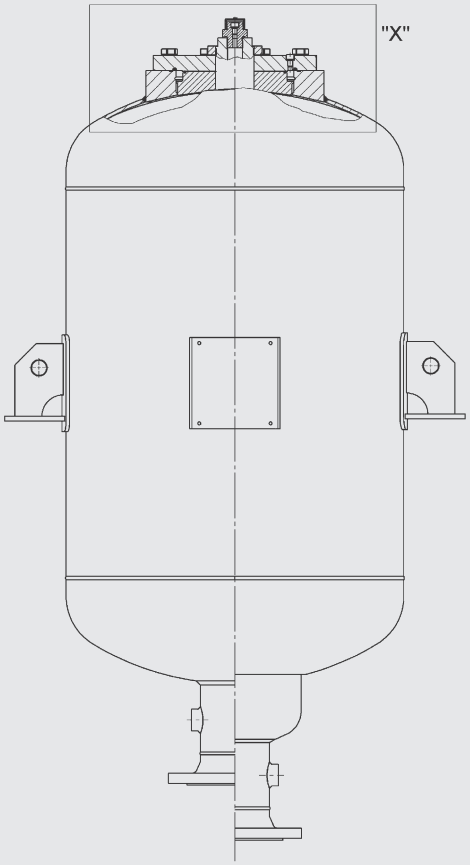
| Nominal volume [l] | Eff. gas volume [l] | SB16AH Part no. Carbon steel | Stainless steel | A (approx.) [mm] | B (approx.) [mm] | C (approx.) [mm] | D ±10 [mm] | Weight [kg] | SB35AH Part no. Carbon steel | Stainless steel | A [mm] (approx.) | B (approx.) [mm] | C (approx.) [mm] | D ±10 [mm] | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 | 149 | 4108720 | 4108702 | 1135 | 638 | | | | 4108773 | 4108729 | 1166 | 641 | | | 180 |
| 200 | 203 | 4108721 | 4108703 | 1366 | 754 | | | 157 | 4108775 | 4108730 | 1408 | 762 | | | 217 |
| 300 | 288 | 4108724 | 4108715 | 1735 | 988 | 108 | 720 | 186 | 4108774 | 4108734 | 1791 | 1000 | 121 | 728 | 270 |
| 375 | 374 | 4108725 | 4108717 | 2111 | 1127 | | | 222 | 4108776 | 4108758 | 2176 | 1146 | | | 324 |
| 450 | 453 | 4108726 | 4108718 | 2452 | 1298 | | | 252 | 4108778 | 4108762 | 2526 | 1321 | | | 373 |

Flange to EN1092-1/11 / DN100 / PN16 or PN40
others on request

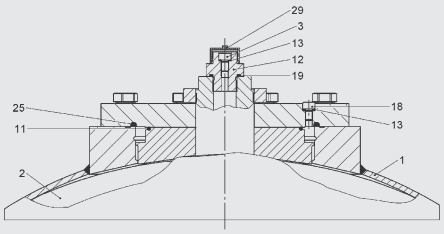
Spare parts

SB16/35A, SB16/35AH

The following spare parts relate exclusively to hydraulic accumulators from construction year 2016 and later.
For low-pressure accumulators of series SB16/35A and SB16/35AH up to construction year 2015 spare parts are available on request.




Detail "X"




| Description | Item |
|---|---|
| Bladder | 2 |
| Gas valve assembly consisting of: | |
| Screw plug | 3 |
| Gas valve body | 12 |
| Seal ring | 13 |
| O-ring | 19 |
| Protective cap | 29 |
| Seal kit consisting of: | |
| O-ring | 11 |
| Seal ring | 13 |
| Vent screw | 18 |
| O-ring | 19 |
| O-ring | 25 |

Accumulator shell (item 1) not available as a spare part

NBR

| Nominal Bladder volume [l] | | Seal kit | |
|---|---|---|---|
| | | Carbon steel | Stainless steel |
| 150 | 4241264 | 4241465 | 4197141 |
| 200 | 4241263 | | |
| 300 | 4113771 | | |
| 375 | 4113731 | | |
| 450 | 4241435 | | |