# Hydraulic Dampers

## 1. HYDRAULIC DAMPERS

### 1.1. DESCRIPTION

#### 1.1.1 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.

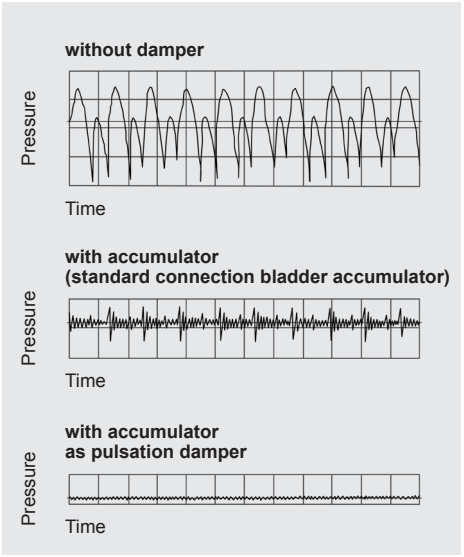
HYDAC hydraulic dampers are particularly suitable for damping such pressure fluctuations.

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.

### 1.2. APPLICATION

#### 1.2.1 Pulsation damping TYPE SB...P / SBO...P




**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.

**Applications**

The pulsation damper is particularly suitable for hydraulic systems, displacement pumps of all types, sensitive measurement and control instruments and manifolds in process circuits in the chemical industry.

**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 is directed straight at the bladder or diaphragm. This causes direct contact of the flow with the bladder or diaphragm which, in an almost inertialess operation, balances the flow rate fluctuations via the gas volume.

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

**Design**

The HYDAC pulsation damper consists of:

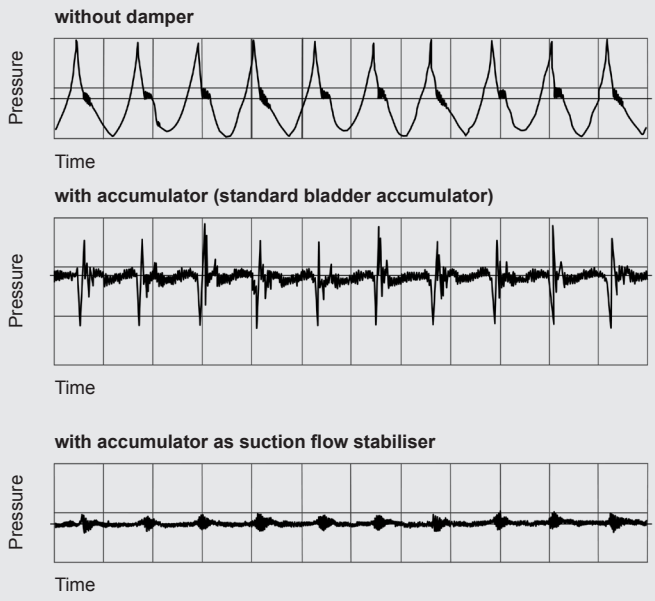
- the welded or forged pressure vessel in carbon steel; available with internal coating or in stainless steel for chemically aggressive fluids.
- the special fluid valve with inline connection, which guides the flow into the vessel (threaded or flange connection).
- the bladder or diaphragm in various elastomers as shown under 1.4.1.

**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 Point 1.3.

## 1.2.2 Suction flow stabiliser Type SB...S




**General**
The HYDAC suction flow stabiliser

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

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

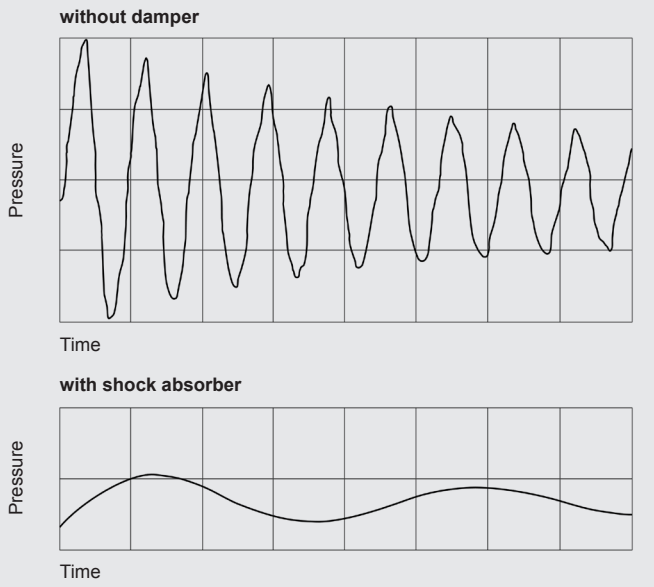
**Operation**
Trouble-free pump operation is only possible if no cavitation occurs in the pump suction and pipe oscillations are prevented.

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 on a baffle. By adjusting the charging pressure of the bladder to the operating conditions, the best possible pulsation damping is achieved.

**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 a vent screw in the cover plate and a drainage facility on the bottom.

**Installation**
As close as possible to the suction inlet of the pump. Mounting position vertical (gas valve uppermost).

## 1.2.3 Shock absorber Type SB...A




**General**
The HYDAC shock absorber

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

**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.

**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, control instruments and other devices from destruction.

**Design**
The HYDAC shock absorber consists of:

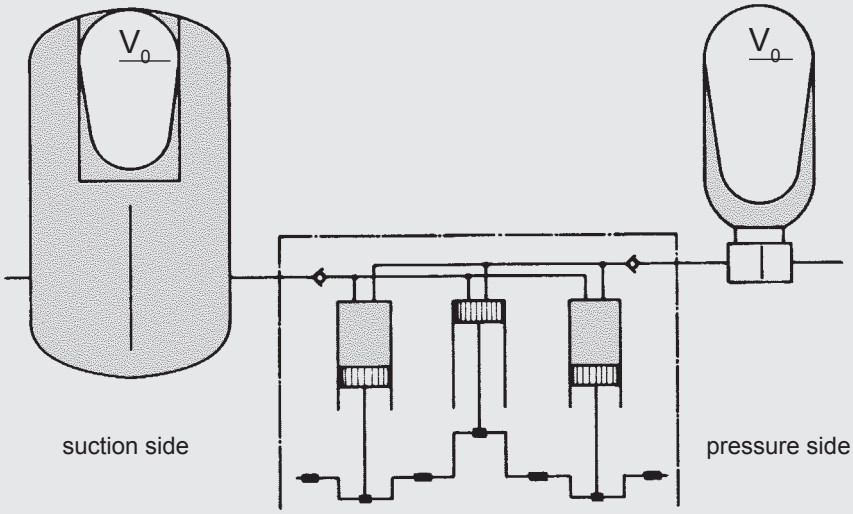
- the welded pressure vessel in carbon steel with or without corrosion protection or in stainless steel.
- the connection including perforated disc which prevents the flexible bladder from extruding from the vessel, and the flange.
- the bladder in various compounds as shown under point 1.4.1 with built-in gas valve, which is used for charging pressure $p_0$ and for possible monitoring activities.

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

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

# 1.3. SIZING

## 1.3.1 Pulsation damper and suction flow stabiliser




On the suction and 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 connection cross-section of the damper must be the same as 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 calculated with the aid of the HYDAC software **ASP** (**A**ccumulator **S**imulation **P**rogram). The results can then be printed out or the data files can be stored in ASP format.

The ASP-program is available free of charge via our website www.hydac.com or via e-mail to speichertechnik@hydac.com.

**Designations:**

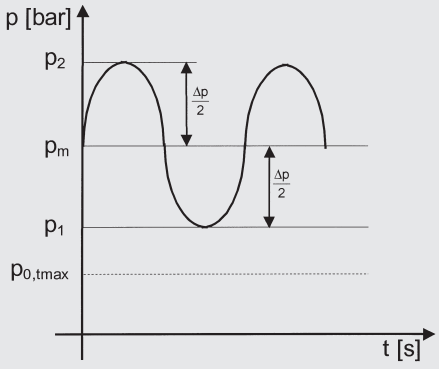
$\Delta V$ = fluctuating fluid volume [l]
$\Delta V = m \bullet q$

q = stroke volume [l]
$$q = \frac{\pi \bullet d_\kappa^{\,2}}{4} \bullet h_\kappa$$

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

$\Delta p$ = height of pressure fluctuations
$\Delta p = p_2 - p_1$ [bar]




**Formulae:**

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

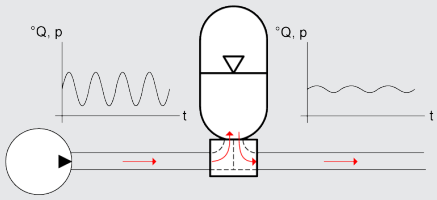
$$\Delta V = m \bullet q$$

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

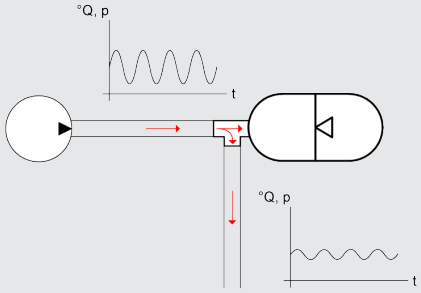
$$= \left|\frac{p_2 - p_m}{p_m} \bullet 100\right|$$

**Schematic of installation options:**

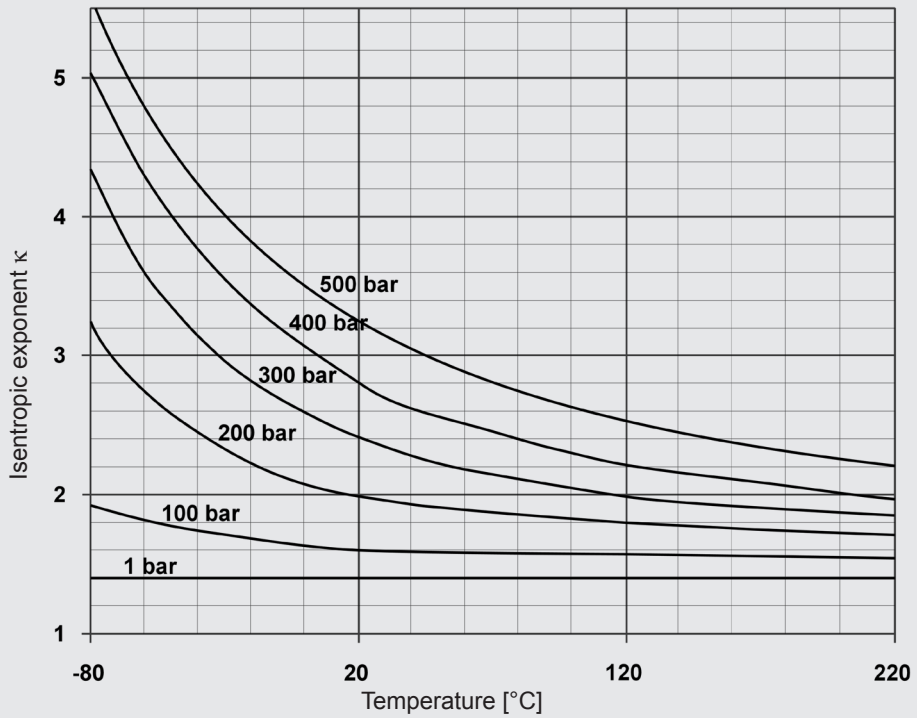
Preferred installation configuration with maximum damping effect




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



**Isentropic exponent κ dependent on pressure and temperature:**




**Amplitude factor (m) for piston pump:**

| | μ– Wert | |
|---|---|---|
| z | single acting | double acting |
| 1 | 0.550 | 0.250 |
| 2 | 0.210 | 0.120 |
| 3 | 0.035 | 0.018 |
| 4 | 0.042 | 0.010 |
| 5 | 0.010 | 0.006 |
| 6 | 0.018 | 0.001 |
| 7 | 0.005 | |
| 8 | 0.010 | |
| 9 | 0.001 | |

others on request

**Calculation example**

**Given parameters:**

Single-acting 3-piston pump

| | | |
|---|---|---|
| Piston diameter: | 70 | mm |
| Piston stroke: | 100 | mm |
| Motor speed: | 370 | $min^{-1}$ |
| Output: | 427 | l/min |
| Operating temperature: | 20 | °C |
| Operating pressure | | |
| - Outlet: | 200 | bar |
| - Inlet: | 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

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

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

$V_0$ = 0.54 l

**Selected:** SB16S-12 with 1 litre gas volume

b) Determining the required pulsation damper

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

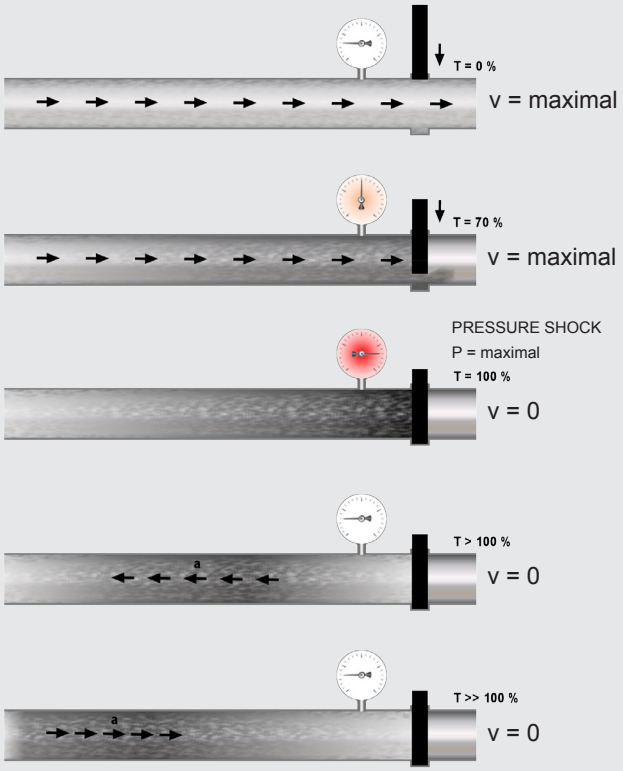
$$V_0 = \frac{0.035 \bullet \frac{\pi \bullet 0.7^2}{4} \bullet 1.0}{\left[\frac{0.7}{1-\frac{0.5}{100}}\right]^{\frac{1}{2.0}} - \left[\frac{0.7}{1+\frac{0.5}{100}}\right]^{\frac{1}{2.0}}}$$

$V_0$ = 3.2 l

**Selected:** SB330P-4

### 1.3.2 **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/m²] = $\rho \cdot a \cdot \Delta v$
$\rho$ [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
v1 [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] = modulus of elasticity of pipeline
D [mm] = internal diameter of 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] = effective operating time (closing) of the valve
If T < t then:
$p_{max} = p_1 + \Delta p$
If T < t then:

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

**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
$p_2$ [bar] = permitted operating pressure
$p_0$ [bar] = pre-charge pressure

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

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

**Given parameters:**

Length of the pipe line L:
2000 m

NW of pipeline D:
250 mm

Wall thickness of pipeline e:
6.3 mm

Material of pipeline:
Steel

Flow rate Q:
432 m³/h = 0.12 m³/s

Density of medium ρ:
980 kg/m³

Zero feed height of pump $p_1$:
6 bar

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

Effective 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/m²

Elasticity modulus (steel) E:
$2.04 \times 10^{11}$ N/m²

**Required:**

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

**Solution:**

Determination of reflection time:

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

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

$$a = 1120 \text{ m/s}$$

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

* since T < t the max. pressure surge occurs and the formula as shown in Point 1.3.2. must be used.

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

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

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

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

$$= 26.89 \text{ bar}$$

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

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

Determining the required gas volume:

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

$$p_0 \leq 0.9 \cdot 5 = 4.5 \text{ bar}$$

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

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

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

$$V_0 = 1641 \text{ l}$$

**Selected:**

4 x shock absorbers
SB35AH-450

# 1.4. TECHNICAL SPECIFICATIONS

## 1.4.1 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 AI**

**Series**

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

**Type**

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 [3]

**Type code**

1 = standard model (not for screw type diaphragm accumulators or pressure shock dampers)
2 = back-up type [1]
6 = standard model for screw type diaphragm accumulators
Type SBO...P-...A6

**Material code**

dependent on operating medium
standard model = 112 for mineral oils

Fluid connection

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

Accumulator shell

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

Accumulator bladder/diaphragm [2]

2 = NBR20 (acrylonitrile butadiene)
3 = ECO (ethylene oxide epichlorohydrin)
4 = IIR (butyl)
5 = NBR21 (low temperature NBR)
6 = FKM (fluoro rubber)
7 = other materials (e.g. PTFE, EPDM)

**Certification code**

U = PED 97/23/EC

**Permitted operating pressure [bar]**

**Connection**

AI = ISO 228 (BSP), standard connection
BI = DIN 13 to ISO 965/1 (metric) [3]
CI = ANSI B1.1 (UNF thread,sealing to SAE standard) [3]
DI = ANSI B1.20 (NPT thread) [3]

SBO250P-0.075E1 and for SBO210P-0.16E1:
AK = ISO 228 (BSP), standard connection

[1] Not available for all models
[2] When ordering a spare bladder, please state diameter of the smaller shell port
[3] Please give full details when ordering

### 1.4.2 General

**Operating pressure**
See tables (may differ from nominal pressure for foreign test certificates).

**Nominal volume**
see tables

**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.

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

**Fluids**
Mineral oils, hydraulic oils, non-flam fluids, water, emulsions, fuels.
Other fluids on request.

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

In principle, the accumulator may only be charged with nitrogen class 4.0, filtered to < 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.

**Permitted operating temperature**
-10 °C ... +80 °C
for material code 112.

Others on request

**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

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

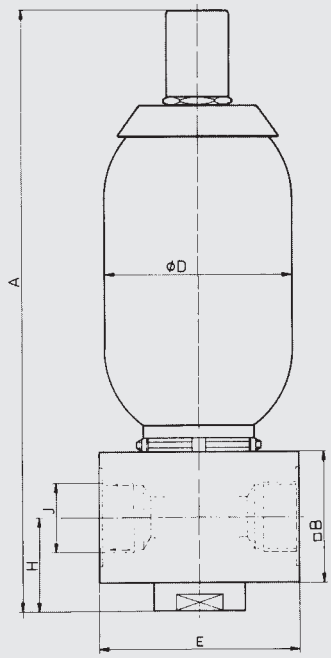
After the hydraulic line has been connected it must be completely vented. Work on systems with hydraulic dampers (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

**Please read the Operating Manuals!**

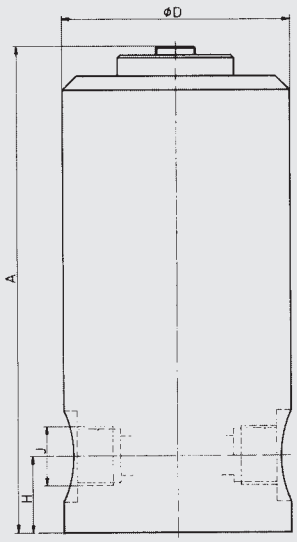
- Bladder Accumulators No. 3.201.CE
- Diaphragm Accumulators No. 3.100.CE
- Piston accumulators No. 3.301.CE

## 1.4.3 Pulsation damper

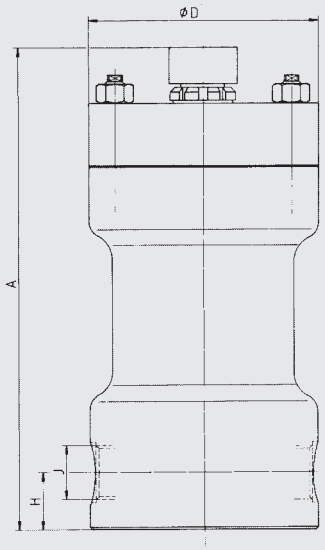
**SB330/550P(PH)-...**




**SB800P-...**




**SB1000P-...**

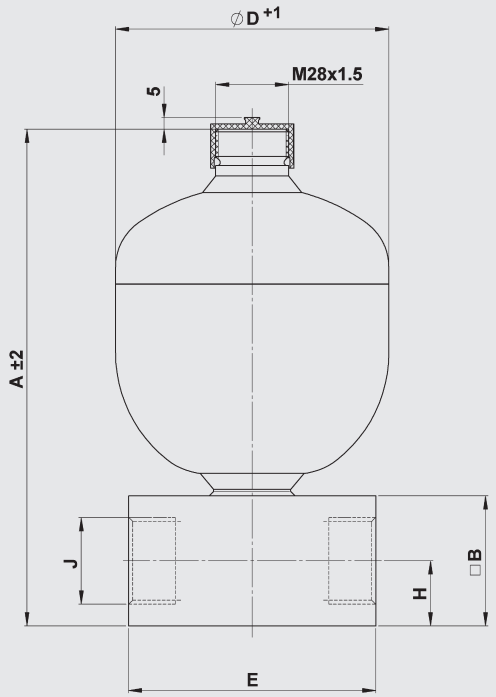



**Dimensions SB**

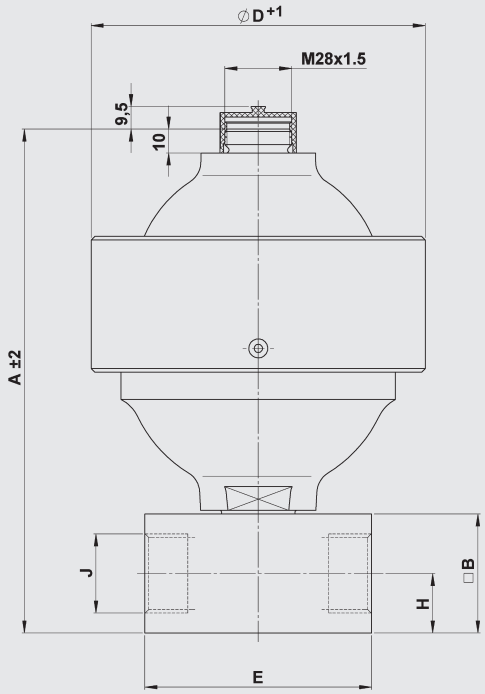
| Nominal volume [l] | Max. operating pressure* [bar] | Eff. gas volume [l] | Weight [kg] | A [mm] | □ B [mm] | Ø D [mm] | E [mm] | H [mm] | J [2] Thread ISO 228 | Series |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 330 | 1 | 11 | 365 | 80 | 118 | 120 | 57 | G 1 1/4 | SB330P |
| | 550 | | 13 | 384 | 70 | 121 | | 53 | | SB550P |
| 1.5 | 800 [3] | 1.3 | 36 | 346 | – | 160 | – | 55 | | SB800P |
| | 1000 [3] | | 94 | 414 | – | 215 | – | 49 | [1] | SB1000P |
| 2.5 | 330 | 2.4 | 16 | 570 | 80 | 118 | 120 | 57 | G 1 1/4 | SB330P |
| | 550 | 2.5 | 20 | 589 | 70 | 121 | | 53 | | SB550P |
| 4 | 330 | 3.7 | 18 | 455 | 80 | 171 | | 57 | | SB330P |
| | | | 26 | 491 | 100 | | 150 | 85 | G 1 1/2 | SB330PH |
| 5 | 550 | 4.9 | 26 | 917 | 70 | 121 | 120 | 53 | G 1 1/4 | SB550P |
| 6 | 330 | 5.7 | 20 | 559 | 80 | 171 | | 57 | | SB330P |
| | | | 28 | 593 | 100 | | 150 | 85 | G 1 1/2 | SB330PH |
| 10 | | 9.3 | 40 | 620 | | 229 | | | | SB330P |
| | | | 50 | 652 | 130x140 | | | 100 | SAE 2" - 6000 psi | SB330PH |
| 13 | 330 | 12 | 48 | 712 | 100 | | | 85 | G 1 1/2 | SB330P |
| 20 | | 18.4 | 70 | 920 | | | | | | SB330P |
| | | | 80 | 952 | 130x140 | | | 100 | SAE 2" - 6000 psi | SB330PH |
| 24 | 330 | 23.6 | 82 | 986 | 100 | | | 85 | G 1 1/2 | SB330P |
| 32 | | 33.9 | 100 | 1445 | | | | | | SB330P |
| | | | 110 | 1475 | 130x140 | | | 100 | SAE 2" - 6000 psi | SB330PH |

* Certification to PED 97/23/EC
[1] M56x4, high pressure connection DN 16, others on request
[2] Standard connection code = AI, others on request
[3] Special model, on request

**SBO...P...E**




**SBO...P...A6**



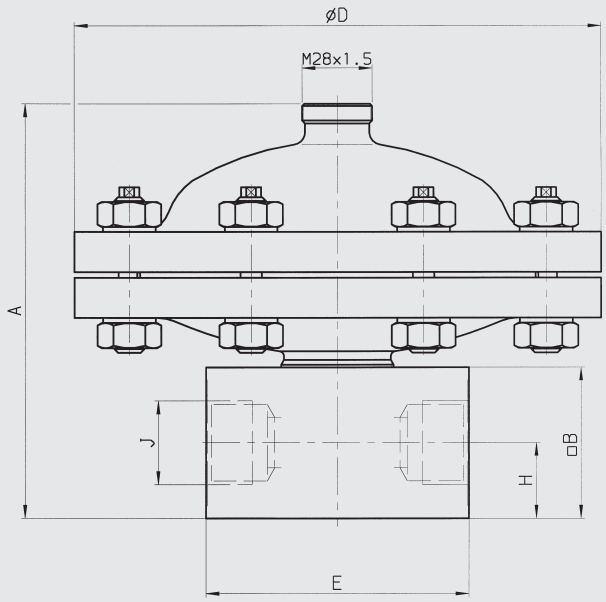

## Dimensions SBO

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

* Certification to PED 97/23/EC
[1] Standard connection code = AK or AI, others on request
( ) Brackets indicate different dimensions for stainless steel version (NIRO)

## Pulsation dampers for aggressive media

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




Pulsation damper in stainless steel with PTFE coated diaphragm and PTFE or FFKM seals.
Also available without connection block.

Certification to PED 97/23/EC

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

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

| Nominal volume [l] | Max. operating pressure [bar] | Weight [kg] | A [mm] | □ B [mm] | Ø D [mm] | E [mm] | H [mm] | J [1] Thread ISO 228 |
|---|---|---|---|---|---|---|---|---|
| 0.2 | 40 | 11 | 140 | 60 | 210 | 105 | 30 | G 1 |
| | 250 | 27 | 197 | | 230 | | | |
| 0.5 | 40 | 12 | 165 | | 210 | | | |
| | 250 | 26 | 200 | | 230 | | | |

[1] Standard connection code = AI, others on request

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

Diagram 1

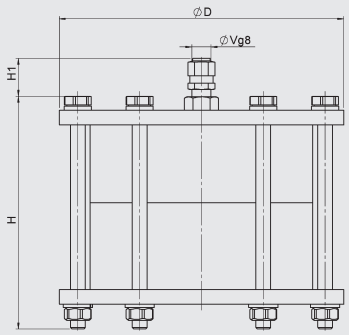
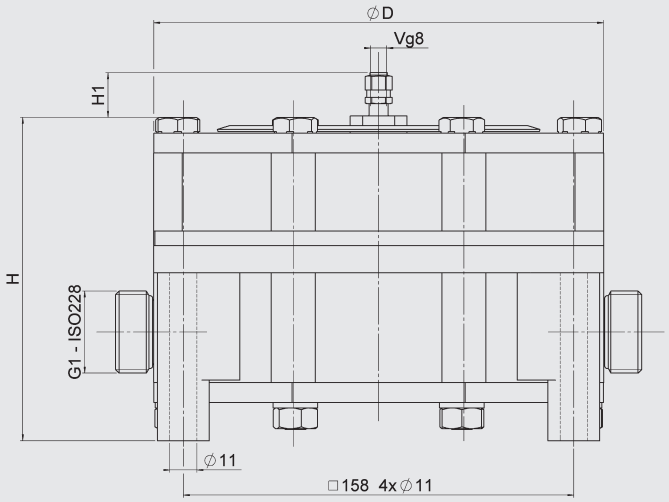



Diagram 2




Pulsation damper in PVDF with PTFE-coated diaphragm.

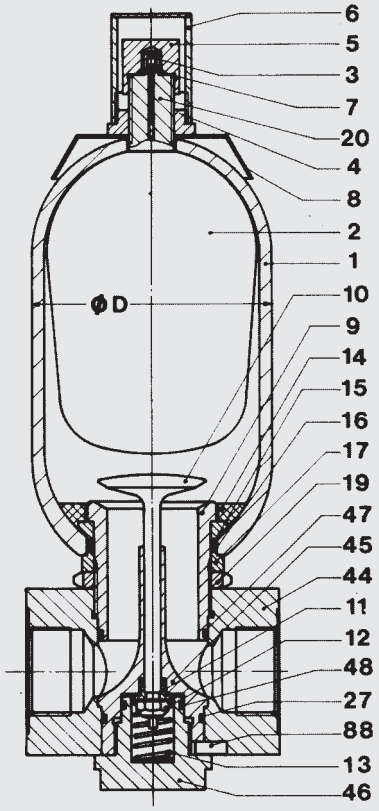
Permitted operating temperature:
-10 °C ... +65 °C

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

| Nominal volume [l] | Max. operating pressure [bar] | Weight [kg] | Ø D [mm] | H [mm] | H [mm] | Diag. |
|---|---|---|---|---|---|---|
| 0.08 | 10 | 1.5 | 115 | 94 | 15 | 1 |
| 0.2 | 10 | 5.7 | 182 | 128 | 20 | 2 |
| | 16 | 6.4 | | 130 | 18 | |
| | 25 | | | | | |
| 0.5 | 10 | 6 | | 168 | 20 | |
| | 16 | 6.8 | | 170 | 19 | |
| | 25 | | | | | |

## Spare parts

### SB...P




| Description | Item |
|---|---|
| **Bladder assembly*** consisting of: | |
| Bladder | 2 |
| Gas valve insert | 3 |
| Retaining nut | 4 |
| Cap nut | 5 |
| Valve protection 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 |
| **Anti-extrusion ring*** | 14 |
| **Gas valve insert*** | 3 |

* recommended spares

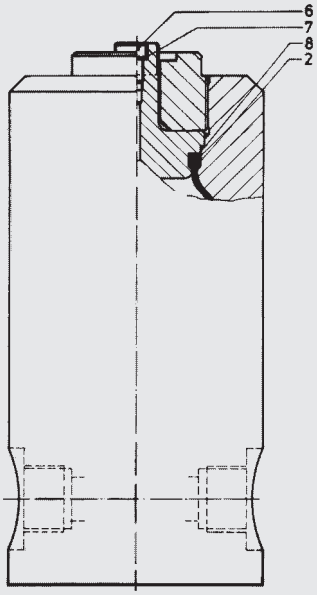
| Description | Item |
|---|---|
| **Connection assembly** consisting of: | |
| Oil valve body | 9 |
| Valve poppet | 10 |
| Damping sleeve | 11 |
| Lock nut | 12 |
| Spring | 13 |
| Anti-extrusion ring | 14 |
| Washer | 15 |
| O-ring | 16 |
| Spacer | 17 |
| Lock nut | 19 |
| Support ring (only for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

### O-ring dimensions (mm)

| Series | Nominal volumes | Item 7 | Item 16 | Item 27 | Item 47 | Item 48 |
|---|---|---|---|---|---|---|
| SB330P | 1- 6 l | 7.5x2 | 55x3.5 [1)] | 42.2x3 [1)] | 46x3 [1)] | 24.2x3 [1)] |
| SB550P | 1- 5 l | 7.5x2 | 50.17x5.33 [1)] | 37.82x1.78 [1)] | 40.94x2.62 [1)] | 23.52x1.78 [1)] |
| SB330P/PH | 10-32 l/4+6 l | 7.5x2 | 80x5 [1)] | 57.2x3 [1)] | 67.2x3 [1)] | 37.2x3 [1)] |
| SB330PH | 10-32 l | 7.5x2 | 100x5 [1)] | 64.5x3 [1)] | 84.5x3 [1)] | 44.2x3 [1)] |

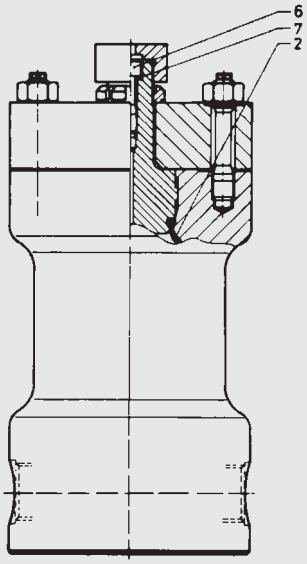
[1)] For code 663 and 665 different dimensions

### SB800P



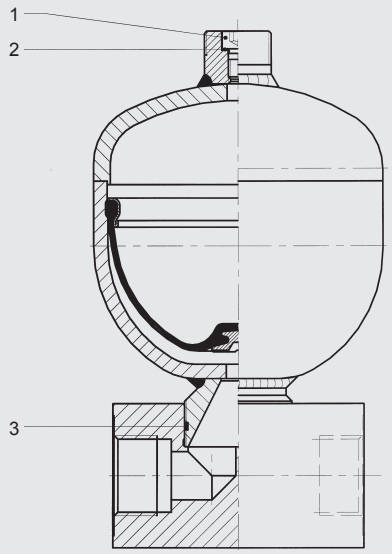

| Description | Item |
|---|---|
| Bladder | 2 |
| Charging screw | 6 |
| Seal ring U 9.3x13.3x1 | 7 |
| Support ring | 8 |

### SB1000P



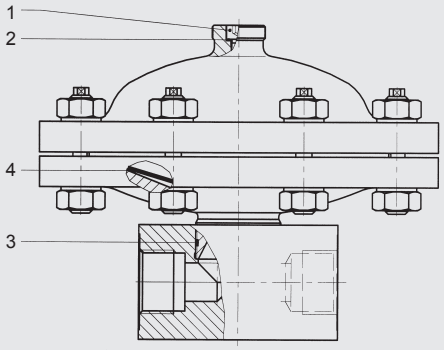

| Description | Item |
|---|---|
| Bladder | 2 |
| Charging screw | 6 |
| Seal ring | 7 |

## SBO...P...E



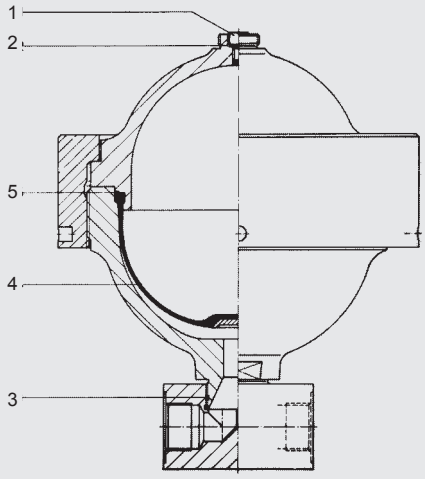

| Description | Item |
|---|---|
| Charging screw | 1 |
| Seal ring | 2 |
| Seal ring | 3 |

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



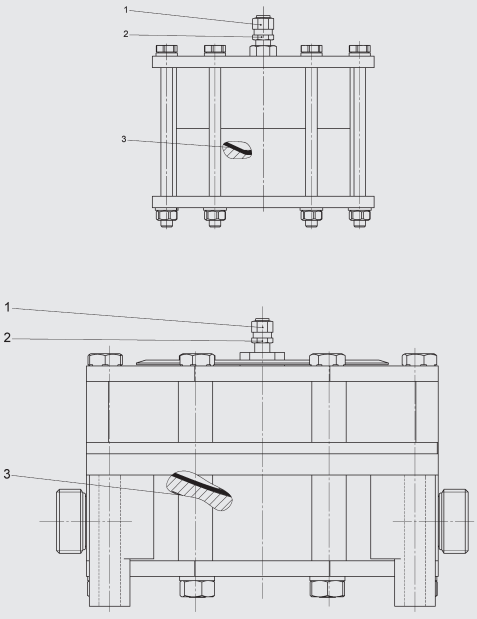

| Description | Item |
|---|---|
| Charging screw | 1 |
| Seal ring | 2 |
| Seal ring | 3 |
| Diaphragm | 4 |

## SBO...P...A6




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

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

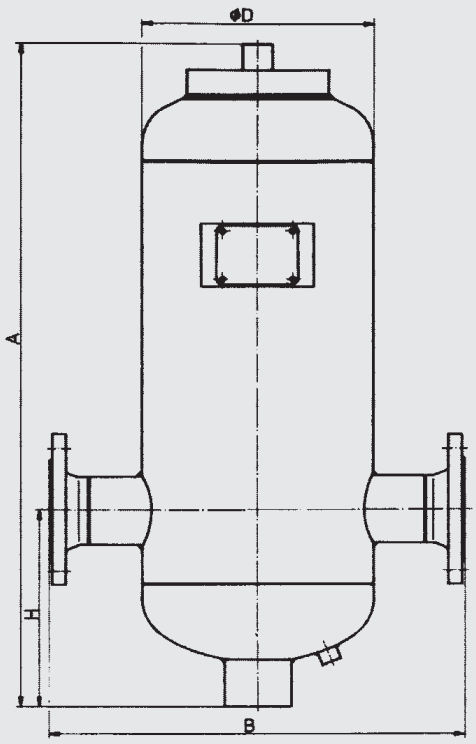



| Description | Item |
|---|---|
| Gas valve complete | 1 |
| Gas valve insert brass / stainless steel | 2 |
| Diaphragm | 3 |

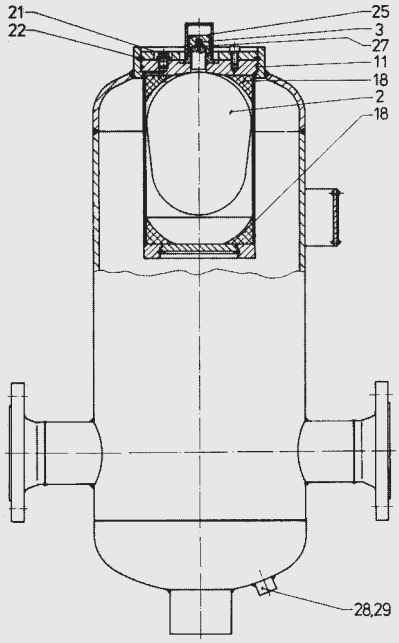
**Relevant operating manual is available on request.**

## 1.4.4 Suction flow stabiliser

### SB16S




### Spare parts




### Dimensions

| SB 16 S - permitted working pressure 16 bar; certified to PED 97/23/EC | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Nominal volume [l] | Fluid volume [l] | Eff. gas volume [l] | Weight [kg] | A [mm] | B [mm] | Ø D [mm] | H [mm] | DN* |
| 12 | 12 | 1 | 40 | 580 | 425 | 219 | 220 | 65 |
| 25 | 25 | 2.5 | 60 | 1025 | | | | |
| 40 | 40 | 4 | 85 | 890 | 540 | 300 | 250 | 80 |
| 100 | 100 | 10 | 140 | 1150 | 650 | 406 | 350 | 100 |
| 400 | 400 | 35 | 380 | 2050 | 870 | 559 | 400 | 125 |

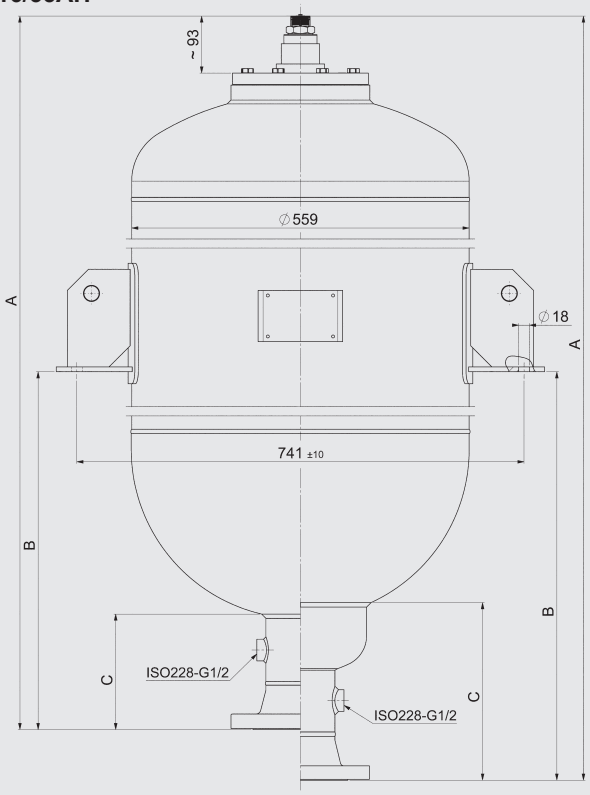
Further pressure ranges 25 bar, 40 bar; others on request.
Other fluid volumes on request.

* to EN1092-1/11 /B1/PN16

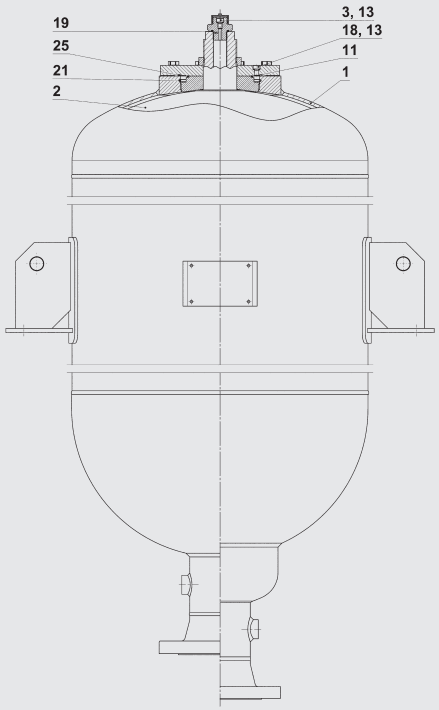
| Description | Item |
|---|---|
| Bladder | 2 |
| Gas valve insert | 3 |
| O-ring | 11 |
| Insertion ring, 2x | 18 |
| Lock nut | 21 |
| Retaining ring | 22 |
| Cap nut | 25 |
| O-ring | 27 |
| Seal ring | 28 |
| Lock nut | 29 |

## 1.4.5 Shock absorber

### SB16/35A, SB16/35AH




### Spare parts




### Dimensions

SB16/35 A - permitted operating pressure 16/35 bar (PED 97/23/EC)

| Nominal volumes | Eff. gas volume | Weight [kg] | | A max. [mm] | | B max. [mm] | | C max. [mm] | | DN* |
|---|---|---|---|---|---|---|---|---|---|---|
| [l] | [l] | SB16A | SB35A | SB16A | SB35A | SB16A | SB35A | SB16A | SB35A | |
| 100 | 99 | 84 | 144 | 880 | 890 | 400 | 400 | 185 | 198 | 100 |
| 150 | 143 | 101 | 161 | 1070 | 1080 | 500 | 500 | | | |
| 200 | 187 | 122 | 223 | 1310 | 1320 | 685 | 685 | | | |
| 300 | 278 | 155 | 288 | 1710 | 1720 | 985 | 985 | | | |
| 375 | 392 | 191 | 326 | 2230 | 2240 | 1250 | 1250 | | | |
| 450 | 480 | 237 | 386 | 2625 | 2635 | 1465 | 1465 | | | |

SB16/35 AH - permitted operating pressure 16/35 bar (PED 97/23/EC)

| Nominal volumes | Eff. gas volume | Weight [kg] | | A max. [mm] | | B max. [mm] | | C max. [mm] | | DN* |
|---|---|---|---|---|---|---|---|---|---|---|
| [l] | [l] | SB16AH | SB35AH | SB16AH | SB35AH | SB16AH | SB35AH | SB16AH | SB35AH | |
| 100 | 99 | 93 | 153 | 910 | 920 | 450 | 450 | 245 | 254 | 100 |
| 150 | 143 | 110 | 170 | 1120 | 1130 | 560 | 560 | | | |
| 200 | 187 | 131 | 230 | 1340 | 1350 | 760 | 760 | | | |
| 300 | 278 | 164 | 297 | 1755 | 1765 | 1040 | 1040 | | | |
| 375 | 392 | 200 | 335 | 2285 | 2295 | 1330 | 1330 | | | |
| 450 | 480 | 246 | 395 | 2670 | 2680 | 1530 | 1530 | | | |

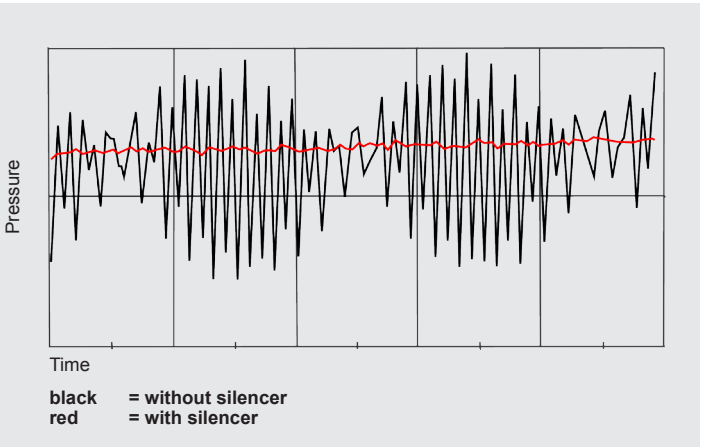
* to EN1092-1/11 /B1/PN16 or PN40
others on request

| Description | Item |
|---|---|
| Bladder | 2 |
| Lock nut | 3 |
| O-ring | 11 |
| Seal ring | 13 |
| Vent screw | 18 |
| O-ring | 19 |
| Retaining ring | 21 |
| O-ring | 25 |

# 2. SILENCER

## 2.1. APPLICATION

### 2.1.1 Silencer for fluid noise damping Type SD...




**black = without silencer**
**red = with silencer**

**General**

All displacement pumps, such as axial and radial piston pumps, vane, gear or screw pumps produce volume and pressure fluctuations which are exhibited as vibrations and noises. Noises are not only generated and transmitted by the pump. They are also the result of mechanical vibrations and vibrations caused by the fluid pulsations, which are amplified when transmitted to larger surfaces. Insulation, the use of flexible hoses and silencer covers can provide only partial solutions to the problem as they do not prevent transmission to other areas.

**Applications**

Vehicles, machine tools, plastics machinery, aeroplanes, ships, hydraulic power stations and other systems with a large "surface" are all applications where the noise level can be reduced.

**Operation**

The HYDAC fluid SILENCER is based on the principle of an expansion chamber with interference line.

By reflecting the oscillations within the silencer the majority of the oscillations are dampened across a wide frequency spectrum.

**Design**

The HYDAC SILENCER consists of a welded or forged external housing, an internal tube and two pipe connections on opposite sides.

The SILENCER has no moving parts and no gas charge and is therefore absolutely maintenance free.

The HYDAC SILENCER can be used for mineral oils, phosphate ester and water glycol. A stainless steel model is available for other fluids.

**Special model**

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

**Installation**

It is recommended that one connection side is joined via a flexible hose in order to reduce the transmission of mechanical vibrations.

The installation position of the damper is optional, but the flow direction must be taken into account.

**Please read the Operating Manual!**
**No. 3.701.CE**

## 2.2. SIZING

### 2.2.1 Silencer

The sizing calculation of the HYDAC SILENCER is designed to result in a small unit with the best possible damping. The starting point for the selection table is to determine the level of transmission damping D from 20 dB upwards.

$$D = 20 \cdot \log \frac{\Delta p_o}{\Delta p_m}$$

$\Delta p_o$ = height of pressure fluctuations without silencer

$\Delta p_m$ = height of pressure fluctuations with silencer

When selecting the damper the following has to be taken into account:

1) the size of the silencer body
2) the fundamental frequency f of the pump.

   f = i • n / 60 in Hz
   i = number of displacement elements
   n = motor speed in $min^{-1}$

### 2.2.2 Calculation example

**Given parameters:**

Axial piston pump with 9 pistons

| | |
|---|---|
| Motor speed: | 1500 $min^{-1}$ |
| Connection: | G1 corresponds to $D_i$ = 19 mm |
| Flow rate: | 300 l/min |
| Operating medium: | mineral oil |
| Max. operating pressure: | 210 bar |

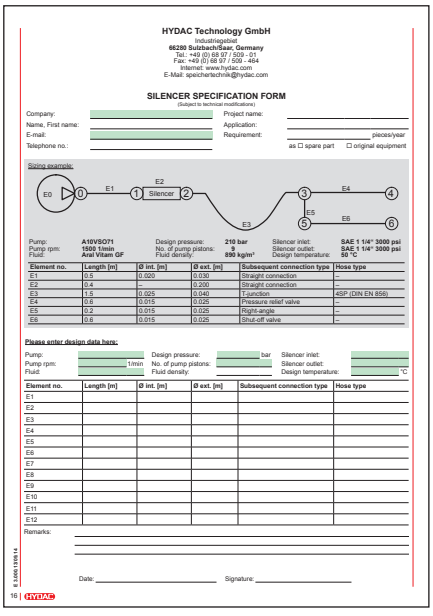
**Solution:**

Fundamental frequency f

f = i • n / 60 in Hz
= 9 • 1500/60
= 225 Hz

By calculating the fundamental frequency and using the system data (e.g. pipe length, ball valves, pressure, temperature, etc.) we can determine the correct size of silencer for you.
Use the specification sheet to provide the required data quickly and conveniently on the PC and send it to us.
See www.hydac.com or catalogue section

- HYDAC Accumulator Technology No. 3.000



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Fax: +49 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-Mail: speichertechnik@hydac.com

SILENCER SPECIFICATION FORM
(Subject to technical modifications)

Company:
Name, First name:
E-mail:
Telephone no.:
Project name:
Application:
Requirement: pieces/year
as ☐ spare part ☐ original equipment

Sizing example:



| | | | | | |
|---|---|---|---|---|---|
| Pump: | A10VSO71 | Design pressure: | 210 bar | Silencer inlet: | SAE 1 1/4" 3000 psi |
| Pump rpm: | 1500 1/min | No. of pump pistons: | 9 | Silencer outlet: | SAE 1 1/4" 3000 psi |
| Fluid: | Aral Vitam GF | Fluid density: | 890 kg/m³ | Design temperature: | 50 °C |

| Element no. | Length [m] | Ø int. [m] | Ø ext. [m] | Subsequent connection type | Hose type |
|---|---|---|---|---|---|
| E1 | 0.5 | 0.020 | 0.030 | Straight connection | – |
| E2 | 0.4 | – | 0.200 | Straight connection | – |
| E3 | 1.5 | 0.025 | 0.040 | T-junction | 4SP (DIN EN 856) |
| E4 | 0.6 | 0.015 | 0.025 | Pressure relief valve | – |
| E5 | 0.2 | 0.015 | 0.025 | Right-angle | – |
| E6 | 0.6 | 0.015 | 0.025 | Shut-off valve | – |

Please enter design data here:

Pump:
Pump rpm: 1/min
Fluid:
Design pressure: bar
No. of pump pistons:
Fluid density:
Silencer inlet:
Silencer outlet:
Design temperature: °C

| Element no. | Length [m] | Ø int. [m] | Ø ext. [m] | Subsequent connection type | Hose type |
|---|---|---|---|---|---|
| E1 | | | | | |
| E2 | | | | | |
| E3 | | | | | |
| E4 | | | | | |
| E5 | | | | | |
| E6 | | | | | |
| E7 | | | | | |
| E8 | | | | | |
| E9 | | | | | |
| E10 | | | | | |
| E11 | | | | | |
| E12 | | | | | |

Remarks:

Date: Signature:

E 3.000.1509.14
16 HYDAC

## 2.3. TECHNICAL SPECIFICATIONS

### 2.3.1 Model code for SD

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

**SD330 M - 4.2 / 212 U - 330 AD/AD**

**Series**

**Type code**
no details = for SD 330
B = bladder accumulator base body*
K = piston accumulator base body*
M = diaphragm accumulator base body*

**Nominal volume [l]**

**Material code**

**Damper**
0 = without pipe
1 = damper for frequencies > 500 Hz
2 = narrow band damper - DR
3 = broadband damper - DR

**Housing material**
1 = carbon steel
2 = carbon steel with protective coating*

**Seal material**
2 = NBR (acrylonitrile butadiene)
6 = FPM (fluoro rubber)

**Certificate code**
U = PED 97/23/EC

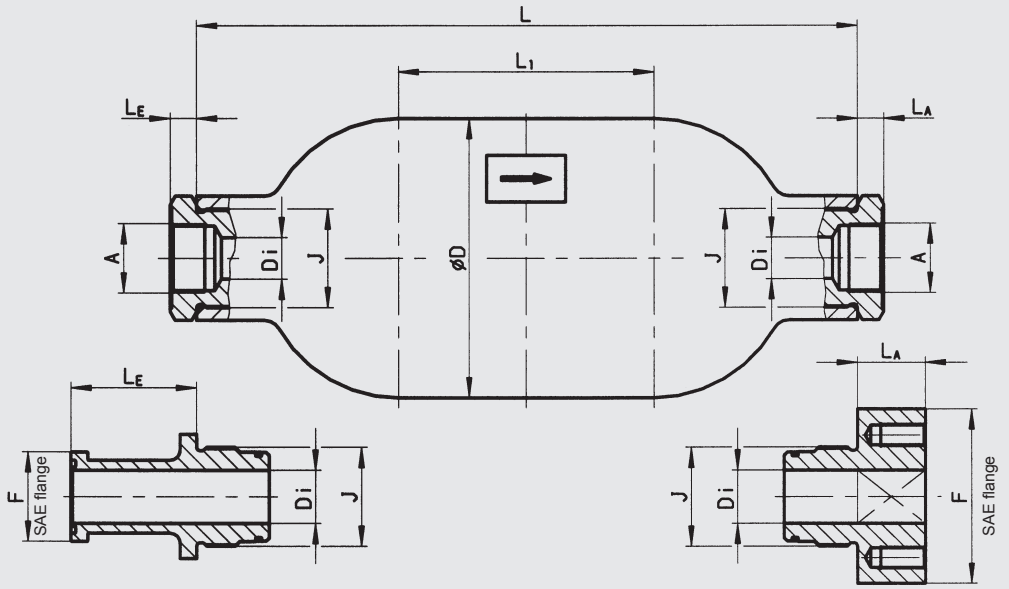
**Permitted operating pressure [bar]**

**Inlet connector / Outlet connector**
see Table 2.3.3

* only on request

2.3.2 **Dimensions**

**SD330**




| Nominal volume [l] | L [mm] | L1 [mm] | Ø D [mm] | J ISO 228 | Weight [kg] |
|---|---|---|---|---|---|
| 1.3 | 250 | – | 114 | G 1 | 6.5 |
| 1.8 | 355 | 155 | | G 1 1/4 | 5.5 |
| 4.2 | 346 | – | 168 | G 1 1/2 | 12.5 |
| 4.7 | 420 | 155 | | G 2" | 11.4 |

2.3.3 **Silencer connections**

**a) Threaded connection to ISO 228**

| | Fluid connection A | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **AB** G 3/8 $D_i$ = 15 mm | | **AC** G 1/2 $D_i$ = 13 mm | | **AD** G 3/4 $D_i$ = 16 mm | | **AE** G 1 $D_i$ = 19 mm | | **AF** G 1 1/4 $D_i$ = 25 mm | | **AG** G 1 1/2 $D_i$ = 32 mm | | **GG** G 1 1/2 $D_i$ = J | |
| Nominal volume [l] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] |
| 1.3 | 17 | 17 | – | | – | | – | | – | | – | | – | | – | |
| 1.8 | – | | 13 | 13 | 13 | 13 | 30 | 30 | 33 | 33 | – | | – | | | |
| 4.2 | – | | – | | – | | – | | – | | – | | Without adapter | | | |
| 4.7 | – | | – | | 16 | 16 | 16 | 16 | 26 | 26 | 36 | 36 | 36 | 36 | | |

**b) Flange connection SAE J518 (Code 62 - 6000 psi)**

| | Fluid connection F | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **FG** SAE 1/2" $D_i$ = 13 mm | | **FH** SAE 3/4" $D_i$ = 19 mm | | **FI** SAE 1" $D_i$ = 25 mm | | **FK** SAE 1 1/4" $D_i$ = 32 mm | | **FL** SAE 1 1/2" $D_i$ = 38 mm | | **FM** SAE 2" $D_i$ = 50 mm | |
| Nominal volume [l] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] | $L_E$ [mm] | $L_A$ [mm] |
| 1.3 | – | | – | | – | | – | | – | | – | | – | |
| 1.8 | 53 | 31 | 59 | 36 | 65 | 36 | – | | – | | – | | | |
| 4.2 | – | | – | | – | | – | | 0 | 33 | – | | | |
| 4.7 | – | | 105 | 36 | 120 | 36 | 76 | 28 | 76 | 28 | * | | | |

- not available
* on request

## 3. NOTE

The information in this brochure relates to the operating conditions and applications described.
For applications and operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.