# 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

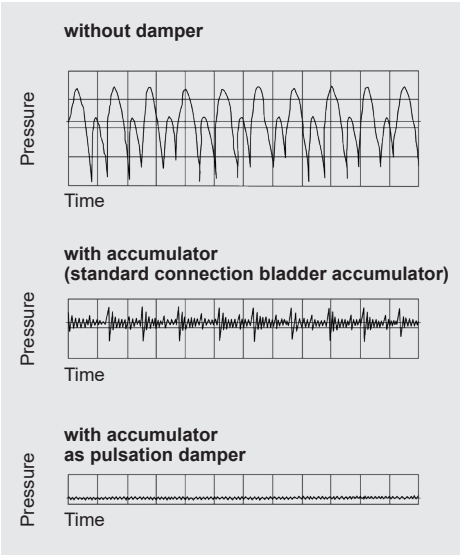
HYDAC hydraulic dampers are particularly suitable for damping such pressure fluctuations.

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 ports 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 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

HYDAC pulsation dampers consist of:

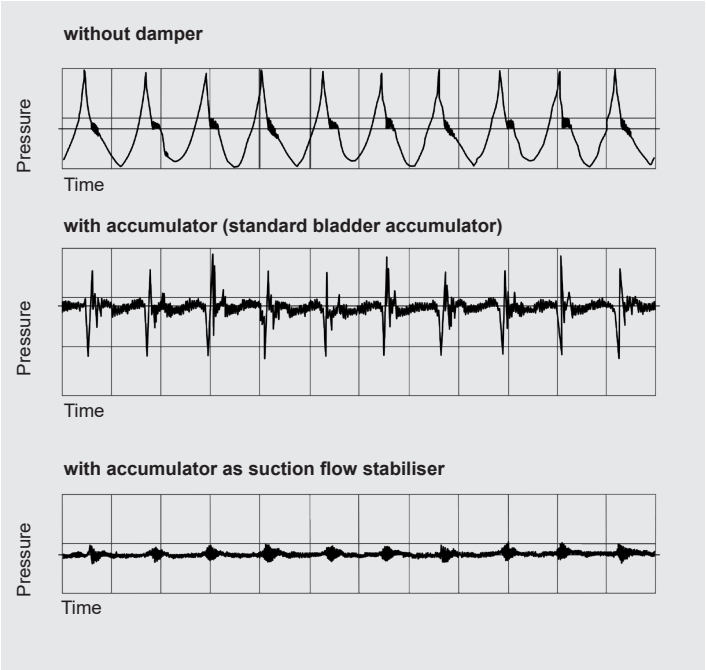
- The welded or forged pressure vessel in carbon steel; available with internal coating or in stainless steel for chemically aggressive fluids
- The special fluid valve with inline connection, which guides the flow into the vessel (threaded or flange connection)
- The bladder or diaphragm in various elastomers as shown in section 4.1.

#### 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 1.3.

## 2.2. SUCTION FLOW STABILISATION




### 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. An air separation is also 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 damping is achieved.

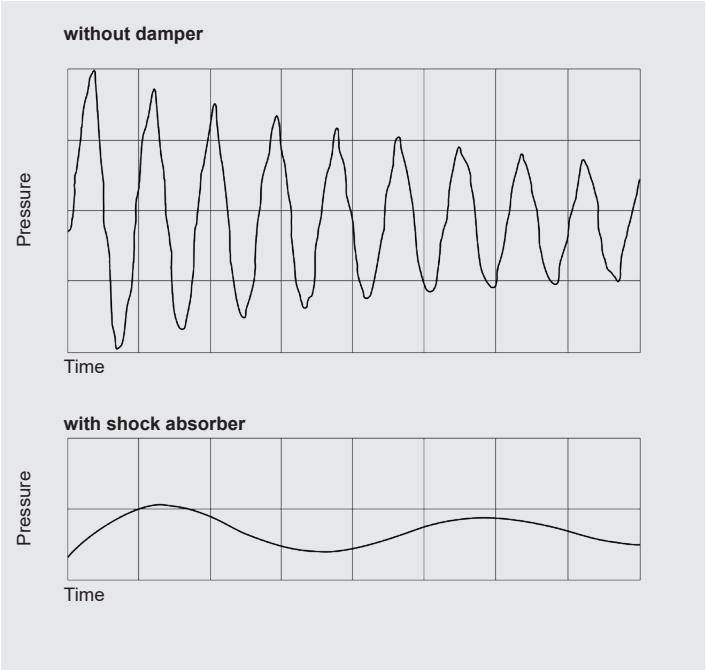
### 2.2.4 Design

The HYDAC suction flow stabiliser consists of a welded vessel in steel or stainless steel.
The inlet and outlet are on opposite sides and are separated by a baffle, other versions on request. The upper part houses the encapsulated bladder. In addition, there is a vent screw in the end cap and a drainage facility on the bottom.

### 2.2.5 Installation

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

## 2.3. SHOCK ABSORPTION




### 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 energy 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 shock absorption can be provided by using bladder, piston and diaphragm accumulators. Further technical details on the individual accumulator types can be found in the following brochure sections:

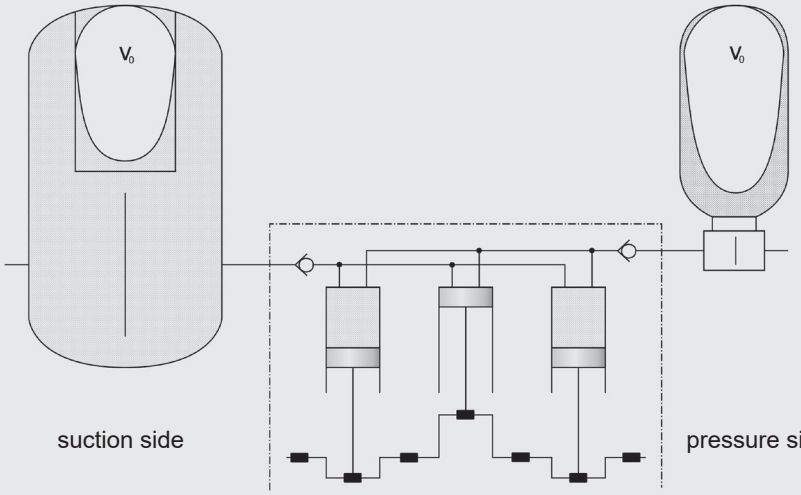
- Bladder accumulators, low pressure
  No. 3.202
- Bladder accumulators, standard design
  No. 3.201
- Diaphragm accumulators
  No. 3.100
- Piston accumulators, standard design
  No. 3.301

### 2.3.5 Installation

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

# 3 SIZING

## 3.1. PULSATION DAMPER AND SUCTION FLOW STABILISER




On the suction side and the pressure side of piston pumps there are almost identical conditions in terms of the irregularity of the flow rate. Therefore, the same formulae for determining the effective gas volume are used to calculate the damper size. The fact that two completely different damper types are ultimately used is due to the different acceleration and pressure ratios on the two sides.

When selecting the pulsation damper, it is not only the gas volume $V_0$ which is a decisive factor. The connection size of the pump also has to be taken into account. In order to avoid additional cross-section variations, which represent reflection points for vibrations, and 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** (**A**ccumulator **S**imulation **P**rogram).

**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

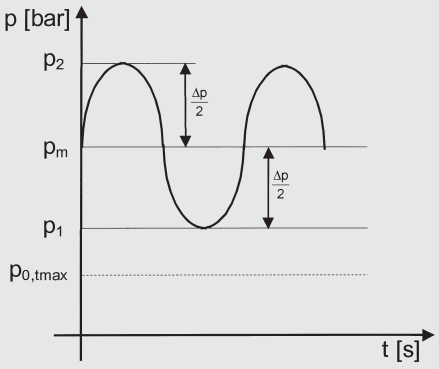
x = residual pulsation [± %]

κ = isentropic exponent

Φ = pressure ratio of pre-charge pressure to operating pressure [0.6 to 0.9]

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

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




**Formulae:**

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

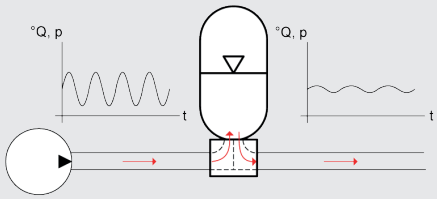
$$\Delta V = m \bullet q$$

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

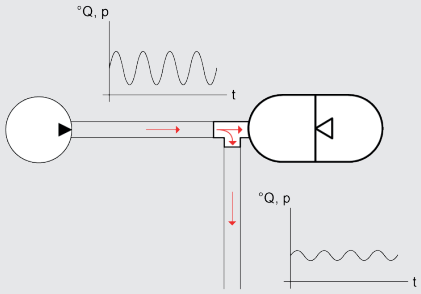
$$= \left|\frac{p_2 - p_m}{p_m} \bullet 100\right|$$

**Diagram of mounting options:**

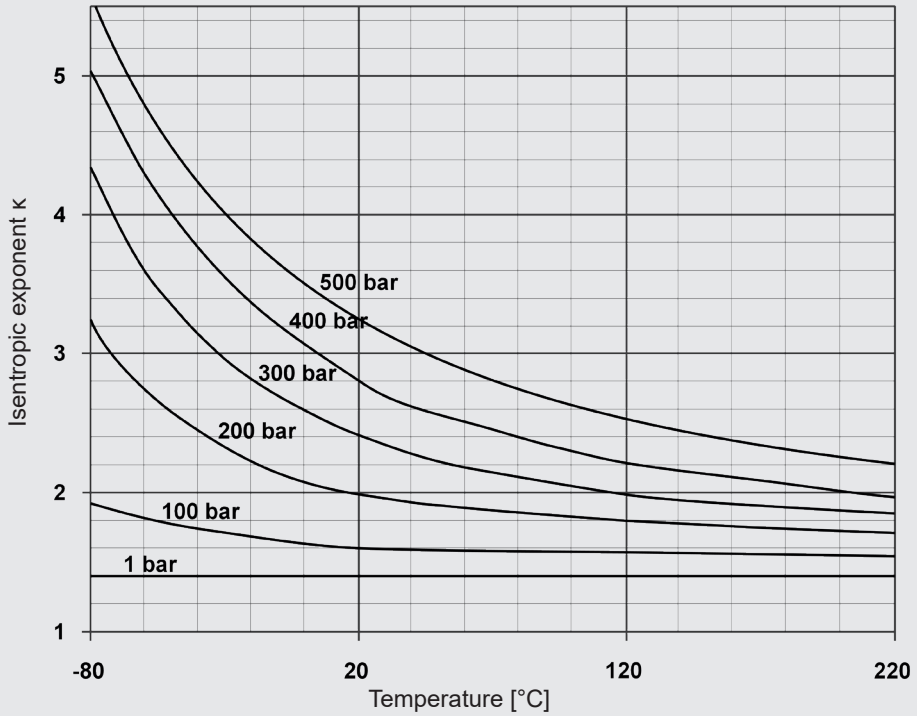
Preferred installation configuration with maximum damping effect




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



**Isentropic exponent κ 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

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

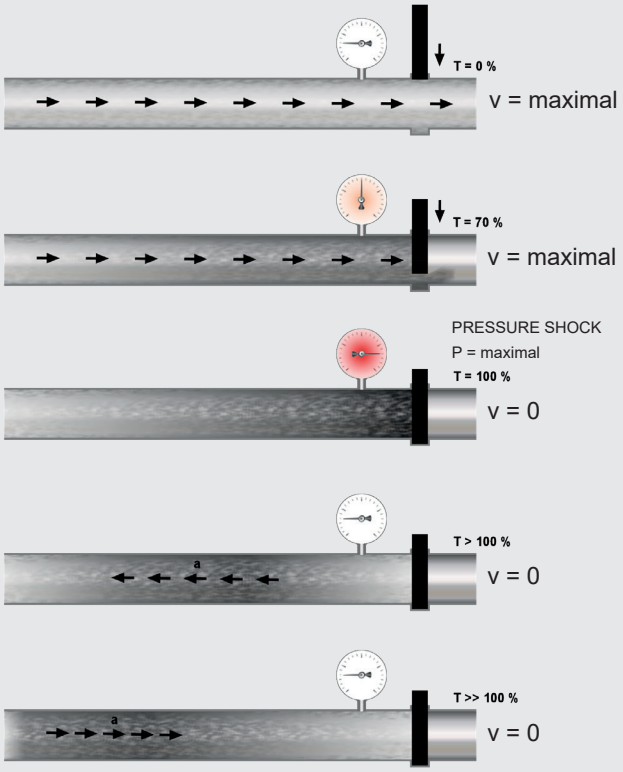
$$V_0 = \frac{0{,}035 \cdot \frac{\pi \cdot 0{,}7^2}{4} \cdot 1{,}0}{\left[\frac{0{,}7}{1-\frac{0{,}5}{100}}\right]^{\frac{1}{2{,}0}} - \left[\frac{0{,}7}{1+\frac{0{,}5}{100}}\right]^{\frac{1}{2{,}0}}}$$

$V_0 = 3.2$ 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 volume

$\Delta v$ = $v - v_1$

$\Delta v$ = change in 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] = elasticity modulus of the 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:

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

**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.

$$V_0 = \frac{m \cdot \Delta v^2 \cdot 0{,}4}{2 \cdot p_1 \cdot \left[\left[\frac{p_2}{p_1}\right]^{1-\frac{1}{\kappa}} - 1\right] \cdot 10^2} \cdot \left[\frac{p_1}{p_0}\right]^{\frac{1}{\kappa}}$$

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] = perm. operating pressure

$p_0$ [bar] = pre-charge pressure

A special calculation program for analysing the pressure curve is available for manifold sizing or sizing with regards to pump failure or start-up.

### 3.2.1 **Calculation example**

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

**Given parameters:**

Length of pipeline L:
2000 m

Size of pipeline D:
250 mm

Wall thickness of pipeline e:
6.3 mm

Material of the 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

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

Operating temperature:
20 °C

Compression modulus of 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 shock occurs and the formula as shown in section 3.2. must be used.

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

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

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

$$\Delta_p = 980 \cdot 1120 \cdot (2.45\text{-}0) \cdot 10^{-5} = 26.89 \text{ bar}$$

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

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

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 shock absorbers
SB35AH-450

# 4. SPECIFICATIONS

## 4.1. EXPLANATIONS, NOTES

### 4.1.1 Operating pressure

See table for relevant series (may differ from nominal pressure for foreign test certificates).

### 4.1.2 Permitted operating temperatures

-10 °C ... 80 °C
Standard design, others on request

### 4.1.3 Nominal volume

See table for relevant series

### 4.1.4 Effective gas volume

See table for relevant series, 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.

### 4.1.5 Effective volume

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

### 4.1.7 Gas charging

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.

### 4.1.8 Limits for gas pre-charge pressure

Ratio of maximum operating pressure $p_2$ to gas pre-charge pressure $p_0$.

The specified values are maximum values and must not be considered as referring to a permanent load. The tolerable pressure ratio is influenced by the geometry, temperature, fluid and flow rate as well as any gas losses due to physical properties.

See catalogue section:

- HYDAC Accumulator Technology No. 3.000
- Bladder accumulators Low pressure No. 3.202
- Bladder accumulators Standard design No. 3.201

### 4.1.9 Notice

All work on HYDAC hydraulic dampers must only be carried out by suitably trained staff.

Incorrect installation or handling can lead to serious accidents.
**The operating instructions must be observed!**

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

Further information such as accumulator sizing, safety information and extracts from the acceptance specifications can be found in the following catalogue section:

- HYDAC Accumulator Technology No. 3.000

Relevant PDF documents can be accessed at:
www.hydac.com » Downloads » Documents » Accumulator Division

### 4.1.6 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 | | Material code [1] | Accumulator type | 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-retardant fluids from the groups HFA, HFB, HFC<br>● Synthetic esters (HEES)<br>● Water<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-retardant fluids from the HFB group<br>● Synthetic esters (HEES)<br>● Water<br>● Sea water | ● Aromatic hydrocarbons<br>● Chlorinated hydrocarbons (HFD-S)<br>● Amines and ketones<br>● Hydraulic fluids from the group HFD-R<br>● Flame-retardant 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-retardant fluids from the group HFC<br>● Water | ● Mineral oils and mineral greases<br>● Synthetic esters (HEES)<br>● Aliphatic, chlorinated and aromatic hydrocarbons<br>● Fuels |
| | | | 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 esters (HEES)<br>● Fuels<br>● Aromatic hydrocarbons<br>● Inorganic acids | ● Amines and ketones<br>● Ammonia<br>● Skydrol and HyJet IV<br>● Steam |

[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 AI**

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

**Type code**
1 = standard design (not for screw type diaphragm accumulators or shock absorbers)
2 = back-up version [2]
6 = standard design for screw type diaphragm accumulators of type SBO...P-...A6
7 = M28x1.5 gas valve (only for SB16/35)

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

Fluid port
1 = carbon steel
2 = high tensile steel
3 = stainless steel [3]
4 = chemically nickel-plated (internal coating) [2]
6 = low temperature steel
7 = 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**
AI = ISO 228 (BSP), standard connection
BI = DIN 13 to ISO 965/1 (metric) [1]
CI = ANSI B1.1 (UNF thread, sealing to SAE standard) [1]
DI = ANSI B1.20 (NPT thread) [1]

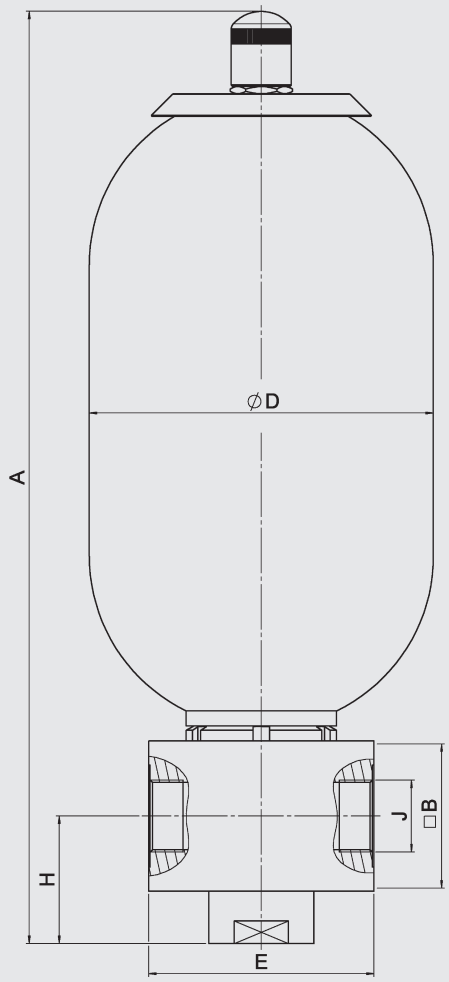
SBO250P-0.075E1 and for SBO210P-0.16E1:
AK = ISO 228 (BSP), standard connection

[1] Specify full details of version
[2] Not available for all versions
[3] Dependent on type and pressure rating
[4] When ordering a spare bladder, please state diameter of the smallest shell port
[5] Observe temperature ranges, see section 4.1.6

# 4.3. DIMENSIONS AND SPARE PARTS

## 4.3.1 Pulsation damper bladder accumulator

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




**Dimensions SB**

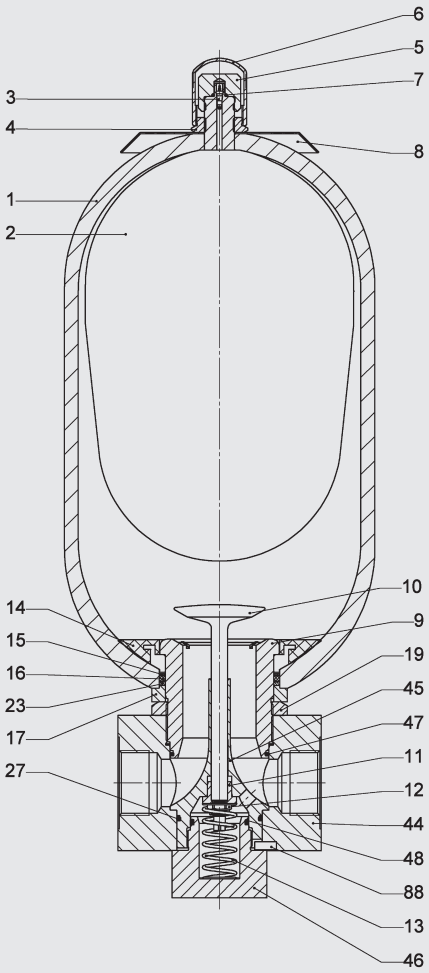
Carbon steel, NBR

| Nominal volume [l] | Series [3] | Max. operating pressure (PED) [bar] | Part no. | Eff. gas volume [l] | A [mm] | □ B [mm] | Ø D [mm] | E [mm] | H [mm] | J [1] Thread ISO 228 | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SB330P | 330 | 296114 | 1 | 365 | 80 | 118 | 120 | 57 | G 1 1/4 | 11 |
| | SB550P | 550 | 3435597 [3] | | 384 | 70 | 121 | | 53 | | 13 |
| 2.5 | SB330P | 330 | 3078967 | 2.4 | 570 | 80 | 118 | 120 | 57 | G 1 1/4 | 16 |
| | SB550P | 550 | 3576155 [3] | 2.5 | 589 | 70 | 121 | | 53 | | 20 |
| 4 | SB330P | 330 | 3121155 | 3.7 | 455 | 80 | 171 | | 57 | | 18 |
| | SB330PH | | – | | 491 | 100 | | 150 | 85 | G 1 1/2 | 26 |
| 5 | SB550P | 550 | 4313259 [3] | 4.9 | 917 | 70 | 121 | 120 | 53 | G 1 1/4 | 26 |
| 6 | SB330P | 330 | 3140558 | 5.7 | 559 | 80 | 171 | | 57 | | 20 |
| | SB330PH | | – | | 593 | 100 | | 150 | 85 | G 1 1/2 | 28 |
| 10 | SB330P | | 3082257 | 9.3 | 620 | | 229 | | | G 1 1/2 | 40 |
| | SB330PH | | – | | 652 | 130x140 | | | 100 | SAE 2" - 6000 psi | 50 |
| 13 | SB330P | 330 | 2107871 | 12 | 712 | 100 | | | 85 | G 1 1/2 | 48 |
| 20 | SB330P | | 3084825 | 18.4 | 920 | | | | | | 70 |
| | SB330PH | | – | | 952 | 130x140 | | | 100 | SAE 2" - 6000 psi | 80 |
| 24 | SB330P | 330 | 3152980 | 23.6 | 986 | 100 | | | 85 | G 1 1/2 | 82 |
| 32 | SB330P | | 3121154 | 33.9 | 1445 | | | | | | 100 |
| | SB330PH | | – | | 1475 | 130x140 | | | 100 | SAE 2" - 6000 psi | 110 |

[1] Standard connection code = AI, others on request
[2] Special/welded version, on request
[3] Material code (MC) = 212, see model code, section 4.2.

## Spare parts

### SB...P




| Description | Item |
|---|---|
| **Bladder assembly** consisting of: | |
| Bladder | 2 |
| Gas valve insert* | 3 |
| Lock 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 | Item |
|---|---|
| **Connection assembly** consisting of: | |
| Oil valve body | 9 |
| Valve plate | 10 |
| Damping bush | 11 |
| Lock nut | 12 |
| Valve spring | 13 |
| Anti-extrusion ring* | 14 |
| Washer | 15 |
| O-ring | 16 |
| Spacer | 17 |
| Groove 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 |

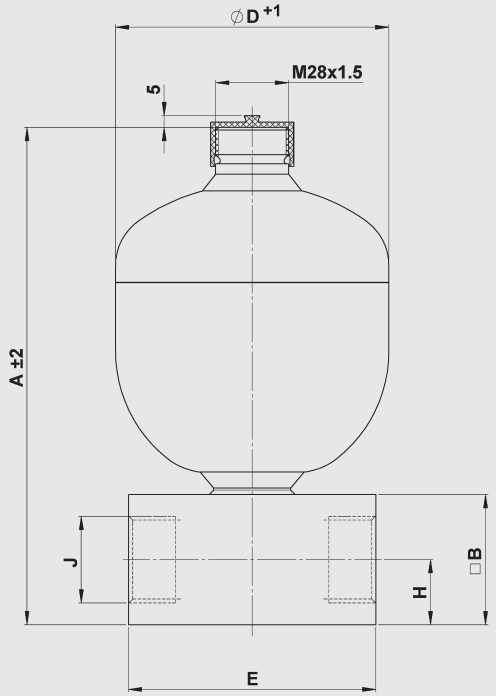
* Available separately

**NBR, carbon steel**
Standard gas valve

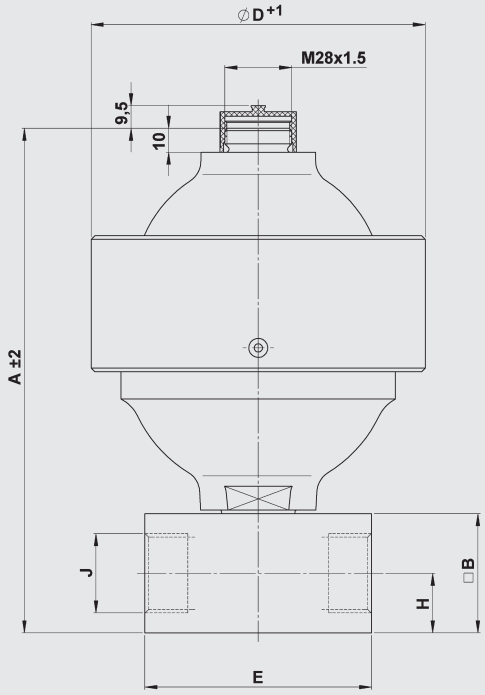
| Volume [l] | Bladder assembly | Seal kit | |
|---|---|---|---|
| | | SB330P/SB400P | SB550P |
| 1 | 237624 | 357055 | 2106402 |
| 2.5 | 236171 | | |
| 4 | 236046 | | |
| 5 | 240917 | | |
| 6 | 2112097 | | |
| 10 | 236088 | 357058 | 357061 |
| 13 | 376249 | | |
| 20 | 236089 | | |
| 24 | 376253 | |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

## 4.3.2 Pulsation dampers diaphragm accumulator

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




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



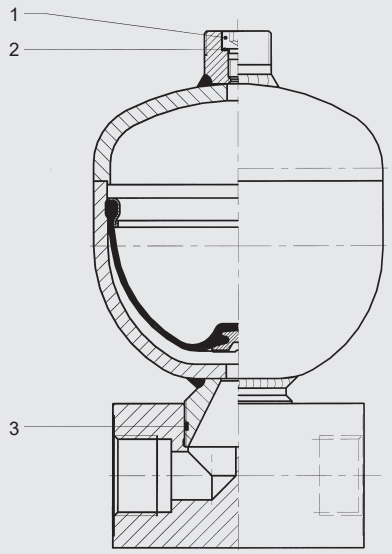

### Dimensions SBO

| 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] | Ø D [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...AI | | 160 | 175 | 50 | 93 | 80 | 25 | G 1/2 | 2.6 |
| 0.5 | | | – | 192 | | 105 | | | | 3 |
| 0.6 | SBO330P-...E1...AI | 330 | – | 222 | 60 | 115 | 105 | 30 | G 1 | 5.6 |
| 0.75 | SBO210P-...E1...AI | 210 | 140 | 217 | | 121 | | | | 5.1 |
| 1 | SBO200P-...E1...AI | 200 | – | 231 | | 136 | | | | 6 |
| 1.4 | SBO140P-...E1...AI | 140 | – | 244 | | 145 | | | | 6.2 |
| | SBO210P-...E1...AI | 210 | – | 250 | | 150 | | | | 7.7 |
| | SBO250P-...E1...AI | 250 | – | 255 | | 153 | | | | 8.2 |
| 2 | SBO100P-...E1...AI | 100 | 100 | 261 | | 160 | | | | 6.3 |
| | SBO210P-...E1...AI | 210 | – | 267 | | 167 | | | | 8.9 |
| 3.5 | SBO250P-...E1...AI | 250 | – | 377 | | 170 | | | | 13.5 |
| 4 | SBO50P-...E1...AI | – | 50 | 368 | | 158 | | | | 7.9 |
| | SBO250P-...E1...AI | | 180 | 377 | | 170 | | | | 13.5 |
| 0.25 | SBO500P-...A6...AI | 500 | 350 | 162 | 50 | 115 (125) | 80 | 25 | G 1/2 | 5.2 (6.3) |
| 0.6 | SBO450P-...A6...AI | 450 | 250 | 202 | 60 | 140 (142) | 95 | | G 1 | 8.9 (9.1) |
| 1.3 | SBO400P-...A6...AI | 400 | – | 267 | | 199 | 105 | 30 | | 13.8 |
| 2 | SBO250P-...A6...AI | 250 | 180 | 285 | | 201 | | | | 15.6 |
| 2.8 | SBO400P-...A6...AI | 400 | – | 308 | | 252 | | | | 24.6 |
| 4 | | | – | 325 | | 287 | | | | 36.6 |

[1] Standard connection code = AK or AI, others on request
( ) Brackets indicate different dimensions for stainless steel version

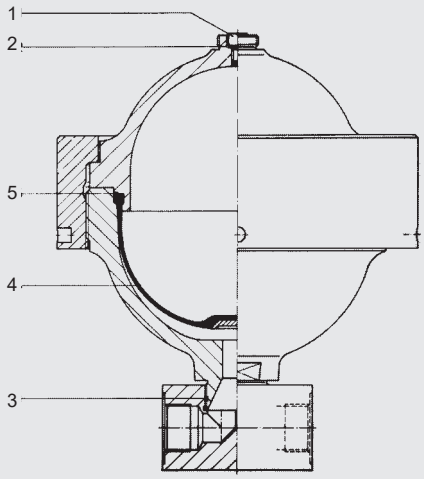
## Spare parts

### SBO...P...E




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

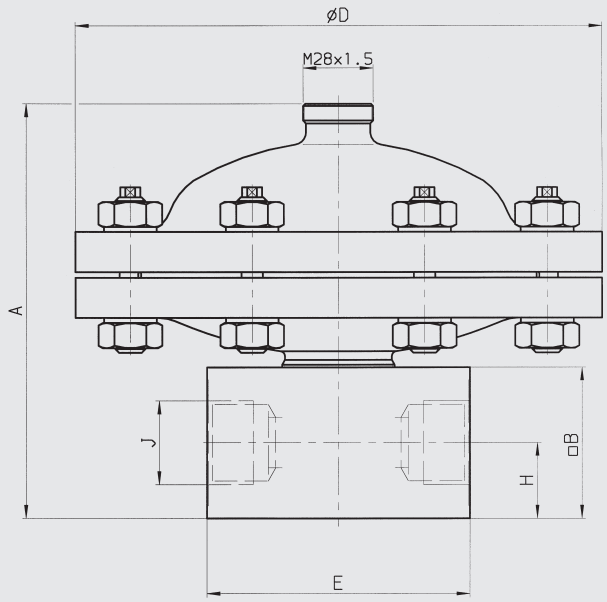
### SBO...P...A6




| Description | 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 $p_2 : p_0 = 2 : 1$

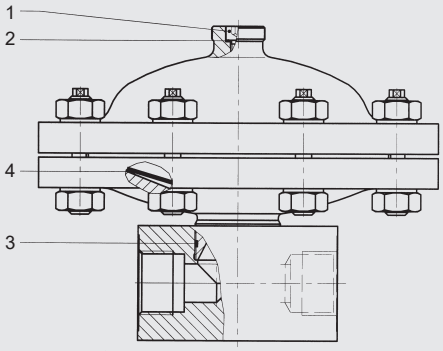
**Dimensions**

| Nominal volume [l] | Max. operating pressure (PED) [bar] | Part no. | A [mm] | □ B [mm] | Ø D [mm] | E [mm] | H [mm] | J [1] Thread ISO 228 | Weight [kg] |
|---|---|---|---|---|---|---|---|---|---|
| 0.2 | 40 | 4328332 | 140 | 60 | 210 | 105 | 30 | G 1 | 11 |
| | 250 | 4328333 | 197 | | 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

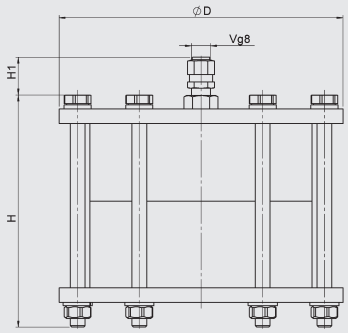
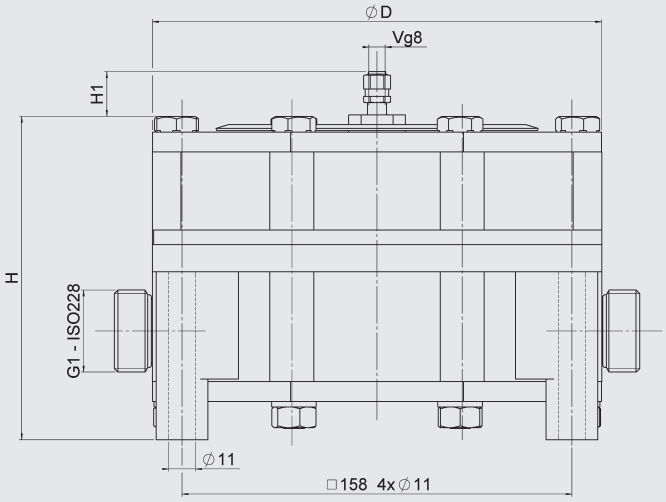



Figure 2




Pulsation damper in PVDF with PTFE-coated diaphragm.

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

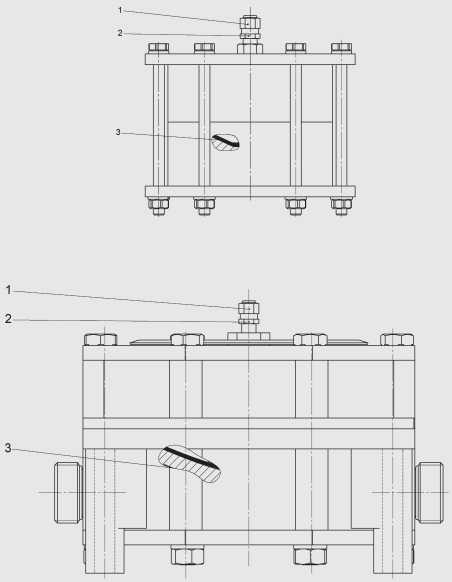
Permitted pressure ratio $p_2 : p_0 = 2 : 1$

**Dimensions**

| Nominal volume [l] | Max. operating pressure (PED) [bar] | Part no. | Ø D [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)**

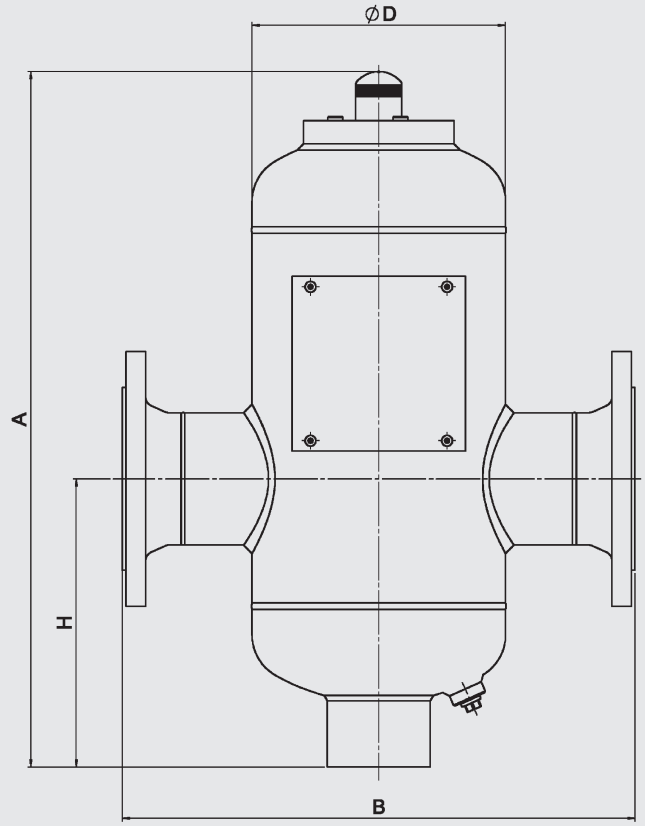



| Description | Item |
|---|---|
| Gas valve assembly | 1 |
| Gas valve insert brass / stainless steel | 2 |
| Diaphragm | 3 |

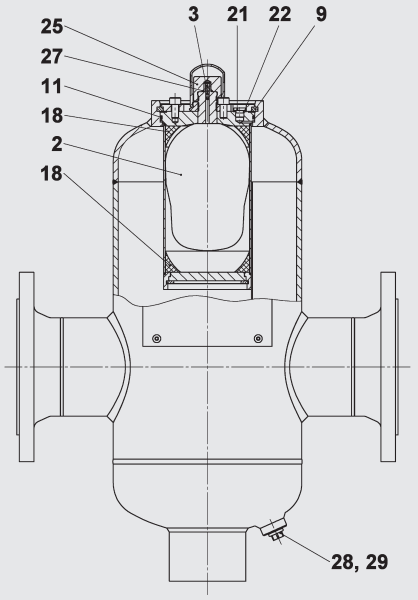
**Relevant operating instructions are available on request.**

## 4.3.4 Suction flow stabiliser

**SB16S**




**Spare parts**




### Dimensions

**SB16S**
Perm. operating pressure 16 bar (PED)

| Nominal volume [l] | Fluid volume [l] | Eff. gas volume [l] | A [mm] | B [mm] | Ø D [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 ratings 25 bar, 40 bar; others on request.
Other fluid volumes on request

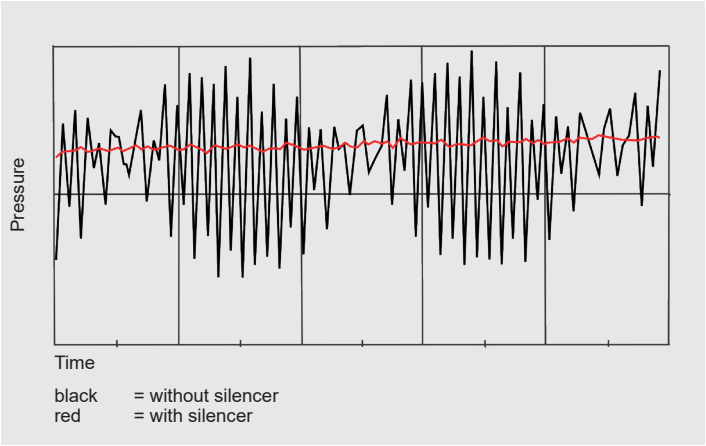
* To EN1092-1/11 /B1/PN16

| Description | Item |
|---|---|
| Accumulator bladder | 2 |
| Gas valve insert | 3 |
| Anti-extrusion ring | 9 |
| O-ring | 11 |
| Insertion ring, 2x | 18 |
| Locking screw | 21 |
| Seal ring | 22 |
| Seal cap | 25 |
| O-ring | 27 |
| Seal ring | 28 |
| Locking screw | 29 |

# 5. SILENCER

## 5.1. APPLICATION

**Silencer for fluid noise damping**
**Type SD...**




### 5.1.1 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 only provide partial solutions to the problem as they do not prevent transmission to other areas.

### 5.1.2 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.

### 5.1.3 Mode of 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.

### 5.1.4 Design

The SILENCER consists of a housing, an internal tube and two pipe connections on opposite sides. It has no moving parts and no gas charge and is therefore absolutely maintenance free.

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

### 5.1.5 Installation

It is recommended that one connection side is joined via a flexible hose in order to reduce the transmission of mechanical vibrations. The damper can be installed in any position.

### 5.1.6 Permitted operating temperatures

-20 °C ... +80 °C

### 5.1.7 Notice

All work on HYDAC silencers must only be carried out by suitably trained staff.

Incorrect installation or handling can lead to serious accidents.
**The operating instructions must be observed!**
**No. 3.701.BA**

Further information such as accumulator sizing, safety information and extracts from the acceptance specifications can be found in the following catalogue section:

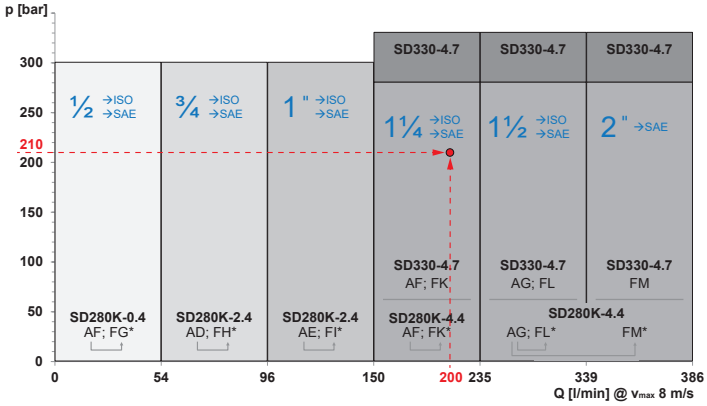
- HYDAC Accumulator Technology
  No. 3.000

Relevant PDF documents can be accessed at:
www.hydac.com » Downloads » Documents » Accumulator Division

## 5.2. SIZING

**Universal broadband silencer**
**Series SD330, SD280K**

With the aid of a few details (max. pressure and nominal flow), the appropriate silencer type for the particular application can easily be chosen by using the following pressure/flow rate matrix.




* SD280K model: ISO connection can be converted to an SAE flange connection (see section 5.4.2)

**Example of the selection process:**

Max. operating pressure p = 210 bar
Flow rate Q = 200 l/min

The following versions can be selected, depending on the connection system available:

- SD330-4.7…AF/AF
- SD330-4.7…FK/FK
- SD280K-4.4…AF/AF
  → with SAE adapter (section 5.4.2), can be converted to FK/FK

**Customer-specific versions**

For special applications, the HYDAC SILENCER can be dimensioned to suit the application.

This can be done on the basis of a piston accumulator or a diaphragm accumulator.

The starting point for the selection table is to determine the level of transmission damping D from 20 dB upwards.

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

$\Delta p_o$ = amplitude of pressure fluctuations without silencer
$\Delta p_m$ = amplitude 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 = rotational speed in rpm

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 a PC and send it to us.
See www.hydac.com or catalogue section:

- HYDAC Accumulator Technology
  No. 3.000

## 5.3. MODEL CODE

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

**SD330 __ – 4.7 / 412 U – 330 FK1/FK2**

**Series**

**Type code***
No details = forged housing
K = piston accumulator base shell
M = diaphragm accumulator base shell

**Nominal volume [l]**

**Silencer type***
0 = without pipe
4 = universal broadband silencer

**Housing material***
1 = carbon steel
3 = stainless steel

**Sealing material**
0 = no seal
2 = NBR (-20 °C ... +80 °C)

**Certification code***
U = European Pressure Equipment Directive (PED)

**Permitted operating pressure [bar]**

**Connections**
See section 5.4.
e.g. FK1 – version 1 with SAE J 518 1 1/4
FK2 – version 2 with SAE J 518 1 1/4

* Others on request

## 5.4. DIMENSIONS, STANDARD TYPES

The following connections are available as standard:

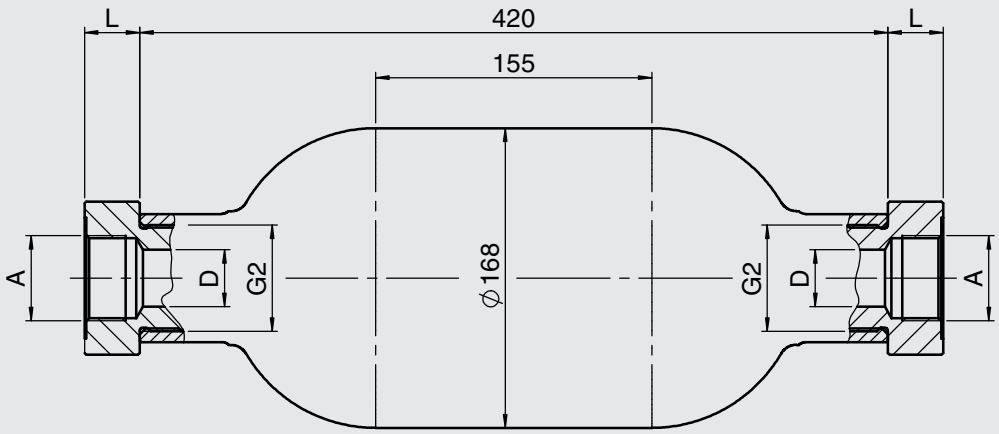
| Series | ISO 228 compliant threaded connection | | | | | | SAE J 518 compliant flange connection | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | | | | | | SAE | | | | | |
| | 3/8 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 2 |
| | AB | AC | AD | AE | AF | AG | FG | FH | FI | FK | FL | FM |
| SD330 | | | | | ● | ● | | | | ● | ● | ● |
| SD280K* | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

* Can be converted to an SAE flange connection, relevant information is highlighted in grey (see section 5.4.2)

With any connection type, care must be taken to ensure that the silencer has enough mechanical support.
Mounting elements can be found in the following catalogue section:

- Mounting elements for hydraulic accumulators
  No. 3.502

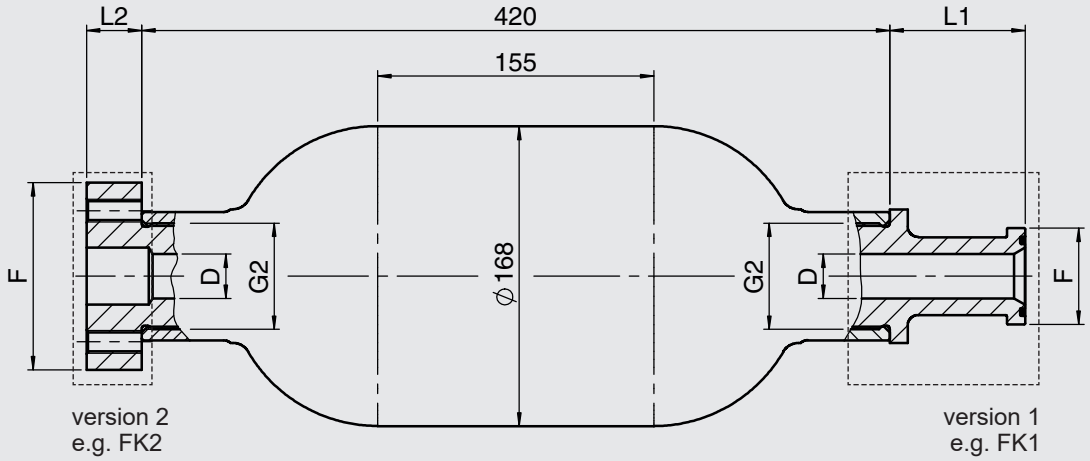
## ISO 228 compliant threaded connection A




| Series | Vol. [l] | Perm. operating pressure [bar] | A ISO 228 | | L [mm] | D* [mm] | Weight [kg] | Part no. |
|---|---|---|---|---|---|---|---|---|
| SD330 | 4.7 | 330 | AF/AF | G 1 1/4 | 31 | 25 | 14.8 | 4390237 |
| | | | AG/AG | G 1 1/2 | 31 | 32 | 15.8 | 4388045 |

* Smallest internal diameter

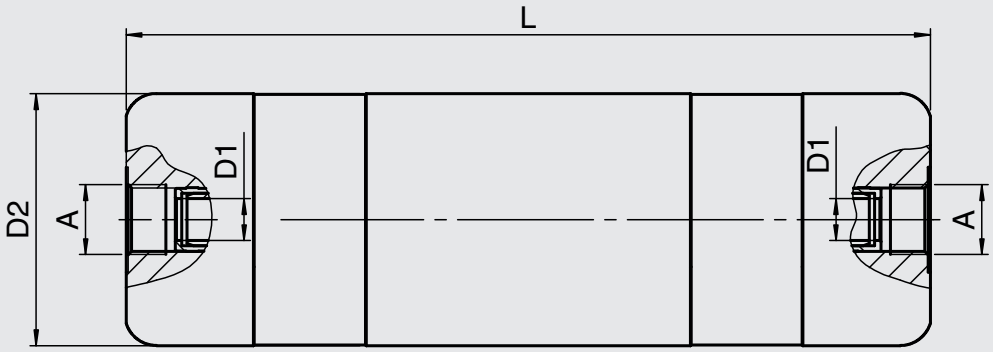
## SAE J 518 compliant flange connection F




| Series | Vol. [l] | Perm. operating pressure [bar] | F SAE J 518 | | L2 for FK2 [mm] | L1 for FK1 [mm] | D* [mm] | Weight [kg] | Part no. |
|---|---|---|---|---|---|---|---|---|---|
| SD330 | 4.7 | 330 | FK2/FK2 | SAE 1 1/4 | 31 | – | 25 | 16.9 | 4413180 |
| | | | FK1/FK2 | SAE 1 1/4 | 31 | 76 | 25 | 15.9 | 4402764 |
| | | | FL2/FL2 | SAE 1 1/2 | 36 | – | 30 | 18.2 | 4390978 |
| | | | FL1/FL2 | SAE 1 1/2 | 36 | 76 | 30 | 16.8 | 4413183 |
| | | | FM2/FM2 | SAE 2 | 41 | – | 32 | 22 | 4413377 |
| | | | FM1/FM2 | SAE 2 | 41 | 93 | 32 | 19.2 | 4413381 |

* Smallest internal diameter

5.4.2 **SD280K**

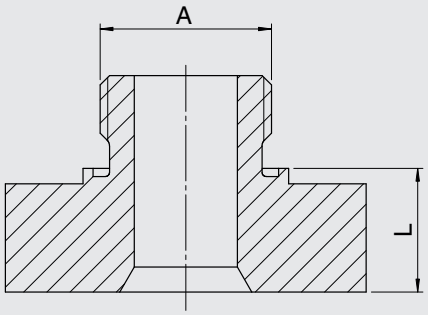


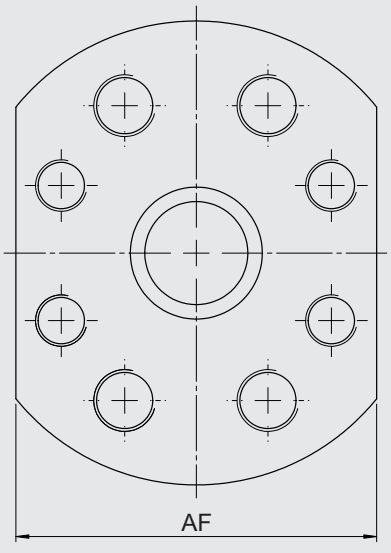

| Series | Vol. [l] | Perm. operating pressure [bar] | A ISO 228 | | D2* [mm] | D2 [mm] | L [mm] | Weight [kg] | Part no. |
|---|---|---|---|---|---|---|---|---|---|
| SD280K | 0.4 | 300 | AC/AC | G 1/2 | 12 | 60 | 250 | 2.4 | 4402343 |
| | 2.4 | 300 | AD/AD | G 3/4 | 16 | 120 | 383 | 14.5 | 4392308 |
| | | | AE/AE | G 1 | 20 | | | | 4392310 |
| | 4.4 | 280 | AF/AF | G 1 1/4 | 25 | 150 | 445 | 26 | 4392311 |
| | | | AG/AG | G 1 1/2 | 32 | | | | 4392312 |

* Smallest internal diameter

**SAE adapter for SD280K**

There is an option to convert the ISO 228 threaded connection on the SD280K model to an SAE J 518 flange connection. This applies to **3000 PSI** as well as **6000 PSI.**




| Series | Vol. [l] | SD280K Part no. | Connection recoding | SAE adapter | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Accumulator connection A ISO 228 | Adapter connection SAE J 518 | L [mm] | Weight [kg] | Part no. | AF |
| SD280K | 0.4 | 4402343 | AC → FG | G 1/2 | SAE 1/2 | 18 | 0.3 | 4437591 | 55 |
| | 2.4 | 4392308 | AD → FH | G 3/4 | SAE 3/4 | 21 | 0.53 | 4416007 | 65 |
| | | 4392310 | AE → FI | G 1 | SAE 1 | 24 | 0.85 | 4416008 | 70 |
| | 4.4 | 4392311 | AF → FK | G 1 1/4 | SAE 1 1/4 | 28 | 1.41 | 4416009 | 85 |
| | | 4392312 | AG → FL | G 1 1/2 | SAE 1 1/2 | 28 | 1.86 | 4416010 | 100 |
| | | | AG → FM | G 1 1/2 | SAE 2 | 38 | 3.42 | 4416011 | 110 |

## 5.5. SPARE PARTS AND ACCESSORIES

### 5.5.1 **Spare parts**

NBR, others on request

| Designation | Part no. |
|---|---|
| Seal kit SD280K NBR | 4416121 |

### 5.5.2 **Mounting elements**

The following table lists the recommended mounting clamps. The choice of clamp depends on the external diameter of the silencer (for more information on mounting elements see section 5.4.).

| Designation | Part no. | Series | | | |
|---|---|---|---|---|---|
| | | SD330 | SD280K | | |
| | | 4.7 | 0.4 | 2.4 | 4.4 |
| HyRac 167-175/178 H5 ST | 445043 | ● | | | |
| HRGKSM 0 R 58-61/62 ST | 3018442 | | ● | | |
| HRGKSM 1 R 119-127/124 ST | 444505 | | | ● | |
| HRGKSM 1 R 146-154/151 ST | 444321 | | | | ● |

## 6. NOTE

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

**HYDAC Technology GmbH**
Industriegebiet
**66280 Sulzbach/Saar, Germany**
Tel.: 0049 (0) 68 97 / 509 - 01
Fax: 0049 (0) 68 97 / 509 - 464
Internet: www.hydac.com
E-mail: speichertechnik@hydac.com