1. HYDRAULIC DAMPERS

1.1. DESCRIPTION

1.1.1 Mode of operation

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 pumps on and off
- 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
- an increase in pump rpm and feed pressure 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 S8...P / SBO...P

Mode of operation

The pulsation damper has two fluid connections and can therefore be fitted directly inline.

The flow is directed straight at the bladder or diaphragm by diverting it in the fluid valve. 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.

Construction

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).
**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.

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

**Construction**  
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 pointing upwards).

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**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.

**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, control instruments and other devices from destruction.

**Construction**  
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 point 1.4.1 with built-in gas valve, which is used for charging pressure $p_0$ and for possible monitoring activities.

**Special model**  
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 drops 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 (Accumulator Simulation Program). 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]
- \( q \) = stroke volume [l]
- \( \pi \cdot d_k^2 \cdot h_\kappa \)
- \( d_k \) = piston diameter [dm]
- \( h_\kappa \) = piston stroke [dm]
- \( m \) = amplitude factor
- \( \Phi \) = isentropic exponent
- \( \kappa \) = isentropic exponent
- \( \Phi = p_{2+} - p_{1-} \) [bar]

**Formulae:**
\[
V_0 = \left( \Phi \cdot \frac{x}{100} \right)^{\frac{1}{\kappa}} - \left( \Phi \cdot \frac{x}{100} \right)^{\frac{-1}{\kappa}}
\]

\[
\Delta V = m \cdot q
\]

\[
x [\pm \%] = \frac{p_1 - p_m \cdot 100}{p_m}
\]

\[
= \frac{p_2 - p_m \cdot 100}{p_m}
\]
m-values for piston pump
(ones on request):

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<tr>
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<td>0.001</td>
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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

\[ V_0 = \frac{\Delta V}{\Phi \left(\frac{1}{x} - \frac{\Phi}{100}\right)} \]

\[ V_0 = 0.035 \cdot \frac{\pi \cdot 0.7^2 \cdot 10}{4} - \frac{0.6}{1 - \frac{2.5}{100}} \]

\[ V_0 = 0.54 \text{ l} \]

Selected: SB16S-25 with 1 l gas volume

b) Determining the required pulsation damper

\[ V_0 = \frac{\Delta V}{\Phi \left(\frac{1}{x} - \frac{\Phi}{100}\right)} \]

\[ V_0 = 0.035 \cdot \frac{\pi \cdot 0.7^2 \cdot 10}{4} - \frac{0.7}{1 - \frac{0.5}{100}} \]

\[ V_0 = 3.2 \text{ l} \]

Selected: SB330P-4
1.3.2 Shock absorber
Pressure shock produced when a valve is closed without a hydraulic accumulator

- 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.

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

- \( m \) (kg) = weight of fluid in the pipeline
- \( v \) (m/s) = 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.

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
- \( \Delta v \) = 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

\[
a = 1 \sqrt{\frac{1}{K \cdot \frac{1}{R} + E \cdot e}}
\]

- \( K \) (N/m³) = compression modulus of the fluid
- \( E \) (N/m³) = 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:

\[
\rho_{\text{max}} = p_1 + \Delta p
\]

If \( T > t \) then:

\[
\rho_{\text{max}} = p_1 + \rho \cdot a \cdot \Delta v \cdot \frac{t}{T}
\]
Calculation example

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

Given parameters:
Length of the pipeline $L$: 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 $p$: 980 kg/m³
Zero head 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:

$$a = \frac{1}{\sqrt{\frac{\rho}{K} \frac{1}{E \cdot e}} \cdot \sqrt{\frac{1}{1}} \cdot \sqrt{\frac{250}{162 \cdot 10^9 + 2.04 \cdot 10^{11} \cdot 6.3}}}$$

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

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

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

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

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

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

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

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

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

Determining the required gas volume:

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

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

$$V_0 = \frac{m \cdot v^2 \cdot 0.4}{2 \cdot p_1 \cdot \left[ \frac{p_2}{p_1} - 1 \right] \cdot 10^2}, \text{ with } m = V \cdot \rho = \frac{\pi}{4} \cdot D^2 \cdot L \cdot \rho$$

$$V_0 = \frac{\pi}{4} \cdot 0.25^2 \cdot 2000 \cdot 980 \cdot 2.45^2 \cdot 0.4 \cdot \left[ \frac{7}{7} \cdot \frac{7}{4.5} \right]^{\frac{1}{12}} \cdot \left[ \frac{1}{1} \right]^{\frac{1}{12}} \cdot 10^2$$

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

Selected:

4 off shock absorbers
SB 35AH-450.
### 1.4. TECHNICAL DATA

#### 1.4.1 MODEL CODE (also order example)

Pulsation damper, suction flow stabiliser, shock absorber

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#### 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 welded construction (diaphragm accumulators only)
- **F** = flange

**Type code**

- **1** = standard model (not for threaded construction)
- **2** = back-up model
- **6** = standard model for thread-type diaphragm accumulators of the type SBO...P...A6

**Material code**

- **1** = standard model = 112 for mineral oils
- **2** = carbon steel
- **3** = high tensile steel
- **4** = stainless steel (Niro)
- **5** = chemically nickel-plated (internal coating)
- **6** = low temperature steel

**Accumulator shell**

- **0** = plastic (internal coating)
- **1** = carbon steel
- **2** = chemically nickel-plated (internal coating)
- **4** = stainless steel (Niro)
- **6** = low temperature steel

**Accumulator bladder/diaphragm**

- **2** = NBR20 (acrylonitrile butadiene)
- **3** = NBR21 (low temperature NBR)
- **4** = IlR (butyl)
- **5** = FKM (fluoro rubber)
- **7** = other (e.g. PTFE, EPDM)

**Certification code**

- **U** = PED 97/23/EC

**Permitted operating pressure [bar]**

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

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

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1) Not available for all models
2) Not all combinations are possible
3) When ordering spare bladder, please state diameter of the smaller shell port
4) Please give full details when ordering
1.4.2 General

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

Nominal volumes
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 usable volume.

On the diaphragm accumulator, the effective gas volume corresponds to the nominal volume.

Usable 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. Others on request.

Gas charge
Hydraulic accumulators must only be charged with nitrogen. Never use other gases. RISK OF EXPLOSION!

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
263 K ... 353 K
with material code 112. Other media on request.

Permitted pressure ratio
Ratio of maximum operating pressure \( p_2 \) to gas pre-charge pressure \( p_0 \).
See catalogue section:

- Accumulators
  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 Manual!
- Bladder Accumulators
  No. 3.201.CE
- Diaphragm Accumulators
  No. 3.100.CE
- Piston accumulators
  No. 3.301.CE
### Dimensions SB

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* 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
### Dimensions SBO

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<td>0.75</td>
<td>210</td>
<td>140</td>
<td>5.1</td>
<td>217</td>
<td>–</td>
<td>12 G 1/4</td>
<td>13 G 1/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>200</td>
<td>–</td>
<td>6.0</td>
<td>231</td>
<td>–</td>
<td>13 G 1/4</td>
<td>13 G 1/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>140</td>
<td>–</td>
<td>6.2</td>
<td>244</td>
<td>60</td>
<td>105</td>
<td>30 G 1</td>
<td>SBO140P...E1</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>210</td>
<td>7.7</td>
<td>250</td>
<td>153</td>
<td>105</td>
<td>30 G 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>250</td>
<td>8.2</td>
<td>255</td>
<td>153</td>
<td>105</td>
<td>30 G 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>–</td>
<td>5.0</td>
<td>7.9</td>
<td>368</td>
<td>60</td>
<td>158</td>
<td>150</td>
<td>30 G 1/2</td>
<td>SBO100P...E1</td>
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<tr>
<td>4.0</td>
<td>–</td>
<td>250</td>
<td>13.5</td>
<td>377</td>
<td>170</td>
<td>150</td>
<td>30 G 1/2</td>
<td>SBO100P...E1</td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>500</td>
<td>5.2 (6.3)</td>
<td>162</td>
<td>155 (125)</td>
<td>50</td>
<td>80</td>
<td>25 G 1/2</td>
<td>SBO500P...A6</td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>330</td>
<td>8.9 (9.1)</td>
<td>202</td>
<td>140 (142)</td>
<td>95</td>
<td>25</td>
<td>105</td>
<td>30 G 1</td>
<td>SBO450P...A6</td>
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<tr>
<td>1.3</td>
<td>400</td>
<td>13.8</td>
<td>267</td>
<td>199</td>
<td>60</td>
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<td>30 G 1</td>
<td>SBO400P...A6</td>
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</tr>
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<td>2.0</td>
<td>250</td>
<td>15.6</td>
<td>285</td>
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<td>105</td>
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<td>400</td>
<td>24.6</td>
<td>308</td>
<td>252</td>
<td>287</td>
<td>287</td>
<td>25 G 1</td>
<td>SBO400P...A6</td>
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<td>4.0</td>
<td>–</td>
<td>36.6</td>
<td>325</td>
<td>287</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

\(^{(1)}\) Certification to PED 97/23/EC

\(^{1}\) Standard connection code = AI, others on request

\(^{(1)}\) 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 $p_2 : p_0 = 2 : 1$

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>40</td>
<td>11</td>
<td>140</td>
<td>60</td>
<td>210</td>
<td>105</td>
<td>30</td>
<td>G 1</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>27</td>
<td>197</td>
<td>230</td>
<td>210</td>
<td>16</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>40</td>
<td>12</td>
<td>165</td>
<td>26</td>
<td>200</td>
<td>230</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Standard connection code = AI, others on request

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

Pulsation damper in PVDF with PTFE-coated diaphragm.

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

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

<table>
<thead>
<tr>
<th>Nominal volume</th>
<th>Max. operating pressure [bar]</th>
<th>Weight [kg]</th>
<th>H [mm]</th>
<th>H1 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>10</td>
<td>5.7</td>
<td>128</td>
<td>20</td>
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<td></td>
<td>16</td>
<td>6.5</td>
<td>130</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>10</td>
<td>6.0</td>
<td>168</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>6.8</td>
<td>170</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Bladder assembly*

<table>
<thead>
<tr>
<th>Description</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder</td>
<td>2</td>
</tr>
<tr>
<td>Gas valve insert</td>
<td>3</td>
</tr>
<tr>
<td>Retaining nut</td>
<td>4</td>
</tr>
<tr>
<td>Cap nut</td>
<td>5</td>
</tr>
<tr>
<td>Valve protection cap</td>
<td>6</td>
</tr>
<tr>
<td>O-ring</td>
<td>7</td>
</tr>
</tbody>
</table>

* recommended spares

#### Seal kit*

<table>
<thead>
<tr>
<th>Description</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-ring</td>
<td>7</td>
</tr>
<tr>
<td>Washer</td>
<td>15</td>
</tr>
<tr>
<td>O-ring</td>
<td>16</td>
</tr>
<tr>
<td>Support ring</td>
<td>23</td>
</tr>
<tr>
<td>O-ring</td>
<td>27</td>
</tr>
<tr>
<td>O-ring</td>
<td>47</td>
</tr>
<tr>
<td>O-ring</td>
<td>48</td>
</tr>
</tbody>
</table>

#### Anti-extrusion ring* 14
#### Gas valve insert* 3

### O-ring dimensions [mm]

<table>
<thead>
<tr>
<th>Series</th>
<th>Nominal vol.</th>
<th>Item 7</th>
<th>Item 16</th>
<th>Item 27</th>
<th>Item 47</th>
<th>Item 48</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB330P</td>
<td>1-6 l</td>
<td>7.5x2</td>
<td>55x3.5</td>
<td>42.2x3</td>
<td>46x3</td>
<td>24.2x3</td>
</tr>
<tr>
<td>SB550P</td>
<td>1-5 l</td>
<td>7.5x2</td>
<td>50.17x5.33</td>
<td>37.82x1.78</td>
<td>40.94x2.62</td>
<td>23.52x1.78</td>
</tr>
<tr>
<td>SB330P/PH</td>
<td>10-32 l/4+6 l</td>
<td>7.5x2</td>
<td>80x5</td>
<td>57.2x3</td>
<td>67.2x3</td>
<td>37.2x3</td>
</tr>
<tr>
<td>SB330PH</td>
<td>10-32 l</td>
<td>7.5x2</td>
<td>100x5</td>
<td>64.5x3</td>
<td>84.5x3</td>
<td>44.2x3</td>
</tr>
</tbody>
</table>

1) For code 663 and 665 different dimensions

### Connection assembly

<table>
<thead>
<tr>
<th>Description</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil valve body</td>
<td>9</td>
</tr>
<tr>
<td>Valve poppet</td>
<td>10</td>
</tr>
<tr>
<td>Damping sleeve</td>
<td>11</td>
</tr>
<tr>
<td>Lock nut</td>
<td>12</td>
</tr>
<tr>
<td>Spring</td>
<td>13</td>
</tr>
<tr>
<td>Anti-extrusion ring</td>
<td>14</td>
</tr>
<tr>
<td>Washer</td>
<td>15</td>
</tr>
<tr>
<td>O-ring</td>
<td>16</td>
</tr>
<tr>
<td>Spacer</td>
<td>17</td>
</tr>
<tr>
<td>Support ring (only for 330 bar)</td>
<td>23</td>
</tr>
<tr>
<td>O-ring</td>
<td>27</td>
</tr>
<tr>
<td>Connector</td>
<td>44</td>
</tr>
<tr>
<td>Guide piece</td>
<td>45</td>
</tr>
<tr>
<td>Cap</td>
<td>46</td>
</tr>
<tr>
<td>O-ring</td>
<td>47</td>
</tr>
<tr>
<td>O-ring</td>
<td>48</td>
</tr>
<tr>
<td>Locking key</td>
<td>88</td>
</tr>
</tbody>
</table>

### Description Item

#### Bladder assembly
- Bladder: 2
- Gas valve insert: 3
- Retaining nut: 4
- Cap nut: 5
- Valve protection cap: 6
- O-ring: 7

#### Seal kit
- 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

### O-ring dimensions [mm]

<table>
<thead>
<tr>
<th>Series</th>
<th>Nominal vol.</th>
<th>Item 7</th>
<th>Item 16</th>
<th>Item 27</th>
<th>Item 47</th>
<th>Item 48</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB330P</td>
<td>1-6 l</td>
<td>7.5x2</td>
<td>55x3.5</td>
<td>42.2x3</td>
<td>46x3</td>
<td>24.2x3</td>
</tr>
<tr>
<td>SB550P</td>
<td>1-5 l</td>
<td>7.5x2</td>
<td>50.17x5.33</td>
<td>37.82x1.78</td>
<td>40.94x2.62</td>
<td>23.52x1.78</td>
</tr>
<tr>
<td>SB330P/PH</td>
<td>10-32 l/4+6 l</td>
<td>7.5x2</td>
<td>80x5</td>
<td>57.2x3</td>
<td>67.2x3</td>
<td>37.2x3</td>
</tr>
<tr>
<td>SB330PH</td>
<td>10-32 l</td>
<td>7.5x2</td>
<td>100x5</td>
<td>64.5x3</td>
<td>84.5x3</td>
<td>44.2x3</td>
</tr>
</tbody>
</table>

1) For code 663 and 665 different dimensions

### Description Item

#### Bladder assembly
- Bladder: 2
- Charging screw: 6
- Seal ring U 9.3x13.3x1: 7
- Support ring: 8

#### Connection assembly
- Bladder: 2
- Charging screw: 6
- Seal ring: 7

---

* Image of diagrams and list of parts for SB800P and SB1000P are not transcribed.

---

* Image of diagrams and list of parts for SB800P and SB1000P are not transcribed.
**SBO...P...E**

<table>
<thead>
<tr>
<th>Description</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging screw</td>
<td>1</td>
</tr>
<tr>
<td>Seal ring</td>
<td>2</td>
</tr>
<tr>
<td>Seal ring</td>
<td>3</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging screw</td>
<td>1</td>
</tr>
<tr>
<td>Seal ring</td>
<td>2</td>
</tr>
<tr>
<td>Seal ring</td>
<td>3</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
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<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging screw</td>
<td>1</td>
</tr>
<tr>
<td>Seal ring</td>
<td>2</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>4</td>
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</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Item</th>
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</thead>
<tbody>
<tr>
<td>Gas valve complete</td>
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</tr>
<tr>
<td>Gas valve insert brass / stainless steel</td>
<td>2</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>3</td>
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</tbody>
</table>

*Please read the Operating Manual! Available on request!*
1.4.4 Suction flow stabiliser

SB16S

Dimensions

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<tbody>
<tr>
<td>12</td>
<td>12</td>
<td>1</td>
<td>40</td>
<td>580</td>
<td>425</td>
<td>219</td>
<td>220</td>
<td>65</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>2.5</td>
<td>60</td>
<td>1025</td>
<td>540</td>
<td>300</td>
<td>250</td>
<td>80</td>
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<td>100</td>
<td>100</td>
<td>10</td>
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<td>250</td>
<td>80</td>
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<td>400</td>
<td>400</td>
<td>35</td>
<td>140</td>
<td>1150</td>
<td>650</td>
<td>406</td>
<td>350</td>
<td>100</td>
</tr>
</tbody>
</table>

Further pressure ranges 25 bar, 40 bar; others on request.
Other fluid volumes on request
* to EN1092-1/11 /B1/PN16 or PN40

Spare Parts

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(H)

Dimensions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>84</td>
<td>144</td>
<td>870</td>
<td>880</td>
<td>390</td>
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<td>150</td>
<td>150</td>
<td>101</td>
<td>161</td>
<td>1070</td>
<td>1080</td>
<td>490</td>
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<td>200</td>
<td>200</td>
<td>122</td>
<td>223</td>
<td>1310</td>
<td>1320</td>
<td>665</td>
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<td>300</td>
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<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>93</td>
<td>153</td>
<td>957</td>
<td>965</td>
<td>457</td>
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<td>1165</td>
<td>557</td>
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<td>200</td>
<td>200</td>
<td>131</td>
<td>230</td>
<td>1417</td>
<td>1425</td>
<td>842</td>
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<tr>
<td>300</td>
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<td>164</td>
<td>297</td>
<td>1865</td>
<td>1873</td>
<td>1092</td>
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<td>375</td>
<td>375</td>
<td>200</td>
<td>335</td>
<td>2307</td>
<td>2315</td>
<td>1342</td>
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<td>450</td>
<td>246</td>
<td>395</td>
<td>2702</td>
<td>2710</td>
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</tbody>
</table>

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

2.1. APPLICATION

2.1.1 Silencer for fluid noise damping

Type SD...

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.

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 damped across a wide frequency spectrum.

Construction
The HYDAC fluid 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 mounting 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

For the selection of 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.

\[
f = \frac{i \cdot n}{60} \text{ in Hz}
\]

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 = 19 mm
Flow rate: 300 l/min
Operating medium: mineral oil
Max. permitted operating pressure: 210 bar

Solution:
1) Fundamental frequency f

\[
f = \frac{i \cdot n}{60} \text{ in Hz}
\]

\(i = 9 \cdot 1500/60\)

\(f = 225 \text{ Hz}\)

2) From the "Damping curve" graph, the following SILENCER type can be selected:

SD330-S10/012U-330AE/AE

Transmission damping = 31 dB

Pressure drop = 2 bar
2.3. TECHNICAL DATA

2.3.1 Model code SD
(also order example)

<table>
<thead>
<tr>
<th>Series</th>
<th>SD330</th>
<th>M - 4.2</th>
<th>/</th>
<th>212</th>
<th>U - 330</th>
<th>AD/AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type code</td>
<td>no details = for SD330</td>
<td>B = bladder accumulator base shell*</td>
<td>K = piston accumulator base shell*</td>
<td>M = diaphragm accumulator base shell*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal volume [l]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material code</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damper</td>
<td>0 = without pipe</td>
<td>1 = damper for frequencies &gt; 500 Hz</td>
<td>2 = narrow band damper - DR</td>
<td>3 = broadband damper - DR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing material</td>
<td>1 = carbon steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seal material</td>
<td>2 = NBR (acrylonitrile butadiene)</td>
<td>6 = FPM (fluoro rubber)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certificate code</td>
<td>U = PED 97/23/EC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permitted operating pressure [bar]</td>
<td>see Table 2.3.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* only on request
2.3.3 Silencer connections

a) Threaded connection to ISO 228

<table>
<thead>
<tr>
<th>Nominal volume [l]</th>
<th>L [mm]</th>
<th>L₁ [mm]</th>
<th>Ø D [mm]</th>
<th>J ISO 228</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>250</td>
<td>–</td>
<td>114</td>
<td>G 1</td>
<td>6.5</td>
</tr>
<tr>
<td>1.8</td>
<td>355</td>
<td>155</td>
<td>168</td>
<td>G 1/4</td>
<td>5.5</td>
</tr>
<tr>
<td>4.2</td>
<td>346</td>
<td>–</td>
<td>114</td>
<td>G 1/2</td>
<td>12.5</td>
</tr>
<tr>
<td>4.7</td>
<td>420</td>
<td>155</td>
<td>168</td>
<td>G 2</td>
<td>11.4</td>
</tr>
<tr>
<td>5.5</td>
<td>815</td>
<td>615</td>
<td>114</td>
<td>G 1 1/4</td>
<td>14.0</td>
</tr>
</tbody>
</table>

**Fluid connection A**

<table>
<thead>
<tr>
<th>Nominal volume [l]</th>
<th>L₁ [mm]</th>
<th>L₂ [mm]</th>
<th>L₃ [mm]</th>
<th>L₄ [mm]</th>
<th>L₅ [mm]</th>
<th>L₆ [mm]</th>
<th>L₇ [mm]</th>
<th>L₈ [mm]</th>
<th>L₉ [mm]</th>
<th>L₁₀ [mm]</th>
<th>L₁₁ [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>–</td>
<td>17</td>
<td>17</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1.8</td>
<td>–</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>30</td>
<td>30</td>
<td>33</td>
<td>33</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>without adapter</td>
</tr>
<tr>
<td>4.7</td>
<td>–</td>
<td>–</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>26</td>
<td>26</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>5.5</td>
<td>–</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>30</td>
<td>30</td>
<td>33</td>
<td>33</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

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

**Fluid connection F**

<table>
<thead>
<tr>
<th>Nominal volume [l]</th>
<th>L₁ [mm]</th>
<th>L₂ [mm]</th>
<th>L₃ [mm]</th>
<th>L₄ [mm]</th>
<th>L₅ [mm]</th>
<th>L₆ [mm]</th>
<th>L₇ [mm]</th>
<th>L₈ [mm]</th>
<th>L₉ [mm]</th>
<th>L₁₀ [mm]</th>
<th>L₁₁ [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1.8</td>
<td>53</td>
<td>31</td>
<td>59</td>
<td>36</td>
<td>65</td>
<td>36</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>33</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4.7</td>
<td>–</td>
<td>105</td>
<td>36</td>
<td>120</td>
<td>36</td>
<td>76</td>
<td>28</td>
<td>76</td>
<td>28</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5.5</td>
<td>53</td>
<td>31</td>
<td>59</td>
<td>36</td>
<td>65</td>
<td>36</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* 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.