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.

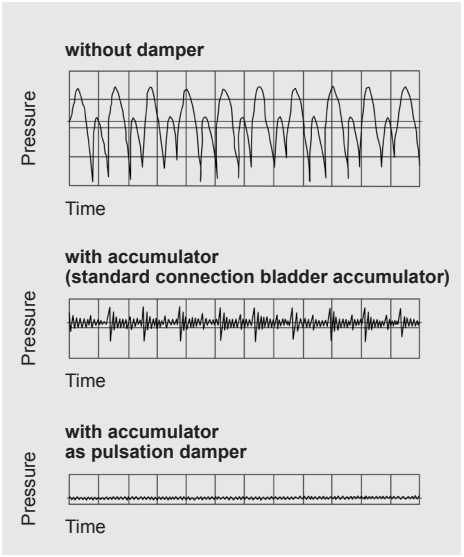
HYDAC hydraulic dampers are particularly suitable for damping such pressure fluctuations.

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:

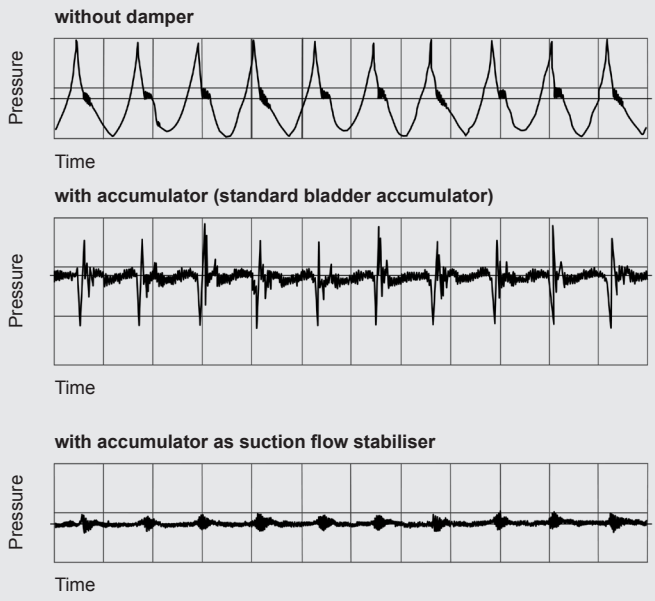
- the welded or forged pressure vessel in carbon steel; available with internal coating or in stainless steel for chemically aggressive fluids.
- the special fluid valve with inline connection, which guides the flow into the vessel (threaded or flange connection).
- the bladder or diaphragm in various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

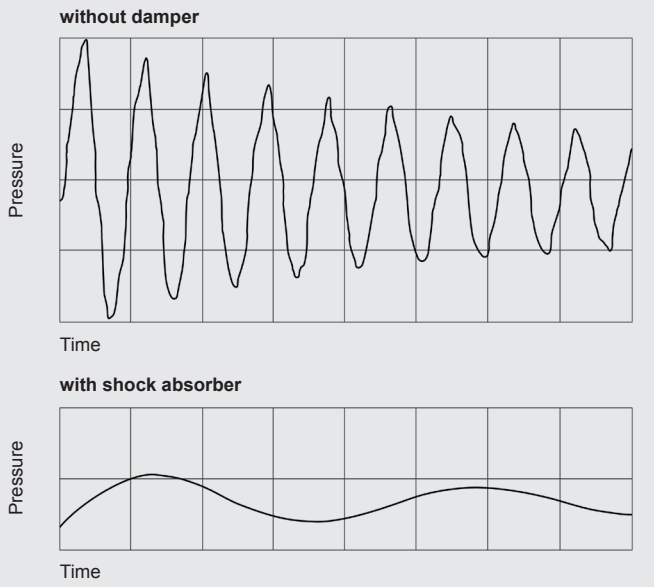
Operation
Trouble-free pump operation is only possible if no cavitation occurs in the pump suction and pipe oscillations are prevented.

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:

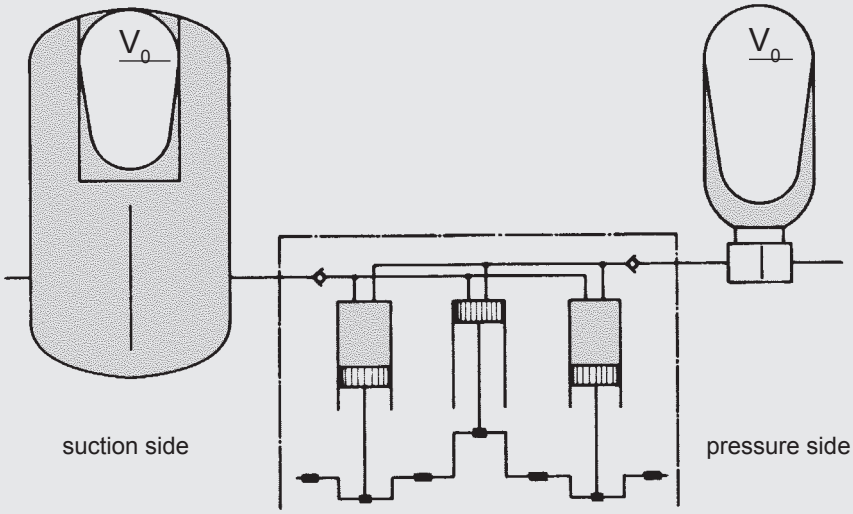
- the welded pressure vessel in carbon steel with or without corrosion protection or in stainless steel.
- the connection including perforated disc which prevents the flexible bladder from extruding from the vessel, and the flange.
- the bladder in various compounds as shown under point 1.4.1 with built-in 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:

ΔV = 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
$m = \frac{\Delta V}{q}$

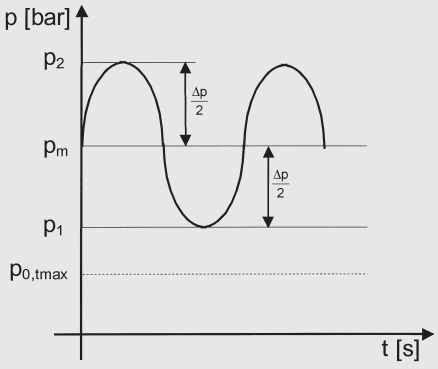
z = no. of compressions / effective cylinders per revolution

x = residual pulsation [± %]

κ = isentropic exponent

Φ = pressure ratio of pre-charge pressure to operating pressure [0.6 ... 0.9]
$\Phi = \frac{p_0}{p_m}$

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



Formulae:

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

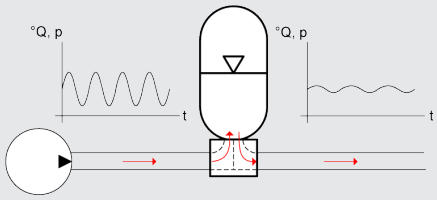
$$\Delta V = m \bullet q$$

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

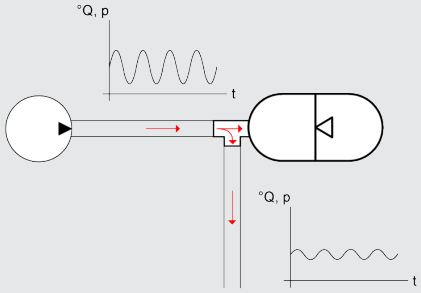
$$= \left|\frac{p_2 - p_m}{p_m} \bullet 100\right|$$

Schematic of installation options:

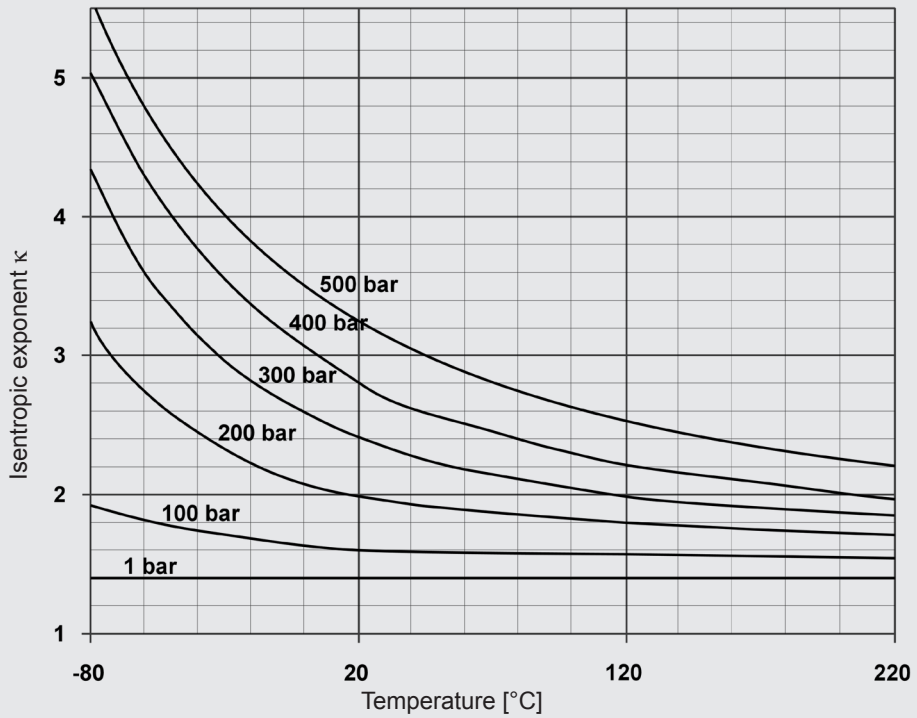
Preferred installation configuration with maximum damping effect



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

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

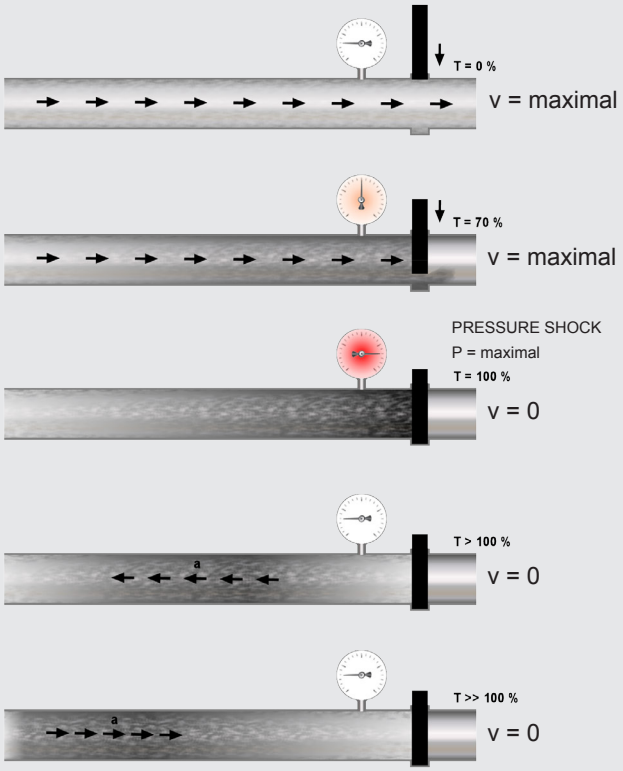
$$V_0 = \frac{0.035 \bullet \frac{\pi \bullet 0.7^2}{4} \bullet 1.0}{\left[\frac{0.7}{1-\frac{0.5}{100}}\right]^{\frac{1}{2.0}} - \left[\frac{0.7}{1+\frac{0.5}{100}}\right]^{\frac{1}{2.0}}}$$

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

Δp[N/m²] = $\rho \cdot a \cdot \Delta v$
ρ [kg/m³] = fluid density
Δv = $v - v_1$
Δv = 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:
1.62×10^9 N/m²

Elasticity modulus (steel) E:
2.04×10^{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.

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

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

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

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

$$= 26.89 \text{ bar}$$

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

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

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.

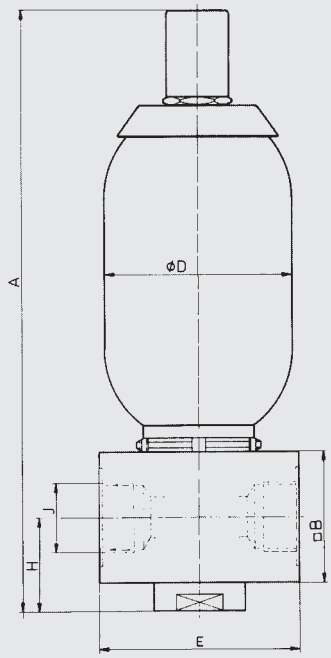
After the hydraulic line has been connected it must be completely vented. Work on systems with hydraulic dampers (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

Please read the Operating Manuals!

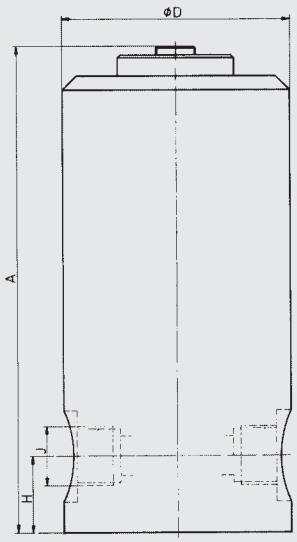
- Bladder Accumulators No. 3.201.CE
- Diaphragm Accumulators No. 3.100.CE
- Piston accumulators No. 3.301.CE

1.4.3 Pulsation damper

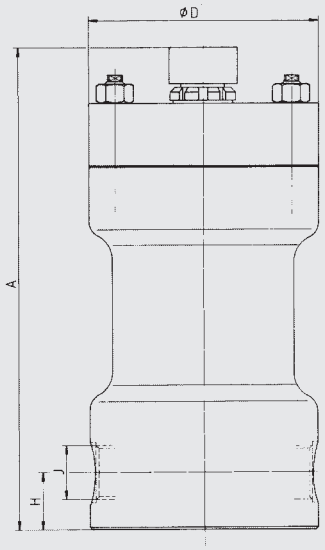
SB330/550P(PH)-...



SB800P-...



SB1000P-...

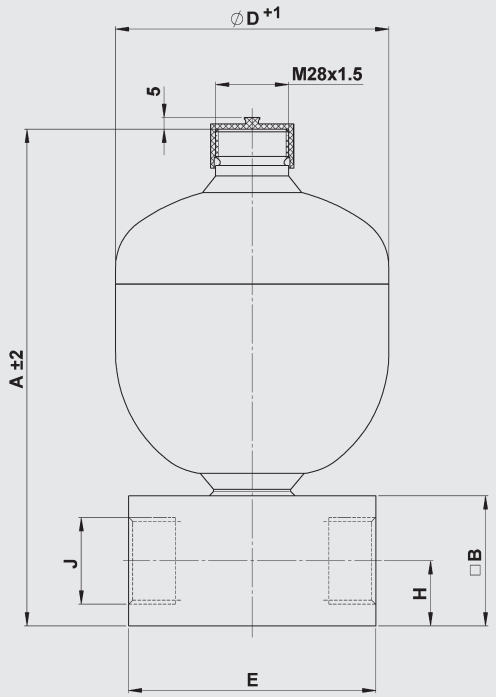


Dimensions SB

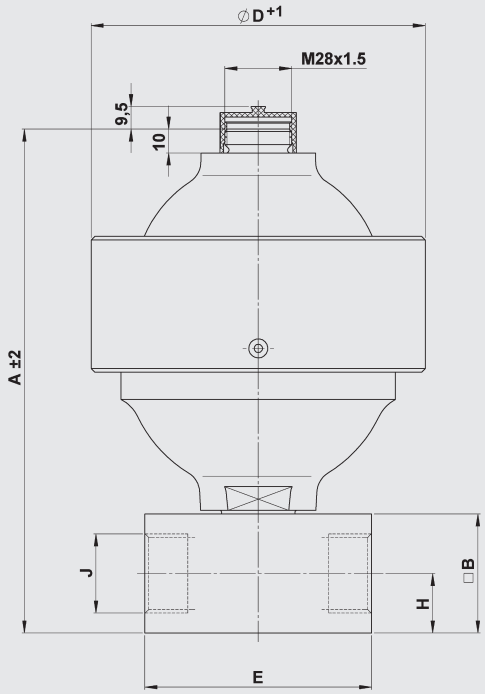
Nominal volume [l]	Max. operating pressure* [bar]	Eff. gas volume [l]	Weight [kg]	A [mm]	□ B [mm]	Ø D [mm]	E [mm]	H [mm]	J [2] Thread ISO 228	Series
1	330	1	11	365	80	118	120	57	G 1 1/4	SB330P
	550		13	384	70	121		53		SB550P
1.5	800 [3]	1.3	36	346	–	160	–	55		SB800P
	1000 [3]		94	414	–	215	–	49	[1]	SB1000P
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



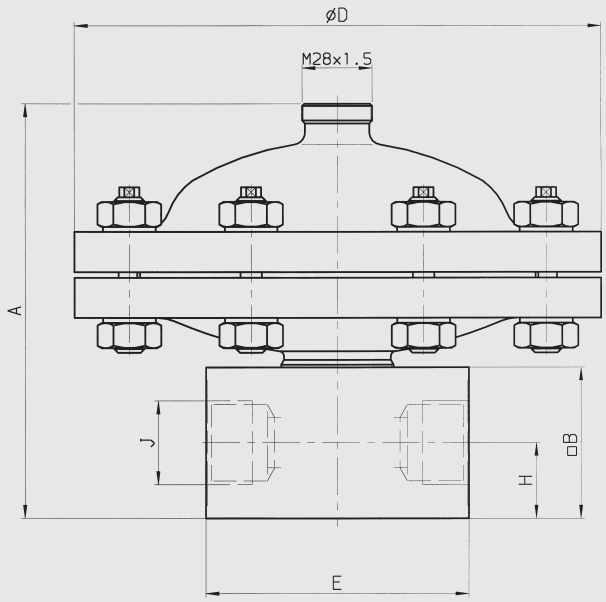
Dimensions SBO

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

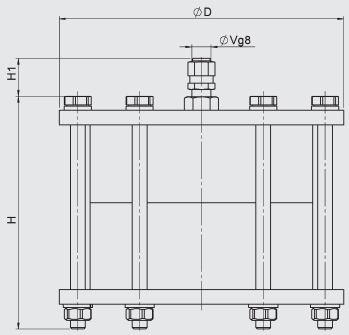
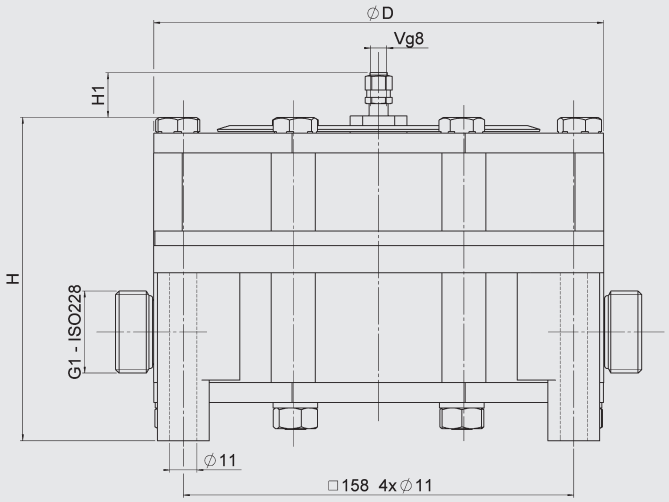


Diagram 2



Pulsation damper in PVDF with PTFE-coated diaphragm.

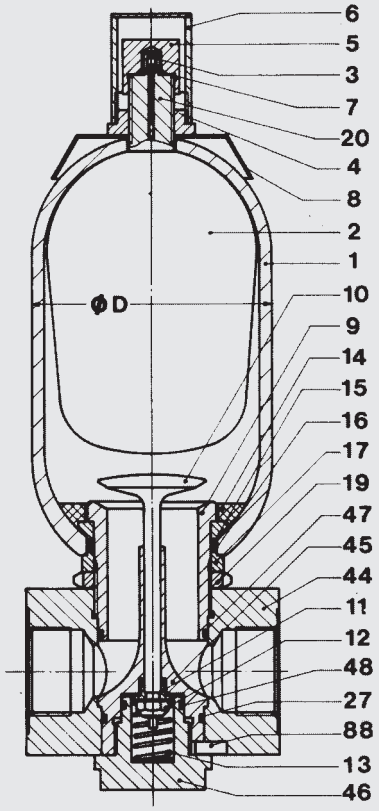
Permitted operating temperature:
-10 °C ... +65 °C

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

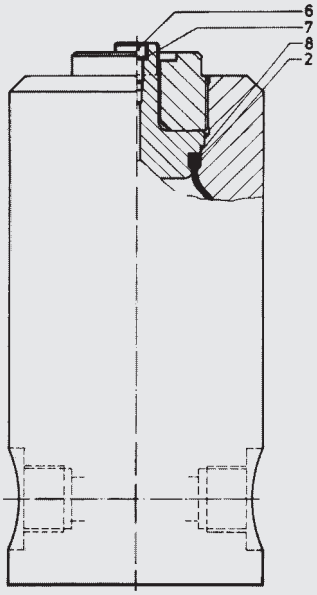
Description	Item
Connection assembly consisting of:	
Oil valve body	9
Valve poppet	10
Damping sleeve	11
Lock nut	12
Spring	13
Anti-extrusion ring	14
Washer	15
O-ring	16
Spacer	17
Lock nut	19
Support ring (only for 330 bar)	23
O-ring	27
Connector	44
Guide piece	45
Cap	46
O-ring	47
O-ring	48
Locking key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

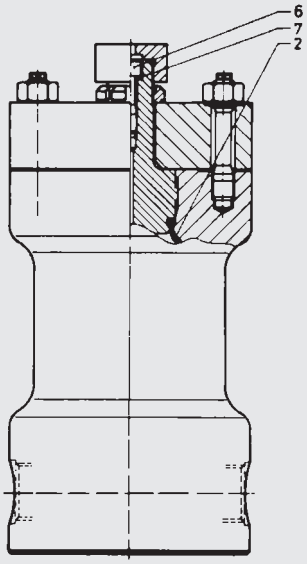
[1)] For code 663 and 665 different dimensions

SB800P



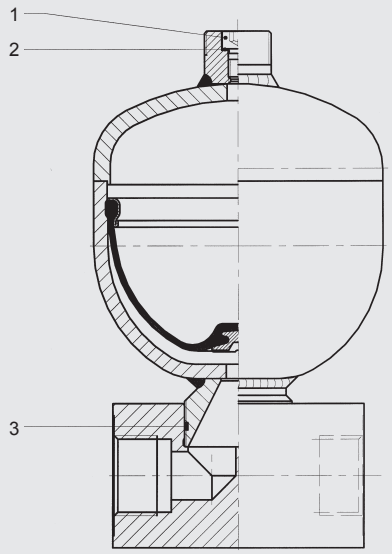
Description	Item
Bladder	2
Charging screw	6
Seal ring U 9.3x13.3x1	7
Support ring	8

SB1000P



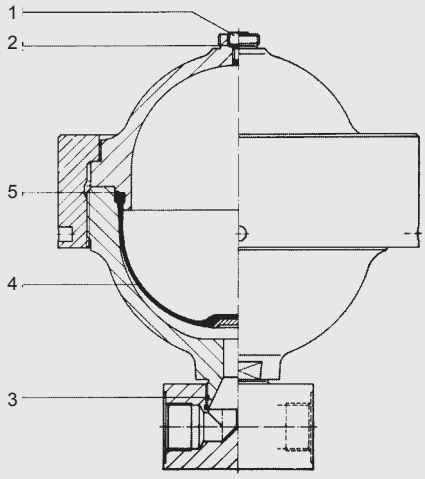
Description	Item
Bladder	2
Charging screw	6
Seal ring	7

SBO...P...E



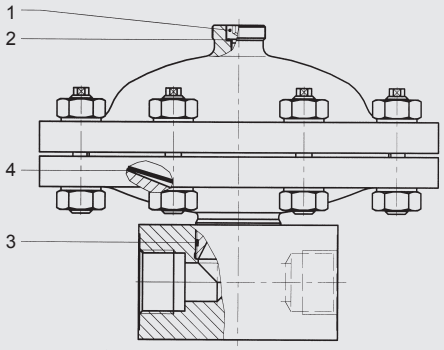
Description	Item
Charging screw	1
Seal ring	2
Seal ring	3

SBO...P...A6



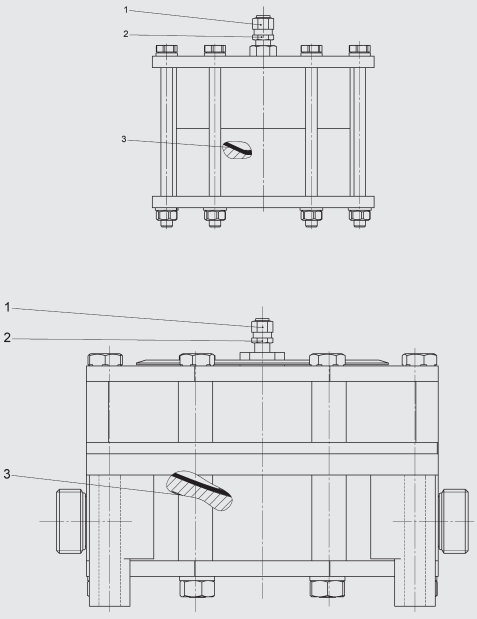
Description	Item
Charging screw	1
Seal ring	2
Seal ring	3
Diaphragm	4
Support ring	5

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



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

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

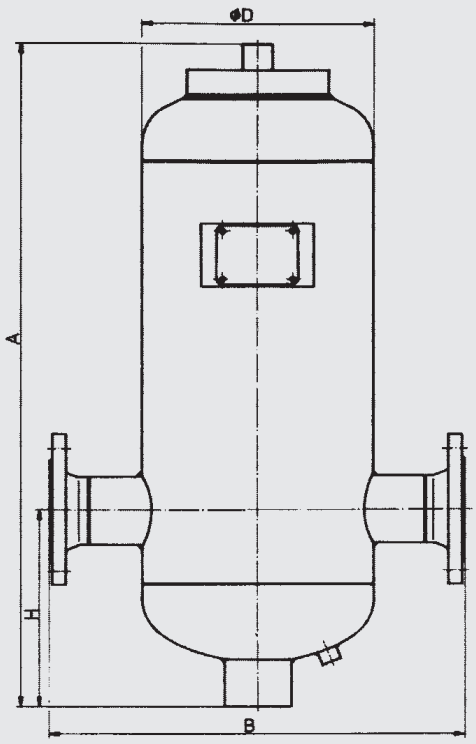


Description	Item
Gas valve complete	1
Gas valve insert brass / stainless steel	2
Diaphragm	3

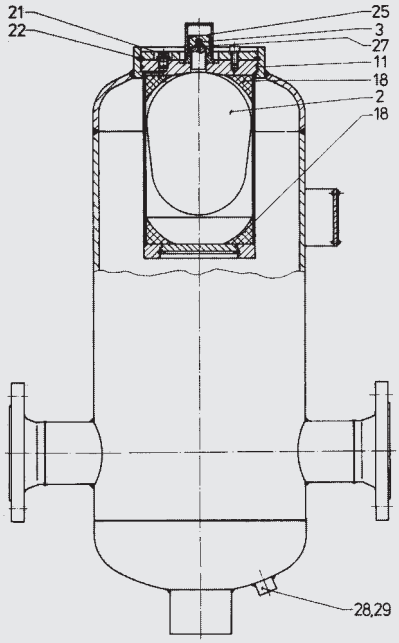
Relevant operating manual is available on request.

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

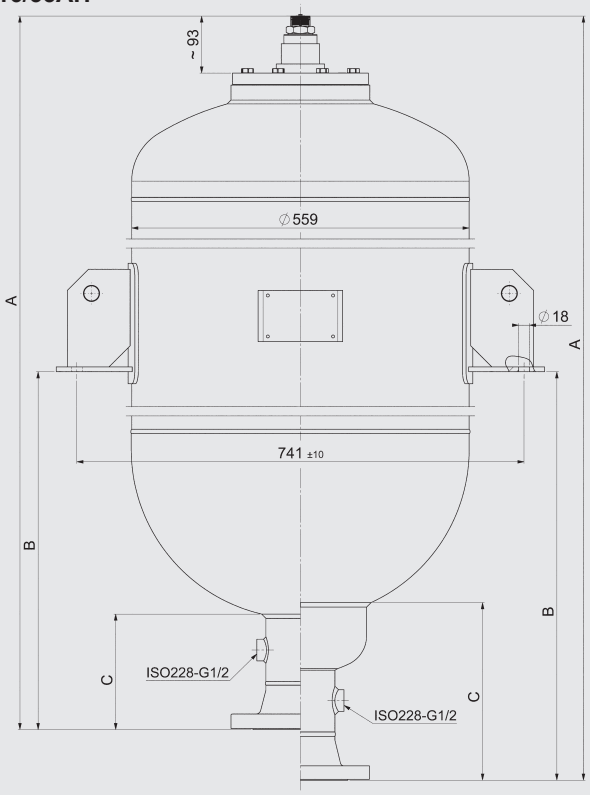
Further pressure ranges 25 bar, 40 bar; others on request.
Other fluid volumes on request.

* to EN1092-1/11 /B1/PN16

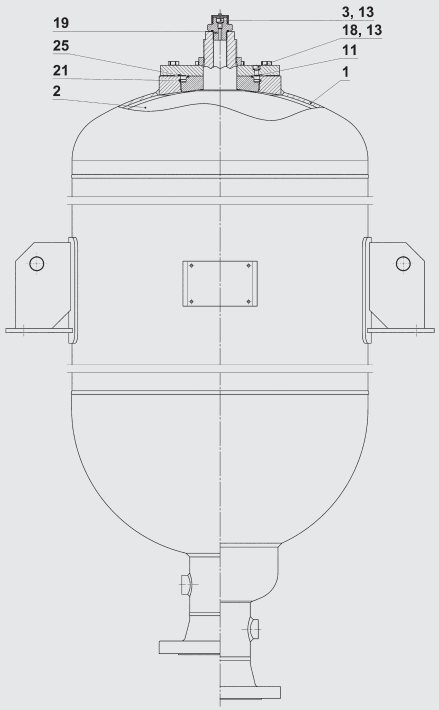
Description	Item
Bladder	2
Gas valve insert	3
O-ring	11
Insertion ring, 2x	18
Lock nut	21
Retaining ring	22
Cap nut	25
O-ring	27
Seal ring	28
Lock nut	29

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			

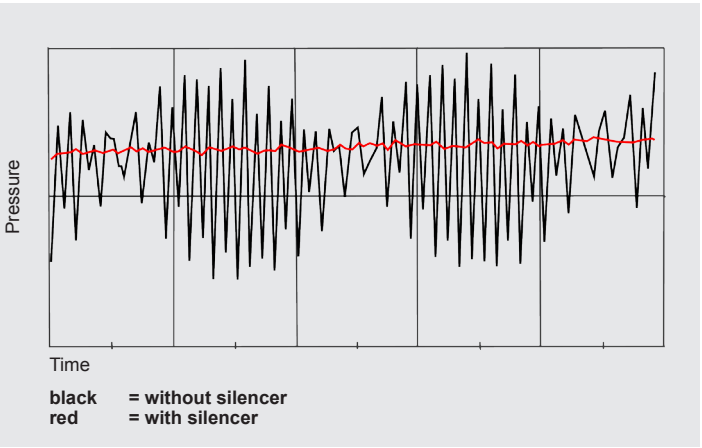
* to EN1092-1/11 /B1/PN16 or PN40
others on request

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.

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

Δp_o = height of pressure fluctuations without silencer

Δp_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

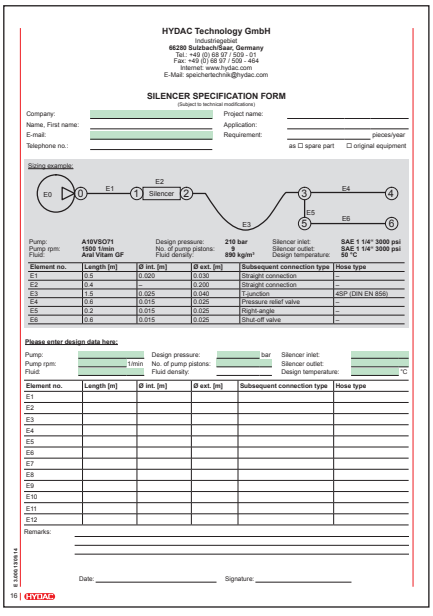
Solution:

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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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

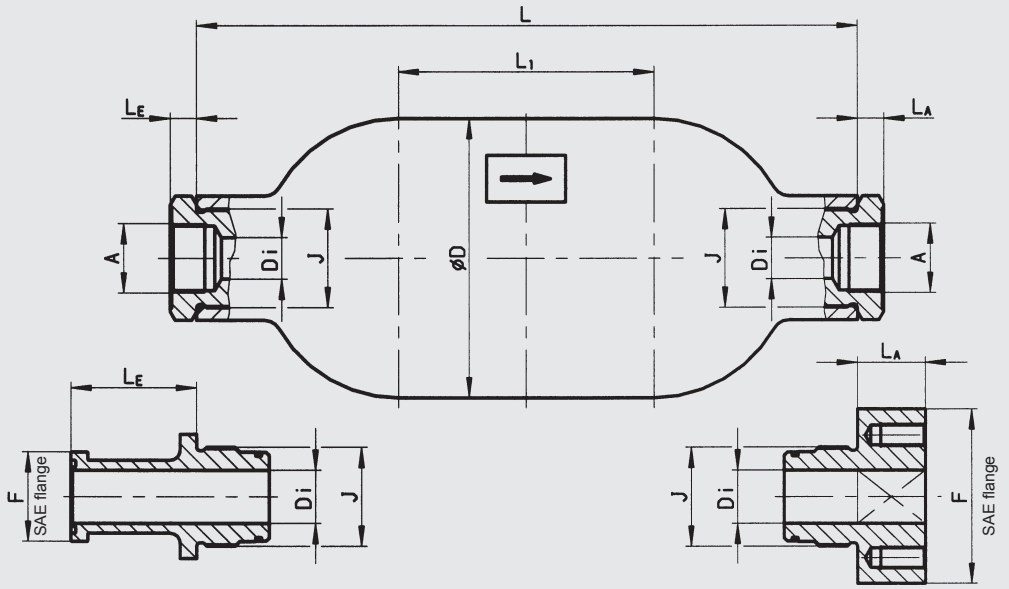
Permitted operating pressure [bar]

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]
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]
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.

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