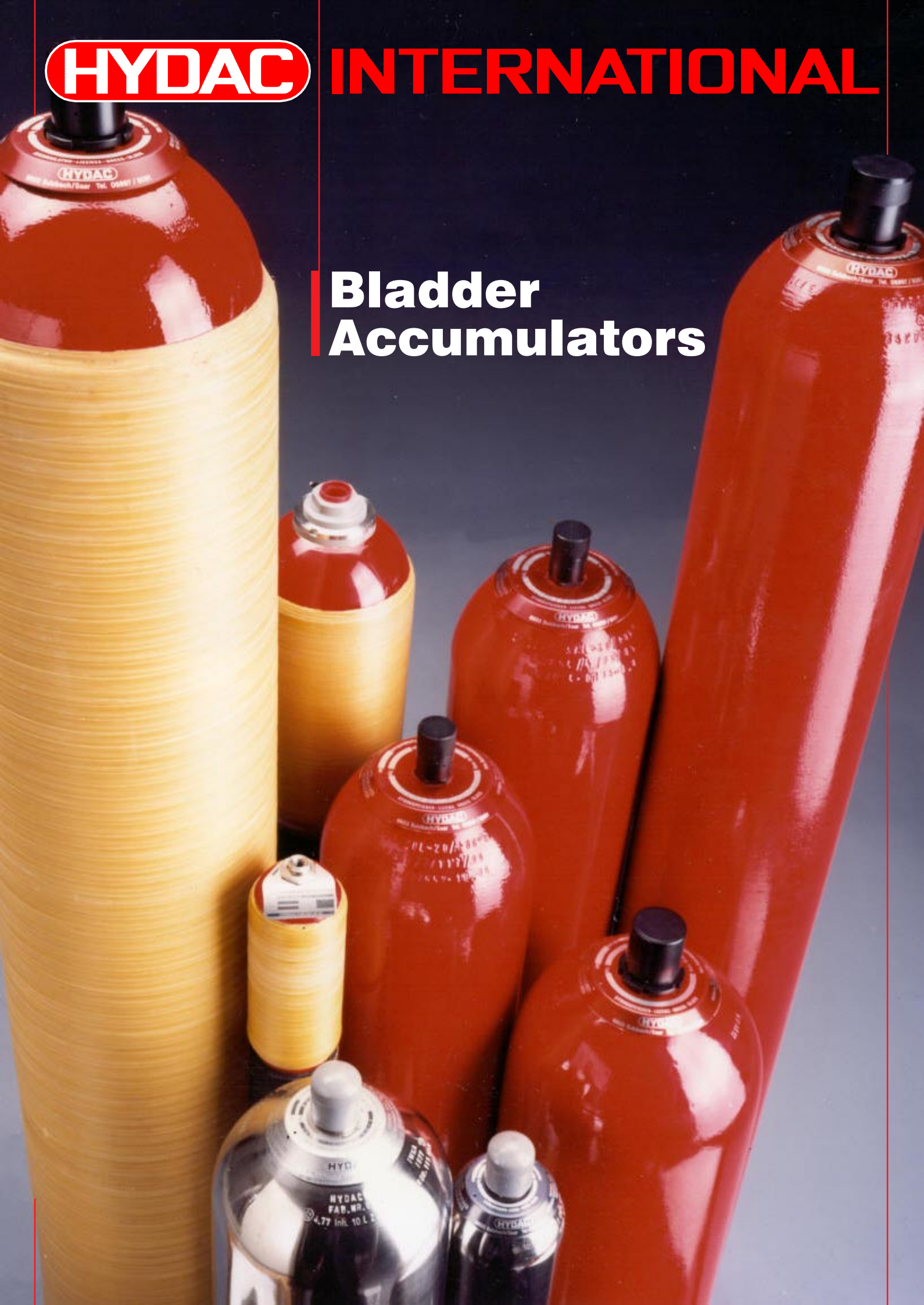
HYDAC INTERNATIONAL

Bladder Accumulators



HYDAC
BLADDER ACCUMULATORS

1. DESCRIPTION

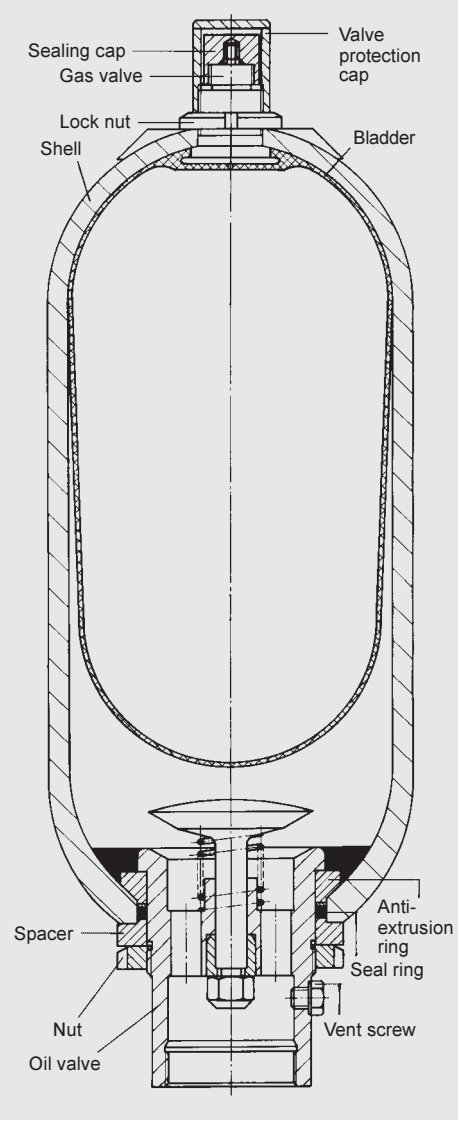
1.1. FUNCTION

Fluids are practically incompressible and cannot therefore store pressure energy.

The compressibility of a gas (nitrogen) is utilised in hydro-pneumatic accumulators for storing fluids. HYDAC bladder accumulators are based on this principle, using nitrogen as the compressible medium.

The bladder accumulator consists of a fluid section and a gas section with the bladder acting as a gas-proof screen. The fluid around the bladder is connected with the hydraulic circuit, so that the bladder accumulator draws in fluid when pressure increases and the gas is compressed. When the pressure drops, the compressed gas expands and forces the stored fluid into the circuit.

1.2. CONSTRUCTION



1.2.1 **Construction**
HYDAC bladder accumulators consist of a welded or forged pressure vessel, an accumulator bladder and valves for gas and oil inlet. The gas and oil sides are separated by the bladder.

1.2.2 **Bladder materials**
The following elastomers are available as standard:

- NBR (acrylonitrile butadiene rubber, Perbunan),
- IIR (butyl rubber),
- FKM (fluoro rubber, Viton®),
- ECO (ethylene oxide epichlorohydrin rubber).

The material used depends on the respective operating medium and temperature.

1.2.3 **Corrosion protection**
For use with chemically aggressive media the accumulator shell can be supplied with corrosion protection, such as plastic coating on the inside or chemical nickel plating. If this is insufficient, then nearly all types can also be supplied in stainless steel.

1.3. MOUNTING POSITION

HYDAC bladder accumulators can be installed vertically, horizontally and at a slant.
When installing vertically or at a slant, the oil valve must be at the bottom. On certain applications listed below, particular positions are preferable:

- energy storage: vertical
- pulsation damping: any position from horizontal to vertical
- maintaining constant pressure: any position from horizontal to vertical
- volume compensation: vertical

If the mounting position is horizontal or at a slant the effective volume and the maximum permissible fluid flow rate are reduced.

1.4. TYPE OF MOUNTING

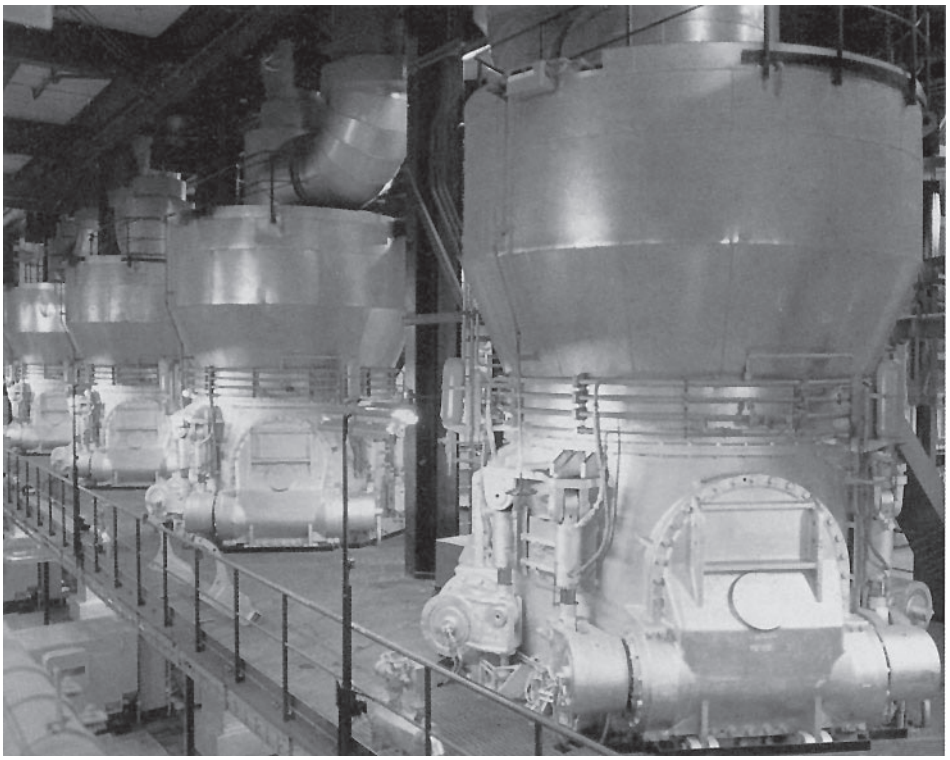
- By using an appropriate adaptor, HYDAC accumulators, up to size 1 l, can be mounted directly inline
- For strong vibrations and volumes above 1 l, we recommend the use of our accumulator supports or accumulator mounting set. (Brochure "Supports for Hydraulic Accumulators" no. 3.502.)

2. APPLICATIONS

2.1. TYPICAL APPLICATIONS

HYDAC bladder accumulators can be used in a wide variety of applications, some of which are listed below:

- energy storage,
- emergency operation,
- force equilibrium,
- leakage compensation,
- volume compensation,
- shock absorption,
- vehicle suspension,
- pulsation damping (see brochure on Hydraulic Dampers).

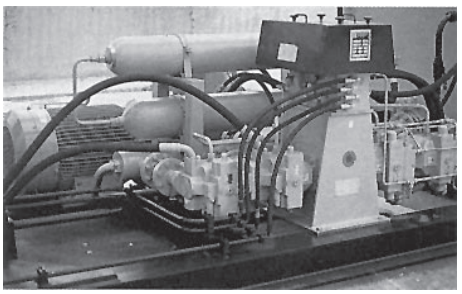


3 bladder accumulators SB 330 - 20

Coal crusher

The coal is crushed by hammers which are forced against the coal hydraulically in a rotary motion. When coal is fed into the crushing bed it does not spread itself out evenly, causing the hammers to oscillate up and down.

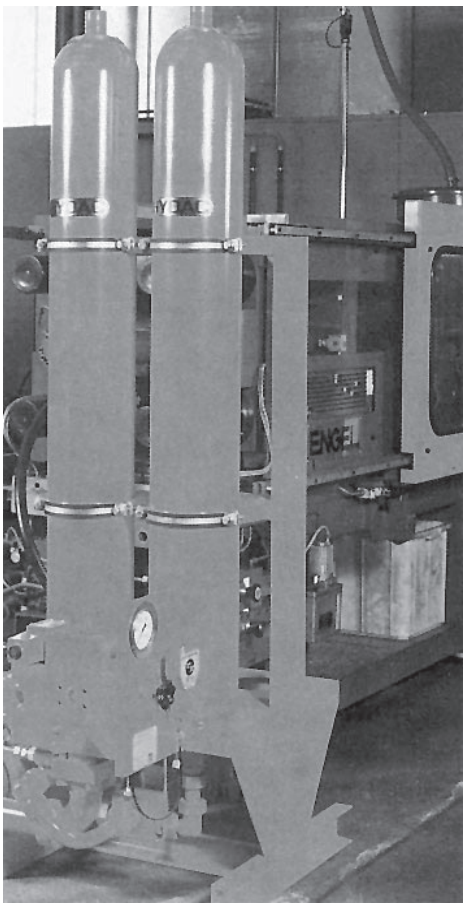
HYDAC bladder accumulators are installed to prevent inadmissible pressure fluctuations and oscillations and to provide the hydro-pneumatic suspension.



1 bladder accumulator SB 330 - 32 with 50 l back-up nitrogen

Crude oil piston pump

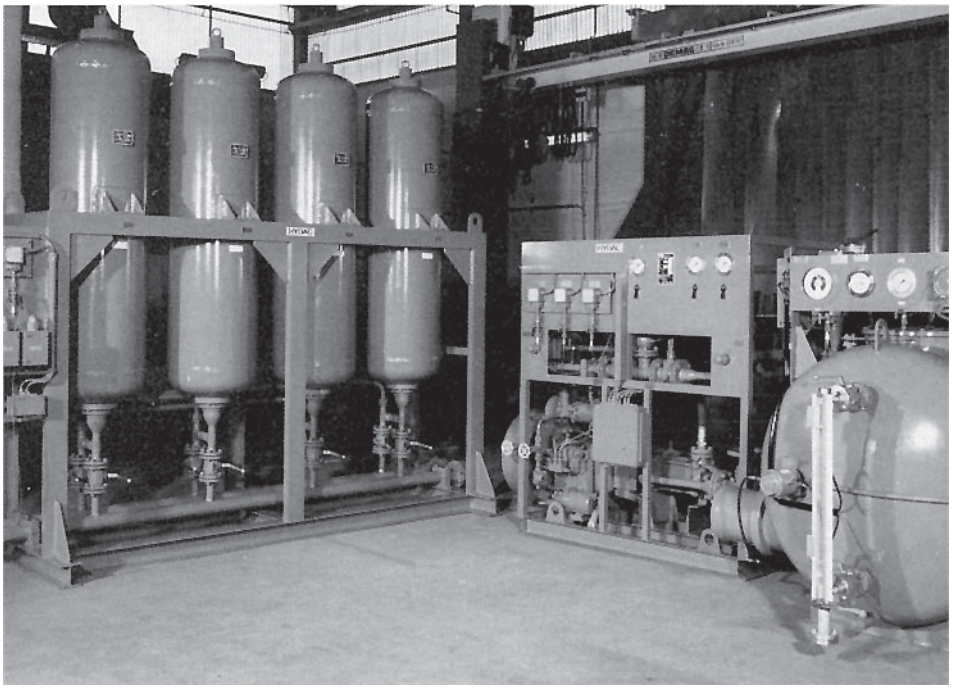
The crude oil piston pump rod is fed by a hydrostatic secondary regulated motor. In support of this motor, a HYDAC bladder accumulator – back-up type – is charged via the pressure-controlled pump and the fluid energy released during the upward stroke, in order to subsequently carry out the acceleration of the upward stroke of the piston.



2 bladder accumulators SB 210 - 50

Plastic injection moulding machine

Periodically high flow rates are required for short periods during the operation of a plastic injection moulding machine. If no accumulators are available, the pump has to be designed for peak requirement.
By using a HYDAC bladder accumulator a smaller pump with a lower capacity can be used and the cycles can be shortened.



4 bladder accumulators SB 35 A – 450

Control valves – Emergency oil supply

In order that control valves can maintain their safety functions when the main energy supply fails, an adequate supply of pressure fluid is stored for immediate use.

HYDAC high volume accumulators (up to 450 l) are particularly suitable for large requirements and low operating and permissible differential pressure.

Airbus A 320

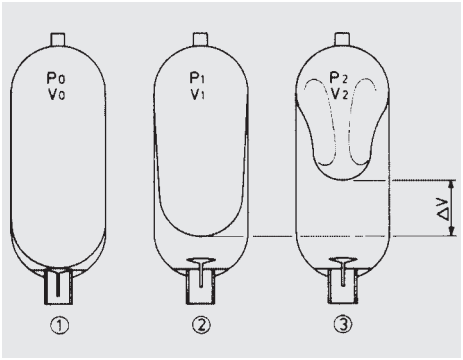
HYDAC bladder accumulators in composite material are used in the A 320 Airbus in the hydraulic braking and wing control system to provide back-up for the pump and pulsation damping.

The composite construction (steel/synthetic fibres) reduces the weight by half, compared with the conventional steel shell.

3. ACCUMULATOR SIZING

3.1. DEFINITION OF VARIABLES

p_0 = gas pre-charge pressure
p_1 = min. working pressure
p_2 = max. working pressure
V_0 = effective gas volume
V_1 = gas volume at p_1
V_2 = gas volume at p_2
t_0 = gas pre-charge temperature
t_{min} = min. working temperature
t_{max} = max. working temperature



① The bladder is pre-charged with nitrogen. The oil valve is closed and prevents the bladder from coming out of the shell.

② When the minimum working pressure is reached, there should be a small quantity of fluid between bladder and check valve (approx. 10% of the accumulator volume), so that the bladder does not hit the valve every time it expands, as this could cause damage.

③ Accumulator at maximum working pressure. The difference in volume between the position at minimum and maximum working pressure corresponds to the effective fluid volume

$\Delta V = V_1 - V_2$.

3.2. SELECTION OF GAS PRE-CHARGE PRESSURE

HYDAC bladder accumulators are designed to use 75% of the effective gas volume.
Therefore the ratio between nitrogen pre-charge pressure and maximum working pressure should not exceed 1 : 4. On the other hand, the gas pre-charge pressure should not exceed 90% of the minimum system pressure.
Keeping to these criteria guarantees that the bladder will last as long as possible.

Other pressure ratios can be achieved by special means.

In order to obtain optimum efficiency of the accumulator, it is recommended that the following values are maintained:

Energy accumulation:

$p_{0,\,t_{max}} = 0.9 \times p_1$

Shock absorption:

$p_{0,\,t_{max}} = 0.6$ to $0.9 \times p_m$
(p_m = average working pressure at free flow)

Pulsation damping:

$p_{0,\,t_{max}} = 0.6 \times p_m$
(p_m = average working pressure)
or
$p_{0,\,t_{max}} = 0.8 \times p_1$
(at several working pressures).

3.2.1 Critical values for gas pre-charge pressure

$p_0 \leq 0.9 \times p_1$
with a permissible pressure ratio of
$p_2 : p_0 \leq 4 : 1$.

On HYDAC low pressure accumulators, it is also important to note:

Type SB 40: $p_{0\,max} = 20$ bar
Type SB 35 HB: $p_{0\,max} = 10$ bar.

3.2.2 Temperature effect

So that the recommended gas pre-charge pressures can be maintained, even at relatively high working temperatures, the $p_{0,\,t_0}$ for filling and testing cold accumulators should be chosen as follows:

$$p_{0,\,t_0} = p_{0,\,t_{max}} \times \frac{t_0 + 273}{t_{max} + 273}$$

t_0 = pre-charge temperature (°C)
t_{max} = max. work. temperature (°C)

In consideration of the temperature effect during accumulator sizing the pre-charge pressure p_0 at min. temperature t_{min} should be chosen as follows:

$$p_{0,\,t_{min}} = p_{0,\,t_{max}} \times \frac{t_{min} + 273}{t_{max} + 273}$$

3.3. FORMULAE FOR SIZING ACCUMULATORS

The compression and expansion processes taking place in a bladder accumulator are governed by the polytropic change of state. The following applies for ideal gases:

$p_0 \times V_0^{\,n} = p_1 \times V_1^{\,n} = p_2 \times V_2^{\,n}$

where time is represented by the polytropic power "n".

For slow expansion and compression processes which occur almost isothermally, the polytropic power can be set at n = 1. For rapid processes, an adiabatic change in state can be calculated using $n = \chi = 1.4$ (for nitrogen, as a diatomic gas)[1].
For pressures above 200 bar the actual gas behaviour differs considerably from the ideal behaviour, with the result that the effective volume ΔV is reduced.
In such cases this can be corrected by altering the χ value.

By using the following formulae, the required gas volume V_0 can be calculated for various applications.
Pressures of up to approx. 10 bar must always be used as absolute pressures in the formulae.

Calculation formulae:

polytropic: $$V_0 = \frac{\Delta V}{\left(\frac{p_0}{p_1}\right)^{\frac{1}{n}} - \left(\frac{p_0}{p_2}\right)^{\frac{1}{n}}}$$

isothermal ($n = 1$): $$V_0 = \frac{\Delta V}{\frac{p_0}{p_1} - \frac{p_0}{p_2}}$$

adiabatic ($n = \chi = 1.4$): $$V_0 = \frac{\Delta V}{\left(\frac{p_0}{p_1}\right)^{0.714} - \left(\frac{p_0}{p_2}\right)^{0.714}}$$

Correction factors for taking into account the real gas behaviour [2]:

for isothermal change of state:

$$C_i = \left(\frac{V_{0\,real}}{V_{0\,ideal}}\right)_{isothermal} \quad \text{or}$$

$$C_i = \left(\frac{\Delta V_{ideal}}{\Delta V_{real}}\right)_{isothermal}$$

for adiabatic change of state:

$$C_a = \left(\frac{V_{0real}}{V_{0ideal}}\right)_{adiabatic} \quad \text{or}$$

$$C_i = \left(\frac{\Delta V_{ideal}}{\Delta V_{real}}\right)_{adiabatic}$$

1) One can estimate the accumulator size and choice of pre-charge pressures according to the explanations given in points 3.2. and 3.2.1. The precise calculation, taking further limiting factors into account, can be carried out by us on request; we have appropriate programmes for this purpose.

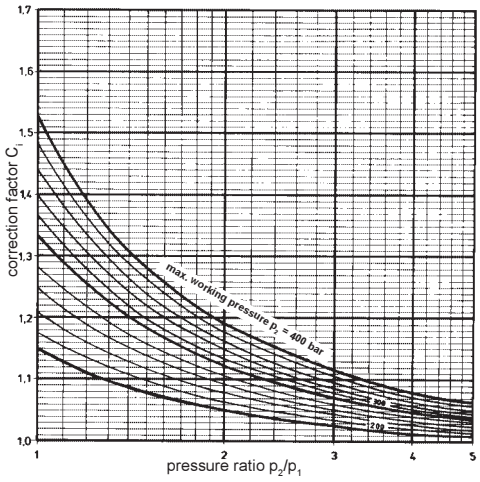
2) The correction factors can be taken directly from the diagrams on page 7 depending on pressure ratio p_2/p_1 and the maximum working pressure given as a parameter p_2 for an isothermal or adiabatic change in state.

Checking the effective volume on a back-up version

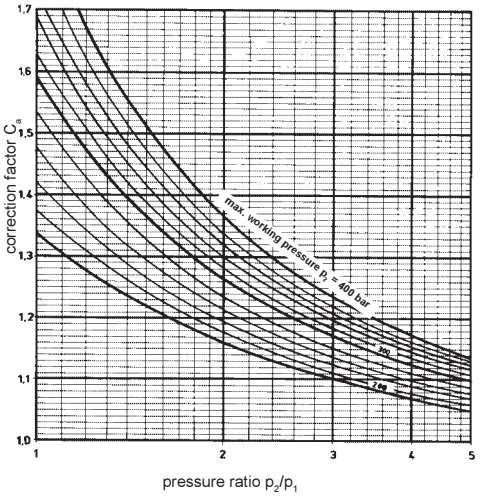
$$\Delta V' = V_{0\,(total)} \times \left(1 - \frac{p_0}{p_2}\right)$$

$$\Delta V' \leq 0.75 \times V_{0\,(accum.)}$$

3.3.1 Correction factors for isothermal change of state



3.3.2 Correction factors for adiabatic change of state



3.4. BACK-UP NITROGEN BOTTLES

With low pressure differentials between min. and max. working pressure, the nitrogen in the accumulator can only be compressed slightly. As a result the effective portion of accumulator volume is correspondingly small. When sizing so-called "back-up" type accumulators, the same principle is used as for individual accumulators, where V_0 represents the total volume of accumulator and nitrogen bottles.

On back-up accumulators, the accumulator should only be charged to 75% of its fluid capacity to avoid the bladder being compressed too much.

The gas pre-charge can be higher than 0.9 times the min. working pressure, so that when discharged to min. working pressure p_1, a residual fluid volume ΔV_R of approx. 10% of the accumulator volume remains.

The calculation must be iterative. After each stage, check whether the effective volume is sufficient to take up the oil quantity during isothermal charging, from gas pre-charge pressure to working pressure.

3.5. CALCULATION EXAMPLE

For an injection moulding machine 5 litres of oil are required in 2.5 seconds.

The max. working pressure is 200 bar, the min. working pressure must not go below 100 bar. The charging time is 8 seconds and the working temperature is stated as between 25 °C and 45 °C.

Parameters:

max. working pressure:
p_2 = 201 bar

min. working pressure:
p_1 = 101 bar

effective volume:
ΔV= 5 l

max. working temperature:
t_{max} = 45 °C

min. working temperature:

t_{min} = 25 °C

Required:

1. required gas volume, taking into account the real gas behaviour.
2. gas pre-charge pressure p_0 at 20 °C.
3. accumulator type

Solution:

Since this is a rapid process, an adiabatic change of state is assumed.

1. Determination of required gas volume:

a) gas pre-charge pressure at t_{max}:

$$p_{0,t_{max}} = 0.9 \times p1$$
$$= 0.9 \times 101 \approx 91 \text{ bar}$$

b) gas pre-charge pressure at t_{min}:

$$p_{0,\,t_{min}} = p_{0,\,t_{max}} \times \frac{t_{min} + 273}{t_{max} + 273}$$

$$= 91 \text{ bar} \times \frac{25 + 273}{45 + 273}$$

$$\approx 85.3 \text{ bar}$$

c) ideal gas volume:

$$V_{0\,ideal} = \frac{\Delta V}{\left(\frac{p_0}{p_1}\right)^{0.714} - \left(\frac{p_0}{p_2}\right)^{0.714}}$$

$$= \frac{5}{\left(\frac{85.3}{101}\right)^{0.714} - \left(\frac{85.3}{201}\right)^{0.714}}$$

$$= 14.53 \text{ l}$$

d) correction factor from diagram 3.3.2:

p_2/p_1 ~ 2.0

$\rightarrow C_a$ = 1.16

e) real gas volume:

$$V_{0\,real} = C_a \times V_{0\,ideal}$$
$$= 1.16 \times 14.53 \text{ l}$$
$$= 16.85 \text{ l}$$

2. Determination of gas pre-charge pressure p_0 at 20 °C:

$$p_{0,\,20\,°C} = p_{0,\,t_{max}} \times \frac{t_{min} + 273}{t_{max} + 273}$$

$$= 91 \text{ bar} \times \frac{20 + 273}{45 + 273}$$

$$= 83.8 \text{ bar (absolute)}$$

3. Selected:
SB 330 - 20 A 1 / 112 A - 330 A
$p_{0,\,20\,°C}$ = 83 bar

4. RECOMMENDATIONS

4.1. GENERAL

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 accumulators (repairs, connecting pressure gauges etc) must only be carried out once the pressure and fluid have been released.

Please observe operating instructions!

4.2. EXTRACT FROM THE APPROVAL SPECIFICATIONS

4.2.1 **Federal Republic of Germany**

As pressure vessels, hydraulic accumulators are subject to the (German) Pressure Vessel Regulations (DruckbehV).
The design, manufacture and testing is in accordance with AD notices. Installation, equipment and operation are controlled by the "Technical Regulations - Pressure Vessels (TRB)". The pressure vessels of hydraulic accumulators are divided into groups according to the permissible operating pressure p in bar, the capacity l in litres and the pressure capacity p x l.

The Pressure Vessel Regulations (DruckbehV) remain in force until 29.05.2002 in parallel with the Pressure Equipment Directive 97/23/EC (transitional regulation), see point 4.2.3.

The following tests are prescribed for each group:

Group	Tests before comissioning at manufacturer's	at user's	Recurrent testing
II $p > 25$ bar and $p \times l \leq 200$	Manufacturer confirms satisfactory manufacture and testing, either by stamping "HP" or by certificate.	Inspection certificate (accuracy test, test of equipment and installation) by authorities.	Test periods must be set by user according to experience of operating method and operating fluid.
III $p > 1$ bar, $p \times l > 200$ and $p \times l \leq 1000$	Preliminary inspection by authorities Construction and pressure testing and certification through manufacturer (registration of design), or through authorities (individual certificate)	Inspection certificate from authorities	As for Group II
IV $p > 1$ bar and $p \times l > 1000$	As for Group III	As for Group III	Internal test: every 10 years for non-corrosive fluids, otherwise every 5 years. Pressure test every 10 years. Testing to be carried out by authorities

HYDAC bladder accumulators fitted with the HYDAC Safety and Shut-off Block comply with the safety regulations laid down by TRB. Please refer to brochure no. 3.551. "Safety and Shut-off Block SAF/DSV".

U-Stamp certificate

HYDAC Technology GmbH of D-66280 Sulzbach is authorised (with effect from 21 August 1985) by the National Board of Boiler and Pressure Vessel Inspectors, in conformity with the appropriate specifications of the American Society of Mechanical Engineers (ASME), to use the Code Symbol

as a stamp and for registration purposes.

4.2.2 **Other countries**

Pressure accumulators which are installed in other countries are supplied with the test certificates required in the country. The user country must be stated when ordering. The German certificate is not generally accepted in all countries.

HYDAC pressure vessels can be supplied with virtually any test certificate.
The permissible working pressure can differ from the nominal pressure.

The following table contains the codes used in the model code for different countries:

Australia	F
Austria	D
Belgium	H
Brazil	K
Canada	S1
CIS	A6
Czech. Rep.	A3
Denmark	A5
EU member states	U
Fed. Rep. of Germany	A
Finland	L
France	B
Great Britain	K
India	N
Italy	M
Japan	P
Luxembourg	A1
Netherlands	C
New Zealand	T
Norway	A1
Poland	A4
Portugal	K
Rep. of Ireland	K
Romania	K
Slovakia	A8
South Africa	E
Spain	A2
Sweden	R
Switzerland	G
USA	S
others on request	

4.2.3 **European pressure equipment directive PED (DGRL/DEP)**

On 29 November 1999 the directive 97/23/EC (pressure equipment directive) came into force. This directive applies to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum permissible pressure of over 0.5 bar. It guarantees the free movement of goods within the European Community. EU member states must not prohibit, restrict or obstruct the circulation and commissioning of pressure equipment on account of pressure related hazards, if the equipment complies with the requirements of the pressure equipment directive and has the CE mark, and is subject to a conformity assessment.

According to Article 3, Paragraph 3, hydraulic accumulators with a capacity $V \leq 1$ l, a maximum permissible pressure $PS \leq 1000$ bar and a pressure capacity $PS \times V \leq 50$ bar x l do not receive a CE mark. Operational safety and repeat testing are controlled as before by national laws.

5. TECHNICAL SPECIFICATIONS

5.1. MODEL CODE

(also order example)

SB 330 H - 32 A 1 / 112 B - 280 A

Series

Type
H = High Flow
A = shock absorber
P = pulsation damper
S = suction flow stabiliser
B = bladder top-repairable
Combinations possible: e.g. HB – High Flow with a top-repairable bladder or PH pulsation damper with high flow rate.
No details = standard

Nominal volume in l

Fluid connection
A = standard connection, thread with internal seal face
F = flange connection
C = valve mounting with screws on underside
E = sealing surfaces on the front interface (e.g. on thread M50 x 1.5)
G = male thread
S = special connection according to customer specification

Gas side
1 = standard model
2 = back-up model
3 = gas valve 7/8-14UNF with M8 female thread
4 = 5/8" gas valve
5 = gas valve M50 x 1.5 in accumulators smaller than 50 l
6 = 7/8-14UNF gas valve
7 = M28 x 1.5 gas valve
8 = M16 x 1.5 gas valve
9 = special gas valve according to customer specification

Material code [1]
112 = standard for mineral oil
depending on operating medium
others on request

Fluid connection
1 = carbon steel
2 = stainless steel 1.4021
3 = stainless steel (Niro) [3]
6 = low temperature steel

Accumulator shell
0 = elastomer (coated internally)
1 = carbon steel
2 = chemically nickel plated (internally)
4 = stainless steel (Niro) [3]
6 = low temperature steel

Accumulator bladder [2]
2 = NBR
3 = ECO
4 = IIR (Butyl)
5 = TT-NBR (low temperature)
6 = FPM
7 = others

User country
A = Federal Republic of Germany
For other countries see table page 8

Permissible operating pressure (bar)

Connection
Thread, codes for fluid connections: A, C, E, G
A = thread to ISO 228 (BSP)
B = thread to DIN 13 or ISO 965/1 (metric)
C = thread to ANSI B1.1 (UN..-2B seal to SAE J 514)
D = thread to ANSI B1.20.1 (NPT)
S = special thread according to customer specification

Flange, codes for fluid connection: F
A = DIN flange
B = flange ANSI B 16.5
C = SAE flange 3000 psi
D = SAE flange 6000 psi
S = special flange according to customer specification

Required gas pre-charge pressure must be stated separately!

1) Not all combinations are possible.
2) When ordering spare bladders, please state bladder connection port size.
3) Depending on type and pressure rating.

5.2. GENERAL

5.2.1 **Working pressure**
see tables
In some countries this can differ from the nominal pressure.

5.2.2 **Nominal volume**
see tables

5.2.3 **Effective gas volume**
see tables; based on nominal dimensions; this differs slightly from the nominal volume and is to be used when calculating the effective volume.

5.2.4 **Effective volume**
The fluid volume available between the working pressures p_2 and p_1.

5.2.5 **Max. pressure fluid flow rate**
In order to achieve the max. flow rate given in the tables, the accumulator must be mounted vertically. It has to be taken into account that a residual fluid volume of approx. 10% of the effective gas volume remains in the accumulator.

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

5.2.7 **Gas charging**
Do not use oxygen when charging bladder accumulators (risk of explosion): nitrogen only.
Before dispatch all bladder accumulators are supplied with a protective pre-charge.

Higher pressures are possible on request.

5.2.8 **Permissible operating temperature**
-10 °C to +80 °C
(263 to 353 K)
Others on request.

5.2.9 **Permissible pressure ratio**
Ratio of max. working pressure p_2 to gas pre-charge pressure p_0 (see point 3.2.1).

6. HIGH PRESSURE ACCUMULATORS

6.1. STANDARD BLADDER ACCUMULATORS SB 330/400/500/550

6.1.1 **Construction**

HYDAC standard bladder accumulators consist of the pressure vessel, the flexible bladder with prevulcanised gas valve and the hydraulic connector with check valve. The pressure vessel is seamless and manufactured from high tensile steel according to the certification regulations. For chemically aggressive fluids the shell can be treated with various corrosion protectives, e.g. elastomer coating or chemical nickel plating, or can be manufactured in stainless steel. The bladder is available in the elastomers listed in point 5.1.

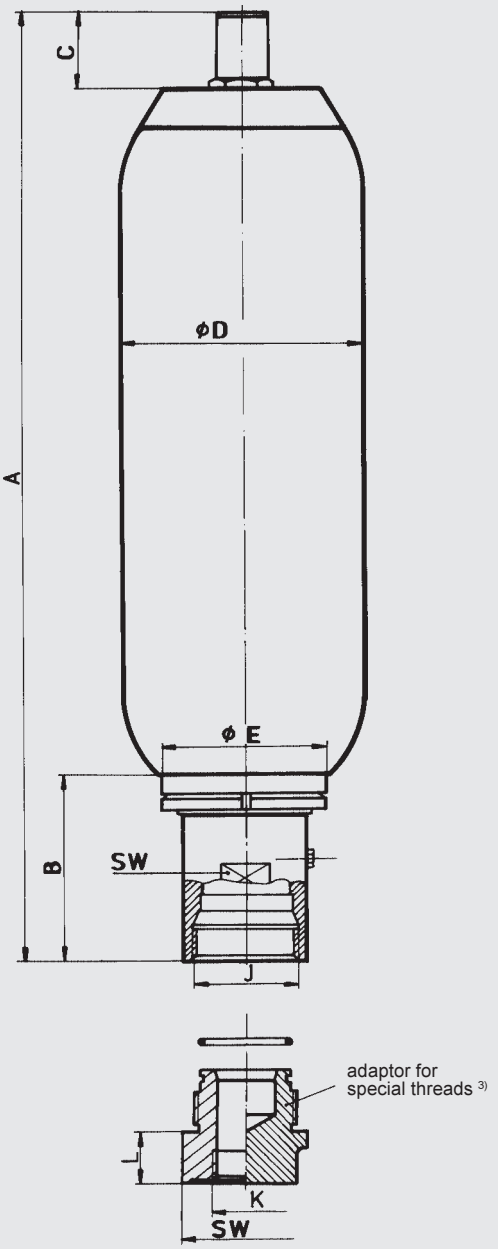
6.2. HIGH FLOW BLADDER ACCUMULATORS SB 330 H

6.2.1 **Construction**

HYDAC high flow bladder accumulators, type SB 330 H, are high performance accumulators with a feed flow of up to 30 l/s. The construction of these accumulators is the same as the standard bladder accumulators:

The fluid connection is enlarged to allow higher feed flows.
The same material combinations are available for the high flow pressure accumulators as for the standard models.

Dimensions



6.3. DIMENSIONS

Nom. volume litres	Max. [2] working pressure (*)	Eff. gas volume litres	Weight kg	A max. mm	B mm	C mm	ØD max. mm	J thread ISO 228	E Ø	SW mm	Q [1] l/s
0.5	400	0.5	2.8	270	57	33.5	90	G 3/4	50	32	4
1	330	1.0	4.5	302		58	118				
	550		8.5	334	68		121	G 1	67	45	
2.5	330	2.4	10	532	63		118	G 1 1/4		50	10
	550	2.5	13.5	539	68		121	G 1		45	4
4	330	3.7	11.5	410	63		173	G 1 1/4		50	10
	400		15.5				172				
5	550	4.9	23	887	68		121	G 1		45	4
6	330	5.7	15	540	63		173	G 1 1/4		50	10
10	330	9.3	31.5	568	103		222	G 2	100	70	15
	400		37.5	572			229				
	500	8.8	37.5	585	77	68	234		110	75	
13	330	12.0	43	660	103	58	229		100	70	
	400		49	666							
20	330	18.4	50.5	896							
	400		63.5				223				
	500	17	75.5	901	77	68	241		110	75	
24	330	23.6	69	1062	103		229		100	70	
32	330	33.9	87	1411							
	400		104.5				233				
	500	33.5	127	1446	77		241		110	75	
50	330	47.5	117.5	1931	103		229		100	70	
	400		142				233				
	500	48.3	169	1951	77		241		110	75	

SB 330 H max. working pressure 330 bar (TRB/AD Regulations)

Nom. volume litres	Effective gas volume litres	Weight kg	A max. mm	B mm	C mm	D Ø mm	J thread ISO 228	E Ø mm	SW mm	Q [1] l/s
10	9	34.5	603	138	58	222	G 2 1/2	125	90	30
13	12	46	695							
20	17.5	53.5	931			229				
24	24	72	1097							
32	32.5	90	1446							
50	47.5	120.5	1966		68					

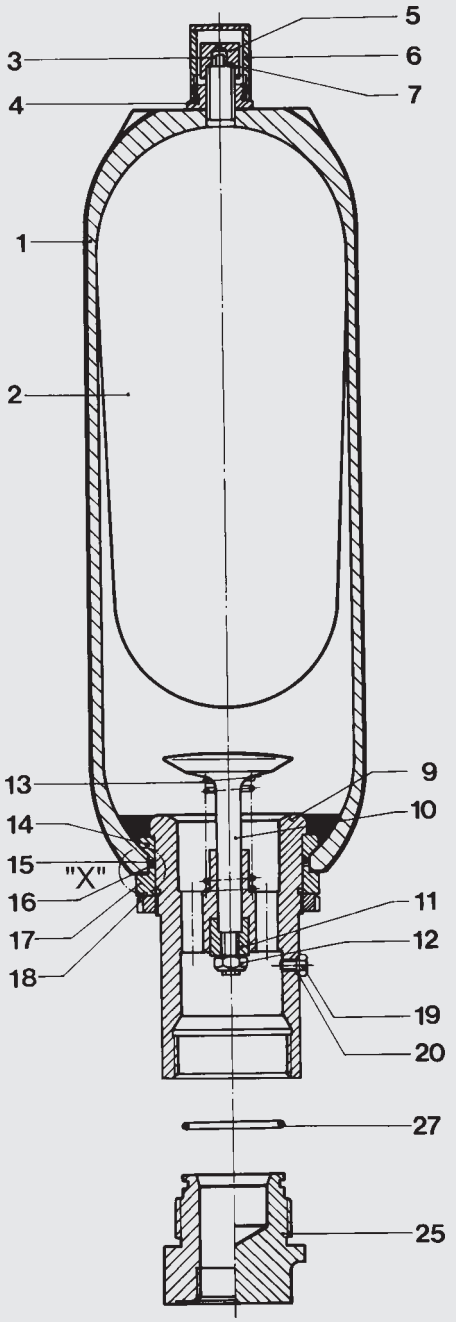
Adaptors [3]

Series	Nominal volume litres	J ISO 228	K ISO 228	L mm	SW mm
SB 330/400	0.5 to 1	G 3/4	G 3/8	27	32
	2.5 to 6	G 1 1/4	G 3/4	13	46
	10 to 50	G 2	G 1 1/2	36	65
SB 330 H	10 to 32 and 50	G 2 1/2	G 2	40	100
	10 to 50	G 3			
SB 550	1 to 5	G 1	G 3/4	31	46

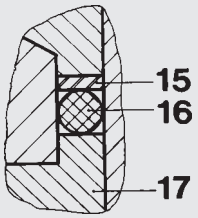
[1] Q = max. operating fluid flow rate
[2] corresponds to series SB …; for 400 and 550 bar, material is 212 (standard)
[3] to be ordered separately
* TRB/AD Regulations

6.4. SPARE PARTS

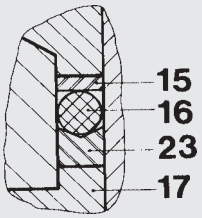
SB 330/400/440/500/550
SB 330 H



Detail "X"
SB 330/400 – 0.5 to 6 l



SB 330/400/500 – 10 to 50 l and
SB 330 H - 10 to 75 l
SB 550 - 1 to 5 l



Description	Item
Anti-extrusion ring	14
Oil valve complete, consisting of:	
Oil valve body	9
Valve	10
Damping sleeve	11
Safety nut	12
Valve spring	13
Anti-extrusion ring	14
Washer	15
O-ring (see above)	16
Spacer	17
Lock nut	18
Vent screw	19
Seal ring	20
Support ring	23
Seal kit * consisting of:	
O-ring (see above)	7
Washer	15
O-ring (see above)	16
Seal ring	20
Support ring	23
O-ring (see above)	27

Description	Item
Gas valve insert *	3
Repair kit * [2] consisting of:	
Bladder	2
Gas valve insert	3
Lock nut	4
Cap nut	5
Valve protection cap	6
O-ring 7.5 x 2.0 [1]	7
Washer	15
O-ring 90 Shore: SB 330 H: Size 10 - 50 l = 100 x 5 [1] Size 35, 56, 75 l = 110 x 8	16
SB 330/400: Size 0.5 - 1 l = 37.69 x 3.53 Size 2.5 - 6 l = 55 x 3.5 [1] Size 10 - 50 l = 80 x 5 [1]	
SB 550: Size 1; 2.5 - 5 l = 50.17 x 5.33	
Seal ring	20
Support ring	23
O-ring 90 Shore: SB 330 H: Size 10 - 50 l = 62 x 4 [1] Size 35, 56, 75 l = 72 x 4	27
SB 330/400: Size 0.5 - 1 l = 17 x 3 [1] Size 2.5 - 6 l = 30 x 3 [1] Size 10 - 50 l = 48 x 3 [1]	
SB 550 Size 1; 2.5 - 5 l = 22.3 x 3 [1]	

* Recommended spare parts
[1] For code 663 and 665 different dimensions.
[2] When ordering please state bladder connection port size.
Item 1 not available as spare part
Item 25 has to be ordered separately (see page 11)
[3] TRB/AD Regulations

6.5. HIGH PRESSURE ACCUMULATORS SB 800/1000

6.5.1 Construction

HYDAC high pressure bladder accumulators, type SB 800/1000, consist of a pressure vessel in high tensile steel and a flexible bladder to separate the nitrogen from the operating fluid. At the base of the bladder is a prevulcanised valve which shuts off the hydraulic outlet when fully empty and prevents damage to the bladder.

6.5.2 Dimensions available on request

Max. working pressure ([3])	Nom. volume litres	Eff. gas volume litres	Weight kg
800	1.5	1.3	31
1000			86
1000	10	10	180

7. LOW PRESSURE ACCUMULATORS

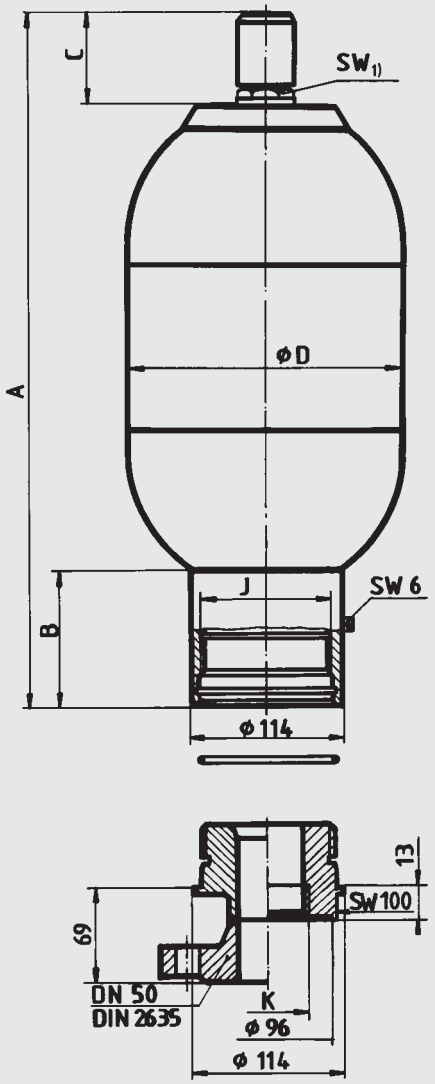
7.1. STANDARD BLADDER ACCUMULATORS SB 40

7.1.1 Construction

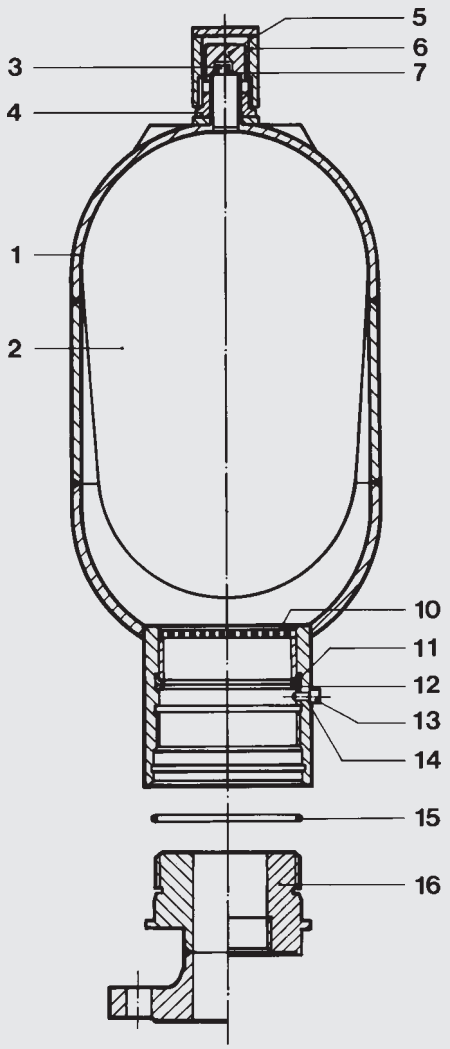
HYDAC standard low pressure accumulators consist of:

- a welded pressure vessel which can be treated with various corrosion protectives against chemically aggressive fluids, or supplied in stainless steel.
- the bladder with gas valve. The bladders are available in the elastomers listed under point 5.1.
- the hydraulic connector with a perforated disc which is held in place with a retaining ring.

7.1.2 Dimensions SB 40 - 2.5 ... 50



7.1.3 Spare parts SB 40 - 2.5 ... 50



SB 40

Perm. work. pressure 40 bar (3)

Nom. volume litres	Eff. gas volume litres	Weight kg	A mm	B mm	C mm
2.5	2.5	9	541	122	68
5	5.0	13	891		
10	8.7	14	533	106	
20	18.0	23	843		
32	33.5	38	1363		
50	48.6	52	1875		

Nom. volume litres	D Ø mm	J Thread ISO DIN 13	K 2) Thread ISO 228	SW_1 mm	Q 1) l/s
2.5	108	M100 x 2	G 2	36	5
5					
10	219				
20					
32					
50					

1) Q = flow rate (at approx. 0.5 bar pressure drop via adaptor)
2) Item 16 must be ordered separately
3) TRB/AD Regulations

Description	Item
Gas valve insert *	3
Repair kit * consisting of:	
Bladder	2
Gas valve insert	3
Lock nut	4
Cap nut	5
Valve protection cap	6
O-ring 7.5 x 2.0	7
Seal ring	14
O-ring 102 x 3	15
Hydraulic connector, complete, consisting of:	
Perforated disc	10
Anti-extrusion ring	11
Retaining ring	12
Vent screw	13
Seal ring	14
O-ring 102 x 3	15
O-ring 102 x 3	15

* Recommended spare parts
Item 1 not available as a spare part.

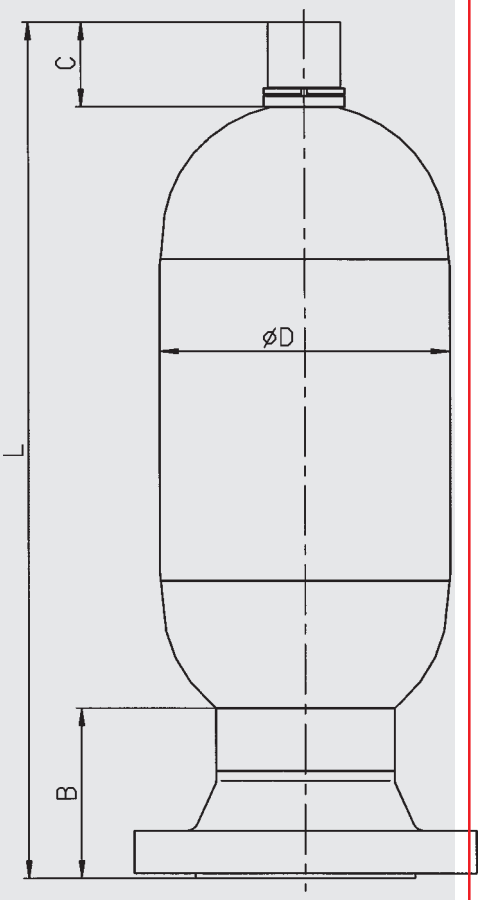
7.2. BLADDER ACCUMULATOR SB 40 - 70 ... 200

7.2.1 Construction

HYDAC low pressure accumulators, type SB 40 – 70 … 200, consist of:

- a welded pressure vessel which is compact and yet suitable for high flow rates and large volumes. The pressure vessel is manufactured in carbon steel, or in stainless steel.
- the accumulator bladder with gas valve. The bladders can be manufactured in NBR or ECO. Other bladder materials on request.
- the hydraulic connector with welded flange and a fitted perforated plate which is held in place with a retaining ring.

7.2.2 Dimensions



SB 40 - 70 ... 200

Perm. work. pressure 40 bar (3)

Nom. volume litres	Eff. gas volume litres	Weight kg	L (DIN Flange) mm	L (ANSI Flange) mm
70	67	136	1155	1200
100	94	164	1475	1520
130	122	192	1805	1850
200	193	265	2655	2700

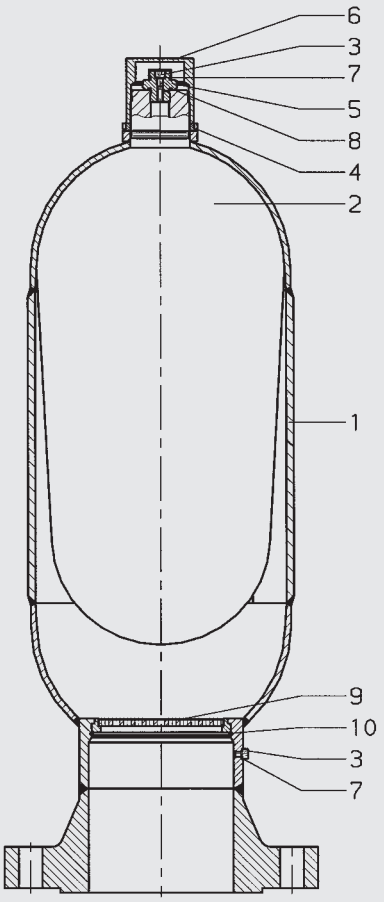
Nom. volume litres	B (DIN Flange) mm	B (ANSI Flange) mm	C mm	D mm
70	177	222	111	355.6
100				
130				
200				

3) TRB/AD Regulations

DIN flange:
Flange C 200 x 219.1 DIN 2635

ANSI flange:
ANSI B16.5 - 8" - 600 lbs

7.2.3 Spare parts



Description	Item
Repair kit * consisting of:	
Bladder	2
Venting and charging screw	3
Lock nut M79 x 2	4
Gas valve	5
Valve protection cap	6
Seal ring	7
O-ring	8
Perforated insert, complete, consisting of:	
Perforated disc	9
Retaining ring	10

* Recommended spare parts
Item 1 not available as a spare part.

7.3. HIGH FLOW BLADDER ACCUMULATORS SB 35 HB

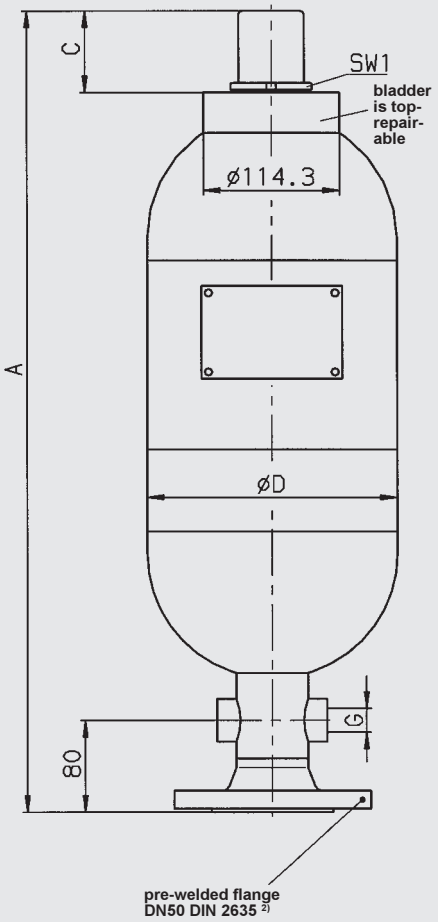
7.3.1 Construction

HYDAC high flow bladder accumulators, type SB 35 HB, are high performance accumulators for flow rates of up to 140 litres/second.

They consist of a pressure vessel in a weld construction and a flexible bladder with gas valve.

The pressure vessel consists of a fixed perforated disc, permitting a high flow rate through its large free cross-section. For use with chemically aggressive fluids, the shell can be manufactured in stainless steel. See point 5.1. for bladder materials.

7.3.2 Dimensions SB 35 HB



SB 35 HB

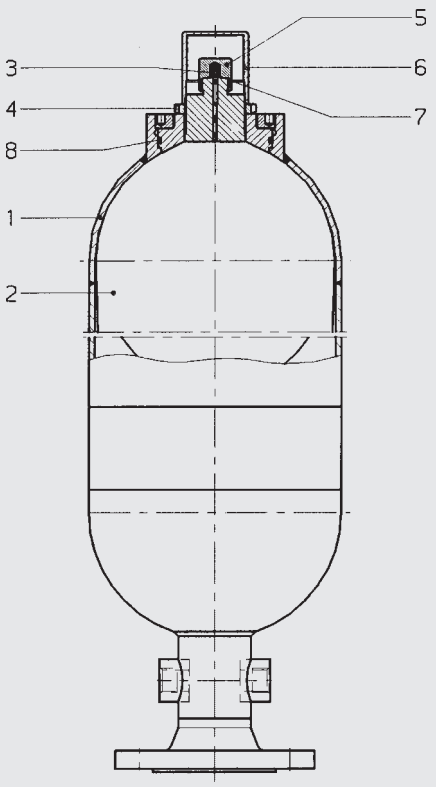
Perm. work. pressure 35 bar (4)

Nom. 2) volume litres	Effect. gas volume litres	Weight kg	A max. mm
20	19.8	43	1081
32	35.0	56	1591
50	50.0	69	2091

Nom. 2) volume litres	C mm	Ø D mm	G Thread ISO 228	SW_1 mm	Q 3) l/s
20	63	219	G 1/2	36	140
32					
50	78			Ø 68 1)	

1) Nut
2) Other sizes on request
3) Q = max. operating fluid flow rate
4) TRB/AD Regulations

7.3.3 Spare parts SB 35 HB



Description	Item
Gas valve insert *	3
Repair kit * consisting of:	
Bladder	2
Gas valve insert	3
Lock nut	4
Cap nut	5
Valve protection cap	6
O-ring 7.5 x 2.0	7
O-ring 84.5 x 3.0	8

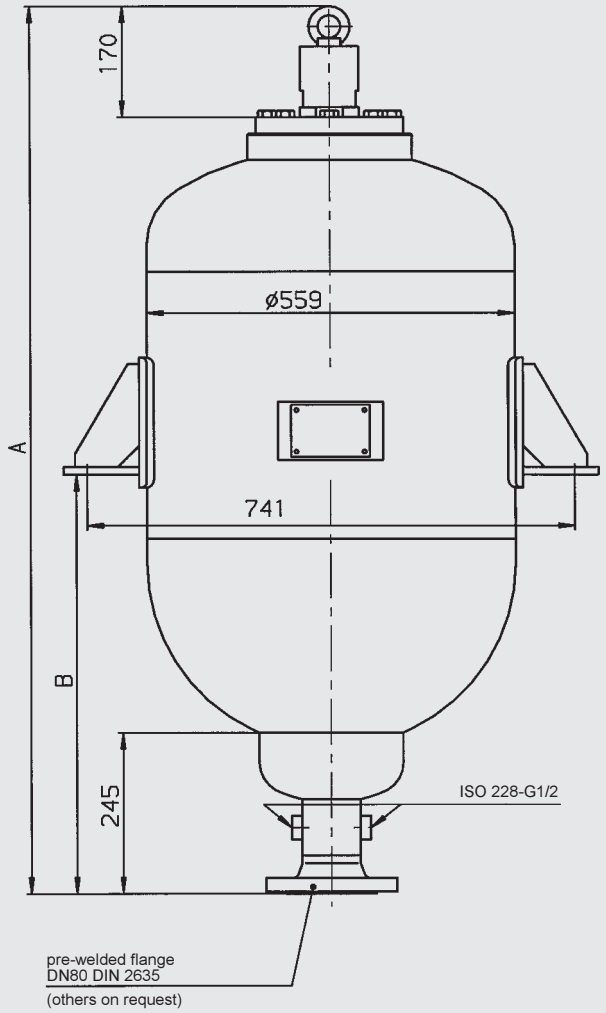
* Recommended spare parts
Item 1 not available as a spare part.

7.4. LOW PRESSURE ACCUMULATORS SB 35 A AND SB 16 A

7.4.1 **Construction**
HYDAC low pressure bladder accumulators for large volumes, type SB 35 A and SB 16 A, are welded constructions in carbon steel or stainless steel.
The hydraulic outlet is covered by a perforated disc, which prevents the flexible bladder from extruding from the shell. The bladder is top-repairable.

7.4.2 **Series SB ... AH**
Bladder accumulators, type SB … AH, have a connection assembly suitable for max. 140 l/s at approx. 2 bar pressure drop.

Series SB 35 AH



Dimensions

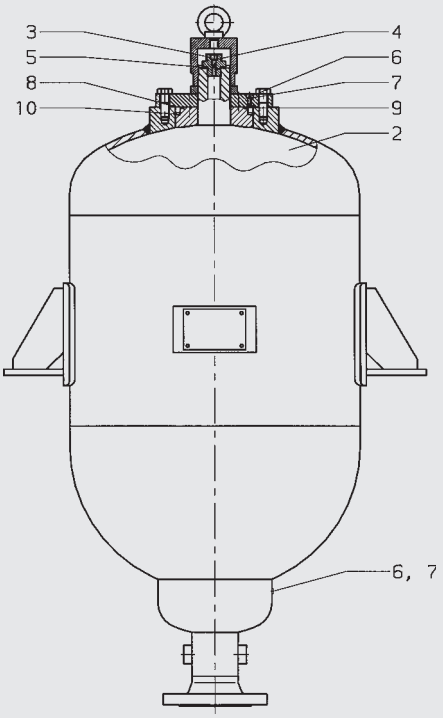
SB 35 AH - permiss. working pressure 35 bar (TRB/AD Regulations)					
Nom. volume litres	Effect. gas volume litres	Weight kg	A (approx.) mm	B (approx.) mm	DN * DIN 2635
100	104	144	1040	465	80
150	149	161	1240	565	
200	197	223	1500	850	
300	297	288	1950	1100	
375	370	326	2390	1350	
450	445	386	2785	1550	

SB 16 AH - permiss. working pressure 16 bar (TRB/AD Regulations)					
Nom. volume litres	Effect. gas volume litres	Weight kg	A (approx.) mm	B (approx.) mm	DN * DIN 2633
100	104	95	1045	465	100
150	149	112	1245	565	
200	197	133	1505	850	
300	297	166	2005	1100	
375	370	202	2395	1350	
450	445	248	2840	1550	

* other sizes on request

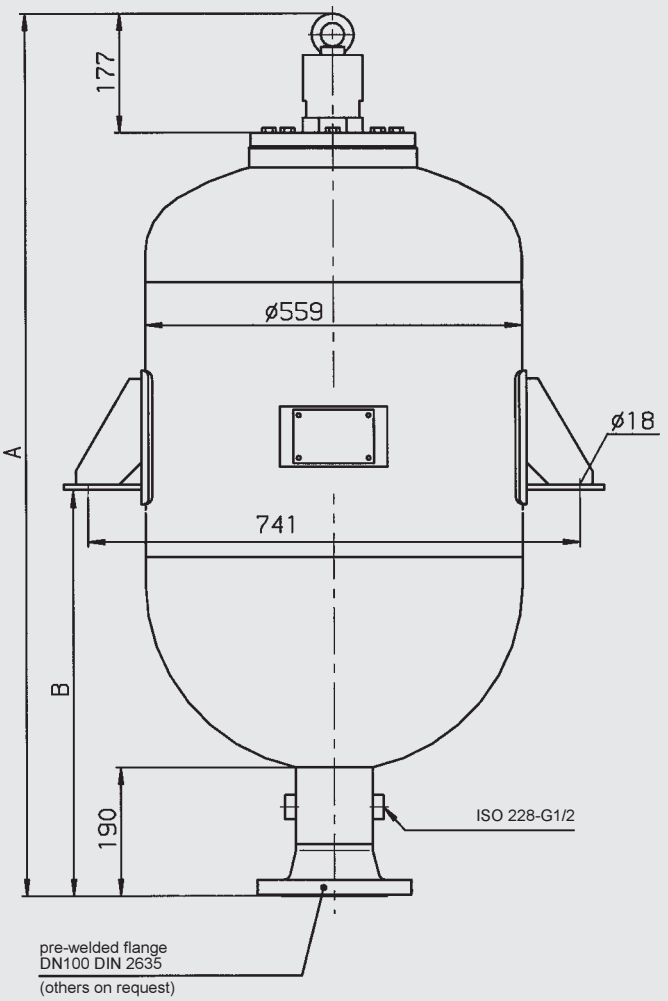
7.4.3 **Series SB ... A**
Bladder accumulators, type SB … A, have a connection assembly suitable for max. 30 l/s at a max. pressure drop of 2 bar.

Spare parts
SB 16 A, SB 35 A, SB 16 AH, SB 35 AH



Designation	Item
Accumulator bladder	2
Blanking plug	3
Seal ring	4
O-ring	5
Vent screw	6
Seal ring	7
O-ring	8
O-ring	9
Retaining ring	10

Series SB ... A



Dimensions

SB 35 A - permiss. working pressure 35 bar (TRB/AD Regulations)

Nom. volume litres	Effect. gas volume litres	Weight kg	A (approx.) mm	B (approx.) mm	DN * DIN 2635
100	104	144	1040	410	100
150	149	161	1240	510	
200	197	223	1500	795	
300	297	288	1950	1045	
375	370	326	2390	1295	
450	445	386	2785	1495	

SB 16 A - permiss. working pressure 16 bar (TRB/AD Regulations)

Nom. volume litres	Effect. gas volume litres	Weight kg	A (approx.) mm	B (approx.) mm	DN * DIN 2633
100	104	84	990	410	100
150	149	101	1240	510	
200	197	122	1450	795	
300	297	155	1900	1045	
375	370	191	2390	1295	
450	445	237	2735	1495	

* other sizes on request

8. BLADDER ACCUMULATORS BACK-UP TYPE SB 330-...A2

8.1. CONSTRUCTION

Based on the bladder accumulators 20 - 50 l, the gas side of these accumulators is designed especially for connecting to nitrogen bottles. A perforated anti-extrusion rod prevents damage to the bladder when the accumulator is charged.

This construction can also be used for the separation of fluids (taking into account the volume ratios valid for bladder accumulators).

Accumulators of the back-up type are available as high pressure accumulators (point 6) as well as low pressure accumulators (see point 7).

8.2. DIMENSIONS

Nom. volume litres	Effect. gas volume litres	Weight kg	A max. mm
20	17.5	53.5	905
24	24	72	1070
32	32.5	89	1420
50	47.5	119.5	1930

8.3. SPARE PARTS

Description	Item
Repair kit * consisting of:	
Bladder	2
Lock nut	4
O-ring 7.5 x 2.0 [1)]	7
Washer	15
O-ring 80 x 5 [1)]	16
Seal ring	20
Support ring	23
O-ring 48 x 3 [1)]	27
O-ring 22 x 2.5 [1)]	31
O-ring 11 x 2 [1)]	33
Anti-extrusion ring	14
Rod	30

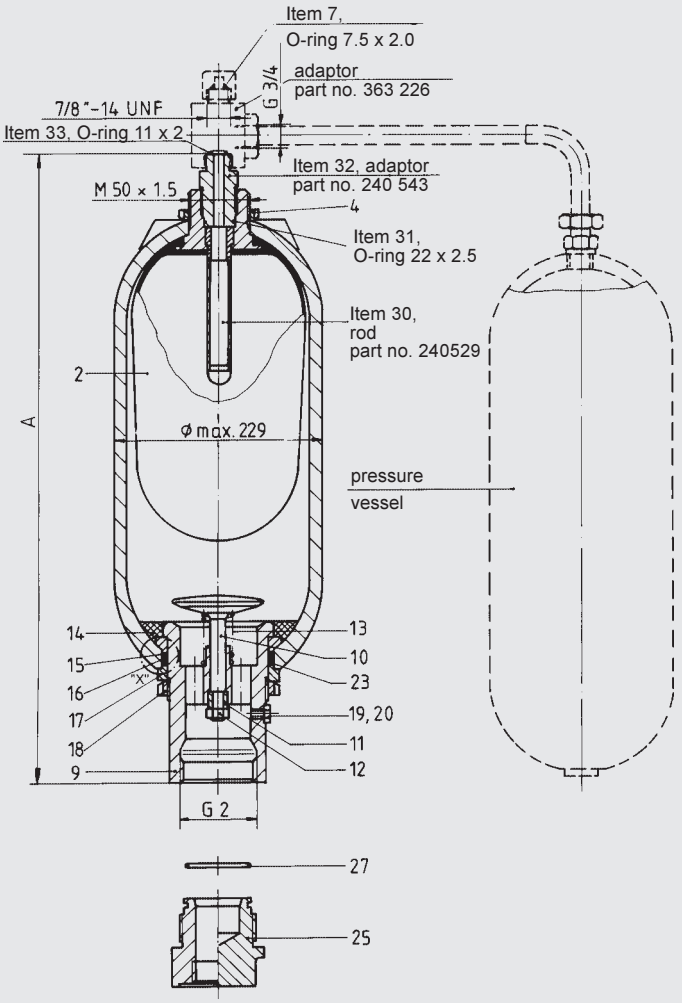
* Recommended spares

[1)] For code 663 and 665 different dimensions.

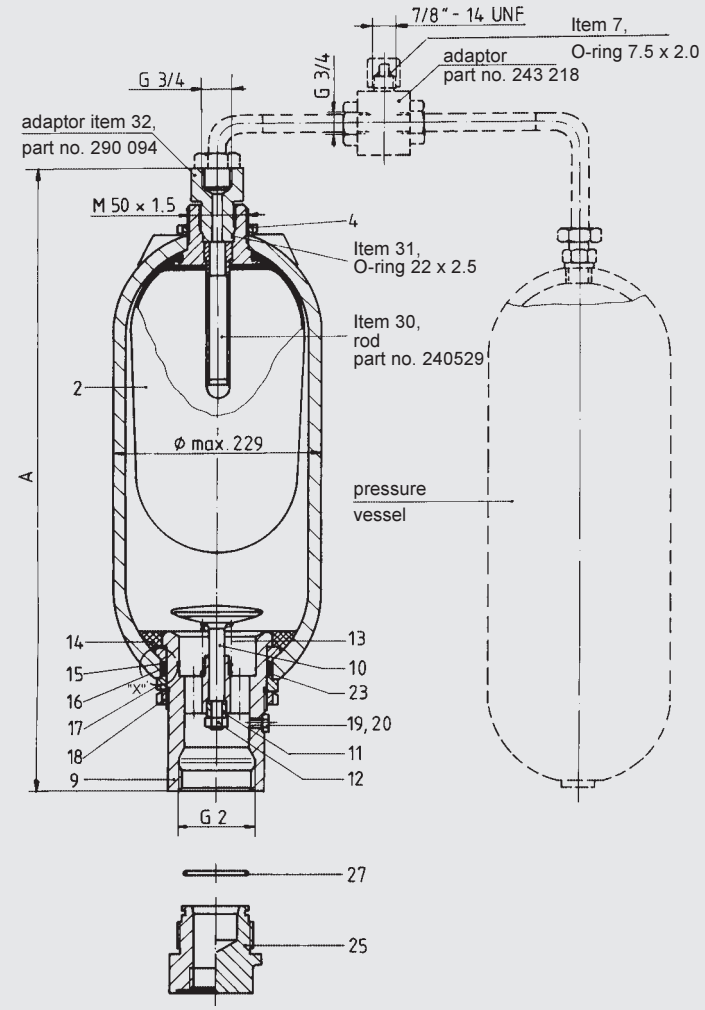
Item 1 not available as spare part.
Item 25 to be ordered separately.
Item 32 type 1 Standard.

Other spare parts – see point 6.

Type 1



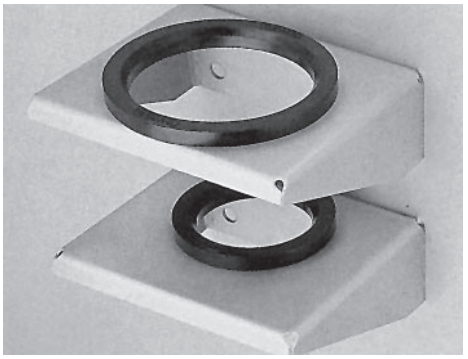
Type 2



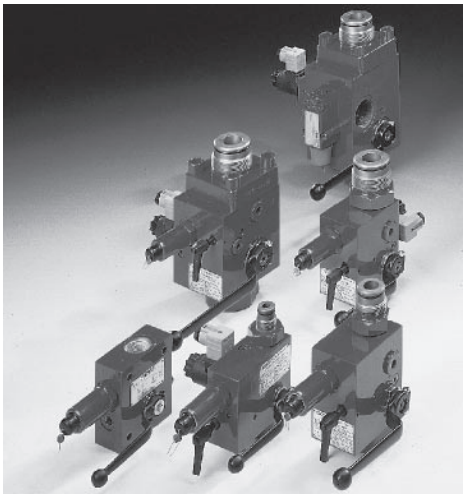
9. ACCUMULATOR UNIT ACCUSET

Compact, ready-to-install unit, consisting of hydraulic accumulator, safety and shut-off block and accumulator set.

10. ACCUMULATOR ACCESSORIES



Accumulator Support
Accumulator sets, clamps, consoles and rubber support rings for optimum mounting of accumulators.

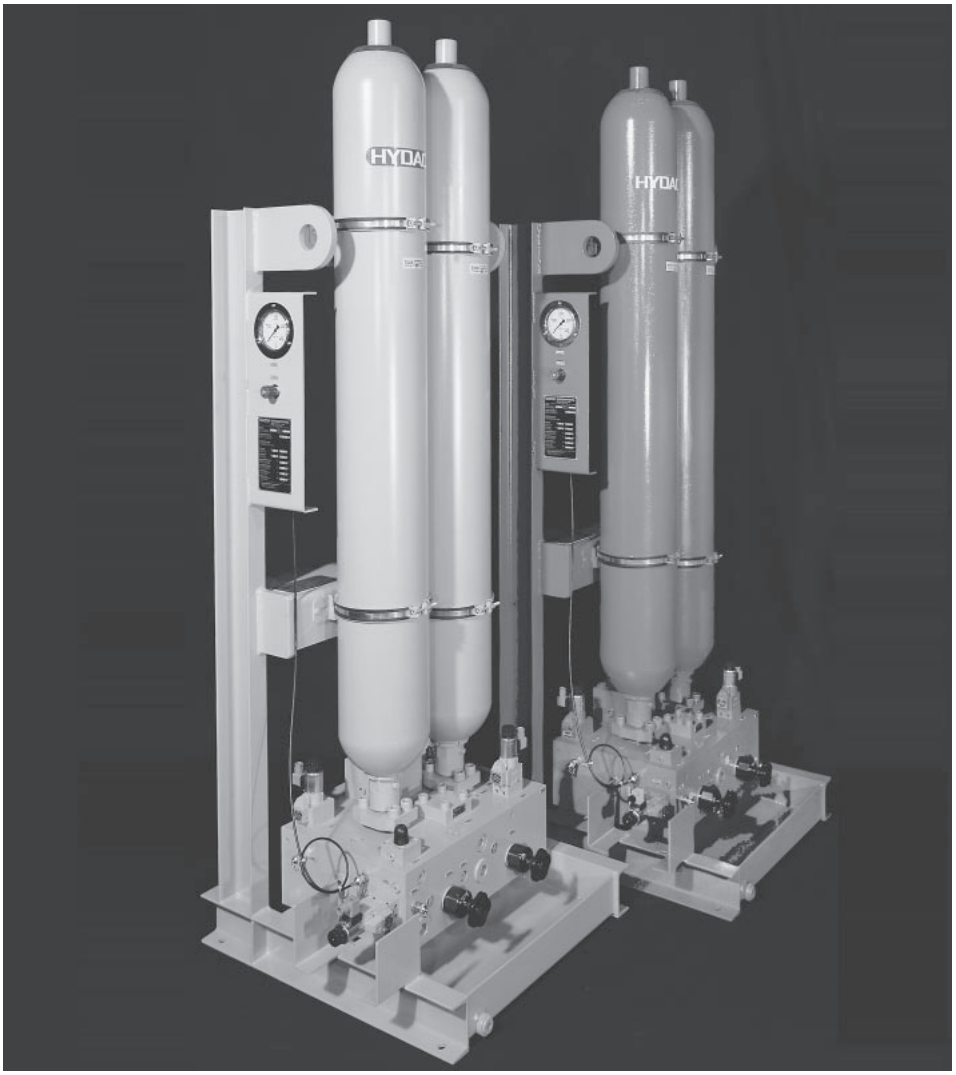


Safety and Shut-off Block SAF/DSV
with mechanical and/or electromagnetic discharge and test gauge connection.

Charging and testing unit FPU-1
with charging hose, pressure gauge and gas pressure release valve for HYDAC accumulators and other makes of accumulator up to 300 bar pre-charge pressure.

11. ACCUMULATOR STATIONS

We supply complete accumulator stations, ready for operation, including all necessary valves, ball valves and safety devices – both single accumulators and back-up type with nitrogen bottles to increase the effective volume.



12. NOTE

All details in this brochure are subject to technical modifications.