EPE

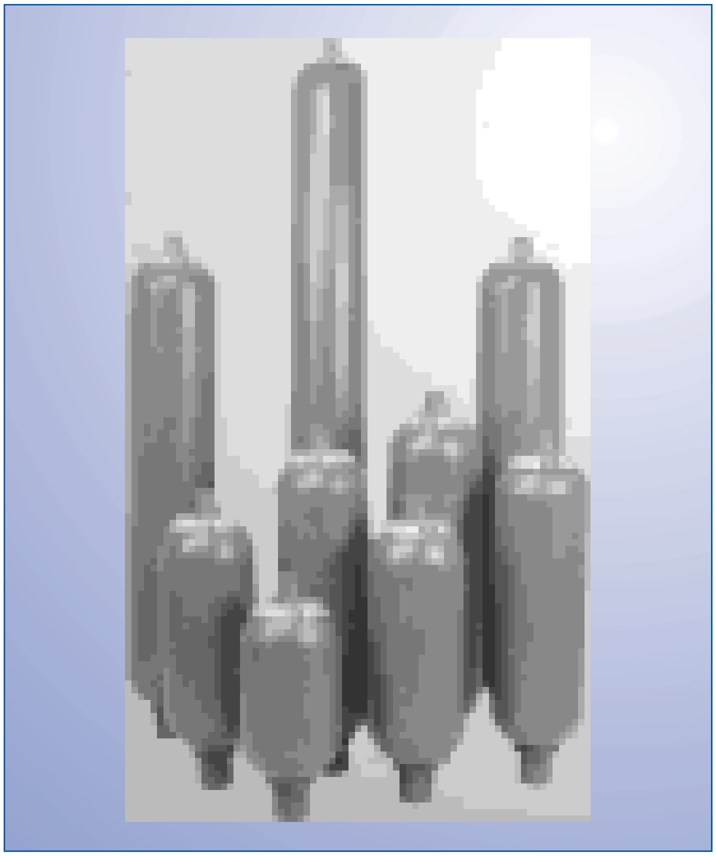
Filters . Accumulators
an ISO 9001 Company

EPE Accumulators are widely used in Hydraulic Systems for following applications :

- Fluid Power Storage
- Counter Balance
- Pulsation Damper
- Hydraulic Semi-Shock Damper
- Emergency Energy Reserve
- Shock Absorber
- Volume Compensator
- Hydraulic Spring
- Pressure Compensator
- Fluid Separator

EPE PROCESS FILTERS & ACCUMULATORS PVT LTD
An ISO 9001 Company
Techni Towers
C-54/A, A.P.I.E., Balanagar
Hyderabad -500 037. A.P.,India.
Tel. Nos. : 23778803/23778804/23871445
Fax Nos. : 040-23871447.
Internet : www.epe-india.com
E-mail : business@epe-india.com

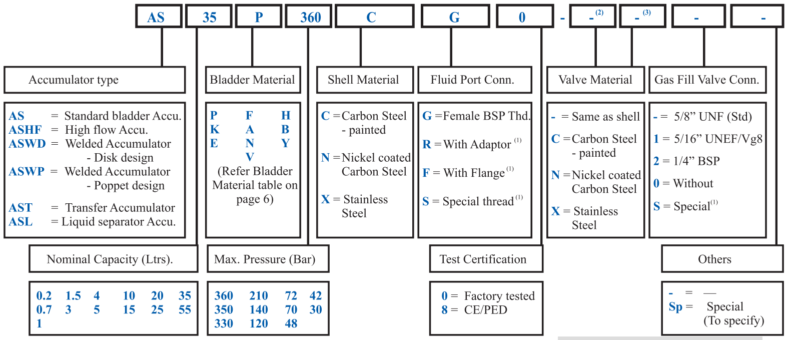
Bladder type Accumulators
Type-AS



Technical Features

Design : Bladder, Repairable
Max. Working pressure : 30 to 360 Bar.
Test pressure : 1.43 times Max. Working Pressure
Temperature range : -10° C to +80° C
Allowable pre. Ratio (P2/P0): 4:1
Nominal capacity : 0.2 to 50 Ltrs.
Material of Construction
Shell : Carbon Steel / Stainless Steel
Bladder : Nitrile/Butyl/Viton/EPDM etc..
Connections - Gas Side : 5/8" UNF (M)
Fluid Side : 3/4" BSP(F) ~ 2" BSP(F)

Identification Code



AS | 35 | P | 360 | C | G | 0 - | -(2) | -(3) | - | -

Accumulator type
AS = Standard bladder Accu.
ASHF = High flow Accu.
ASWD = Welded Accumulator - Disk design
ASWP = Welded Accumulator - Poppet design
AST = Transfer Accumulator
ASL = Liquid separator Accu.

Nominal Capacity (Ltrs).
0.2 1.5 4 10 20 35
0.7 3 5 15 25 55
1

Bladder Material
P F H
K A B
E N Y
V
(Refer Bladder Material table on page 6)

Max. Pressure (Bar)
360 210 72 42
350 140 70 30
330 120 48

Shell Material
C = Carbon Steel - painted
N = Nickel coated Carbon Steel
X = Stainless Steel

Fluid Port Conn.
G = Female BSP Thd.
R = With Adaptor (1)
F = With Flange (1)
S = Special thread (1)

Test Certification
0 = Factory tested
8 = CE/PED

Valve Material
- = Same as shell
C = Carbon Steel - painted
N = Nickel coated Carbon Steel
X = Stainless Steel

Gas Fill Valve Conn.
- = 5/8" UNF (Std)
1 = 5/16" UNEF/Vg8
2 = 1/4" BSP
0 = Without
S = Special(1)

Others
- = —
Sp = Special (To specify)

(1) = To be specified in full besides the code.
(2) = Fluid Port Material.
(3) = Gas Valve Material.

Note : Technical specifications are subject to change.

The hydro-pneumatic accumulator is a device designed specifically for the storage of liquids under pressure. As liquids are, for all practical purposes, incompressible, the objective is achieved by utilising the compressibility of gases (Fig.1):

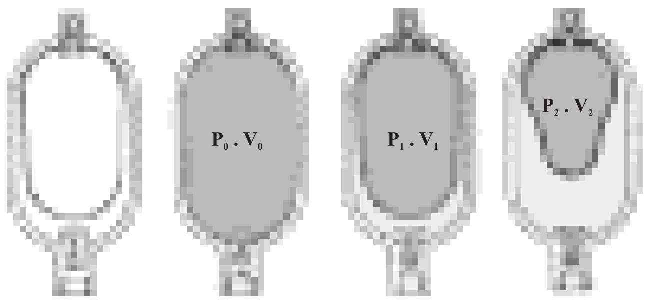


Fig.1

A) A flexible separator bladder is fitted into a pressure vessel (accumulator shell).

B) Through a special valve an inert gas (nitrogen) is introduced into the bladder with a pressure P_0. The bladder expands, filling the entire volume V_0 of the accumulator shell.

C) When circuit pressure P_1 is higher than the gas precharge pressure P_0, the liquid valve opens, and the bladder is compressed reducing the gas volume to V_1.

D) Should the liquid pressure rise to P_2, the volume of gas reduces to V_2 with an attendant rise in pressure, thus balancing the liquid pressure.

This means that the accumulator has been pressurised $\mathbf{\Delta V = V_1 - V_2}$, and a potential energy has been created to be utilised as desired.

Construction

The EPE Bladder Accumulator comprises a steel shell in which is fitted a bladder complete with a gas valve and a fluid port with the poppet valve (Fig.2)

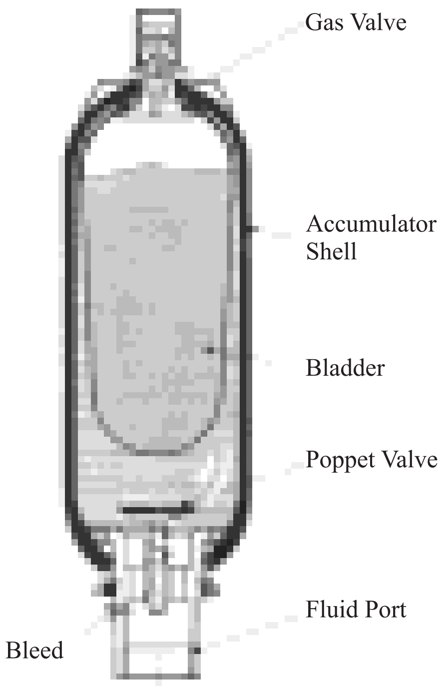


Fig.2

The accumulator shell is a pressure vessel forged or fabricated from high grade steel designed and manufactured to meet relevant international standards. For special applications various surface coatings are available as well as stainless steel construction.

The bladder construction which is unique to EPE is moulded in a single piece thus obviating problems associated with seamed construction. The gas valve is fitted in such a manner which allows it to be connected and easily and safely. In addition the valve, not an integral part of the bladder, can be re-used, thus reducing maintenance costs.
Bladders are normally manufactured from nitrile, but for special applications butyl, neoprene, ethylene-propylene etc, are available.

The gas valve is connected to the bladder by a rubber coated washer to ensure a gas tight joint and a non return valve is incorporated for bladder inflation. The bladder, complete with the gas valve is attached to the accumulator shell by a lock nut, and the assembly is protected by a cover.

In low-pressure range (type-ASWD) the **anti-extrusion valve** prevents the bladder from extruding into the fluid port and, at the same time, allows the liquid to flow. In the high pressure range (types - AS / ASHF / ASWP) a **poppet valve** is used**.**

Material for accumulator shell and valves

In standard version, the shelf is made of carbon steel and painted on the outside with a coat of rust inhibitor; the valves are made from phosphated carbon steel.
This configuration is suitable for **oils and non-corrosive liquids** and the whole assembly is indicated in the identification code by the letter **C**.
For mildly corrosive liquids the shell and the valves are also made from carbon steel, but are nickel-plated and identified by code letter **N** (specify different thicknesses separately).

For very corrosive liquids, assemblies in stainless steel (indicated by an **X**) are available.
If specifically requested, the fluid port and/or the gas valve can be supplied in a material different to that used for the accumulator shell. **Only in this case** Is it necessary to add to the identification code the letter indicating each valve (see Identification Code).

Many parameters are involved in the selection of an accumulator, the most important being:

a) **Minimum working pressure P_1 and maximum pressure P_2** - The value of P_2 must be lower or equal to the maximum authorised working pressure of the accumulator to be chosen for safety reasons.
   The value of P_1 is found in the ratio $P_2/P_0 \leq 4$ which will give optimum efficiency and operating life. (for calculating of pre-loading pressure P_0, refer to section *Gas Precharge Pressure - page-3*).

b) **Volume ΔV of liquid to be stored or utilised** - This information is required in addition to the maximum and minimum pressures for the correct sizing of the accumulator.

c) **Method and application -** It is important to establish in the gas during operation is subjected to isothermal or adiabatic conditions. If compression (or expansion) is slow, (more than 3 minutes) so that the gas maintains approximately constant temperature, the condition is ISOTHERMAL. (examples: pressure stabilisation, volume compensation, counter balancing, lubricating circuits). In other cases (energy accumulator, pulsation damper, shock wave damper etc) owing to the high speed transfer heat interchange is negligible, and therefore the condition is ADIABATIC. As a guide the adiabatic condition exist when the compression or expansion period is less than 3 minutes.

d) **Operating temperature** - Operating temperature will determine the choice of materials for the bladder and steel shell and will also have an influence on the pre-loading pressure, and consequently the accumulator volume.

e) **Type of fluid** - This will determine the choice of material.

f) **Maximum required flow rate** - The volume V_0 and/or the size of the connection is influenced by the speed of response.

G) **Location** - It is important to know the eventual destination of the accumulator in order that the design can meet local design and test parameters.

Based on the foregoing it is possible to choose a suitable accumulator for the specific application required.

Gas precharge pressure

The accurate choice of precharge pressure is fundamental in obtaining the optimum efficiency and maximum life from the accumulator and its components. The maximum storage (or release) of liquid is obtained theoretically when the gas precharge pressure P_0 is as close as possible to the minimum working pressure.

For practical purposes to give a safety margin, and to avoid valve shut-off during operation, the value (unless otherwise stated) is :

$$P_0 = 0.9 \times P_1$$

The limit values of P_0 are $P_{0\,min} \geq 0.25 \cdot P_2$

$P_{0\,max} \leq 0.9 \cdot P_1$

Special values are used for

Pulsation damper and shock absorber :

$\mathbf{P_0 = 0.6 \text{ to } 0.75\, P_m}$ or $\mathbf{P_0 = 0.8\, P_1}$

where P_m = average operating pressure.

Hydraulic line shock damper :

$\mathbf{P_0 = 0.6 \text{ to } 0.9\, P_m}$

where P_m = average working pressure with free flow.

Accumulator + additional gas bottles :

$\mathbf{P_0 = 0.95 \text{ to } 0.97\, P_1}$

Calculation principles

Compression and expansion of gas inside the accumulator takes place according to the Boyle-Mariotte law regarding the status change in the perfect gases:

$$P_0 \cdot V_0^n = P_1 \cdot V_1^n = P_2 \cdot V_2^n$$

Where

P_0 = precharge pressure (bar)
P_1 = minimum operating pressure (bar)
P_2 = maximum operating pressure (bar)
V_0 = nitrogen precharge volume at pressure P_0 (liters). It is the maximum volume of gas which can be stored in the accumulator and it is equal to, or slightly lower than, nominal capacity.
V_1 = nitrogen volume at pressure P_1 (liters)
V_2 = nitrogen volume at pressure P_2 (liters)
ΔV=volume of discharged or stored liquid (liters)
n = polytropic exponent.

The curve of volume variation as a function of pressure is dependant on the exponent n, which for nitrogen is contained between the limit values of:

$n = 1$ In case compression or expansion of nitrogen takes place so slowly that a complete interchange of heat is allowed between gas and environment, that is at constant temperature; the condition is isothermal.

$n = 1.4$ When operation is so quick that no interchange of heat can take place; the condition is adiabatic.

These are theoretical and not practical conditions.

It is however possible to state, with reasonable accuracy that when an accumulator is used as a volume compensator, leakage compensator or as a lubrication compensator and pressure compensator, the condition is isothermal. In the remaining applications, such as energy accumulator, pulsation damper, emergency power source, dynamic pressure compensator, water hammer absorber, shock absorber, hydraulic spring etc., it is possible to state, with reasonable accuracy that the condition is adiabatic.

Should a more accurate calculation be needed, it is possible to use intermediate values of n as function of t, that is of expansion or compression time.

Note: In all calculations **pressures** are expressed as **absolute bar** and **temperatures as Kelvin degrees**.

Special Note:

Value P_0 is valid for MAXIMUM OPERATING TEMPERATURE REQUIRED BY THE USER.

Checking and pre-loading (charging) of accumulator takes place generally at a different temperature to the operational one θ_2, so that the value P_0 at the checking temperature θ_c, becomes:

$$P_{0c} = P_0 \cdot \frac{\theta_c + 273}{\theta_2 + 273} \;\; ; \;\; P_{0(20^\circ)} = P_0 \cdot \frac{293}{\theta_2 + 273}$$

Note : *Precharge of accumulators directly supplied from the factory at a temperature of 20° C.*

nal condition)

When n = 1 the Boyle-Mariotte law becomes:

$$P_0 \,.\, V_0 = P_1 \,.\, V_1 = P_2 \,.\, V_2$$

So that, $V_1 = V_0 \,.\, \dfrac{P_0}{P_1}$; $V_2 = V_0 \,.\, \dfrac{P_0}{P_2}$

The difference between volume V_1 (at minimum operating pressure) and V_2 (at maximum operating pressure) gives the amount of stored liquid.

$$\Delta V = V_1 - V_2 = V_0 \,.\, \frac{P_0}{P_1} - V_0 \,.\, \frac{P_0}{P_2}$$

So that $\Delta V = V_0 \left(\dfrac{P_0}{P_1} - \dfrac{P_0}{P_2} \right)$

Accumulator volume will be:

$$V_0 = \frac{\Delta V}{\left(\dfrac{P_0}{P_1} - \dfrac{P_0}{P_2} \right)}$$

Which could also be written as:

$$V_0 = \frac{\Delta V}{P_0 \left(\dfrac{1}{P_1} - \dfrac{1}{P_2} \right)}$$

Which shows that accumulator volume increases when ΔV is increasing, when P_0 is decreasing and when the difference between the two operating pressures P_1 & P_2 is decreasing.

Volume calculation (adiabatic condition)

Starting from the basic formula

$$P_0 \,.\, V_0^n = P_1 \,.\, V_1^n = P_2 \,.\, V_2^n$$

and following what is shown for isothermic calculation, we have

$$\Delta V = V_0 \left[\left(\frac{P_0}{P_1} \right)^{\frac{1}{n}} - \left(\frac{P_0}{P_2} \right)^{\frac{1}{n}} \right]$$

Where $\dfrac{1}{n} = 0.7143$

$$V_0 = \frac{\Delta V}{\left(\dfrac{P_0}{P_1} \right)^{\frac{1}{n}} - \left(\dfrac{P_0}{P_2} \right)^{\frac{1}{n}}}$$

Formulas are valid when operation is taking place in adiabatic conditions both in the expansion as well as in the compression phase.

Bear in mind however that accumulator yield, and therefore the accumulator calculation is influenced by both operating temperature and pressure.

Temperature influence

It should be anticipated that the operating temperature will change considerably during the cycle, and this variation should be taken into account when the volume is calculated.

If an accumulator is sized to a maximum temperature then the precharge pressure will be referenced to that temperature. When the temperature drops there will be a comparable reduction of the precharge pressure according to the Gay Lussac law on the relationship between pressures and volumes, as a result, you will get a lower accumulator capacity.

It will therefore be necessary to have a higher V_0 to accumulate or to yield the same amount of liquid ΔV.

The relationship between pressures and volumes is:

$$V_{0T} = V_0 \,.\, \frac{T_2}{T_1}$$

Where:

T_2 = θ_2 (°C) + 273 = max. Working temp. (°K)

T_1 = θ_1 (°C) + 273 = max. Working temp. (°K)

V_0 = volume calculated neglecting thermal variations (ltrs)

V_{0T} = increased volume for thermal variations (ltrs)

Correction coefficient for high pressure

The formulas refer to ideal gases, but industrial nitrogen used in accumulators does not behave according to ideal gas laws when pressures increase. It is important to keep in mind this characteristic for pressures $P_2 > 200$ bar, both for adiabatic as well as isothermal conditions.

Accordingly the values of V_0 & yielded volume ΔV become:

(Isothermal)	(adiabatic)
$V_{0r} = \dfrac{V_0}{C_i}$;	$V_{0r} = \dfrac{V_0}{C_a}$
$\Delta V_r = \Delta V \,.\, C_i$;	$\Delta V_r = \Delta V \,.\, C_a$

Where:

V_{0r} = real volume of accumulator to be used for operating Pressures P_1 and P_2.

ΔV_r = real yield obtained from accumulator.

C_i, C_a = coefficients to be derived from Fig.3 & Fig.4.

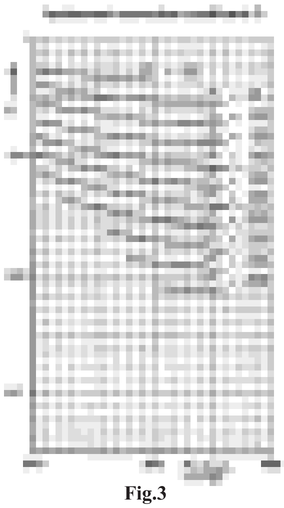


Fig.3

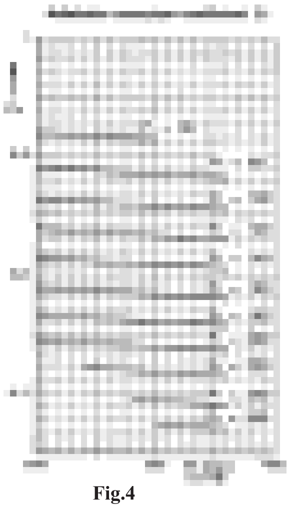


Fig.4

Typical application when storage is slow (isothermal) and discharge is quick (adiabatic).

Volume will be given by:

$$V_0 = \frac{\Delta V}{\left(\frac{P_0}{P_2}\right)^{\frac{1}{nc}} \cdot \left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]}$$

And stored volume by:

$$\Delta V = V_0 \left(\frac{P_0}{P_2}\right)^{\frac{1}{nc}} \cdot \left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]$$

Where:
n = 1.4 adiabatic coefficient (quick discharge phase)
nc = 1 to 1.4 polytropic coefficient (slow storage phase)

Value of n is a function of time.

In the majority of cases it is possible to suppose nc = 1, so that calculation is simplified and result not affected:

$$V_0 = \frac{\Delta V \cdot \left(\frac{P_2}{P_0}\right)}{\left(\frac{P_2}{P_1}\right)^{0.7143} - 1} \; ; \qquad \Delta V = V_0 \, . \, P_0 \, \frac{\left(\frac{P_2}{P_1}\right)^{0.7143} - 1}{P_2}$$

Pulsation compensator / damper

A typical calculation in adiabatic conditions due to high speed storage and discharge.

The liquid amount ΔV to be considered in the calculation is a function of type and capacity of the pump.

$$\Delta V = K \, . \, q$$

Volume becomes: $$V_0 = \frac{K \, . \, q}{\left(\frac{P_0}{P_1}\right)^{0.7143} - \left(\frac{P_0}{P_2}\right)^{0.7143}}$$

Where:
q = pump displacement (liters)
= A x C (piston surface x stroke)
= Q / n (flow rate in lpm / speed in spm)
P = average working pressure (bar)
P_1 = P - X (bar)
P_2 = P + X (bar)
X = α . P / 100 (bar) deviation from average pressure
α = remaining pulsation ± (%)

K = coefficient taking into account the number of pistons and if the pump is single acting or double acting.

The value of K may be obtained from the following table.

No. of Pistons	One	Two	Three	Four	Five	Six	Seven
Single Acting	0.69	0.29	0.12	0.13	0.07	-	-
Double Acting	0.29	0.17	0.07	0.07	0.023	0.07	0.023

Table.1

Accumulator + additional gas bottle (transfert)

In all cases where a considerable amount of liquid must be obtained with a small difference between P_1 and P_2, the resultant volume V_0 is large compared to ΔV.

In these cases it could be convenient to get the required nitrogen volume by additional bottles.

Volume calculation is performed, as a function of application, both in isothermal as well as in adiabatic conditions using the formulas given before taking temperature into account.

To get the maximum efficiency it is convenient to fix for precharge quite a high value. In case of energy reserve, volume compensators, hydraulic line shock dampers etc., it is possible to use:

$P_0 = 0.97 \text{ x } P_1$

Once the required gas volume is calculated, the volume must be allocated between the minimum indispensable portion V_{OA}, which will be contained in the accumulator, and the remaining portion V_{OB}, which represents the volume of additional bottles.

$$V_{OT} = V_{OA} + V_{OB}$$

Where

$$V_{OA} \geq \frac{\Delta V + (V_{OT} - V_O)}{0.75}$$

That means that the sum of volume of required liquid plus volume change due to temperature must be lower than 3/4 of accumulator capacity.

The bottle volume is given by the difference

$$V_{OB} = V_{OT} - V_{OA}$$

Hydraulic line shock damper

The volume of accumulator able to absorb the hydraulic shock wave is obtained with:

$$V_0 = \frac{4\,Q \, . \, P_2 \, . \, (0.0164 \, . \, L - t)}{10^3 \, . \, (P_2 - P_1)}$$

Where:
Q = flow rate in the piping (l/min)
P_2 = max. Permissible pressure (bar)
L = length of pipeline (m)
t = acceleration or deceleration time (s) (valve shut down)
P_1 = operating pressure with free flow (bar)

After the size of the accumulator has been defined, it is necessary to check whether the required flow rate (l/min) is compatible with the permissible flow rate for that accumulator, according to the following table.

Maximum flow rate can be achieved with the accumulator installed in vertical position with the gas valve on top. Further it is indispensable that a residual volume of liquid as under remains in the accumulator.

***Residual volume of liquid* $\geq$ *10% of* V_0**

Type	Mean Flow Rate (l/min)	Max. Permissible Flow Rate (l/min)
AS 0.2	70	160
AS 0.7 to 1.5	150	300
AS 3 - 5	300	600
AS 10 to 55	500	1000

Table.2

Bladder Material

The choice of elastomer used for the bladder depends on the liquid to be used and on the operating temperatures (and, at times, storage). In the chart below, each polymer has a designated letter which, in the identification code, denotes the material used for the bladder, the gaskets and rubber-coated parts.

Code	Polymer	ISO	Temperature range (° C)	Some of the liquids compatible with the polymer
P	Standard nitrile (Perbunan)	NBR	-20 +85	Mineral, vegetable, silicon and lubricating oils, industrial water, glycols, nonflammable liquids (HFA-HFB-HFC), aliphatic hydrocarbons, butane, diesel oil, kerosene, fuel oils, etc.
F	Low temperature nitrile	NBR	-40 +70	The same as with standard nitrile + a number of different types of Freon. (This contains less acrylonitrile than the standard and is therefore more suitable for low temperatures, but its chemical resistance is slightly lower).
H	Nitrile for hydrocarbons	NBR	-10 +90	Regular and premium grade slightly aromatic gasoline (and all the liquids for standard nitrile).
*K	Hydrogenated nitrile	HNBR	-50 +130	The same as with standard nitrile but with excellent performance at both high and low temperatures.
A	For food-stuffs	NBR	-20 +85	Foods (specify which type when ordering).
B	Butyl	IIR	-20 +90	Phosphoric esters (HFD-R), phosphate esters, fyrquel, hot water, ammonia, caustic soda, some kinds of Freon (22-31-502), glycol-based brake fluids, some acids, alcohols, ketones, esters, skydrol 7000, etc.
E	Ethylene-propylene	EPDM	-20 +90	Break fluids, hot water, leaching fluids, detergents, water-glycol (HFC), many acids and bases, saline solutions, skydrol 500, etc.
*N	Chloroprene (Neoprene)	CR	-20 +85	Freon (12-21-22-113-114-115), water and aqueous solutions, ammonia, carbon dioxide, mineral, paraffin and silicon oils.
*Y	Epichloridrin	ECO	-30 +100	Lead-free gasoline, mineral oils.
*V	Flouroelastomer (Viton)	FKM	-20 +121	The same as with standard nitrile but with excellent performance at both high and low temperatures.

* *Before ordering, check for availability*

Durability of the Bladders

It is essential, in order to make the correct choice, to take into consideration the working conditions that the bladder will be operating in, because these can considerably affect the durability of the bladder. Assuming that the liquid used is **clean** and compatible with the bladder material, there are a number of factors which can affect the life of the bladder:

The precharge pressure P_0. In most cases the values recomended in *Gas Precharge Pressure - page-3* are valid although, as the pressure and, above all, the velocity of the yield required increase, there is the danger that in each cycle the bladder will knock against the poppet valve. In these cases it is possible to use $P_0 = 0.8$ to $0.7\ P_1$.

The P_2/P_0 ***ratio.*** Any increase in this, will increase the stress the bladder is subjected to in each cycle.

The maximum operating pressure P_2. Any increase in this will subject the bladder to greater stress.

Flow rate. Flow rate does not affect bladder working life if values given in Table.2 are not exceeded. When approaching the maximum values, make sure there remains a residual volume of liquid > 10% of the volume V_0 in the accumulator, in both loading & unloading conditions.

The frequency or number of cycles per day.

Installation. The vertical position with gas valve on top is the recommended arrangement. When the position is horizontal the bladder tends to rest and rub against the accumulator body. This could result in quicker wear.

The operating temperature. This is one of the factors which most affects the life of the bladder: at very low temperatures the bladder tends to become brittle; as the temperature rises, reaching, or going beyond the limits for the elastomer, the stress the bladder is subjected to increases exponentially, which can lead to fracturing within a short time.

It should be remembered that the temperature in the accumulator is in many cases higher than the one of the system, and that it rises with each increase of P_2, of P_2/P_1, and with the volume of the accumulator (in other words, larger the accumulator, lesser is the capacity to dissipate heat).

et design) - type : AS/ASHF/ASWP

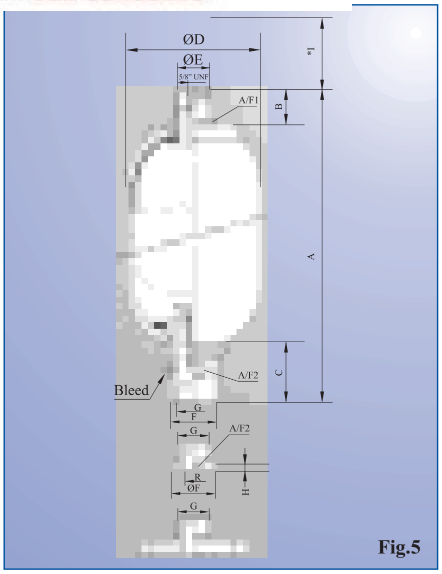


Fig.5

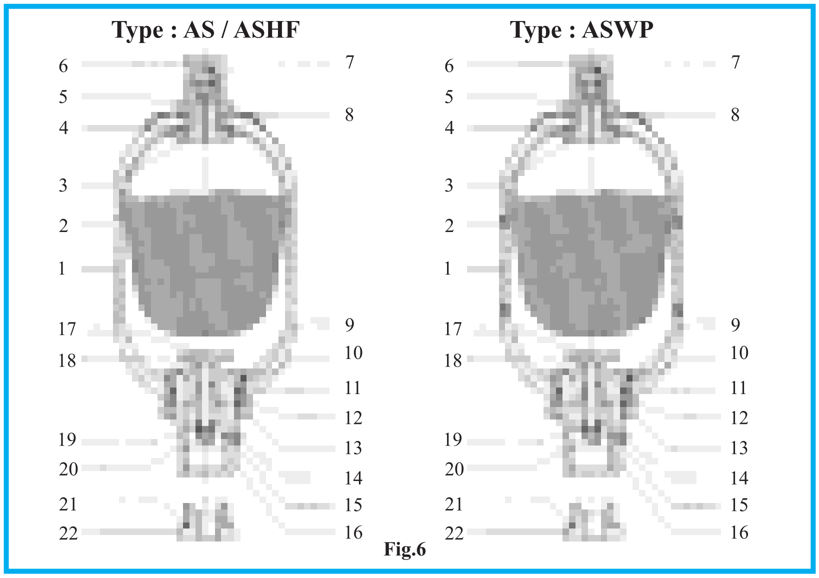


Fig.6

AS/ASHF/ASWP - Sizes & Dimensions (Refer Fig.5)

Model	Max. Working Pressure (bar)	Gas Volume (ltrs)	Dry Weight (kgs)	Fluid Port Connection		A	B	C	ØD	ØE	ØF	H	I(3)	A/F1	A/F2
				G (BSP)	R (BSP)										
AS-0.2	350	0.2	1.4	1/2"	—	250	22	40	51	20	26	—	140	24	23
AS-0.7		0.65	3.9	3/4"	3/8"	280	47	52	90	25	36	11		32	32
AS-1		1	4.5			300			114						
AS-1.5		1.45	7.1			355									
AS-3		2.95	11	1-1/4"	3/8" - 1/2" - 3/4"	550		65			53				50
AS-4		4	13			390			168						
AS-5		5	14			455									
AS-10	330(1)	9.1	38	2"	½" - 3/4" - 1" - 1-1/4" - 1-1/2"	570	60	101	220	55	77			70	70
AS-15		14.5	45			720									
AS-20		18.2	53			875									
AS-25		23.5	63			1050									
AS-35		33.5	83			1390									
AS-55		50	115			1900									
ASHF-35	330	33.5	83	2-1/2"	1" - 1-1/2" - 2"	1430	60	137	220	55	97	11	140	70	90
ASHF-55		50	115			1945									
ASWP-**	42-48-72-120(2)	3 to 50	Outer dimensions & connections same as standard AS type Accumulators as indicated in the table.												

(1) = 360 Bar on request.
(2) = Other pressures on request.
(3) = Charging overall dimensions
All dimensions are in mm.
Subject to change.

AS/ASWP - Spare parts list and Part Nos. (Refer Fig.6) - {for ASHP : Add "-HP" for Item # 9-22, Fluid Port Assembly & Gasket set.}

Item #	**Description**	**Qty.**	**Model Code (AS / ASWP)**					
			0.2	**0.7**	**1 - 1.5**	**3**	**4 - 5**	**10 - 15 - 20 - 25 - 35 - 55**
1	Accumulator shell	1	Not supplied as spare part					
2	Bladder	1	See detailed designation on page No.9					
3	Gas valve body	1	2001	10107			10202	10333
4	Rubber-coated washer	1	10024	10104	10106		10205	10334
5	Gas valve lock nut	1	10023	10109				10302
6	Protection cap	1	10337	10103				10301
7	Gas-fill valve	1	—	2072				
8	Name plate	1	—	10300-A	10300-B		10300-C	10300-D
9	Retaining ring	1	10035	10123	10127	10146	10222	10317
10	"O" ring	1	OR4112	OR4150		OR159	OR6212	OR181
11	Supporting ring	1	10038	10133		10150	10227	10320
12	Spacer ring	1	10037	10120		10145	10223	10319
13	Fluid port ring nut	1	10039	10122		10217		10321
14	Bleed screw	1	—	10128				10316-A
15	Seal ring	1	—	10129				10336-A
16	Fluid port body	1	10031	10115		10144		10311
17	Poppet	1	10028	10111		10221		10310
18	Spring	1	10029	10112		10149		10322
19	Brake bushing	1	—	10113		10226		10314
20	Self-locking nut	1	10033	10116		10211		10315
21	Adaptor O-ring	1	—	OR2093		OR3150		OR3218
22	Adaptor	1	—	10131/thread		10233/thread		10323/thread
	Gas valve assembly (# 3-7)	1	2002	2021	2022		2042	2062
	Fluid port assembly (# 9-20)	1	2004	2023	2024	2025	2044	2064
	Gasket sets	1	2010 = # 9, 10, 11, 15 & Gas fill valve seals	2030 = # 9, 10, 11, 15 & Gas fill valve seals		2031 = # 9, 10, 11, 15 & Gas fill valve seals	2050 = # 9, 10, 11, 15 & Gas fill valve seals	2080 = # 9, 10, 11, 15 & Gas fill valve seals

Subject to change.

design) - type : ASWD

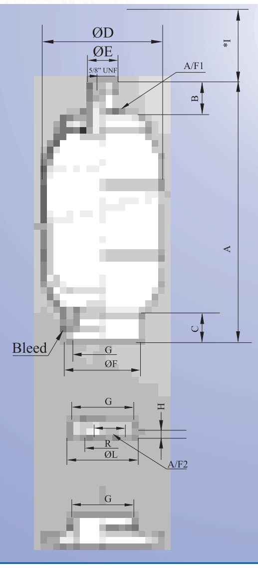


Fig.7

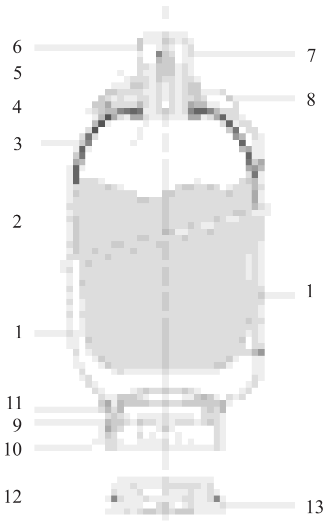


Fig.8

ASWD - Sizes & Dimensions (Refer Fig.7)

Model	Max. Working Pressure (bar)	Gas Volume (ltrs)	Dry Weight (kgs)	Fluid Port Connection G (BSP)	Fluid Port Connection R (BSP)	A	B	C	ØD	ØE	ØF	H	I [(1)]	ØL	A/F1	A/F2
ASWD-1.5	70	1.5	6.1	2"	3/4" - 1" - 1-1/4"	290	47	48	114	25	72	11		74	32	70
ASWD-3		2.95	9.1			460										
ASWD-4		4	14.5	2-1/2"	1" - 1-1/4" - 1-1/2"	355			168		88			88		80
ASWD-5		5	15.7			412										
ASWD-10	30	9.6	18	4"	2" - 3"	470	60	50	219	55	130	14		130	70	120
ASWD-15		14.5	23			610										
ASWD-20		18.8	28			750										
ASWD-25		23.5	33			895										
ASWD-35		33.5	47			1325										
ASWD-55		50	65			1850										

(1) = Charging overall dimensions.

All dimensions are in mm.

Subject to change.

ASWD - Spare parts list and Part Nos. (Refer Fig.8)

Item #	Description	Qty.	Model Code ASWD 1.5-3	Model Code ASWD 4-5	Model Code ASWD 10-15-20-25-35-55
1	Accumulator shell	1	Not supplied as spare part		
2	Bladder	1	See detailed designation on page 9		
3	Gas valve body	1	10107	10202	10333
4	Rubber-coated washer	1	10106	10205	10334
5	Gas valve locknut	1	10109		10302
6	Protection cap	1	10103		10301
7	Gas-fill valve	1	2072		
8	Name plate	1	10300-B	10300-C	10300-D
9	Bleed screw	1	10316		
10	Seal ring	1	10336		
11	Anti-extrusion Assy	1	10159-1	10241-1	10421-1
12	Adaptor "O" ring	1	OR3218	OR3281	OR4425
13	Adaptor	1	10323/thread	10244/thread	10444/thread
Gas valve assembly (parts 3-4-5-6-7)		1	2022	2042	2062
Gasket sets		1	2032 { OR2050 10341 10342 OR3218	2052 { OR2050 10341 10342 OR3281	2082 { OR2050 10341 10342 OR4425

Subject to change.

General

The main feature of the bladder lies in an original and well developed EPE process by which the bladder being of **a single piece construction** without splices or joints and with a unique method for connecting gas valves, allows **various valves** to be fitted thus promoting considerable economic savings, especially when several accumulators of the same size, but with differing gas valves, are to be used in the same plant.

In addition, valves do not have to be replaced at the same time as the bladder.

The attachment of the valve to the bladder is a simple operation by use of a special rubber coated washer.

Technical and constructional features

- * **THE BLADDER** used on standard version of the accumulator for both high and low pressures, is in butadiene-acrilonitrile rubber, oil resistant (nitrile) suitable for operating temperature - 20ºC to +80ºC.

For other applications the bladder can be supplied in butyl, neoprene, ethylene-propylene, natural rubber, low temperature nitrile (-40ºC), nitrile for hydrocarbons, epichloroidrin, silicones, for food, viton etc.

* **THE GAS VALVE** is of phosphated carbon steel in the following three versions:

S = **STANDARD (Fig.9a)**. Besides the standard diameter B the valve could be supplied with special ØB indicated in brackets in the table.
For capacities 0.2 to 55 litres.

ST = **TRANSFERT** liquid-gas **(Fig.9b)**. For accumulators where additional gas bottles are used.
For capacities of 1 to 55 litres.

SL = **LIQUID SEPARATOR (Fig.9c)**. Its application is for cases where the bladder separates two liquids.
For capacities 0.2 to 55 litres.

* **ON REQUEST** valves can be supplied either nickel coated or in stainless steel.

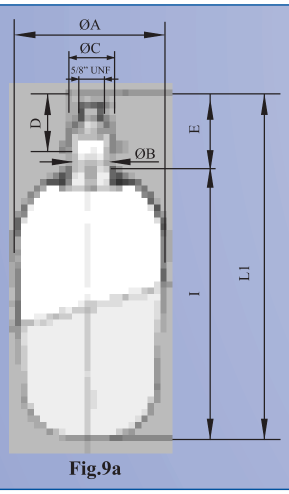


Fig.9a

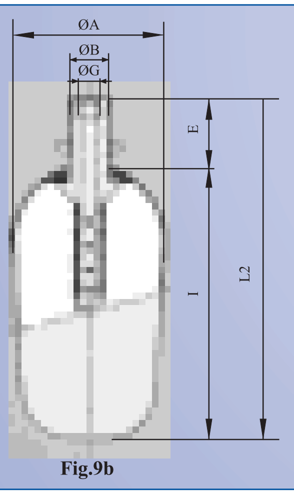


Fig.9b

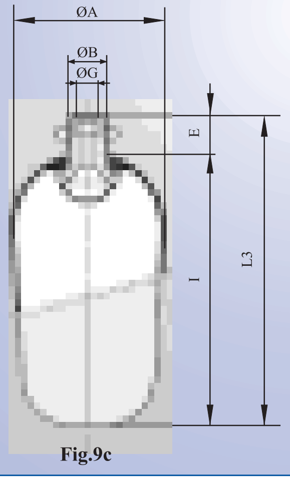


Fig.9c

Spare Bladder Assembly Identification Code

S 35 P 1 X - 1

Bladder design	Nominal capacity (liters)	Bladder material	Gas Valve	Gas Valve Material	Gas Fill Valve Connection
S = Standard(fig.9a) **ST** = Transfer Barrier (Fig.9b) **SL** = Liquid separator (fig.9c)	**0.2 3 15** **0.7 4 20** **1 5 25** **1.5 10 35** **2.5 12 55**	**P** = Standard Nitrile (Perbunan/Buna-N) **F** = Low-Temp Nitrile **H** = Nitrile for Hydrocarbons **K** = Hydrogenated Nitrile **A** = For foods **N** = Neoprene / Chloroprene **B** = Butyl **E** = Ethylene-Propylene **V** = Flouroelastomer (Viton) **Y** = Epichlorohydrin	**0** = Without Valve **1** = With Valve ØB Standard **2** = With Valve ØB Special	**-** = Phosphated Carbon Steel **N** = Nickel-coated Carbon Steel **X** = Stainless Steel	**-** = 5/8" UNF (Standard) **1** = 5/16" UNEF/Vg8 **2** = 1/4" BSP **0** = Without **S** = Special

Bladder dimensions and spare codes for standard valves

Dim.	Bladder dimensions with valves Fig.9a - 9b - 9c												Wt. kg.	Fig.9a		Fig.9b		Fig.9c	
	ØA	ØB	ØC	D	E	F	ØG	H	I	L1	L2	L3		Code	Wt.kg.	Code	Wt.kg.	Code	Wt.kg.
0.2	38	5/8" UNF	20	—	27	—	1/8" BSP	23	154	181	—	178	0.03	2002	0.10	—	—	2003	—
0.7	75	M22x1.5 (Ø Special 5/8" UNF)	25	47	45	—	1/4" BSP	24	126	178	162	151	0.07	2021	0.30	—	—	2027-1	0.27
1	95					36			140	190	176	173	0.13	2022	0.30	2026	0.55	2027	0.18
1.5									195	245	231	226	0.17						
2.5									325	378	361	350	0.30			2029	0.70		
3									380	432	416	399	0.36						
4	145				50	37		29	210	265	250	245	0.33	2042	0.42	2043	1.10	2048	0.33
5									282	338	319	314	0.43						
10	198	M50x1.5 (Ø Special M22x1.5)	55	60	61	78	1" BSP	40	310	385	388	350	0.96	2062	1.70	2065	2.60	2073	1.10
12									405	480	483	445	1.08						
15									445	520	525	485	1.29						
20									588	662	666	628	1.79			2066	3.10		
25									730	805	808	770	2.22						
35									1115	1190	1193	1155	3.28			2067	3.60		
55									1570	1645	1648	1610	4.59						

All dimensions are in mm.

Subject to change.

Bottles in forged steel construction, especially designed as additional nitrogen bottles for installation with Bladder or Piston Accumulator Stations.

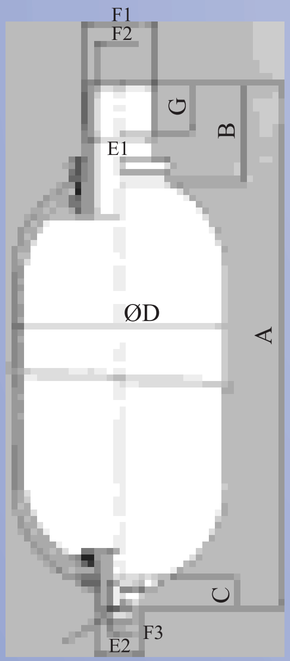


Fig.10

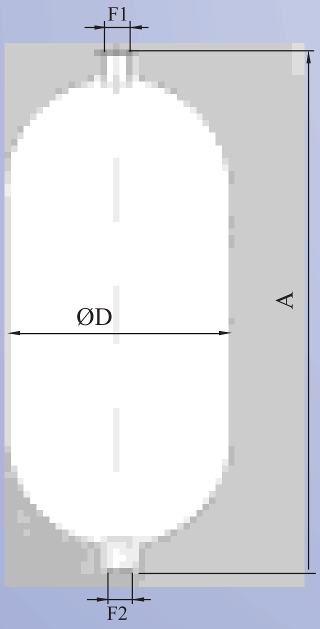


Fig.11

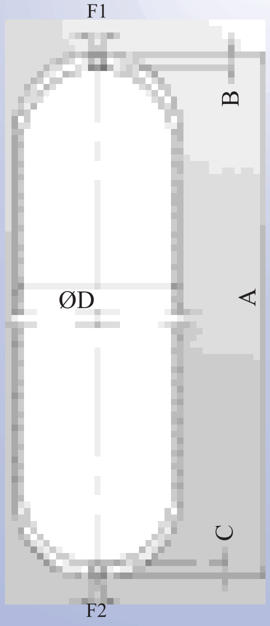


Fig.12

Additional Bottles Identification Code

BA **35** **330** **C** **0** **0**

Bottle type	Nominal Capacity (ltrs)	Max. Op. Pressure (Bar)	Shell Material	Connections	Test Certification
BA = Additional bottle - Accumulator design (fig.10) **BB** = Additional bottle - Neck design (fig.11) **BD** = Additional bottle - Threaded design (fig.12)	**3** **4** **5** **10** **15** **20** **25** **35** **50** **55**	**330** **350** **360**	**C** = Painted Carbon Steel **N** = Nickel-coated Carbon Steel **V** = Carbon Steel with special coating [1]	**0** = Standard **S** = Special[1]	**0** = Factory testing **8** = CE/PED

[1] = To be specified in full besides the model code

Additional Bottles dimensions

Model	Max. Working Pressure (bar)	Gas Volume (ltrs)	Dry Weight (kgs)	Figure	A	B	C	ØD	E1	E2	ØF1	ØF2	ØF3	G
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]		[illegible]			[illegible]						
[illegible]		[illegible]	[illegible]		[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]		[illegible]									
[illegible]		[illegible]	[illegible]		[illegible]									
[illegible]		[illegible]	[illegible]		[illegible]									
[illegible]		[illegible]	[illegible]		[illegible]									
[illegible]		[illegible]	[illegible]		[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	—	[illegible]	[illegible]	—	—
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	[illegible]	—	—
[illegible]		[illegible]	[illegible]		[illegible]				—	—			—	—
[illegible]		[illegible]	[illegible]		[illegible]				[illegible]	[illegible]			[illegible]	[illegible]
[illegible]		[illegible]	[illegible]		[illegible]				—	—			—	—
[illegible]		[illegible]	[illegible]		[illegible]				—	—			—	—

All dimensions are in mm.

Subject to change.

Accumulator stations are used when demand on **flow rate or capacity are required that exceed** the capacity of any one accumulator available in our range.
Simple stands of 2 to 5 accumulators (Fig.14) or double stands of 4-6 to 8-10 accumulators (Fig.13) are normally assembled.

Construction

The accumulators are mounted in a welded steel frame painted with a coat of rust inhibitor.

Depending on the quantity and the overall size that is required, they can be positioned in one row (Fig.14) or in two rows (Fig.13). Each accumulator rests on a rubber support ring, is fastened with one or two clamps and is fitted with a safety block (series B10/20 or BS25/32).

A delivery manifold (dimensions determined by the flow rate and operating pressure) join the various blocks. The two ends have a BSP female thread, or, on request, are flanged. One of the ends is closed off with a plug or blind flange. The manifold linking the discharge outlets of each block follows the same pattern. If requested, a pressure gauge or pressure switch to control the delivery pressure and a oil drip tank can be fitted. The double stand may also be used for installing transfer accumulators connected up to additional, parallel mounted, nitrogen bottles. A number of variants can be supplied. To make the best choice, we recommend, therefore, that you contact our technical information service.

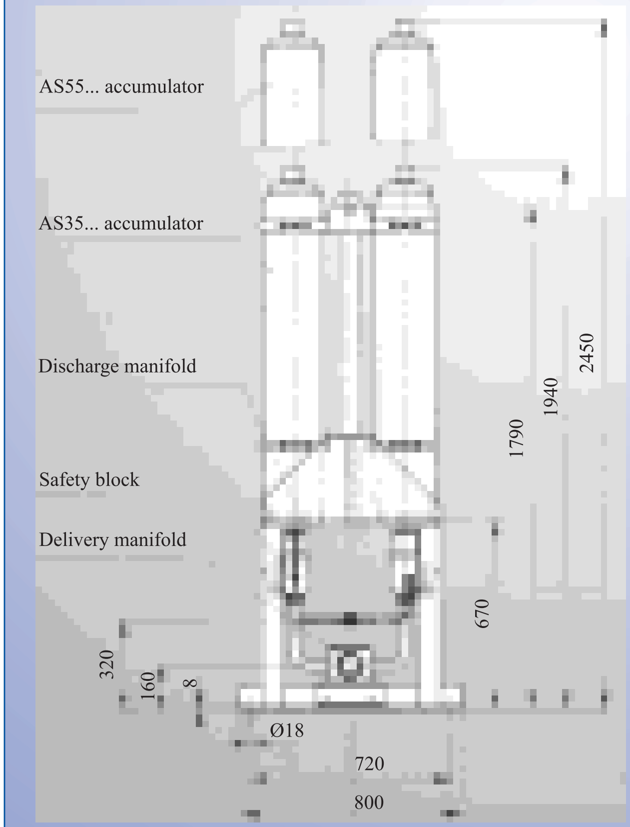


Fig.13

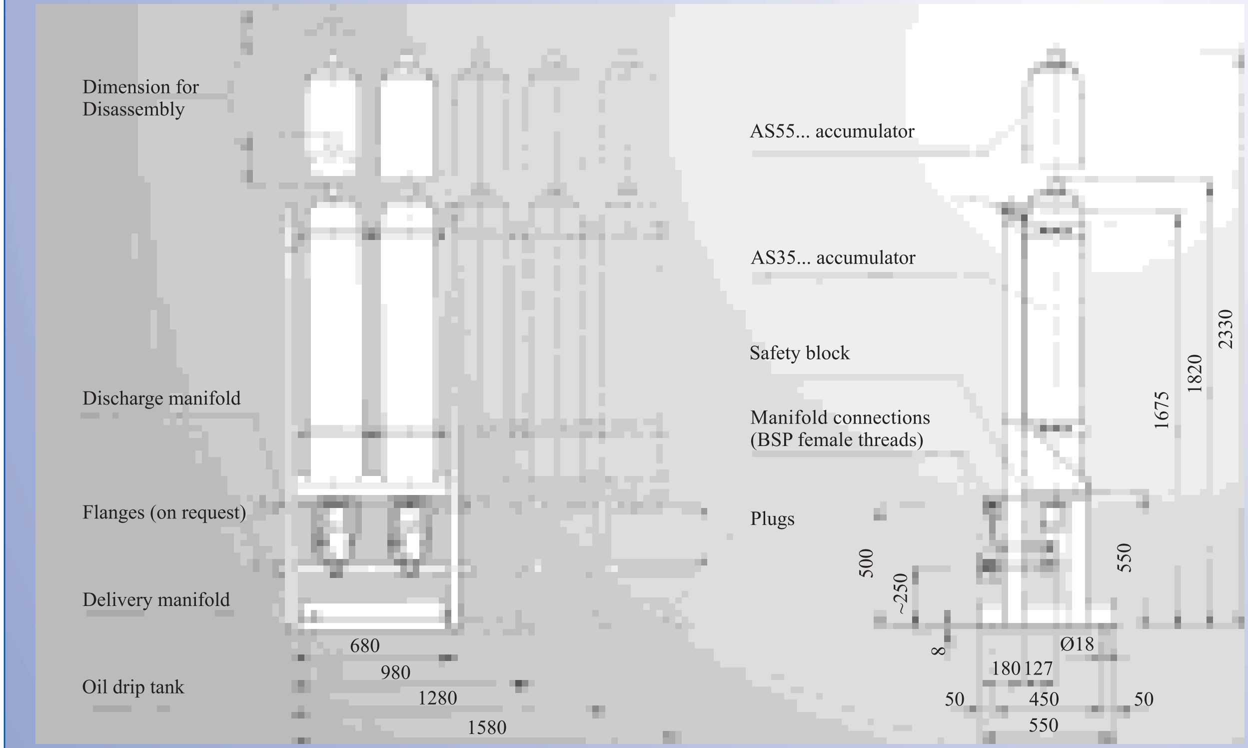


Fig.14

All EPE accumulators are carefully inspected and tested at the factory and are exactly as designated by **the code** printed on the name plate.
In addition the name plate carries the accumulators serial number and if specified on order, the value on precharge.

On the accumulator shell are also marked :
Manufacturer's serial number and **date shell manufactured; identification mark; design standard applicable; maximum recommended working pressure; temperature range; capacity in liters.**
Accumulators are normally supplied empty (uncharged).
Charged units can be supplied on request.
ATTENTION: The max working pressure marked on the accumulator must be ≥ that the calibrated pressure of the relief valve.
Before undertaking any work (repairs, replacement, etc.) on the hydraulic circuit for mounting an accumulator, it is advisable to release completely the liquid pressure.
Test certificates if required are supplied with the accumulator, or forwarded by mail.

Installation

To achieve a high degree of efficiency, the accumulator should be fitted **as close as Possible** to the installation it serves.
The space necessary for testing and filling equipment is at least 150mm around the gas-fill valve.

POSITION is possible from vertical one (gas valve on top) to the horizontal one.
The manufacturers name plate stating initial pressure must remain visible.
Access to vent screw must be kept unobstructed.

MOUNTING by means of clamps, brackets and rubber support rings.
The mounting must be such that should a rupture occur on the pipe system at the liquid connection, or should the gas-fill valve break, the accumulator cannot be pulled from its mounting by the forces involved.
No welding or other mechanical process must be carried out on the accumulator shell for the purpose of attaching fastenings.

CONNECTION adopters and flanges are available on request. When fitting screws**,** reducers or the safety and shut-off block, care must be taken that the accumulator is held firmly by means of a spanner at the liquid valve, so that the liquid valve is not turned **independently** of the accumulator body.
To guarantee trouble free operation, the following points should be observed:
A **non-return valve** to be fitted between pump and accumulator to prevent reversal.
The installation **relief valve** must be fitted directly to the accumulator, after the non-return valve, and calibrated lower than the working pressure marked on the accumulator shell.
A **shut-off valve** and a **dump valve** are recommended to enable periodic checks or removals during normal operation.
EPE safety blocks type **B or BS** incorporates all the essential functions.

Preliminary Checking

Upon receipt check:
❋That there has been no damage in transit.
❋The identification code is as ordered.
Before installation it is most important to ensure that the gas pressure corresponds to the desired value.
The initial gas pressure must be selected to meet the service requirement.
In general the design values are as follows:
$P_0 = 0.9\ P_1$, (energy reserve, line shock absorber, etc.)
$P_0 = 0.6 - 0.7\ P_1$ (pulsation damper)
Gas precharge pressure is of crucial importance to the correct functions of the accumulator and the durability of the bladder.
The gas pressure, when the accumulator is supplied pre-charged **is related to the temperature of 20°C.**
In the case of accumulators supplied without pre-loading pressure, or after repair work it is necessary to perform inflation with nitrogen; must also be performed also the verification of the system by using the equipment type-PC following procedure *checking & charging - page-13*.

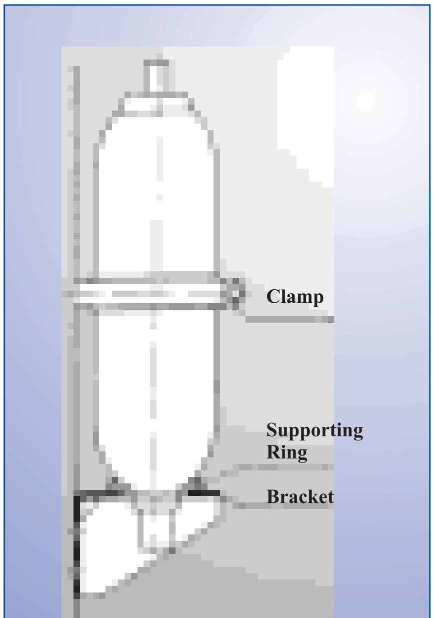


Fig.15

Initial Operation

Before the system is pressurised it has to be bled. For this, the vent screw in the fluid port assembly has to be eased until fluid emerges.
Then retighten the gas valve locknut carefully.
The system is charged with maximum pressure and sealings and connections should be checked.

Periodic Checking

After the installation of a new unit, or following repairs, the initial pressure must be tested as follows:
Atleast once during the first week so that any gas losses can be immediately observed and remedied.
If no gas losses are observed during the first check, a second check should be carried out approximately 3 months later,
If during this check no gas losses are evident, a six-month check should be sufficient.
It is however recommended that heavy duty applications be checked every month.

Pre-Loading & Checking Set type-PC (refer Fig.16) is to be used for checking / charging of Bladder Accumulators. When charging, the nitrogen bottles must be capable of delivering pressure higher than the desired accumulator gas pressure.
Use dry industrial nitrogen. ***NEVER USE OXYGEN OR AIR.***
Proceed as follows :

- Fit the suitable pre-charging equipment to the gas valve;
- Connect it to the nitrogen cylinder with the charging hose;
- Slowly introduce nitrogen into the accumulator until reaching a pressure slightly above the required level;
- Close the valve of nitrogen cylinder and disconnect the charging hose from the equipment;
- Wait for the gas temperature stabilization;
- Set the pressure by venting off the excess of gas.

Periodic Checking

It is important that the gas pressure be kept constant and should therefore be checked periodically by means of the **filling and checking equipment PC/...**
The same equipment is used for re-infalting the bladder after repair work or change of use.
Connection is made by the special hose to the dry nitrogen bottle.

ONLY NITROGEN MUST BE USED. AIR OR OXYGEN COULD CAUSE AN EXPLOSION.

Pressure Checks

This is simple operation, the correct procedure is as follows :
Isolate the accumulator from the system and reduce the liquid **pressure to zero.**
Remove the protective and sealing caps from the gas valve.
Prior to the mounting PC/ - equipment ensure that the valve **A is unscrewed,** that bleed valve **B is closed** and that is non-return valve **C is screwed tight.** (refer Fig.17)
Attach the unit to the gas-fill valve by means of the knurled nut **D.**
Screw valve **A** to a point where pressure is registered.
If the pressure is OK remove the PC/unit as follows :
Unscrew the valve **A**.
Open the bleed valve **B** and unscrew the nut **D.**

Pressure Reduction

If the pressure has to be **reduced** this is done by **opening the bleed valve B slowly** until the correct pressure is registered on the gauge.

Increase or reset precharge pressure

If it is necessary to fill, or to increase the gas pressure, proceed as follows:
Fit the PC/ unit as described above.
Fit the connection to nitrogen cylinder. (refer Fig.17 & Fig.18)
Connect the hose between the cylinder and the non-return valve C.
Slowly open the valve on the cylinder till the gauge registers a pressure slightly higher than the one desired, then **shut.**
Unscrew A and reduce the pressure PC/ unit to zero by means of the bleed valve **B.**
Disconnect the hose from the non-return valve C. and **replace cap.**
Close the **bleed valve** and wait approximately 5 mins. for the temperature to adjust.
Screw valve **A** until the pressure can be read. This should be slightly higher than the desired pressure.
Adjust by means of bleed valve, remove the filling unit.
Use soapy water test for leaks.
Replace the valve cover and protection cap.
The accumulator is ready for use.

A PRESSURE REDUCING VALVE MUST BE INSTALLED BETWEEN THE NITROGEN GAS CYLINDER AND THE ACCUMULATOR WHEN THE GAS CYLINDER PRESSURE IS HIGHER THAN MAX PERMISSIBLE PRESSURE OF ACCUMULATOR.

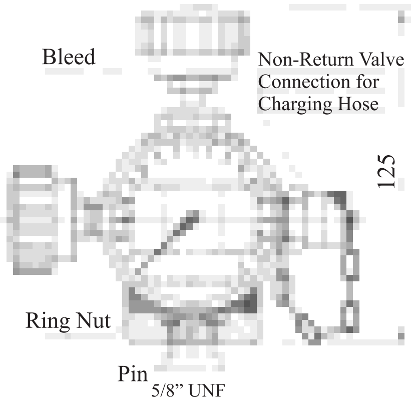


Fig.16

Fig.17

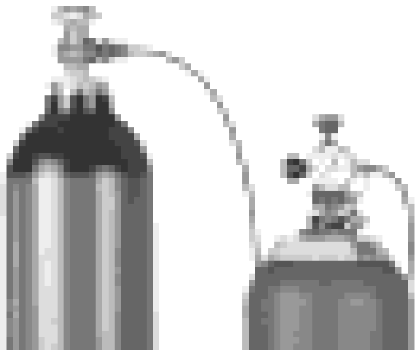


Fig.18

Standard equipment PC-280/70 is supplied with two pressure gauges: the high pressure gauge (280 bar) is used for pre-loading values higher than 50 bar. & low pressure gauge (70 bar) for values lower than 50 bar.

General

If the Accumulator has to be stripped for any reason, the following procedure **must be followed in the sequence shown below.**

- Before removing Accumulators for servicing, the fluid pressure must be reduced to zero by exhausting the fluid through the system and back to the reservoir.

- When this is not possible the Accumulator shut-off valve must be closed and the dump valve opened to exhaust the Accumulator directly to the reservoir.

- As the liquid connections for the HP & LP Accumulators differ (refer Fig.19 & Fig.20) the procedure will also vary.

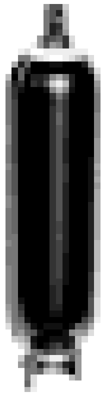


Fig.19
Type-ASWD

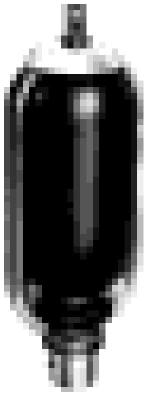
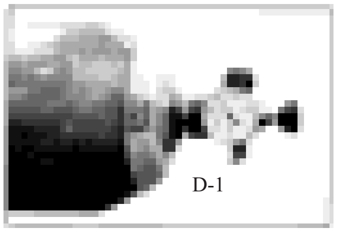


Fig.20
Types-AS
ASHF/ASWP

Dismantling the Accumulator

- **Isolate** from the liquid connection and **drain.**
- Place the Accumulator in a vice horizontally.
- Remove the protection caps.
- Discharge gas from the bladder by means of pre-loading & checking device. (Fig. D-1).
- Dismantle the gas-fill valve

Only at this point can the liquid connection be dismantled.

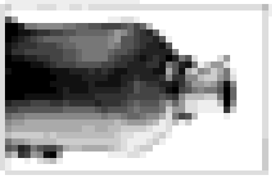


D-1

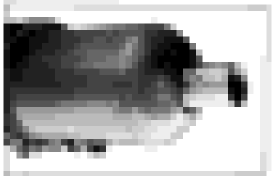
WARNING : Before any work is undertaken the gas pressure must be fully relieved.

High Pressure Range (types - AS / ASHF / ASWP):

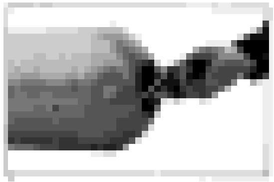
- Remove the bleed screw. (Fig. D-2)
- Remove the ring nut and the spacer ring. (Fig. D-3)
- Push the fluid port body into the vessel and remove the gasket and 'O'Ring. (Fig. D-4)
- Remove by bending the rubber coated retaining ring. (Fig. D-5)
- Remove the fluid port body. (Fig. D-6)
- Remove the nut holding the gas valve and nameplate. (Fig. D-7)
- Remove the bladder from the liquid side by slightly twisting. (Fig. D-8)



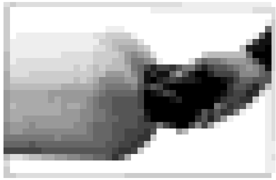
D-2



D-3

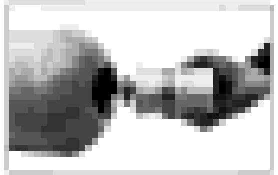


D-4

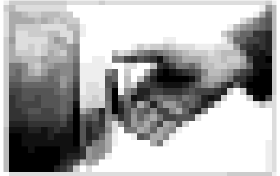


D-8

D-5



D-6



D-7

Low Pressure Range (type-ASWD):

- Remove the bleed screw.
- Unscrew the anti extrusion body assembly.
- Remove the nut holding the gas valve and nameplate.
- Remove the bladder from the liquid side by slightly twisting.

Carefully clean all components including the bladder and the inside of the Accumulator body.

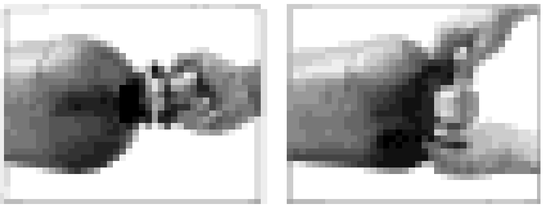
Mainly check that:

- THE BLADDER **is not damaged, worn** or **perished.**
- THE POPPET VALVE in High Pressure Range (types - AS / ASHF / ASWP) slides freely and that the spring is undamaged.
- GASKETS AND SEALS are not worn.
- THE INTERIOR of Accumulator body has no cracks or signs of failure.
- THE ANTI EXTRUSION plate in Low Pressure Range (type-ASWD) is not damaged or worn.

REPLACE ALL SUSPECT AND WORN PARTS. THE BLADDER CAN'T BE REPAIRED.

Bladder Gas Valve Assembly

Should the bladder have to be replaced and the gas valve is in good condition it is possible to fit a new bladder to the old gas valve (or vice-versa) taking care to ensure that the edge of the mouth piece makes a **perfect fit** with the valve seat. The valve is then put into place, by means of hand pressure on the rubber coated washer until it is no longer possible to remove unless force is used. The bladder can now be inserted into the Accumulator.

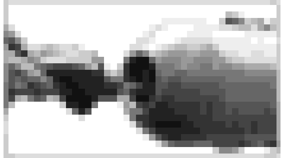


Assembling the Accumulator

Ensure that all components are in good condition and perfectly clean. Assemble in the following order:

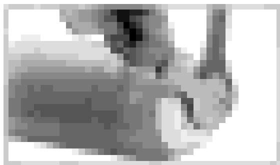
High Pressure Range (types - AS / ASHF / ASWP):

- Insert the bladder (use a threaded tube M 12 x 1.5). (Fig. A-1)
- Mount name plate and nut for the gas valve body. (Fig. A-2)
- Tighten the nut holding the gas valve body with a spanner. (Fig. A-3)
- Insert the fluid port assembly and the rubber coated retaining ring. (Fig. A-4)
- Locate the fluid port on to the support ring, fit gaskets and spacer ring. (Fig. A-5)
- Tighten the ring nut making sure the assembly is centrally located. (Fig. A-6)
- Fit the bleed screw and gasket. Pour a small amount of liquid into the accumulator to lubricate. (Fig. A-7)
- Finally mount the gas-fill valve, charge accordingly to *checking & charging - page-13* and again tighten the gas valve nut.



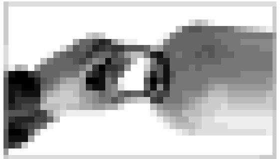
A-1

A-2

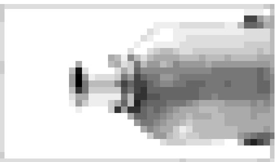


A-3

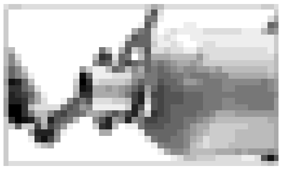
A-7



A-4



A-5



A-6

Low Pressure Range (type-ASWD):

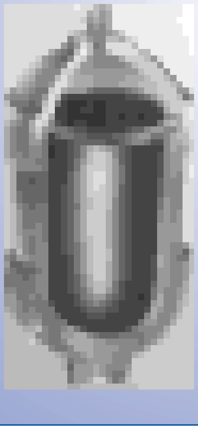
- Insert the bladder (use a threaded tube M 12 x 1.5)
- Mount name plate and nut for the gas valve body
- Tighten the nut holding the gas valve body with a spanner
- Tighten the anti extrusion body assembly.
- Tighten the reducer assembly.
- Fit the bleed screw and gasket. Pour a small amount of liquid into the Accumulator to lubricate.
- Finally mount the gas-fill valve, charge accordingly to *checking & charging - page-13* and again tighten the gas valve nut.

EPE

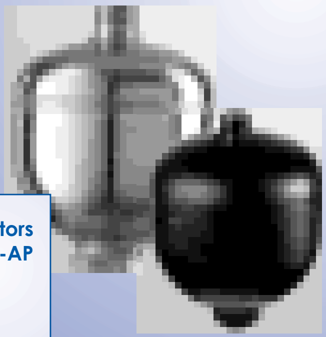
Filters . Accumulators
an ISO 9001 Company

Other Products of Interest

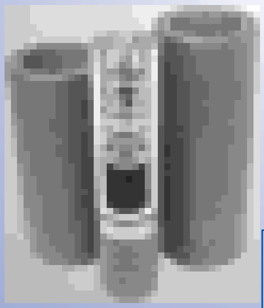
Repairable Diaphragm Accumulators
Type-AM



Welded Diaphragm Accumulators
Type-AMW



Piston type Accumulators
Type-AP



Safety cum Shut-Off Blocks
Type-B/BS

EPE
EPE PROCESS FILTERS & ACCUMULATORS PVT LTD
An ISO 9001 Company

Techni Towers
C-54/A, A.P.I.E., Balanagar
Hyderabad -500 037. A.P.,India.
Tel. Nos. : 23778803/23778804/23871445
Fax Nos. : 040-23871447.
Internet : www.epe-india.com
E-mail : business@epe-india.com

Catalogue Ref. : EPE/BTA/09-10/001