2009 Product Catalog
1175 Brittmoore Rd. Houston, TX 77043-5003 USA
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Bladder Material Specifications

The following chart is for typical applications at moderate cycles and is based on laboratory results. System fluid and contamination can significantly affect performance. Since real world usage can vary widely, Acc. Inc. cannot warrant the acceptability of any particular system **or the expected life of an elastomer product**.

RUBBER COMPOUND	CODE	PEAK RANGE (F)	OPTIMAL RANGE (F)	PERMEANCE	HARDNESS SHORE (A)	TENSILE (PSI)	ELONGATION (%)
Buna-Nitrile	(None)	-10 to 210	35 to 160	5	60	2000	500
Low Temp Buna-Nitrile	L	-60 to 200	-25 to 145	26	45	1500	500
Butyl	B	-45 to 200	35 to 160	3	60	1500	475
Ethylene- Propylene (EPR)	E	-55 to 300	35 to 250	20	60	1500	500
Fluoro-Elastomer	V	+10 to 480	35 to 350	2	60	1200	400
Extreme Low Temp Nitrile	XL	-80 to 200	-25 to 145	*	60	1600	400
High Temp Nitrile	XH	+10 to 300	35 to 250	*	60	2400	700

Temperature Ranges (F). PEAK: Upper value is based on polymer vendor data. Lower value is based on ASTM D-1053. OPTIMAL: Based on good hydraulic practices. Extended operation beyond these temperatures will shorten the life of the bladder. *Unavailable at press time

The use of compatible clean fluids is highly recommended. Proper filtration is necessary. High Temperature applications should use oil coolers. Low temperature applications require fluid that is in a liquid state.

Permeance to Nitrogen. Parts per million based on ASTM D-1434.

Physical Properties. Values are nominal and are based on Laboratory results.

Bladder Elastomer Compatibility

There are literally thousands of chemical compounds that bladder elastomer compounds have been tested with. An up-to-date listing of the most popular fluids can be found on our website at
www.accumulators.com/rubber-compatibility.html
We also maintain an extensive library of elastomer manufacturers' compatibility tables.
Please contact our Sales Applications Department, for you application.

Bladder Special Orders

Accumulators, Inc. manufactures a wide range of special accumulators and bladders that can be adapted to most customer applications.

Bladders can be made with many different types of gas valves, with a wide range of materials, and at many pressure ranges. Many elastomers are available.

Accumulators, Inc. can help you design your special parts.

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Sizing of Accumulators

Our easy to use sizing program is available under Tech Info, on our website at www.accumulators.com.

Our Sales & Engineering Personnel can also help you with your Application, at info@accumulators.com or call us a 713-465-0202

Accumulator Sizing Formulas

(Sizing of Accumulators is based on the application of the ideal gas laws.)

Nomenclature:

A = Pipe cross-sectional area, ft^2
B = Pump cylinder bore area, $in.^2$
g = Gravitational constant, ft/s^2
K = Pump constant
L = Pipe length, ft
n = Polytropic constant, typ. nitrogen
P = Normal system pressure, psia
P_i = Initial pre-charge pressure, psia
P_N = Nitrogen bottle pressure, psia
P_{max} = Maximum operating pressure, psia
P_{min} = Minimum operating pressure, psia
P_P = Pre-charge pressure, psia
S = Pump stroke length, in.
V_a = Total volume of accumulator (gas volume), $in.^3$
V_N = Nitrogen bottle volume, $in.^3$
V_x = Volume of fluid collected or discharged by accumulator, $in.^3$
V_1 = Required accumulator volume, $in.^3$
X = Number of accumulators
Y = Number of nitrogen bottles required
v = Fluid velocity, fps
γ = Fluid specific weight, lb/ft^3

SIZING FOR FLUID STORAGE:
Used for auxiliary power, emergency stand-by power, and pressure holding applications.

$$V_1 = \frac{V_x \left(P_{min} / P_P \right)^{1/n}}{1 - \left(P_{min} / P_{max} \right)^{1/n}}$$

The above equation is based on the adiabatic method. It assumes the accumulator will charge and discharge rapidly, less than one minute cycle time. For applications with longer cycles this equation will give conservative results. The polytropic constant depends on pressure and working pressure. It can be looked up in a good hydraulic or pneumatic handbook.

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SIZING FOR LINE SHOCK:

$$V_1 = \frac{12\gamma A L v^2 (n-1)}{2gP\left[\left(\frac{P_{max}}{P}\right)^{\frac{n-1}{n}} - 1\right]}\left(\frac{P}{P_P}\right)^{\frac{1}{n}}$$

Fluid line shock or "water hammer" is caused by the rapid closing of a valve in the line system. An accumulator placed close to the valve will dampen the resulting pressure shock wave.

SIZING FOR SUCTION STABILIZATION:

Rule of thumb: Volume of accumulator = 8 to 10 times the total displacement demand of the pump, per revolution. Note: Fluid connections must allow adequate flow area.

SIZING FOR PULSATION DAMPENERS:

$$V_1 = \frac{BKS\left(\frac{P}{P_P}\right)^{\frac{1}{n}}}{1-\left(\frac{P}{P_{max}}\right)^{\frac{1}{n}}}$$

The pump constant can be obtained from the pump manufacturer.

QUANTITY OF NITROGEN BOTTLES NEEDED:

$$Y = \frac{P_i V_a X}{V_N (P_N - P_i)}$$

This equation gives the number of nitrogen bottles required to fill a number of accumulators to a specified pre-charge. Round the number of nitrogen bottle up to the next largest whole numbers when figuring the number required. Nitrogen bottle pressure is typically 2400 psig with a volume of 2700 cu. in.

NITROGEN BOTTLES NEEDED WHEN USING A BOOSTER:

$$Y = \frac{P_i V_a X}{P_N V_N}$$

This equation assumes that the accumulators start at one atmosphere of pressure absolute and that the nitrogen bottles will be drained by the booster to one atmosphere of pressure absolute.

Accumulator Polytropic Coefficient:

AVERAGE SYSTEM TEMPERATURE

$\frac{P+P_P}{2}$	Below 100°F	100°F	140°F	170°F	200°F
100 psig	1.4	1.4	1.4	1.4	1.4
200 psig	1.4	1.4	1.4	1.4	1.4
300 psig	1.5	1.5	1.5	1.5	1.5
400 psig	1.5	1.5	1.5	1.5	1.5
500 psig	1.5	1.5	1.5	1.5	1.5
600 psig	1.5	1.5	1.5	1.5	1.5
700 psig	1.5	1.5	1.5	1.5	1.5
800 psig	1.6	1.5	1.5	1.5	1.5
900 psig	1.6	1.6	1.5	1.5	1.5
1000 psig	1.6	1.6	1.6	1.5	1.5
1500 psig	1.7	1.7	1.6	1.6	1.5
2000 psig	1.8	1.7	1.7	1.7	1.6
2500 psig	1.9	1.8	1.7	1.7	1.7
3000 psig	1.9	1.9	1.8	1.8	1.7

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Alternate Design Codes and Inspection Agencies

Most Accumulators sold by Accumulators, Inc. are designed, manufactured, inspected and tested under Section VIII, Div. I for unfired pressure vessels within the ASME Boiler and Pressure Vessel Code.

Most units are stamped with the ASME "U" stamp and have the form U-1A data report available. Additionally, each unit is registered with the National Board of Boiler and Pressure Vessel Inspectors and assigned a unique National Board number.

Accumulators, Inc. is contracted with Bureau Veritas/One CIS Insurance Group. They are authorized by ASME (American Society of Mechanical Engineers) and the State of Texas as our Authorized Inspection Agency (AIA). Additionally, vessels that we have fabricated and tested by our regular outside suppliers may be inspected by other ASME Authorized Inspection Agencies. (Some examples are: Hartford Steam Boiler, Kemper Insurance, Underwriters Laboratory or various city, county or state official agencies.)

There are numerous alternate inspection codes and standards in existence, promulgated by various government, statutory, jurisdictional or industry authorities. Each of these codes has its own qualifying and inspection procedures. Some recognize the ASME code with no further action required. Some require a simple registration. Others require a more detailed registration process and proof of adherence to the ASME code. Others have their own various procedures which are reviewed by an appointed Authorized Inspection Agency (AIA).

Many customers confuse the AIA with the code. Many of these agencies can inspect for more than one code. Consequently, when special orders are received, we must know which agency and which code requirements are requested.

Accumulators, Inc. has formal contracts with several AIAs and working relationships with several others and is familiar with numerous codes. Codes are constantly changing and new codes are often created. The list of which AIAs can inspect for which specific code is also constantly changing. When an inquiry or order is received by Accumulators, Inc., we determine the proper code and current AIA and the costs involved.

The cost for ASME design, manufacture, inspection, testing, stamping and National Board Registration, plus the U-1A data report is included in our list prices. Most alternate codes are at additional cost, which may include:

1. Application preparation and AIA application fees
2. Documentation preparation
3. AIA review fees
4. Testing, examinations and inspections
5. AIA fees for inspections, reports or registrations
6. Data books

The following is a list of selected codes and AIAs. It is far from a complete list, and not all are available:

AIAs and Authorities*	Codes*
Bureau Veritas/One CIS	**ASME** (USA) "U", "R"
Kemper Insurance	D.En. (UK)
Underwriters Lab	NPD (Norway)
Hartford Steam Boiler	USCG (USA)
Det Norske Vertias (DNV)	Service des Mines (Fr)
ABS Americas (Abstech)	TUV (Germany)
Lloyds Register	Stoomwezen (Europe)
Work Health Authority	CSA B51 (Canada) & CRN (Canada)
Delta Lloyds	AS-1210 (Australia)
Lloyds of London	DOT (USA)
TUV	API (USA)
EC (Common Market)	BS 7201 (UK)
"**CE**" Mark under PED	NR13 (Brazil)

***For a more complete list contact our Engineering Department**

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