

Bladder type shock suppressor water hammer application

General

Bladder type shock suppressors can be used to solve certain water hammer problems using this sizing procedure.

Operation

The bladder type shock suppressor eliminates water hammer by storing the kinetic energy in the form of a compressed gas. An ample air cushion, precharged at the factory, of calculated volume and pressure is retained and controlled by a mechanically sealed-in heavy-duty butyl bladder. This combination of air cushion and flexible bladder accepts live surges before any damaging shock waves can develop.

Water is contained in an NSF61 listed bladder. This provides a completely non-metallic water reservoir, eliminating any contact of system water with metal.

When a sudden valve closure occurs, the resulting pressure surge travels back from the valve to the bladder type shock suppressor forcing the bladder to expand into the air cushion.

The shock is absorbed by the compressing of the air. After absorption of the shock, the system water pressure and the air chamber pressure equalize at the static pressure level.

Maximum system conditions

- Static pressure – 100 psig
- Temperature
 - Continuous - 160°F
 - Intermittent - 200°F (1 hour)
- Shock Pressure – 150 psig
- Compatible liquid – water
- Velocity – 6 Ft./Sec.

The above limiting factors should all be obvious except for the velocity. For every one (1) ft./sec. of water velocity that is stopped, there is a potential pressure rise of 60 psig. To maintain this pressure within the structural adequacy of the bladder type shock suppressor, a maximum velocity of six (6) ft./sec. has been specified.

Sizing Procedure

The size of the bladder type shock suppressor is calculated by relating the energy of the system to the amount of energy stored in one (1) cubic foot of compressed air.

To determine the total kinetic energy of a system, the following information is required:

- **Pipe Size** – all pipe diameters in inches from the quick closing valve to the water source, i.e., water meter, storage tank, or main line where kinetic energy is not significant.
- **Effective Pipe Length** – the total length in feet of a given pipe diameter. All lengths of various pipe diameters are to be considered until the kinetic energy is negligible.
- **Maximum Flow** – the flow through the system measured in gallons per minute.
- **Static Pressure** – the system pressure with no water flowing measured in psig.
- **Flow Pressure** – the pressure in psig at the point of the bladder type shock suppressor installation while water is flowing.
- **Maximum Shock Pressure** – the design pressure of the system. The Plumbing and Drainage Institute (P.D.I.) recommends using 150 psig.

With the above information, select the proper size bladder type shock suppressor using the following procedure:

- Determine the system velocity from Fig. #1, page 2.
- Determine the kinetic energy (KE) per lineal foot of pipe from Fig. #2, page 2.
- Obtain total kinetic energy (KE) from equation:

$$\text{Total Kinetic Energy} = \text{KE} \times \text{Effective Pipe Length}$$

- Determine pressure factor from Table A at intersection of Flow Pressure and Maximum Allowable Shock Pressure

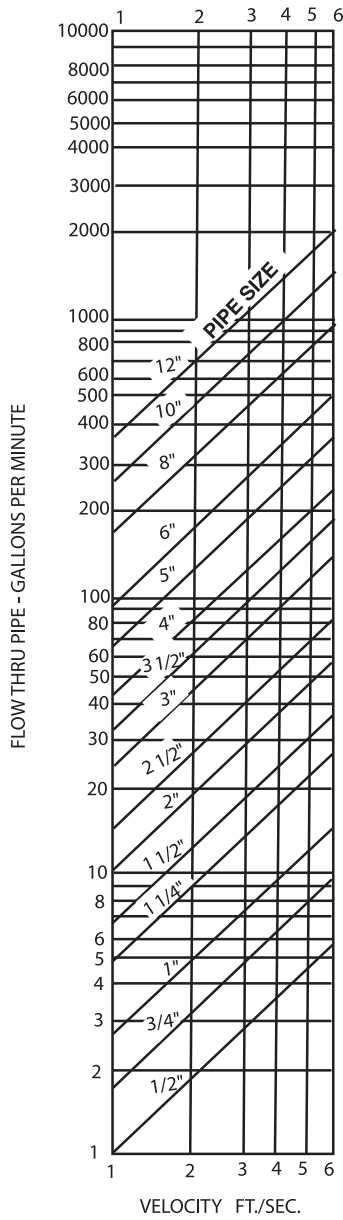


FIG. #1

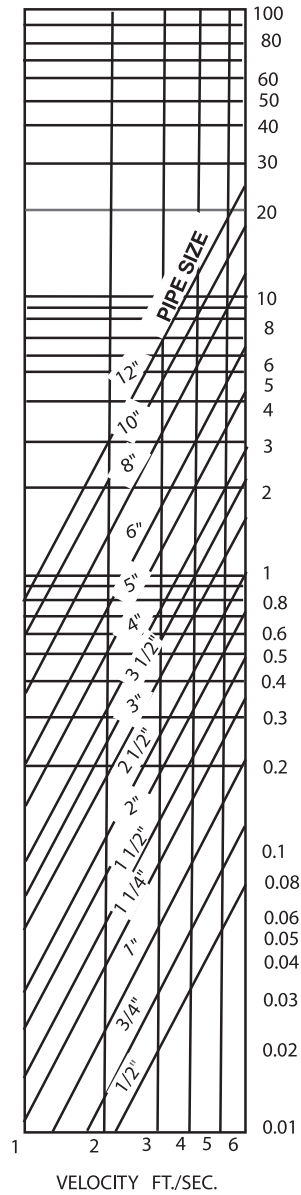


FIG. #2

PRESSURE FACTORS TABLE A

Max. Shock Pressure PSI	Line Pressure PSI – Water Flowing									
	20	30	40	50	60	70	80	90	100	110
100	2500	2130	1730	1265	880	445	230			
110	2880	2490	2075	1700	1210	780	505	230		
120	3110	2800	2420	1980	1525	1110	805	460	130	
130	3430	3110	2740	2275	1930	1470	1100	690	375	160
140	3780	3430	3065	2600	2275	1785	1385	900	600	375
150	4080	3730	3415	3070	2650	2160	1760	1310	900	635

• Determine required bladder type shock suppressor volume in gallons from equation.

$$(V) \text{ Volume} = \frac{(7.48) \text{ Total Kinetic Energy}}{\text{Pressure Factor}}$$

• Determine the shock suppressor acceptance factor from Table B or the equation.

$$A.F. = 1 - \frac{P_1 + 14.7}{P_2 + 14.7}$$

Where: P₁=flow pressure – psig
P₂=static pressure – psig

ACCEPTANCE FACTORS

TABLE B

Flow Pressure – PSIG															
Static Pressure – PSIG	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
30	.22														
35	.30	.20													
40	.37	.27	.18												
45	.42	.34	.25	.17											
50	.46	.39	.31	.23	.15										
55	.50	.43	.36	.29	.22	.14									
60	.54	.47	.40	.33	.27	.20	.13								
65		.50	.44	.38	.31	.25	.19	.13							
70		.53	.47	.41	.35	.30	.24	.18	.12						
75			.50	.45	.39	.33	.28	.22	.17	.11					
80			.53	.48	.42	.37	.32	.26	.21	.16	.11				
85				.50	.45	.40	.35	.30	.25	.20	.15	.10			
90				.53	.48	.43	.38	.33	.29	.24	.19	.14	.10		
95					.50	.46	.41	.36	.32	.27	.23	.18	.14	.09	
100					.52	.48	.44	.39	.35	.31	.26	.22	.17	.13	.09

- Multiply the acceptance factor by the determined bladder type shock suppressor volume (V) to obtain the acceptance volume.
- Determine the shock suppressor precharge pressure by making it two (2) psig below the flow pressure at the point of installation.

$$\text{Acceptance Volume} = (\text{A.F.}) \times V$$

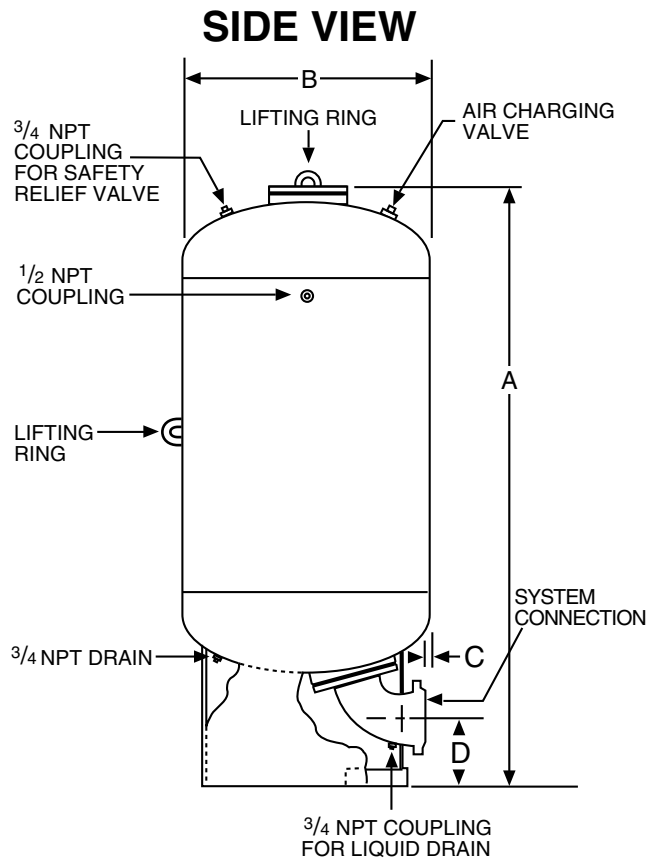
- Select the model shock suppressor by checking both the total volume and the maximum acceptance volume. To insure long bladder life, the maximum recommended acceptance volume must not be exceeded. Multiple of smaller tanks may be used to meet this requirement.

D-Series Diatrol® ASME Models

Model No.	Tank Vol.		A Height		B Diameter		Sys. Conn.	C	D	Ship Wt.	
	Lit.	Gal	mm	ins.	mm	ins.	ins.	ins.	ins.	kg	lbs.
D-7	200	53	1245	48 ⁷ / ₈	610	24	4	1 ⁹ / ₁₆	8 ³ / ₁₆	178	390
D-11	300	80	1600	62 ⁷ / ₈	610	24	4	1 ⁹ / ₁₆	8 ³ / ₁₆	230	505
D-14	400	106	1956	76 ⁷ / ₈	610	24	4	1 ⁹ / ₁₆	8 ³ / ₁₆	282	618
D-18	500	132	2311	90 ⁷ / ₈	610	24	4	1 ⁹ / ₁₆	8 ³ / ₁₆	333	731
D-21	600	158	1893	74 ¹¹ / ₁₆	762	30	4	1 ³ / ₈	7 ¹ / ₄	433	950
D-28	800	211	2365	93 ¹ / ₈	762	30	4	1 ³ / ₈	7 ¹ / ₄	513	1125
D-35	1000	264	2086	82 ¹ / ₈	914	36	6	3 ¹ / ₄	7 ¹ / ₂	693	1520
D-42	1200	317	2465	94 ¹ / ₂	914	36	6	3 ¹ / ₄	7 ¹ / ₂	784	1720
D-50	1400	370	2781	109 ¹ / ₂	914	36	6	3 ¹ / ₄	7 ¹ / ₂	866	1900
D-56	1600	422	2178	85 ³ / ₄	1220	48	8	1 ³ / ₄	10 ⁷ / ₈	1049	2300
D-70	2000	528	2528	99 ⁵ / ₈	1220	48	8	1 ³ / ₄	10 ⁷ / ₈	1231	2700

Notes: Allow 18" (460mm) minimum clearance.

Constructed per ASME Code Section VIII, Division 1.



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