THE JOHN WOOD COMPANY
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TECHNICAL BULLETIN

Form 001

Sizing and Selection Guide

ASME Bladder Type Expansion Tanks For Hot Water Heating and Chilled Water Systems

APPLICATION

ASME Bladder Type Expansion Tanks can be used in a variety of applications including hot water heating, snow melt, radiant, and chilled water systems. The tanks are designed to absorb the expansion forces of heating or cooling system water to maintain the proper system pressurization. Expanded water, resulting from increased temperature, is stored in the expansion tank during periods of high temperatures and returned to the system when the water temperature is lower. The tank must be properly sized to store the required volume of water without exceeding the maximum pressure allowable and to maintain the required pressure when the system is cold.

These tanks utilize a flexible full acceptance butyl bladder to separate the incoming water from the compressible air cushion. This eliminates the possibility that the water will absorb air – a condition that can occur when air is in direct contact with the water at pressures above atmospheric. This condition is commonly referred to as waterlogging – when the compression tank reaches the point where all of the air has been removed from the tank and there is no room for expansion.

OPERATION

The air charge pressure in the tank is typically set equal to or 3 PSI below the system cold fill pressure. This minimum pressure equals the static head plus a small margin of additional pressure to ensure a positive pressure at the top of the system and to prevent boiling for systems operating at temperatures over 212° F. When the system is cold, the expansion tank will be almost empty of water. As the system temperature increases, the tank accepts the expanding volume of water, causing an increase in system pressure. Upon reaching the maximum system temperature, the tank will contain all of the expanded water. As the system temperature drops, water will be discharged back into the system, starting the cycle again.

Bladder type expansion tanks are typically installed on the suction side of the pump.

SIZING

Proper tank sizing requires a basic understanding of compressible gases – in this case, air. If a gas is held in a sealed container at constant temperature, the gas pressure increases at the same rate as the volume of the gas is reduced. As water fills the bladder, the volume of the air cushion is reduced. As the volume is reduced, the pressure will rise. If the air cushion is reduced to half its original volume, the pressure will rise to two times its original value. If the air cushion is further squeezed to one-third of its original volume, the pressure will rise to 3 times the original value.

Boyle's law is commonly used to predict the result of introducing a change in volume and pressure to the initial state of a fixed quantity of gas. The "before" and "after" volumes and pressures of the fixed amount of gas are related by the equation:

$$p_1V_1=p_2V_2$$

Forcing the volume V of the fixed quantity of gas to increase, the pressure p must decrease proportionally. Conversely, reducing the volume of the gas increases the pressure.

SIZING INFORMATION REQUIREMENTS

Proper tank sizing is important for two reasons:

1. The system will run more efficiently and as a result, use less electricity.
2. The system will last longer – providing long term cost savings through reduced maintenance charges and fewer replacement parts.

Determine the following:

1. Total system water volume required
2. Minimum system operating temperature (ambient fill for heating; average design temp. for chilled water)
3. Maximum operating pressure (average design temperature for heating; ambient temp. for chilled water)
4. Minimum operating pressure
5. Maximum operating pressure

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STEP 1: DETERMINE THE REQUIRED TANK SIZE

1. Enter the following:

Total system water volume	(A) _____	Gallons
Minimum system temperature	_____	° F
Maximum system temperature	_____	° F
Minimum operating pressure at tank	(B) _____	PSIG
Maximum operating pressure at tank	(C) _____	PSIG
Air precharge pressure (if different than minimum system pressure)	(D) _____	PSIG

2. Select the net expansion of water coefficient from Table 1 (E) _____ PSIG

3. Determine the amount of expanded water (F) _____ Gallons
   Multiply the total system water volume (A) by the expansion of water coefficient (E):

   (A) _____ Gallons x (E) _____ Expansion of water coefficient = (F) _____ Gallons

4. Select the acceptance factor from Table 2 (G) _____
   NOTE: If the precharge pressure does not equal the minimum system pressure or if the minimum and maximum operating pressures are not listed in Table 2, use the following formula to determine the acceptance factor:

$$\text{Acceptance factor} = \frac{(D) + 14.7}{(B) + 14.7} - \frac{(D) + 14.7}{(C) + 14.7}$$

5. Determine the minimum total volume required (H) _____ Gallons
   Divide the amount of expanded water (F) by the acceptance factor (G):

   (F) _____ Gallons ÷ (G) _____ Acceptance factor = (H) _____ Gallons

STEP 3: SELECT THE REQUIRED BLADDER TANK

1. Select a bladder tank from Table 3. Choose the tank with the lowest tank capacity greater than or equal to the minimum total volume required (I). Standard pressure ratings are listed. Higher working pressures are available upon request.

EXAMPLE

1. Select a bladder tank for an application with a total system volume of 3,000 gallons, a 20 to 40 PSIG system operating pressure range, a precharge pressure of 17 PSIG, and minimum and maximum temperatures of 50 to 190° F.

Determine the total system water content required	A	3,000 Gallons
Enter the air precharge pressure	D	17 PSI
Select the net expansion of water coefficient from Table 1	E	0.03121
Determine the amount of expanded water (A) x (E)	F	93.63 Gallons
Select or determine the acceptance factor	G	0.33402
Determine the minimum total volume required (F) ÷ (G)	H	280.31 Gallons
Select the required bladder tank from Table 3 or 4	I	317 Gallons

TABLE 1 – NET EXPANSION OF WATER

MAX SYSTEM TEMP (°F)	MINIMUM SYSTEM TEMPERATURE												
	40	45	50	55	60	65	70	75	80	85	90	95	100
50	0.00006	0.00008	-	-	-	-	-	-	-	-	-	-	-
55	0.00025	0.00027	0.00019	-	-	-	-	-	-	-	-	-	-
60	0.00055	0.00057	0.00049	0.0003	-	-	-	-	-	-	-	-	-
65	0.00093	0.00095	0.0087	0.00068	0.00038	-	-	-	-	-	-	-	-
70	0.00149	0.00151	0.00143	0.00124	0.00094	0.00056	-	-	-	-	-	-	-
75	0.00194	0.00196	0.00188	0.00169	0.00139	0.00101	0.00045	-	-	-	-	-	-
80	0.0026	0.00262	0.00254	0.00235	0.00205	0.00167	0.00111	0.00066	-	-	-	-	-
85	0.00326	0.00328	0.0032	0.00301	0.00271	0.00233	0.00177	0.00132	0.00066	-	-	-	-
90	0.00405	0.00407	0.00399	0.0038	0.0035	0.00312	0.00256	0.00211	0.00145	0.00079	-	-	-
95	0.00485	0.00487	0.00479	0.0046	0.0043	0.00392	0.00336	0.00291	0.00225	0.00159	0.0008	-	-
100	0.00575	0.00577	0.00569	0.0055	0.0052	0.00482	0.00426	0.00381	0.00315	0.00249	0.0017	0.0009	-
105	0.00671	0.00673	0.00665	0.00646	0.00616	0.00578	0.00522	0.00477	0.00411	0.00345	0.00266	0.00186	0.00096
110	0.00771	0.00773	0.00765	0.00746	0.00716	0.00678	0.00622	0.00577	0.00511	0.00445	0.00366	0.00286	0.00196
115	0.00879	0.00881	0.00873	0.00854	0.00824	0.00786	0.0073	0.00685	0.00619	0.00553	0.00474	0.00394	0.00304
120	0.01004	0.01006	0.00998	0.00979	0.00949	0.00911	0.00855	0.0081	0.00744	0.00678	0.00599	0.00519	0.00429
125	0.01111	0.01113	0.01105	0.01086	0.01056	0.01018	0.00962	0.00917	0.00851	0.00785	0.00706	0.00625	0.00536
130	0.01236	0.01238	0.0123	0.01211	0.01181	0.01143	0.01087	0.01042	0.00976	0.0091	0.00831	0.00751	0.00661
135	0.01368	0.0137	0.01362	0.01342	0.01313	0.01275	0.01219	0.01174	0.01108	0.01042	0.00963	0.00883	0.00793
140	0.01501	0.01503	0.01495	0.01476	0.01446	0.01408	0.01352	0.01307	0.01241	0.01175	0.01096	0.01016	0.00926
145	0.01643	0.01645	0.01637	0.01618	0.015888	0.0155	0.01494	0.01449	0.01383	0.01317	0.01238	0.01158	0.01068
150	0.01787	0.01787	0.01779	0.0176	0.0173	0.01692	0.01636	0.0591	0.01525	0.01459	0.0133	0.013	0.0121
155	0.01937	0.01939	0.01931	0.01912	0.01882	0.01844	0.01788	0.01743	0.01677	0.01611	0.01532	0.01452	0.01362
160	0.02092	0.02094	0.02086	0.02067	0.02037	0.01999	0.01943	0.01877	0.01811	0.01732	0.01652	0.01572	0.01482
165	0.02252	0.02254	0.02246	0.02227	0.02197	0.02159	0.02103	0.02058	0.01992	0.01926	0.01847	0.01767	0.01677
170	0.02418	0.0242	0.02412	0.02393	0.02363	0.02325	0.02269	0.0224	0.02158	0.02092	0.02013	0.01933	0.01843
175	0.02588	0.0259	0.02582	0.02563	0.02553	0.02495	0.02439	0.02394	0.02328	0.02262	0.02183	0.02103	0.02013
180	0.02763	0.02765	0.02757	0.02738	0.02708	0.0267	0.02614	0.02569	0.02503	0.02437	0.02358	0.02278	0.02188
185	0.02941	0.02943	0.02935	0.02916	0.02886	0.02848	0.02792	0.02747	0.02681	0.02615	0.02536	0.02456	0.02366
190	0.03127	0.03129	0.03121	0.03102	0.03072	0.03034	0.02978	0.02933	0.02867	0.02801	0.02722	0.02642	0.02552
195	0.03314	0.03316	0.03308	0.03289	0.03259	0.03221	0.03165	0.0312	0.03054	0.02988	0.02909	0.02829	0.02739
200	0.0351	0.03512	0.03504	0.03485	0.03455	0.03417	0.03361	0.03316	0.0325	0.03184	0.03105	0.03025	0.02935
205	0.03707	0.03709	0.03701	0.03682	0.03652	0.03614	0.03558	0.03513	0.03447	0.03381	0.03302	0.03222	0.03132
210	0.03911	0.03913	0.03905	0.03885	0.03856	0.03818	0.03762	0.03717	0.03651	0.03585	0.03506	0.03426	0.03336
215	0.0412	0.04122	0.04114	0.04095	0.04065	0.04027	0.03971	0.03926	0.0386	0.03794	0.03715	0.03635	0.03545
220	0.04335	0.04337	0.04329	0.0431	0.0428	0.04242	0.04186	0.04141	0.04075	0.04009	0.0393	0.0385	0.0376

TABLE 2 – Acceptance factors

MAXIMUM OPERATING PRESSURE PSIG	MINIMUM OPERATING PRESSURE AT TANK LOCATION (PSIG)										
	5	10	12	15	20	30	40	50	60	70	80
27	0.527	0.408	0.360	0.288	0.168						
30	0.560	0.447	0.403	0.336	0.224						
35	0.604	0.503	0.463	0.403	0.302	0.101					
40	0.640	0.548	0.512	0.457	0.366	0.183					
45	0.670	0.586	0.553	0.503	0.419	0.251	0.084				
50	0.696	0.618	0.587	0.541	0.464	0.309	0.155				
55	0.717	0.646	0.617	0.574	0.502	0.359	0.215	0.072			
60	0.736	0.669	0.643	0.602	0.536	0.402	0.268	0.134			
65	0.753	0.690	0.665	0.627	0.565	0.439	0.314	0.188	0.062		
70	0.767	0.708	0.685	0.649	0.590	0.472	0.354	0.236	0.118		
75	0.780	0.725	0.702	0.669	0.613	0.502	0.390	0.279	0.167	0.056	
80	0.792	0.739	0.718	0.686	0.634	0.528	0.422	0.317	0.211	0.106	
90	0.812	0.764	0.745	0.716	0.669	0.573	0.478	0.382	0.287	0.191	0.096
100	0.828	0.785	0.767	0.741	0.698	0.610	0.523	0.436	0.347	0.261	0.174
110	0.842	0.802	0.786	0.762	0.723	0.642	0.561	0.481	0.401	0.321	0.241

TABLE 3 – ASME Bladder Type Expansion Tanks*

MODEL NUMBER	MAWP	TANK VOLUME		DIAMETER		OVERHEADS		SYS. CONN	BASE DIAMETER		SHIPPING WEIGHT	
	PSIG	GAL	L	IN	MM	IN	MM	INCH (NPT)	IN	MM	LBS	KG
JAER-20-601	150	10	40	12	305	23	584	1	8⅝	219	50	23
JAER-20-602	150	15	60	12	305	33½	851	1	8⅝	219	65	30
JAER-20-603	150	24	90	12	305	52	1321	1	8⅝	219	90	41
JAER-20-604	150	30	110	14	356	48	1219	1	8⅝	219	90	41
JAER-20-605	150	35	130	14	356	55½	1410	1	8⅝	219	100	45
JAER-20-606	150	40	150	14	356	63	1600	1	8⅝	219	115	52
JAER-20-607	150	60	230	16	406	72⅜	1838	1½	11½	292	155	70
JAER-20-608	125	80	300	20	508	63	1600	1½	18	457	175	79
JAER-20-668	125	105	400	24	610	56	1422	1½	18	457	225	102
JAER-20-609	125	120	450	24	610	66	1676	1½	18	457	255	116
JAER-20-610	125	135	500	24	610	72	1829	1½	18	457	285	129
JBER-22-011	125	158	600	30	762	58	1473	1½	24	610	380	172
JBER-22-012	125	211	800	30	762	76	1930	1½	24	610	450	204
JBER-22-013	125	264	1000	36	914	67	1702	2	30	762	650	295
JBER-22-014	125	317	1200	36	914	78½	1994	2	30	762	750	340
JBER-22-015	125	370	1400	36	914	91	2311	2	30	762	865	392
JBER-22-016	125	422	1600	48	1219	63½	1613	2	42	1067	1050	476
JBER-22-017	125	528	2000	48	1219	77¼	1962	2	42	1067	1225	556
JBER-22-018	125	660	2500	48	1219	94	2388	2½	42	1067	1445	655

*see catalog for additional sizes

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