

November 2, 2015

# Hydropneumatic Tanks for Variable-Speed Pressure Boosters (Part 2 of 4)

In last week's RLD Monday Morning Minute, I described a [brief history of pressure-boosting systems](#) and the introduction of the pre-pressurized tank. This week we continue with the sizing of these tanks for constant-speed systems. All of this is to introduce the terms and data needed for the sizing of bladder tanks in variable speed booster systems. Let's get started....

## Sizing Bladder Storage Tanks

Bladder storage tanks are used in constant-speed pressure-booster systems for three purposes:

- Energy savings
- Prevention of short cycling
- Providing a minimum pressure required in the building when the pump is off

Gil Carlson, Director of Engineering at [Bell and Gossett](#), used to say, "No pump uses less energy than a pump that is off." The more water we can store and use in the bladder tank, the more energy we save. We want to keep the booster off for 15-30 minutes or more in a constant-speed system. Even a small 7-1/2 HP lead pump could use over \$400 a year at low or no flow.

## Constant Speed System Analysis

Staging Method: END-OF-CURVE	Motor Size: 7.5HP Service Factor 1.15 Manufacturer: Typical, High Eff Catalog:
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Load	Hours	Flow GPM	Head Feet	Pump Eff.	BHP	Motor Eff.	kWHR	Cost/day	Wire/Water Eff
10%	10.50	10.0	104.51	25.85	1.02	82.81	9.65	\$0.97	21.41%
25%	5.25	25.0	105.26	35.08	1.89	86.16	8.61	\$0.86	30.23%
45%	4.50	45.0	105.45	45.60	2.63	88.26	9.99	\$1.00	40.25%
70%	3.50	70.0	104.40	55.87	3.30	89.61	9.62	\$0.96	50.07%
95%	0.25	95.0	101.90	62.95	3.88	90.20	0.80	\$0.08	56.78%

Constant Speed Operating Cost	
Total Kilowatt Hours = 14,116	Cost per kwhr = \$0.10
Total Hours per Year = 8,760	Annual Operating Cost = \$1,412

Taken from B&G  
ESP-PLUS Program

Once we turn the pump off, we want it off for a while. Starter and motor people used to regularly speak about damage caused by starting and stopping a motor too frequently. The industry determined that the standard was to keep the motor starts to under 6 starts per hour, or once every 10 minutes. Now the goal is to store enough usable water in the tank at low flow periods to keep the booster off for 10 minutes.

The third purpose of the tank is to maintain the minimum pressure in a system when the booster system is off. If the tank is located at the pressure booster discharge, the tank fill pressure should be this minimum pressure. This is the pressure needed to lift the water and provide the minimum pressure needed at a fixture without safety factors. The maximum pressure is the booster discharge pressure, in a constant speed system.

## Tank Example

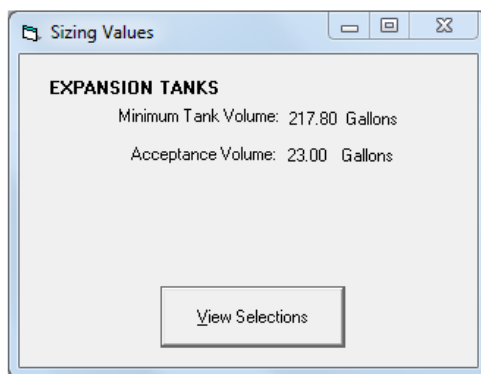
Let's use a tank example, and let's assume the tank is on the discharge header of the booster system. There may be a better place for the tank but let's save that for another day. When sizing this bladder tank for hydropneumatic use, you need the acceptance volume required, the initial pressure, and the maximum or final pressure. When the tank is empty it should be charged on the air side to the minimum pressure needed in the system. As the booster system starts, it will fill the tank until the pressure in the tank is the same as the pump. The amount of water in the tank is the acceptance volume.

So let's assume the discharge pressure of this example constant-speed booster is 80 PSIG and the minimum required is 70 PSIG. This is an apartment building with 150 GPM load. The Bell and Gossett Pressure Booster TEH-1096A design manual shows the recommended acceptance volume for various buildings for 30 minutes of storage.

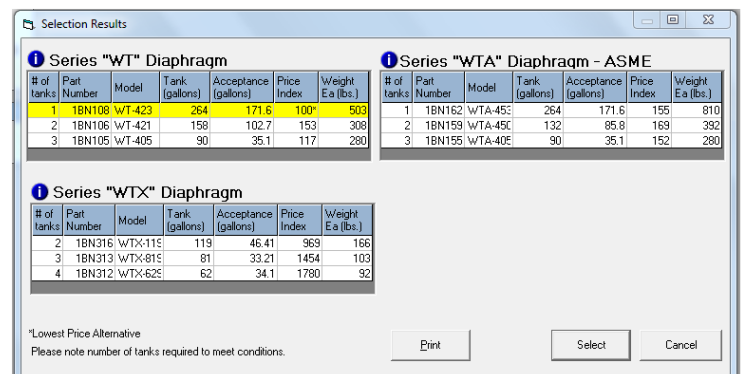
Total System Demand (GPM)	(Gallons)							
	Apartment Building	Hospital	School	University Class Rooms	University Dormitories	Commercial	Hotel	Prison
50	8	60	15	15	23	11	15	38
100	15	120	30	30	45	22	30	75
150	23	180	45	45	68	33	45	113
200	30	240	60	60	90	44	60	150
250	38	300	75	75	113	55	75	188
300	45	360	90	90	135	66	90	225
350	53	420	105	105	158	77	105	263
400	60	480	120	120	180	88	120	300
450	68	540	135	135	203	99	135	338
500	75	600	150	150	225	110	150	375

B&G Pressure Booster design manual (pg. 34)

Let's run some programs. Just as we do in HVAC hydronic systems, we must select a tank that meets both the tank volume and acceptance volume. Let's select the ASME tank. (For dimensions, go to our [plumbing products page](#) and click on the WTA link.



Required acceptance is 23 and tank is 218 gallons



Selections that satisfy both acceptance and tank volume

So what is different in a variable speed system? LOTS.... See you next week.