Water Facts

Manitoba
Water Stewardship

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PRESSURE TANKS FOR WATER SYSTEMS

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On any water supply system where a pump cuts on and off depending upon demand, a pressure tank is utilized. The air inside the pressure tank expands as water is drawn from the system and is compressed again while the pump operates. A pressure tank should be operated in conjunction with a pump pressure system to:

- provide a minimum storage of useable water
- reduce sudden pressure fluctuations in the system
- prevent the pump from starting and stopping (recycling) frequently
- stop water hammer when water is flowing through a pipe and the valve is closed suddenly causing a pounding noise in the pipes

The amount of air in the tank is important since it determines the amount of water to be released before the pump restarts.

Types of Tanks

1. Galvanized Upright Tanks

The galvanized upright tank was more commonly used prior to 1970 for jet and piston pumps. These tanks require an automatic air volume control (A.V.C.) to maintain the correct air-to-water volume in the tank. These tanks are available in sizes of 57 litres (15 gals), 114 litres (30 gals), 160 litres (42 gals), 310 litres (82 gals) and 450 litres (120 gals).

Figure 1 shows the conventional galvanized pressure tank and air volume control (A.V.C.) Three types of arrangements for A.V.C. are:

a) With a jet pump, a vacuum is created inside the flexible tubing leading from the A.V.C. to the pump when the pump cuts in. Air is sucked into the A.V.C. when the jet pump is operating. This air is then pushed into the pressure tank when the pump stops. Therefore, the water level in the tank is maintained at the height of the A.V.C. at cut-in pressure.

b) With shallow well reciprocating (piston) pumps, air is sucked through the pump from a float-regulated valve in the A.V.C. This maintains the water level in the tank at the location of the A.V.C. at cut-out-pressure.

c) Submersible pumps add excessive air to the tank, which is bled off by a float-type, reverse-acting A.V.C.

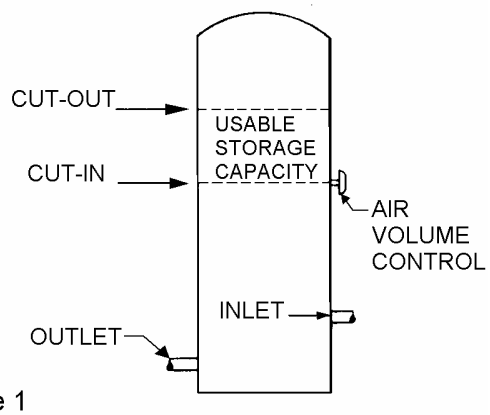


Figure 1

Table 1: Useable Storage Capacity in Pressure Tanks

Pressure Switch Setting		Pressure Tank Size									
kPa	(psi)	57 L	(15 gal)	114 L	(30 gal)	160 L	(42 gal)	310 L	(82 gal)	450 L	(120 gal)
		Useable Storage (Drawdown) in litres (gallons)									
140-275	(20-40)	9	(2.3)	18	(4.8)	25	(6.6)	48	(12.7)	70	(18.5)
200-350	(30-50)	6	(1.6)	12	(3.2)	16	(4.2)	32	(8.5)	46	(12.2)
275-410	(40-60)	4	(1.0)	8	(2.1)	12	(3.2)	23	(6.1)	33	(8.7)

With these types of pumps, the water level in the tank is maintained at the A.V.C. at cut-in pressure. Table 1 gives the approximate useable storage capacity (volume in litres and gallons, between "on and off" pressure) for galvanized pressure tanks using A.V.C.'s.

Failure of an A.V.C. to function is usually caused by plugging of orifices in the A.V.C., improper pump control valve setting, insufficient suction lift on the pump and by a defective A.V.C. Where there is insufficient suction lift, (e.g. flowing well or cistern) a globe valve should be installed on the pump suction pipe and adjusted to increase the vacuum the pump is developing.

2. Pre-charged Pressure Tanks

Pre-charged pressure tanks do not require an automatic A.V.C. A floating diaphragm separates the air and water in the tank thus reducing dissipation of air from the tank by absorption into the water. Some pressure tanks, which are commonly referred to as "perma-pressure" tanks have a glass lining and the float is installed when manufactured. These tanks are upright and available in the same sizes as the standard galvanized tanks.

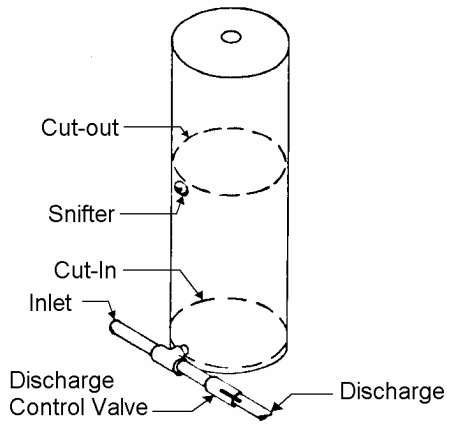


Figure 2

There are several types of float diaphragms on the market, which can be inserted into standard sized vertical galvanized pressure tanks. In all cases after the pump has been primed, the tank is pre-charged with air through a tank (snifter) valve to about 20 kPa (3 psi) below the starting (cut-in) pressure of the pump. (See pre-charging instructions in a following section). Immediately after a proper pre-charge, the useable storage capacity is approximately double the amount shown for standard tanks in Table 1.

3. Saddle Tanks

Saddle tanks are horizontal as opposed to vertical, and have a bracket attached for the pump (jet or piston) to be mounted on top. Because these tanks are horizontal, a float separating the air and water cannot be used. Thus it cannot be pre-charged.

The only method maintaining the proper air: water volume is by using an automatic A.V.C. (See Note 6 Page 4, General Recommendations)

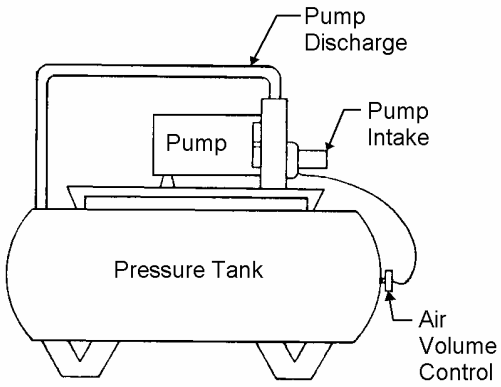


Figure 3

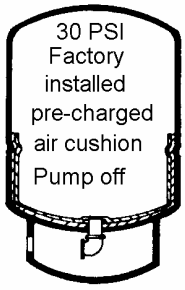
4. Fixed Diaphragm Tanks

A fixed diaphragm tank is another variation of the pre-charged tanks but with an expandable rubber diaphragm attached solidly to the sides of the tank to separate air from water.

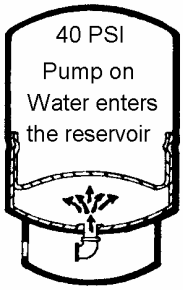
Since the diaphragm is bonded to the sides, these tanks will never waterlog (water completely displacing the air); no extra service will be required after the initial installation. These tanks usually are pre-charged at the factory, simplifying installation and start-up. The fixed diaphragm allows installation in any position. Figure 4 shows a schematic of how a fixed diaphragm tank works.

Table 2: Pre-charged Tank vs. Galvanized Tank

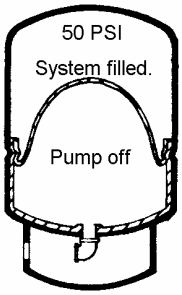
Equivalent Size			
Pre-charged Pressure Tank		Galvanized Pressure Tank	
Litres	Gallons	Litres	Gallons
8	(2.0)	19	(5)
17	(4.5)	45	(12)
32	(8.5)	76	(20)
53	(14.0)	114	(30)
76	(20.0)	160	(42)
120	(32.0)	310	(82)
168	(44.4)	450	(120)
235	(62.0)	606	(160)
330	(87.0)	850	(225)



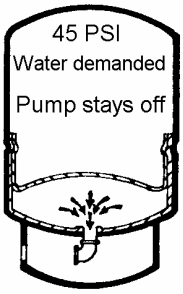
The pressure tank has a permanently separated air chamber that is pre-pressurized before it leaves the factory. Air and water never mix.



When the pump starts, water enters the tank. As system pressure passes the minimum (cut-in) setting, this is usable water.



When the pressure in the air chamber reaches maximum system pressure, the pump stops. The tank is filled to maximum capacity.



When water is demanded, pressure in the air chamber forces water into the system.

Figure 4

Pre-charging a Pressure Tank
(Not applicable to fixed diaphragm tanks)

After the pressure tank is installed and the pump primed, the pump control valve (globe, slotted key, ball, or butterfly) on the discharge line (Figure 2) should be adjusted and the tank pre-charged as follows:

1. Open all household taps and let pump start and run for approximately 10 to 15 minutes so the pumping water level in the well stabilizes.
2. If pressure drops below the cut-in pressure, close the discharge control valve until the pressure (on the pressure gauge) remains and stabilizes at approximately 20 kPa (3 psi) higher than the cut-in pressure switch setting. The valve handle should then be removed so the valve cannot be tampered with.
3. Close all the taps and switch the pump off.
4. Open one tap, close by and with an air compressor, pump air into the tank until air spurts from the tap.
5. Close the tap and pre-charge tank to approximately 20 kPa (3 psi) less than the cut-in pressure switch setting.
6. Switch pump on. The system is now ready for service.

With this setting, the pump is producing very close to maximum capacity and the pressure tank will not lose its pre-charge. The above procedure should be repeated every year or two with heavier water users pre-charging more frequently.

Selecting a Tank Size

Two considerations are important when selecting a tank size. The larger the tank the less often the pump starts and stops (recycles), increasing the life of the motor and pressure switch and cutting down the electrical bill. The smaller the tank, however, the lower the initial cost and space requirement.

The useable storage capacity of a pressure tank for a given water system depends on the well yield, pump capacity, maximum water requirements and the operating range required.

As a general rule for domestic use, a tank should be large enough so the pump will not cycle more than 20 times an hour on a 200 kPa (30 psi) (cut-in) – 350 kPa (50 psi) (cut-out) pressure setting.

Table 2 shows a comparison of equivalent tank sizes for a pre-charged pressure tank versus a galvanized tank.

General Recommendations

1. Unless the water system is to be used only for limited service such as a summer cottage, the pressure tank should always be 114 litres (30 gals) or larger for standard upright tanks, or have a volume of 53 litres (14 gals) or larger for fixed diaphragm tanks.
2. At least a 160 litre (42 gals) sized standard tank or an equivalent 68 litre (18 gals) volume for fixed diaphragm tanks should be used for livestock watering.
3. **The minimum volume of the pressure tank should be three to four times the pumping capacity of the pump in litres per minute (gallons per minute). This would ensure that at any constant water withdrawal rate the pump would not recycle more than 20 times per hour.**
4. Pre-charged pressure tanks can be calculated the same way as pressure tanks using automatic A.V.C. (Table 1). By pre-charging the pressure tank with air, the useable storage capacity can double that of a pressure tank using A.V.C. However, water logging can reduce the useable volume. Thus pre-charged pressure tanks should be recharged every six months.
5. Choosing and sizing a fixed diaphragm tank is accomplished by matching the drawdown (useable storage capacity) of the tank with the average pumping rate of the pump. For example, a pump rated at 20 litres per minute should have a drawdown of 20 litres. This drawdown of 20 litres on a 200 kPa to 350 kPa (30 to 50 psi) pressure range would require a minimum size tank with a volume of 76 litres (20 gals). (See Table 3).
6. Saddle tanks are generally not recommended because:
   a) they cannot be pre-charged and rely on an automatic A.V.C. which usually fails after a few years.
   b) because the pump is above the tank, air or dissolved gases cannot escape naturally from the pump head thus causing inefficient pumping and/or loss of prime.
7. Pressure tanks larger than 450 litres (120 gallon standard tanks) or larger than a volume of 330 litres (82 gallons, fixed diaphragm) should not be used. Where more useable storage capacity is required, two or more tanks can be connected in parallel.
8. Rather than have all the water run in one side of the tank and out the other, it is recommended that the water line be "**TEED**" into the pressure tank so that water runs "in and out" the same port. This will help in preventing corrosion to the tank, water logging, and will also supply cold fresh water for drinking.

Table 3: Useable Storage Capacities of Fixed Diaphragm Tanks

Volume of Pressure Tank		Useable Storage (Drawdown) in litres (gallons)			
Litres	(gallons)	140-275 kPa (20-40 psi) range	200-350 kPa (30-50 psi) range	275-410 kPa (40-60 psi) range	350-480 kPa (50-70 psi) range
8.0	(2.0)	2.6 (0.7)	1.9 (0.15)	1.5 (0.4)	1.4 (0.4)
17	(4.5)	5.7 (1.5)	4.5 (1.2)	3.8 (1.0)	3.5 (0.9)
32	(8.5)	10.2 (2.7)	8.3 (2.2)	7.2 (1.9)	6.4 (1.7)
53	(14.0)	17.0 (4.5)	13.6 (3.6)	11.7 (3.1)	10.6 (2.8)
76	(20.0)	24.2 (6.4)	19.7 (5.2)	16.7 (4.4)	15.0 (4.0)
120	(32.0)	39.0 (10.3)	31.4 (8.3)	26.5 (7.0)	24.2 (6.4)
168	(44.0)	53.0 (14.0)	43.5 (11.5)	37.0 (9.8)	33.3 (8.8)
235	(62.0)	72.3 (19.1)	61.0 (16.1)	51.5 (13.6)	47.0 (12.4)
330	(87.0)	105.2 (27.8)	85.6 (22.6)	72.3 (19.1)	65.9 (17.4)

METRIC CONVERSIONS

Pressure
1 psi = 6.895 kPa

Capacity
1 Imp. Gal. = 4.546 litres
1 U.S. Gal. = 3.785 litres

Weights
1 lb. = 0.4536 kg
2.2 lb. = 1 kg

Dimensions
1 ft. = 0.3048 metre
3.28 ft. = 1 metre

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