

WATER STORAGE

Adequate ground and elevated storage tanks are essential for the proper operation of a water system. These tanks are necessary in order to provide an ample supply of water during peak demands, dependable fire protection with lower insurance rates, adequate water pressure to outlying areas, and lower pumping costs. Elevated storage tanks are said to "float" on the system. This means that they hold large volumes of water high enough in the air to supply the system with water at usable pressures during peak demands. In order to maintain a static pressure of 50 psi, water must be stored 115 feet above the customer.

The type and size of a storage tank to be used depends on the desired operating main pressure and the highest daily peak demand. Ground elevations in the area should be surveyed and the storage tanks located at the highest possible elevation to the area served. Ample storage capacity in a water distribution system will mean lower operating costs and fewer pressure problems for the operator.

GROUND STORAGE TANKS

The purpose of ground storage is to hold enough water in reserve to compensate for fluctuation of the water demand in the system. The most common location of ground storage tanks is near the well field or treatment plant. These storage tanks are usually referred to as clear wells. Clear wells are also used to store additional water, which can be pumped into the system for fire fighting purposes.

CONSTRUCTION OF GROUND STORAGE TANKS

Ground storage tanks are constructed of reinforced concrete, pre-stressed concrete, and steel. Reinforced or pre-stressed concrete is the preferred material since it does not deteriorate in contact with water. Concrete requires little maintenance and can help minimize rust scale in corrosive water. Concrete construction is more expensive than when steel is used. Steel is sometimes used when construction budgets are limited. The initial savings may be sufficient to justify the added expense of maintenance on the steel structure.

DESIGN CAPACITIES OF GROUND STORAGE TANKS

A clear well should provide storage equivalent to at least 4 to 6 hours supply at peak daily flow (2.5 times daily average). This amount will usually permit a uniform pumping rate throughout the day. Clear wells should also contain additional storage for filter backwash water. Plants that operate on a part time basis may require additional clear well capacity to meet these peak flow demands. This storage capacity may range from several thousand gallons in small rural systems to several million gallons in very large ones.

LOCATION OF GROUND STORAGE TANKS

Some ground storage tanks are built above ground while others may be partial or completely underground. Underground storage should be located above the local ground water table. All tanks should be located so that surface and underground drainage is away from the structure. Tanks should never be located within the 100-year flood plain. Sewer lines within 50 feet of the tank must be watertight cast iron.

PROTECTION OF GROUND STORAGE TANKS

Provisions must be made to insure that sunlight, rain, winds, bugs, and people do not enter the tank. This will prevent possible contamination of the supply from outside sources.

- Vents and overflows should be pointed down to exclude sunlight and rainwater. Sunlight will cause algae to grow, which may result in customer complaints.
- Vents and overflows should have a fine mesh screen cover to prevent the entrance of birds and insects. Some gnats lay eggs in water that hatch into "bloodworms". These are harmless, but their presence in water will always bring customer complaints.
- Manholes should be extended above roof levels. They should be fitted with a watertight cover that should be locked except when working in the tank.
- The drain line from a ground storage tank **MUST** be separated from any connecting storm sewer by an air gap. This must be done to prevent a potential cross-connection.

FIRE PROTECTION

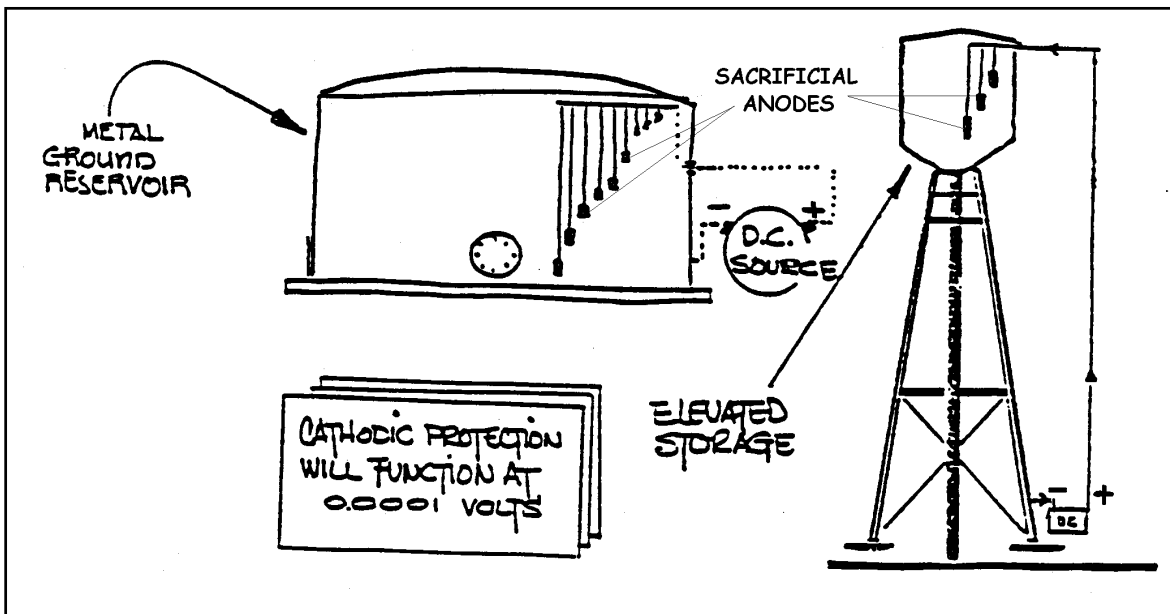
In some cases, elevated storage tanks are located near the center of high value districts in order to provide greater protection from fire loss in these areas. Standards set by the Fire Insurance Commission must be met to receive credit in establishing fire insurance rates. The minimum storage for fire protection should be 60 gallons per capita per 24 hours, or at least 50,000 gallons per day. This quantity of water plus the amount needed to satisfy daily peak demands must be available in storage.

CATHODIC PROTECTION

When two dissimilar metal rods are connected to a voltage meter and submerged in water that contains dissolved salts, a very small voltage reading (less than 0.0001 volts) will occur. This is the way electric storage batteries work. In an elevated storage tank the impurities in the water and the tank itself can cause a voltage to be generated, with the tank giving up metal as the current flows into the surrounding water and to ground.

Cathodic protection systems can be installed to prevent this corrosion by reversing the flow of the electrical current from the water to the tank. The basic theory of cathodic protection is to supply current, from an outside source, through sacrificial anodes suspended in the tank and back into the tank. This electrical current is D.C. and the voltage should be just enough to compensate for the natural voltage set up between the tank and the water. The tank is now the ground and will not become pitted.

The sacrificial anode is usually a piece of iron, magnesium, carbon, or aluminum that is 1-2 inches in diameter and 12 to 18 inches long. The anodes are designed to give up metal to the water instead of the tank. Therefore, they will eventually need replacing. They should be inspected every six months and usually replaced yearly. Installation and maintenance of a cathodic protection system can be hazardous work and should be done by a professional tank and tower company. The success of an installation depends on the proper spacing of the anodes so that all surfaces of the tank receive the flow of current equally. When cathodic systems run at too high a voltage, above 1.2v on a test cell, hydrogen gas can be generated between the tank and any coating material. This can result in blistering and peeling of the coating, which can also cause corrosion



LEVEL INDICATORS

Automatic pump controls are operated by signals from the storage tank that indicate that the water is at the lowest or highest desired level. A signal from the low-level indicator will start the pump. The pump will continue to run until the water fills the tank up to the high level. A signal will then go back to the pump to shut it off. There are three main types of liquid level control systems. They are electrode systems, float systems, and pressure sensing systems.

ELECTRODE SYSTEMS

The use of electrodes is the most common system used today. Pump controls are activated as the water level rises above or drops below these electrodes. As the water level drops below the low-level electrode, the circuit is opened triggering a control signal to start the pump. As the water level rises to contact the high level electrode the circuit is closed triggering a control signal to shut off the pumps. The pump will not restart until the water level drops below the low-level electrode again.

FLOAT SYSTEMS

Float systems are used primarily in ground storage tanks. As the float rises or falls with the water level, high level or low level switches are tripped activating the pump control circuit. This type of level control will have to be checked on a regular basis to prevent malfunctions. Freezing during the winter is always a problem with floats and electrodes due to damage caused as the water level (and the ice) rises and falls. Circulation of water inside the tank may help minimize ice buildup.

PRESSURE SENSING SYSTEMS

Pressure sensing controls are normally located near the bottom of the storage tank. This type of control is activated by the amount of head pressure in the tank. As the pressure increases, a spring or metal band is expanded tripping a microswitch or a mercury switch that then activates the pump. The on and off levels on these switches are set by applying or decreasing the tension on the spring, or by setting manual control points on a dial for the mercury switch. These switches must be protected from freezing and extreme vibrations for proper operation. Pressure transmitters can also be used to control multiple wells or pumps and the signal can be converted into a tank level reading.

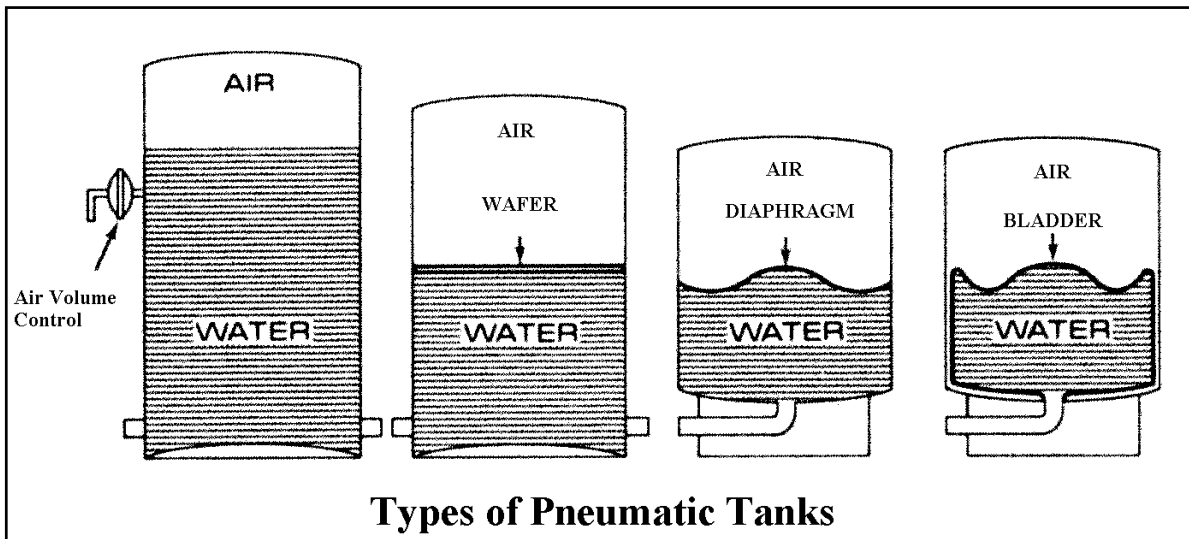
HYDROPNEUMATIC STORAGE

Very small water systems may find that elevated storage tanks are too expensive and, in some types of terrain, very difficult to install. They must resort to other means of supplying pressure to the customer. One way to do this would be to run a pump continuously to pressurize a closed system. This is sometimes referred to as a deadhead condition. Without special control valving and bypass piping, this could result in the pump running against shutoff head much of the time and cause the pump to overheat. It also limits consumption to the rated flow of the pump.

Hydropneumatic storage tanks are pressurized by a surcharge of air that forms a bubble in the tank. They can be used to pressurize the system and provide storage. The storage capacity keeps the pump from cycling off and on every time a faucet opens. Pneumatic tanks are also used in large systems as surge protection systems. As the pressure from a water hammer surge enters the tank, the force is exerted against the air pocket. The air pocket is compressed and absorbs the energy to dampen the shock wave.

TYPES OF PNEUMATIC TANKS

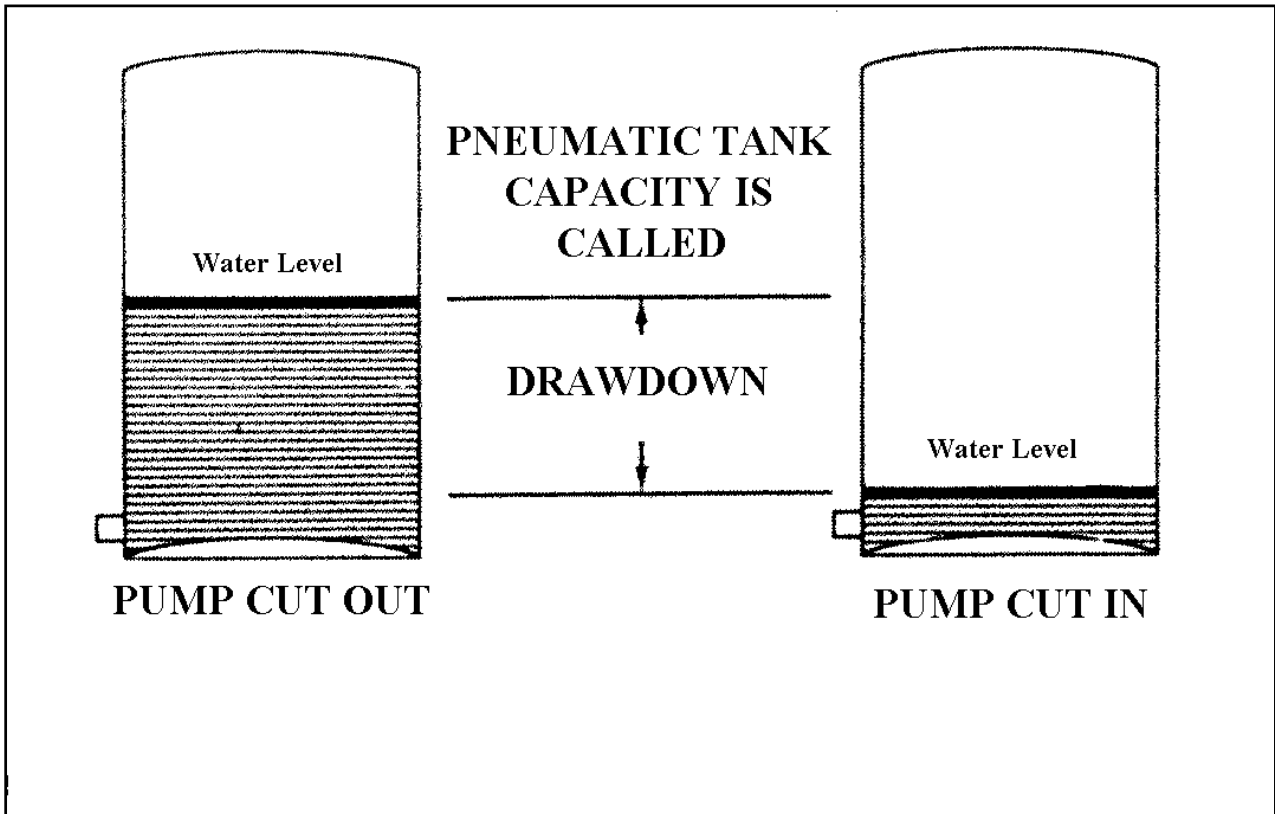
Pneumatic storage tanks are available in several designs. They all look the same from the outside. The difference is how the air pocket inside is controlled. The plain steel tank simply has an air bubble in it. There is nothing to separate the air from the the water. The advantage of this tank is that air that may be in the water can be separated in the tank. The disadvantage is that air is being continuously dissolved in the water, so the bubble will shrink over time. This means that air must be introduced into the tank periodically. Some wells have a special snifter valve on the discharge line that injects a small amount of air into the line as the pump runs. Since this may put too much air in the tank, a relief valve acts as a level control to keep the proper volume of air in the tank.



The other types of pneumatic tanks have a barrier between the air and water to minimize or eliminate the amount of air lost to absorption. Wafers and diaphragms separate the water from the air, but a bladder design also prevents the water from coming in direct contact with the sides of the tank. This can help prevent corrosion from soft, low alkalinity water. The wafer, diaphragm, and bladder designs require air charging from an external source. Air compressors tied to level switches automatically maintain the proper air volume in large tanks. Smaller tanks should be checked regularly and charged with portable air compressors or air tanks. If the air pocket does disappear, the tank will be full of water and the pump will begin to cycle more often since there will be no drawdown in the tank.

SIZING A PNEUMATIC SYSTEM

The capacity of a pneumatic tank is the drawdown. The drawdown is the difference in water levels from the point where the pump cuts in to the point where it cuts out. The general rule for sizing a pneumatic tank is that the drawdown in the tank should equal at least two minutes of the pump's rated flow. For example, if a well produces 30 gallons per minute, the drawdown should be at least 60 gallons. This means that the pump will always run for at least two minutes each time it cycles on and off. This will greatly reduce the impact that cycling has on the pump.



The pump will actually get a start signal from a pressure switch rather than a level indicator. The pressure switch will normally be set to start at 40 psi and stop at 60 psi, although some very small systems may run from 20-40psi. The equipment supplier can calculate what this means in terms of gallons of drawdown for a new tank. For an existing tank, isolate the tank at shutoff pressure and see how much water drains out to drop the pressure to the cut in point.

Elevated storage tanks are located in areas that have pressure problems due to small lines or long runs of piping. Pneumatic tanks can be moved out into the system where pressure problems exist too. It will also increase the amount of in storage for the system. Pneumatically pressurized systems provide no fire protection since there is not enough water available at pressure.

REFERENCES:

Sacramento, *Water Distribution System O & M*, 4th Edition, 1999, Chapter 2
 Sacramento, *Small Water System O & M*, 4th Edition, 2001, Chapter 3

BASIC STUDY QUESTIONS

1. Where would you find an air gap on a ground storage tank?
2. What does cathodic protection do?
3. What are sacrificial anodes?
4. What is the drawdown in a pneumatic storage tank?

BASIC SAMPLE TEST QUESTIONS

1. All vents and overflows on a storage tank should be screened.

A. True
B. False
2. Pneumatic storage tanks must be full of water to work properly.

A. True
B. False

ADVANCED STUDY QUESTIONS

1. Which types of storage tanks are more likely to have corrosion problems?
2. What are three ways to control the water level in a storage tank?
3. Why is ice a problem in the winter?

ADVANCED SAMPLE TEST QUESTIONS

1. What type of electrical current is used in cathodic protection?

A. AC current
B. DC current
C. 3-phase current
D. Synchronous current
2. What is likely to grow in a storage tank that is not covered?

A. Sulphur bacteria
B. Algae
C. Trout

