



Introduction to Water Towers

An Online Continuing Education Course for Engineers

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INTRODUCTION

This is a course about water towers. A water tower is an elevated structure supporting a water tank at a height that is sufficient to pressurize a column of water to a specified pressure. Water towers are ubiquitous in our culture. They are so common that you might not notice some of them, as we sometimes disguise them as monuments or other structures. In this course you will learn why we build water towers. You will learn how they work.

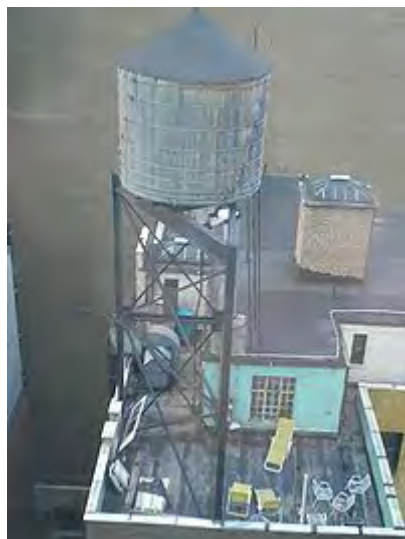
You will learn about the relationship between the height of a water column and the pressure the column produces due to the weight of the water. You will be shown how to calculate the pressure supplied by a water column of a given height. You will also learn why using water towers in a potable water distribution system is usually more economical than using ground-level storage tanks. You will learn how to read a centrifugal pump curve, and why that is important in understanding water towers.

A case study based on my actual experience is presented in the course. This study is about how a new water tower caused problems in a small town's potable water distribution system. You will be led to understand the problems and see their solutions through the eyes of a forensic investigative engineer. The name of the town and the names of the participants have been changed.

People have used water towers for thousands of years. The Romans, those marvelous engineers, made extensive use of water towers in their water distribution system. Many water towers were constructed in America during the Industrial Revolution. Some of these are now considered architectural landmarks and monuments. Water towers vary in size, shape, and appearance over a tremendous spectrum. Some are simple standpipes, or cylinders, like the one shown in the photograph below:



A century ago, there were hundreds of standpipe water towers in America, but today there are only a few left. Many water towers are multi-leg, elevated tanks with cone-shaped roofs, like the one shown on a rooftop in this photograph:



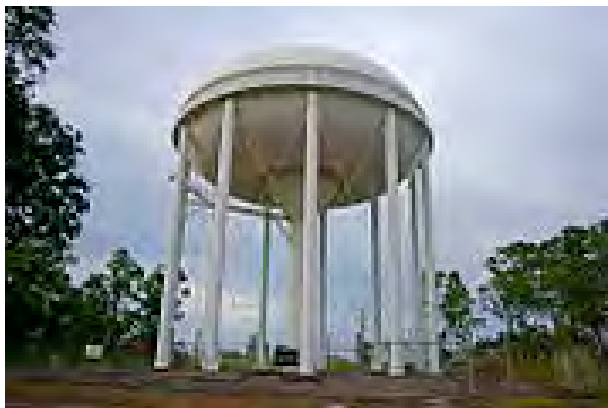
Since sometime in the 19th century, all buildings in New York City higher than six stories must by law be equipped with a rooftop water tower. The main intent of the law was to ensure a supply of water in the event of fire. In this next photograph, you can see at least six rooftop water towers.



Many water towers have spherical tanks, such as shown here in this photograph of a type of water tower that looks like a sphere on a pedestal and for that reason is sometimes called a pedestal sphere.



Some water towers are multi-leg towers with ellipsoidal tanks, like the one shown in this next photograph. A horizontal cross-section of the tank forms a circle, whereas a vertical cross-section of the tank forms an ellipse:



The water tower shown in this next photograph is known as a fluted-column water tower.



Huge numbers of water towers, generally of the smaller variety, are constructed of wood, as is the one shown in this next photograph. Wooden rooftop water towers are quite common in New York City. An interesting thing about wooden water towers is that the tanks do not require caulking of the seams between the wooden planks, because the water makes the wood swell, thus sealing the seams. The same is true of wooden barrels. In fact, wooden tanks are very similar in design to wooden barrels. The first wooden water tower tank makers probably started out as barrel makers. Obviously, the wood used to build water tower tanks must not be chemically treated for termites, etc., given that the tanks hold drinking water.



Now, we will move on to the case study.

CASE STUDY OF HOW A NEW WATER TOWER CAUSED SOME PROBLEMS IN A TOWN'S POTABLE WATER DISTRIBUTION SYSTEM

Background Information

People build water towers to ensure that a sufficient and secure supply of potable water, at some specified minimum pressure, is available at all times. A column of water 27.7 inches high, or about 2.31 feet high, will result in a pressure of one pound per square inch gauge (psig) at the bottom of the water column. For every additional 2.31 feet in column height, the pressure at the base of the column increases by one psig. Thus, for example, if we wanted a water system pressure of 100 psig, we would need a water column 231 feet high. Typically, modern water towers are about 120-130 feet tall, yielding a pressure of about 52-56 psig at its base.

An alternative to using a water tower is to use ground-level water tanks and pumps. However, one significant factor that favors the use of water towers instead of ground-level tanks and pumps is having water available at pressure during power outages. For fire protection purposes, water under pressure is vital. It is likely that in some cases municipalities with elevated water storage systems may enjoy lower property insurance costs on average than those with only pumped water systems. This is because fire protection systems in these areas would have a higher reliability factor. Also, for sanitary purposes, elevated tanks are advantageous, in that during emergencies involving the loss of electricity, water is available for drinking and removal of wastes.

The Waterloo Water Tower Problems

The Wet Zone Water Works (Wet Zone) serves a community by the name of Waterloo. At some time in the past, Wet Zone contracted with Can Do Engineering Company (Can Do), to make certain improvements to the town's potable water distribution system. Can Do was contracted to:

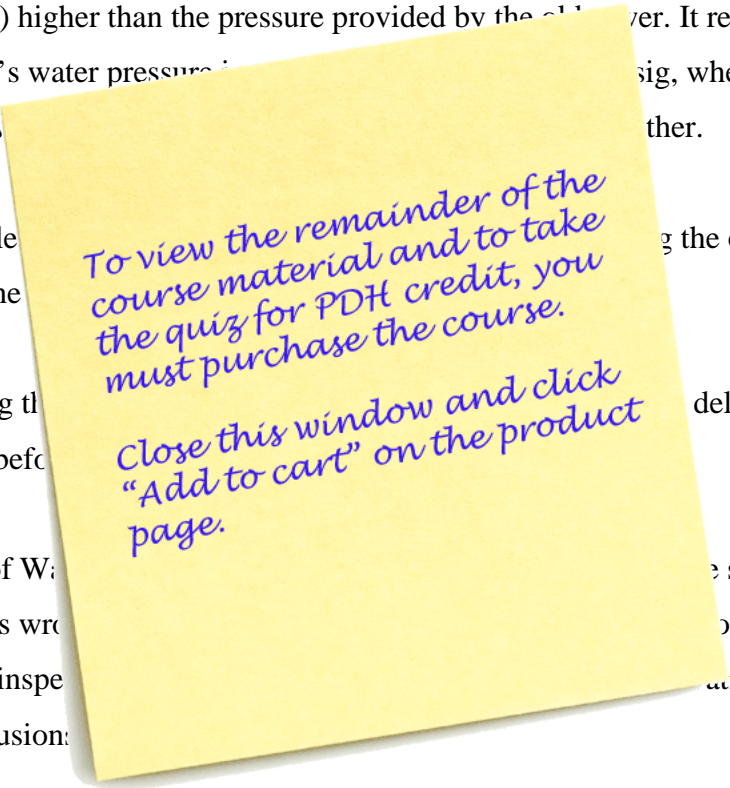
- design and construct a new water tower;
- drill a new water well;
- install a pump for the new well; and,
- connect all the new components into the existing water distribution system.

At that time, the potable water distribution system consisted of a water tower that was built many years before, several existing water wells, associated pumps and piping, and some ground level storage tanks.

The new tower that Can Do built was 42 feet higher in elevation than the old tower. The new tower was equipped with what is called an altitude valve. Its function was to control the water level in the tank and prevent overflows. The valve is roughly analogous to the float-and-valve device in a toilet tank. The old tower did not have an altitude control valve. The new tower was connected into the pre-existing distribution system into which the old tower was connected.

Wet Zone was not satisfied with the new system. Wet Zone's main complaints were as follows:

- The water pressure provided by the new tower was about 18 pounds per square inch gauge (psig) higher than the pressure provided by the old tower. It resulted in the community's water pressure being 18 psig higher, whenever the source of the town's water was the new tower.
- The new (elevated) tank was 42 feet higher in elevation than the old (elevated) tank, except by the 42 feet difference in elevation.
- When filling the new tank, the water level in the old tank would rise and deliver water as fast as they could before the water level in the old tank reached the altitude valve.



The City Council of Wet Zone was not satisfied with the new system and determined what was wrong with the system and how to operate it satisfactorily. We inspected the system and conducted a series of tests and analysis, we drew several conclusions: