Expansion Tanks Sizing for Heating and Cooling Systems

An Online Continuing Education Course for Engineers

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Expansion Tanks Sizing for Heating and Cooling Systems

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Water, as we all know, expands when it is heated. Conversely, it contracts when cooled. If we don't have some means to compensate for all this expansion and contraction, the fluid pressure in our systems will fluctuate wildly. Expansion tanks help absorb any excess pressure created due to thermal expansion and prevent over-pressurization of the system. In any situation where fluid in a "closed system" is heated, an expansion tank is required.

There are a few different types of expansion tanks available. The type and size of tanks used are usually governed by the intended application and can range from simple expansion tanks to pre-charged diaphragm or bladder type. It is more common for newer systems to use a diaphragm/bladder type expansion tank, though steel expansion tanks are still in use.

Understanding how an expansion tank works, where to install, and how to select the most appropriate one for your application is a must for mechanical and process engineers connected to closed-loop hydronic systems.

This course explains various types of expansion tanks, their features, and the applications for which they are suited. By the end of this course, no one will be able to argue about the importance of the expansion tank.

Learning Objectives

a. Why you need an expansion tank
b. Understanding how expansion tanks work
c. The different types of expansion tanks
d. How to size and select an expansion tank
e. What data is required for sizing an expansion tank
f. What the "point of no pressure change" is
g. How to choose between plain steel, diaphragm, and bladder type tank
h. When and where to place the expansion tank
i. Practical examples, useful hydronic information, and rules of thumb

Contents

1.0. Chapter 1: Introduction

An expansion tank is a metal tank connected in a closed-loop heating or chilled water system that absorbs the expanding fluid and accommodates fluctuations in the volume of a water supply system. These fluctuations occur because water expands as it gets hot and loses volume as it cools.

Let's start with the basics. We all know that things expand when they are heated and contract when they are cooled. Water is no different, and this becomes a major factor in a closed-loop hydronic HVAC system. For example, the cold water in a standard 50-gallon water heater expands to 52 gallons when heated to 120 degrees Fahrenheit. If the water is restrained from expanding by the plumbing, the result will be an increase in pressure. The resulting pressure can cause damage to the water heater, plumbing fixtures, and the water pipes themselves unless the hot water system contains a relief valve to compensate for this expansion. After enough water has passed through the relief valve, the pressure in the system drops, and the valve closes again. The concern is that the repeated pressure excursions and relief valve operation reduces the system integrity, wastes energy, and pose a risk of bursting components if the relief valve gets plugged with scale or corrosion over a period of time.

For this reason, a thermal expansion tank is recommended. The basic objective behind a thermal expansion tank is to give the expanding water a place to go so that the increase in pressure brought about by heating the water can be controlled.

1.1 Why You Need Expansion Tanks

All hydronic systems operate under a variable amount of pressure. For closed systems, the pressure varies primarily due to the expansion of water as it is heated or cooled. As the water is heated, the pressure increases, and as the water is cooled, the pressure decreases.

Expansion tanks are hydro-pneumatic vessels that absorb these changes in volume and, therefore, largely keep the pressure constant. In open-loop heating and cooling systems, there will be no increase in pressure because the water is unrestrained.

Expansion tanks basically fulfill three important functions in closed-loop systems:

a. To compensate volume fluctuations in the heating or cooling water as a result of temperature fluctuations. This occurs in a heating system when the system is heated from its coldest fill temperature to operation temperature, and this expansion occurs in a chilled water system when the system is shut down, and the system temperature rises from operating to ambient.
b. To keep the pressure at every point of the system within permissible limits. This means that the maximum operating pressure may not be exceeded, but also that a minimum pressure has to be ensured to satisfy NPSH and prevent vacuums, cavitation, and vaporization.
c. To counterbalance system-related water losses in the system and avoid the intrusion of air into the piping network. Good air removal is crucial to the proper operation of any closed system.

There are several other functions that an expansion tank can perform.

a. In a booster pump application, it can provide water to the system during periods of a no-flow shutdown of the booster pump, or it can provide water to replace leak loads.
b. In a well water application, it can provide the desired volume of water required between the pump shut down pressure and the pump turn on the pressure.
c. In a sprinkler or irrigation pump application, the tank may provide a cushion to maintain the necessary pressure so the jockey pump will not short cycle.

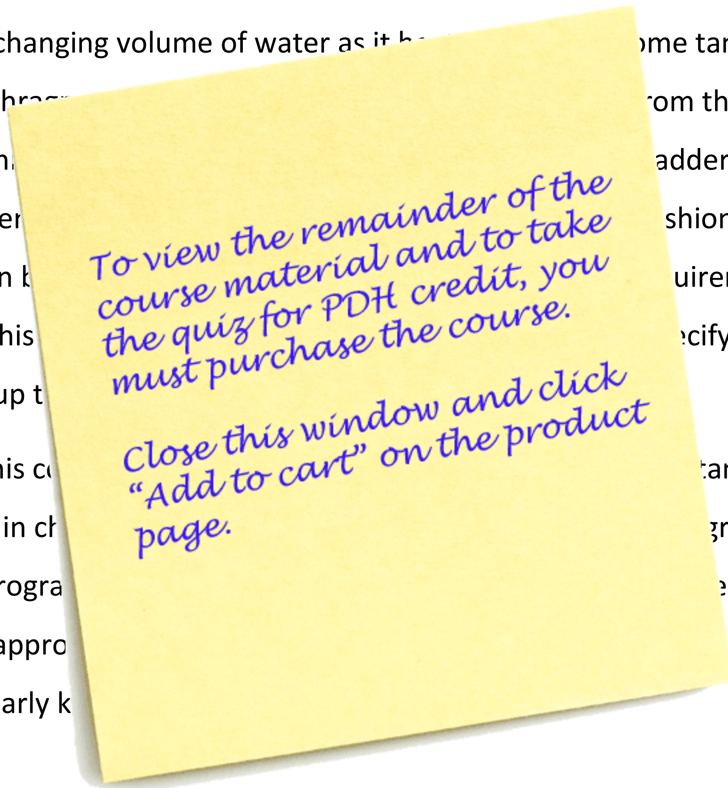
1.2 How an Expansion Tank Works

Because water is incompressible, but the air is, the expansion tank uses a cushion of compressed air to accept this increased volume of water as it is heated.

Expansion tanks are usually charged with air or an inert gas, such as nitrogen. Nitrogen is often used in high-temperature water applications due to its low corrosive nature. Regardless of the charging media, expansion tanks are charged at a pressure slightly higher than the static pressure on the tank with the system at ambient temperature.

An expansion tank is only partially full of water on startup. The rest of the tank contains air. As the system water expands, the added system volume moves into the expansion tank, compressing the air, thereby increasing the air pressure, which "pushes back" to increase the system pressure.

The simplest expansion tank uses compressed air to maintain system pressures by accepting and expelling the changing volume of water as it h ome tank designs incorporate a diaphr rom the pressure controlling air cush adder to prevent tank corrosion and water shion is pre-charged at the factory and can b uirements. This design and operation of this cifying engineer to reduce tank sizes up t



The objective of this c tanks in any closed system, especially in c graphs, selection tables, software progra ers to give system designers a quick appro ics of science must be learned and clearly k