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Water Heater Thermal Expansion Tank Sizing Safety Factors

Monday Morning Minutes | by Norm Hall, April 30, 2018

In the last R. L. Deppmann Monday Morning Minutes we used the Bell & Gossett Systemwize selection program to size and select a water heater thermal expansion tank. Safety factor when sizing is always on the mind of the engineer or plumbing contractor. Where do I apply safety factors and what happens if the tank is undersized? Today we address these concerns.

What Happens in the Water Heater Thermal Expansion Tank is Undersized?

The purpose of the thermal expansion tank is to limit the pressure rise when the volume of water in the hot water system is heated from the initial temperature to the design temperature when there is no draw on the system. Last week we introduced the formula:

$$V_t = \frac{\{(E_w - E_d) \times V_s\}}{(1) - (P_f / P_o)}$$

You can visit last week's Monday Morning Minute, Thermal Expansion Tank Sizing: Bell & Gossett Systemwize, for more information on this formula.

- If the tank volume (VT) is fixed and we underestimated the system volume (VS), the maximum pressure (PO) will rise above our expected maximum.
- If the tank volume (VT) is fixed and the starting pressure (PF) is greater than design, the maximum pressure (PO) will rise above our expected maximum.

- If the tank volume (VT) is fixed and the maximum temperature is greater than we expected, it will cause the expansion of water to rise (EW-EP) and the maximum pressure (PO) will rise above our expected maximum.

In all cases shown above, a missed selection will cause the pressure in the system to be higher than design. If that pressure gets close to the pressure relief setting, the relief valve will open. We never want to use a safety device as a control mechanism. That is the job of the thermal expansion tank.

Building in a Safety Factor in Thermal Expansion Tank Sizing

Let's look at a table using the example from last week's Monday Morning Minute.

Safety Factor Applied	Start tem	Max. Temp	Start PSI	Max. PSI	System Volum	Acceptance Volume	Tank Volun
DESIGN	40°F	140°F	50	100	270	4.05	9.3
Increase Volume by 50%	40°F	140°F	50	100	**405**	6.08	13.95
Decrease maximum	40°F	140°F	50	**90**	405	4.05	12.79
Increase starting pressure by 20	40°F	140°F	**70**	100	270	4.05	15.49

We can see that missing the volume has a huge effect on the tank size, so safety factors should be applied to the volume. Your choice of safety depends on the reliability of your calculations.

Troubleshooting Thermal Expansion Tanks

One final note about thermal expansion tanks. As mentioned above, the result of any undersizing is increased pressure. If the pressure is getting so high that the relief valve is opening, there are two places to look first.

1. A properly charged expansion tank should have a fill pressure equal to the system pressure. There is no water in the tank until the water is heated. If the tank fill pressure is too low, there will be a volume of water in the tank before we even start heating the water. This has the effect of reducing the tank size and causing a pressure increase. Before the engineer worries about their calculations, check the fill pressure of the tank. Make sure the tank is properly charged.

2. The other issue could be a bad tank. If the tank cannot hold an air charge there could be a leak in the Schrader valve or a damaged tank.

Reference the Manufacturer IOM for instructions on properly charging the thermal expansion tank as well as troubleshooting recommendations.