CHAPTER 11 HEATING - HYDRONIC SYSTEM SIZING

11.2 Expansion Tank

Expansion Tank Sizing

The expansion tank accommodates expansion in volume of the water in a hydronic system (see section 11.1) due to change of temperature (about 70 -80 degC), i.e. it provides the space into which the noncompressible liquid expands. The preferred location for the expansion tank is after the boiler/heater but before the pump to decrease the risk of cavitation at the pump inlet due to low pressure. The volume required for the expansion tank (generally closed type) is a function of the difference in system water volume due to the change in temperature and pressure (ASHRAE, 1996).

Example: Consider selection of an expansion tank for a hydronic heating system serving an apartment in the fifth floor of a 5-story high building. Assume that the boiler, located on the ground floor, is connected to the radiator system with a reverse return system.

First estimate total system volume:

Piping estimate (assume reverse return system):

$r := 14\ mm \qquad h := 15\ m$

$Vp := \pi \cdot r^2 \cdot h \cdot 4 \qquad Vp = 0.037\ m^3$ volume of water in pipes

$Vb := 25\ liter$ water in boiler

Estimate of water in radiators (total output 14 Kw). It is assumed that the radiator length is approximately 1 m per 1160 watts and that it holds 4.2 liters per meter of length:

$Qaux := 14000\ watt \qquad Lrad := Qaux \dfrac{m}{1160\ watt} \qquad Vr := Lrad \cdot 4.2\ \dfrac{liter}{m}$

$Vr = 50.69\ liter$

System volume:

$Vs := Vp + Vb + Vr \qquad Vs = 112.635\ liter$

Now consider change of volume between cold (1) and hot (2) conditions (see **section 8.2**):

$v_1 := .0010007 \ \frac{m^3}{kg}$ spec. vol. of water at 14 degC

$v_2 := .0010361 \ \frac{m^3}{kg}$ spec. vol. of water at 90 degC

$\rho := 1000 \ \frac{kg}{m^3}$ $P_1 := \rho \cdot g \cdot h + 101000 \ Pa$

$P_1 = \left(2.481 \cdot 10^5\right) \ Pa$ pressure at low temperature

$P_2 := 400000 \ Pa$ pressure at high temperature $dT := 60 \ K$

$\frac{v_2}{v_1} = 1.035$ $\alpha := \frac{17.1 \cdot 10^{-6}}{K}$ expansion coefficient for pipes

$Vt := Vs \cdot \frac{\frac{v_2}{v_1} - 1 - 3 \cdot \alpha \cdot dT}{1 - \frac{P_1}{P_2}}$ $Vt = 9.579 \ liter$ diaphragm type expansion tank

$Vt := Vs \cdot \frac{\frac{v_2}{v_1} - 1}{\frac{101000 \ Pa}{P_1} - \frac{101000 \ Pa}{P_2}}$ $Vt = 25.774 \ liter$ closed expansion tank without diaphragm (neglecting pipe expansion)

References

ASHRAE, 1996, Handbook- Systems and Equipment, Atlanta, GA.