
PROBLEM 7-11N QUESTION

Pressurizer Transient Problem

A pressurizer is to be designed in such a way that it can accommodate anticipated pressure fluctuations. Suppose the pressure range which the pressurizer should control is from 14.0 MPa to 16.6 MPa with 15.5 MPa as the nominal condition. During depressurization transients, because of rainout and flashing the water in the pressurizer is assumed at saturation conditions. However, for the overpressurization transient, the steam and liquid in the pressurizer is assumed at non-equilibrium conditions, i.e., steam is saturated because of the spray, but the liquid is subcooled (see Figure 1). Using the single region approach, answer the following questions with the information given in Table 1.

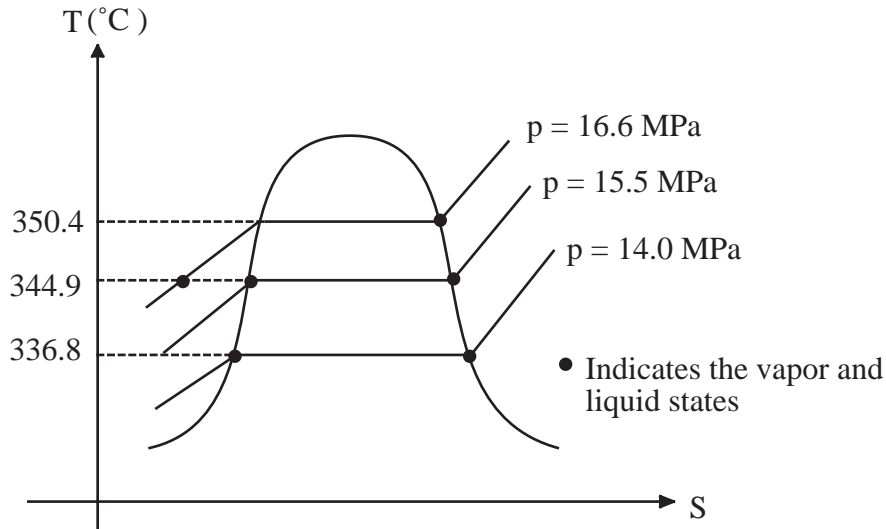


Figure 1

- Determine the pressurizer volume which accommodates the overpressurization transient assuming the end state of this transient is at $p = 16.6$ MPa. What is the vapor volume fraction at the end of this transient?
- Determine the heater size which accommodates the depressurization transient assuming the end state of this transient is 14.0 MPa with the pressurizer volume obtained in (a) above. What is the liquid volume fraction at the end of transient? Is it large enough to cover the heaters, if the minimum liquid volume to cover the heaters is 13% of the pressurizer volume?

TABLE 1

- Vapor and Liquid Conditions in the Pressurizer during Transients:

Pressure (MPa)	v_f ($10^{-3}m^3/kg$)	v_g ($10^{-3}m^3/kg$)	u_f (kJ/kg)	u_g (kJ/kg)
14.0	1.61	11.5	1549	2478
15.5	1.68	9.81	1600	2444
16.6	1.68*	8.73	1600*	2416

* Subcooled Condition

- Initial Conditions:

The pressurizer is initially 60% full of liquid water, and at 15.5 MPa.

- Overpressurization Transient:

$$\dot{m}_{insurge} = 9200 \text{ kg}$$

$$h_{insurge} = 1442 \text{ kJ/kg}$$

$$\frac{\dot{m}_{spray}}{\dot{m}_{insurge}} = 0.09$$

$$h_{spray} = 1285 \text{ kJ/kg}$$

During Overpressurization, Heaters are Off

- Depressurization Transient:

$$\dot{m}_{outsurge} = 14,166 \text{ kg}$$

$$h_{outsurge} = 1600 \text{ kJ/kg}$$

During Depressurization, Sprays are Turned Off

- Assumptions:

$h_{insurge}$, $h_{outsurge}$, h_{spray} are constant during transients.

For the depressurization transient, heaters are operating at the full capacity, and the transient is over after 15 minutes.