Answer on Question #74323-Engineering-Other

0.05 kg of steam at 15 bar is contained in a rigid vessel of volume 0.0076m3 what is the temperature of the steam?

if the vessel is cooled until the pressure in the vessel is 11 bar calculate the dryness fraction of the steam and the total heat rejected?

Solution

Specific volume is

$$v_s = \frac{V}{m} = \frac{0.0076}{0.05} = 0.152 \frac{m^3}{kg}$$

We know that the pressure is 15 bar.

$$v_g(15\ bar) = 0.1317 \frac{m^3}{kg} < v_s.$$

Thus, steam is superheated.

Thus, the temperature of the steam:

$$T_{steam} = 250℃.$$

$P_2 = 15\ bar$ - steam is dry saturated.

$$t_2 = t_s = 198.3℃.$$

$P_3 = 11\ bar$

$$v_3 = v_2 = v_s = 0.152 \frac{m^3}{kg}$$

The dryness fraction of the steam:

$$x_3 = \frac{v_3}{v_{g3}} = \frac{0.152}{0.1774} = 0.856.$$

The total heat rejected is

$$Q_{13} = (u_3 - u_1)m$$

$$u_1 = u_{superheat}(15\ bar, 250℃) = 2697 \frac{kJ}{kg}$$

$$u_3 = \left(u_f + x(u_g - u_f)\right) = (780 + 0.856(2586 - 780)) = 1547.42 \frac{kJ}{kg}$$

$$Q_{13} = (1547.42 - 2697)0.5 = -57.48\ kJ.$$