Example (4): A rigid tank contains saturated liquid water at (95 °C). Determine the pressure in the tank and the specific volume of the water.

Solution:

$Saturated$ water @ T = 95 ℃ ⇒ Table (A − 4) ⇒ $P = P_{sat} = 84.609\ kPa$

$Saturated$ water @ T = 95 ℃ ⇒ Table (A − 4) ⇒ $v = v_f = 0.001040\ kg/m^3$

Example (5): Determine the specific volume, internal energy, enthalpy and entropy for a mixture of (10 %) quality at (0.15 MPa).

Given, x = 0.1

@ P = 0.15 MPa = 150 kPa ⇒ Table (A − 5)

$v_g = 1.1593\ \text{m}^3/\text{kg}$

$u_f = 466.94\ \text{kJ/kg},$ $u_{fg} = 2052.7\ \text{kJ/kg}$

$h_f = 467.11\ \text{kJ/kg},$ $h_{fg} = 2226.5\ \text{kJ/kg}$

$s_f = 1.4336\ \text{kJ/kg. K},$ $s_{fg} = 5.7897\ \text{kJ/kg. K}$

Specific volume, $v = x.v_g$

$= 0.1 \times 1.159 = 0.1159\ \text{m}^3/\text{kg}$

Internal energy, $u = u_f + x.u_{fg}$

$= 466.94 + 0.1 \times 2052.7 = 672.21\ \text{kJ/kg}$

Enthalpy, $h = h_f + x.h_{fg}$

$= 467.11 + 0.1 \times 2226.5 = 689.759\ \text{kJ/kg}$

Entropy, $s = s_f + x.s_{fg}$

$= 1.4336 + 0.1 \times 5.7897 = 2.01257$ kJ/kg. K

Example (6): Determine the temperature of superheated steam at a state of (0.5 MPa) and enthalpy (2960.7 kJ/kg).

Solution:

$@P = 0.5\ MPa$ & $h = 2960.7$ kJ/kg $\Rightarrow Table\ (A-6) \Rightarrow T = 250$ ℃

Example (7): Determine the phase for each of the following water states:

a. 120 °C, 500 kPa

b. 120 °C, 0.5 m^3/kg

Solution:

(a) @ T = 120 ℃ & P = 500 KPa ⇒ Table (A − 4)

⇒ @ $T = 120$ ℃ ⇒ $P_{sat} = 198.5kPa < P$ ⇒ compretssed liquid

We could also have used Table (A-5)

$@\ P = 500\ kPa$ ⇒ Table (A − 5) ⇒ $Tsat = 151.86°C > T \Rightarrow compressed\ liquid$

(b) @ T = 120 ℃ ⇒ Table (A − 4) ⇒ $v_f = 0.00106\ m^3/kg$ & $v_g = 0.89133\ m^3/kg$

$v_f < v < v_g$ ⇒ two phase mixture of liquid and vapor

Example (8): Determine the temperature for water at a pressure of (300 kPa) and (1 m^3/kg).

Solution:

$@\ P\ =\ 300\ kPa\ \Rightarrow$ Table $(A-5) \Rightarrow v_g = 0.60582\ m^3/kg \Rightarrow v\ >\ v_g$

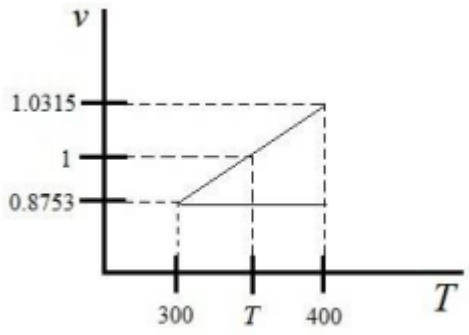
$\Rightarrow superheated\ vapor$

$@\ P\ =\ 300\ kPa = 0.3\ MPa\ \ \&\ v = 1\ m^3/kg \Rightarrow$ Table $(A-6) \Rightarrow T$

T can be found by interpolation between 300°C and 400°C at 300 kPa.

$$\frac{T-300}{400-300} = \frac{1-0.8753}{1.0315-0.8753}$$

$$\boldsymbol{T = 379.8°C} \qquad \textbf{Ans.}$$



HOMEWORK (4)

1- A (1.8 m^3) rigid tank contains steam at (220°C). Onethird of the volume is in the liquid phase and the rest is in the vapor form. Determine (*a*) the pressure of the steam, (*b*) the quality of the saturated mixture, and (*c*) the density of the mixture.

2- A piston–cylinder device contains (0.1 m^3) of liquid water and (0.9 m^3) of water vapor in equilibrium at (800 kPa). Heat is transferred at constant pressure until the temperature reaches (350 °C). (*a*) What is the initial temperature of the water? (*b*) Determine the total mass of the water. (*c*) Calculate the final volume. (*d*) Show the process on a *P-v* diagram with respect to saturation lines.

3-A piston–cylinder device initially contains (0.05 m^3)of liquid water at (40 °C) and (200 kPa). Heat is transferred to the water at constant pressure until the entire liquid is vaporized. (*a*) What is the mass of the water? (*b*) What is the final temperature?
(*c*) Determine the total enthalpy change. (*d*) Show the process on a *T-v* diagram with respect to saturation lines.

4- Determine the specific volume, internal energy, and enthalpy of compressed liquid water at (100 °C) and (15 MPa) using the saturated liquid approximation.

5- A piston cylinder device contains steam initially at (1 MPa), (450 °C), and (2.5 m^3). Steam is allowed to cool at constant pressure until it first starts condensing. Show the process on a *T-v* diagram with respect to saturation lines and determine
(*a*) The mass of the steam, (*b*) the final temperature, and (*c*) the amount of heat transfer.