# STEAM FORMATION AND PROPERTIES

- All the substance under suitable conditions of temperature and pressure can exist in one of the three states via **solid, liquid or gas**

- **water** is one of the pure substance that exists in all the three phases namely in solid phase as ice, liquid phase as water and gaseous phases as vapour (steam)

**Why steam?**

**In the Industries :**

Hospitals & Healthcare Facilities, Breweries & Distilleries, Food & Beverage Processing Plants, Commercial Laundry Facilities, Textile Manufacturing, Automotive, Manufacturing, indoor heating

**Steam is used for:**

Electricity generation, cleaning, dyeing, Propulsion /Drive, Moisturization & humidification (indoor heating).

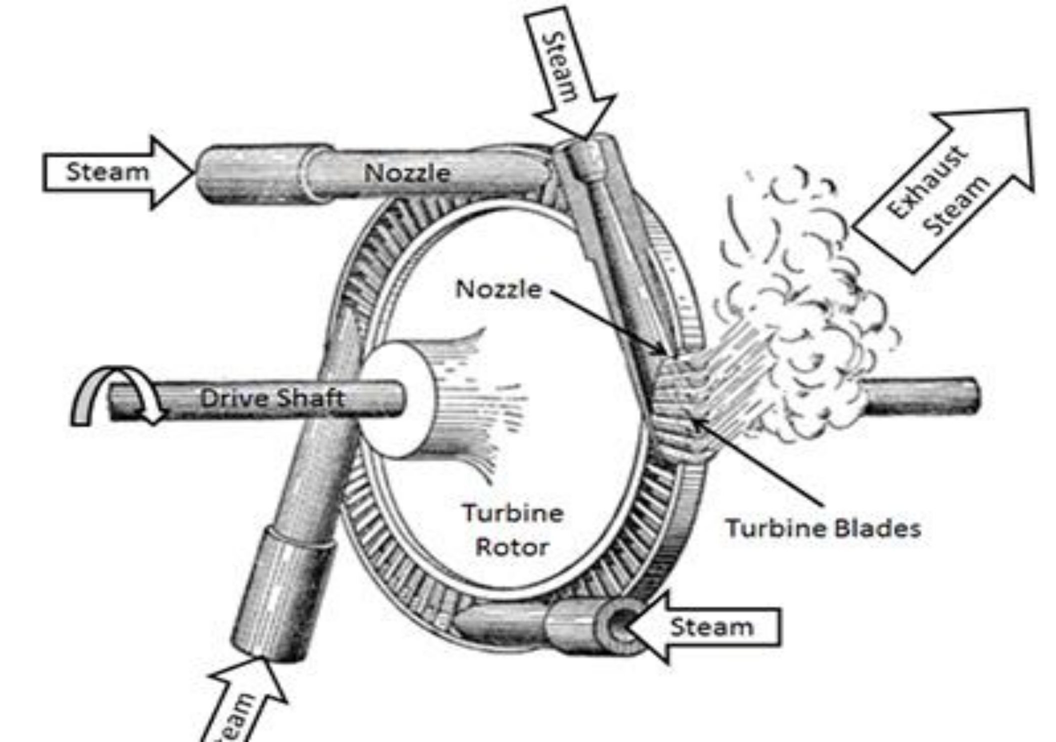
# STEAM FORMATION AND PROPERTIES

**The important properties of steam are**

| | | |
|---|---|---|
| 1. | Pressure | 4. Enthalpy |
| 2. | Temperature | 5. Internal energy |
| 3. | Specific volume | 6. Entropy |

**Formation of steam at constant pressure:**

**Why?**



# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:** Consider 1 kg of water at $0^0$ C taken in a cylinder

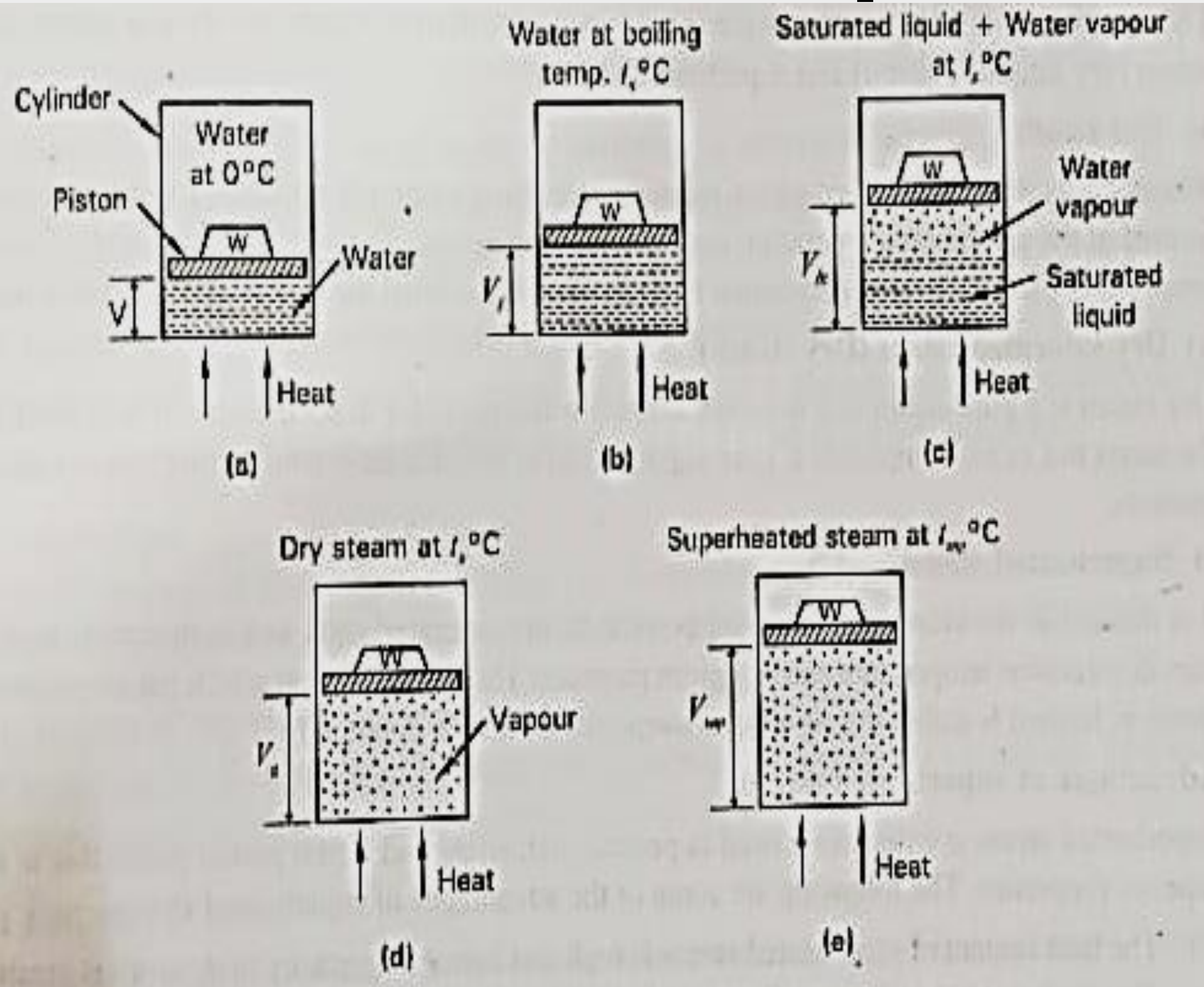



Figure 3.1 Formation of steam at constant pressure

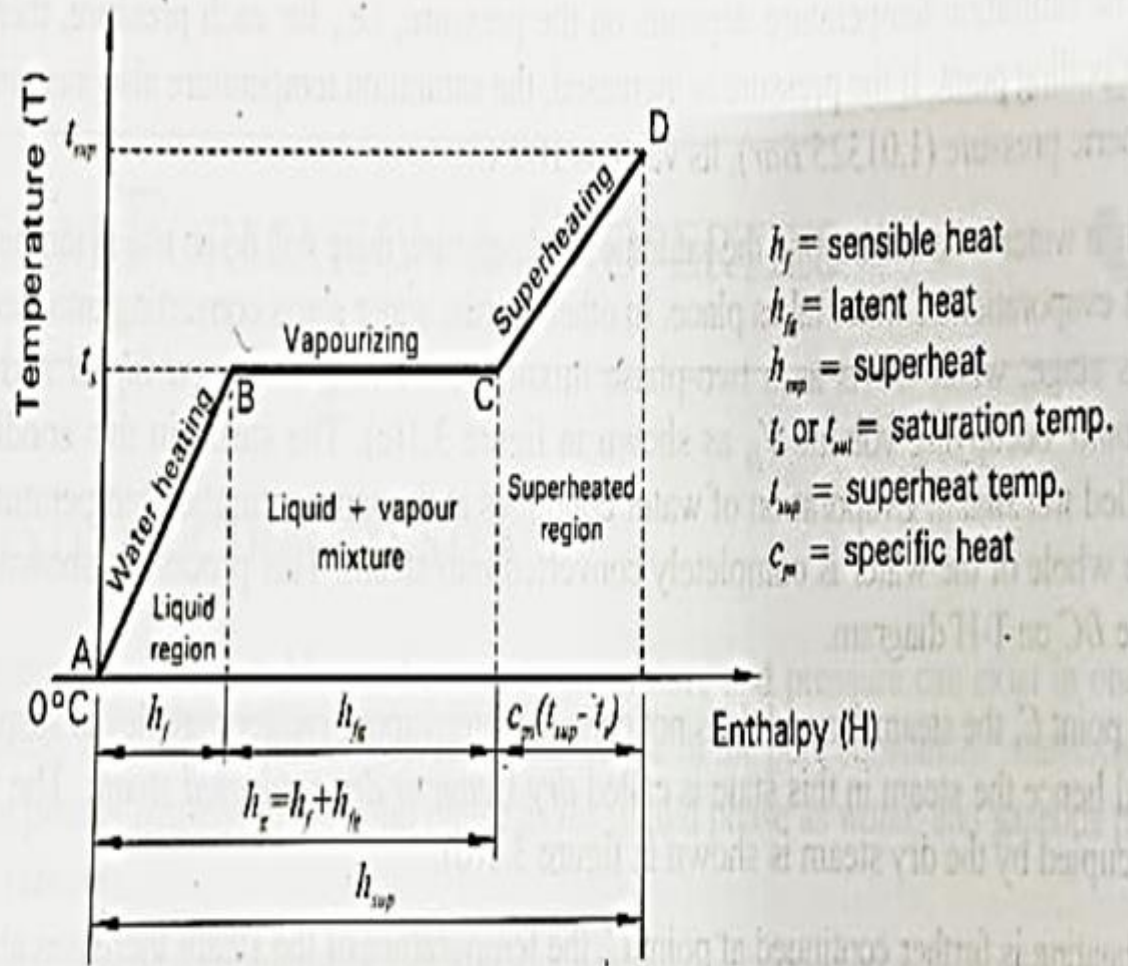



Figure 3.2 Temperature-enthalpy (TH) diagram

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

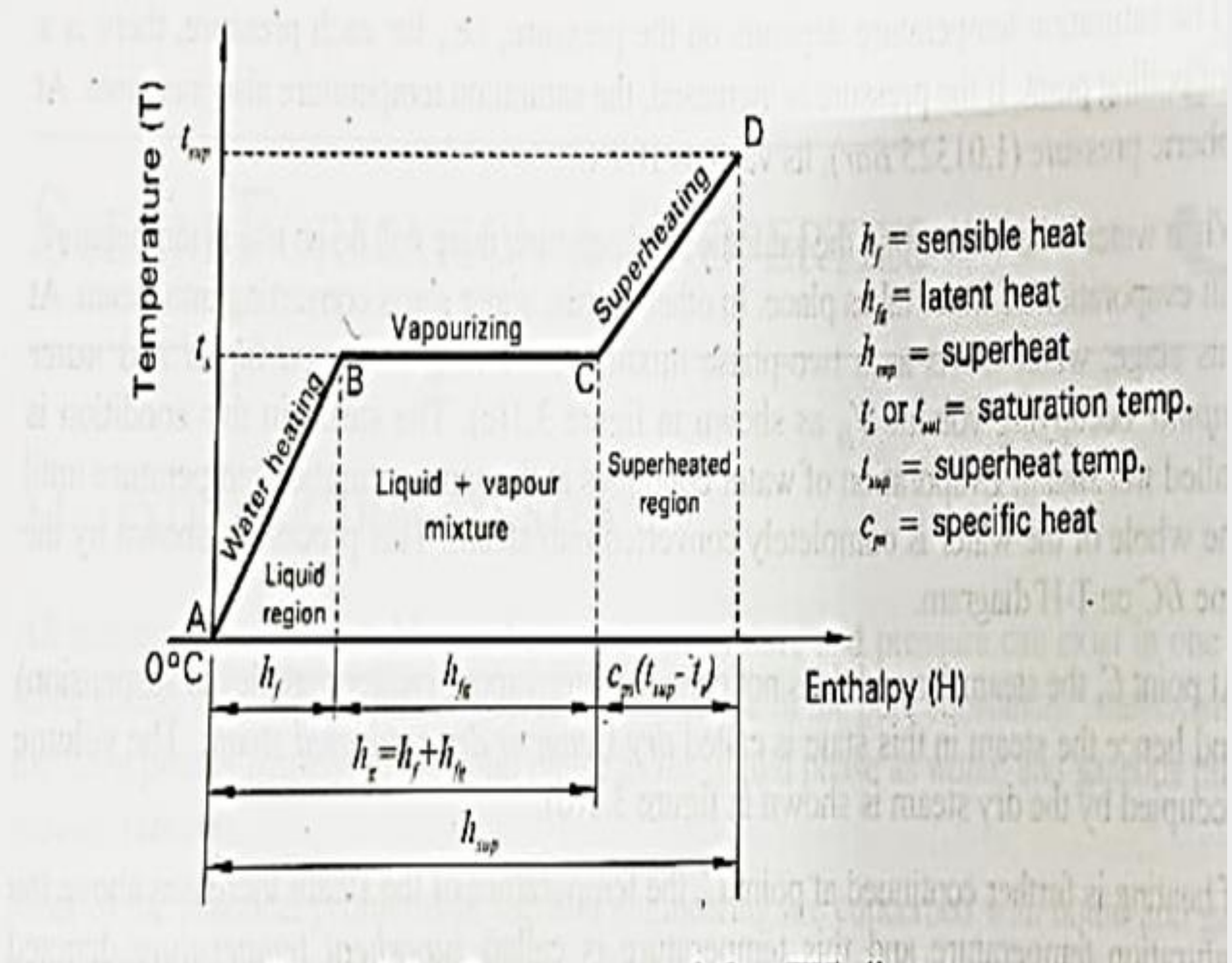


Figure 3.2 Temperature-enthalpy (TH) diagram

1. **Saturation temperature ($T_s$):** It is defined as the temperature at which the water begins to boil at constant pressure.

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

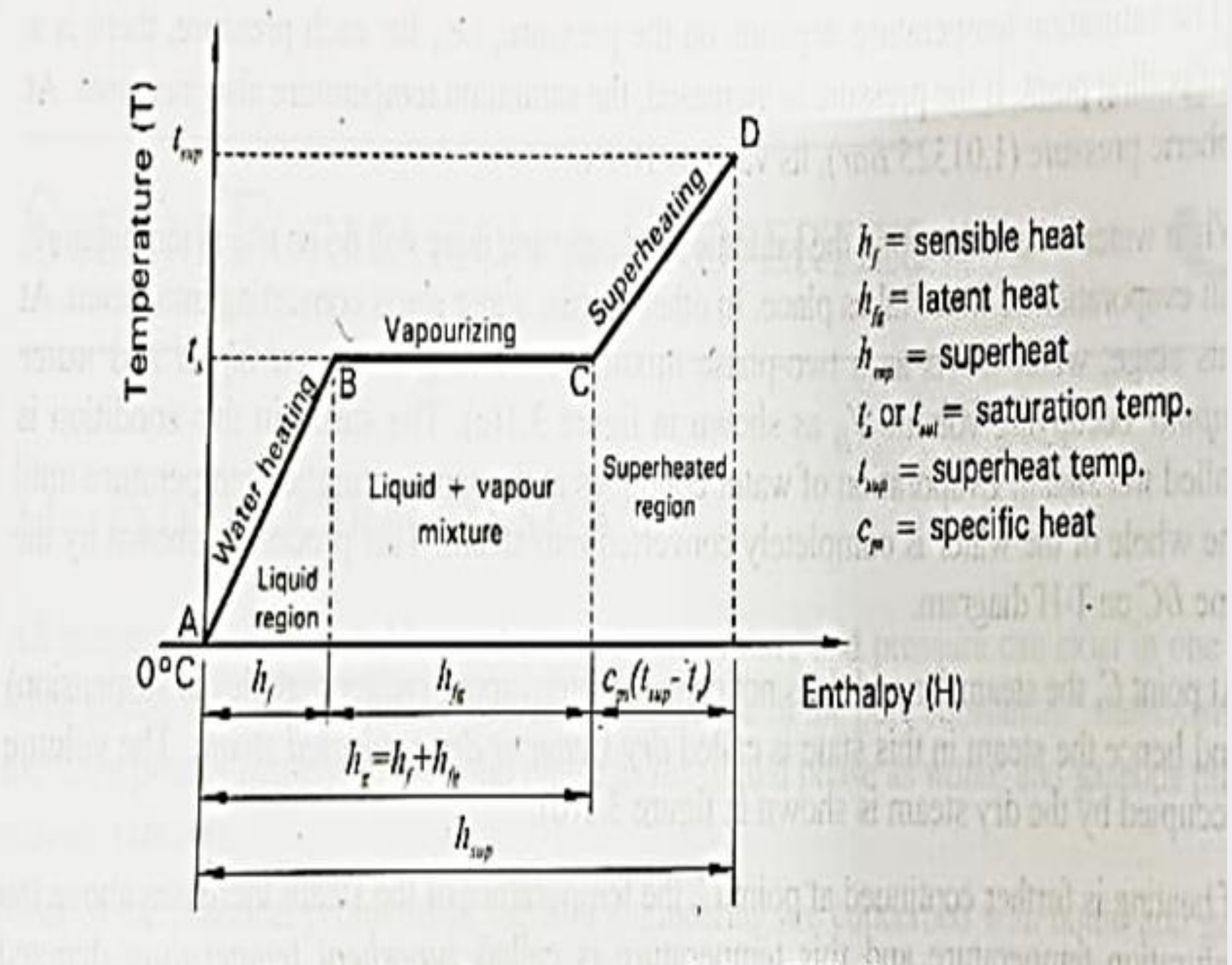



Figure 3.2 Temperature-enthalpy (TH) diagram

**Sensible heat ($h_f$):** It is the amount of heat required to convert 1 kg of water from $0^0$C to 1kg of saturated water at the saturation temperature (boiling point - **($T_s$)**) at constant pressure. It is also known as enthalpy of the liquid.

Sensible heat ($h_f$) for water at $0^0$C can get from steam table. If water is not at $0^0$C (more than $0^0$C) then the

Sensible heat ($h_f$) = $C_{pw}\,(T_s - T_{water})$ KJ/Kg

(where Cpw = specific heat of water = 4.18 kJ/kg$^o$K)

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

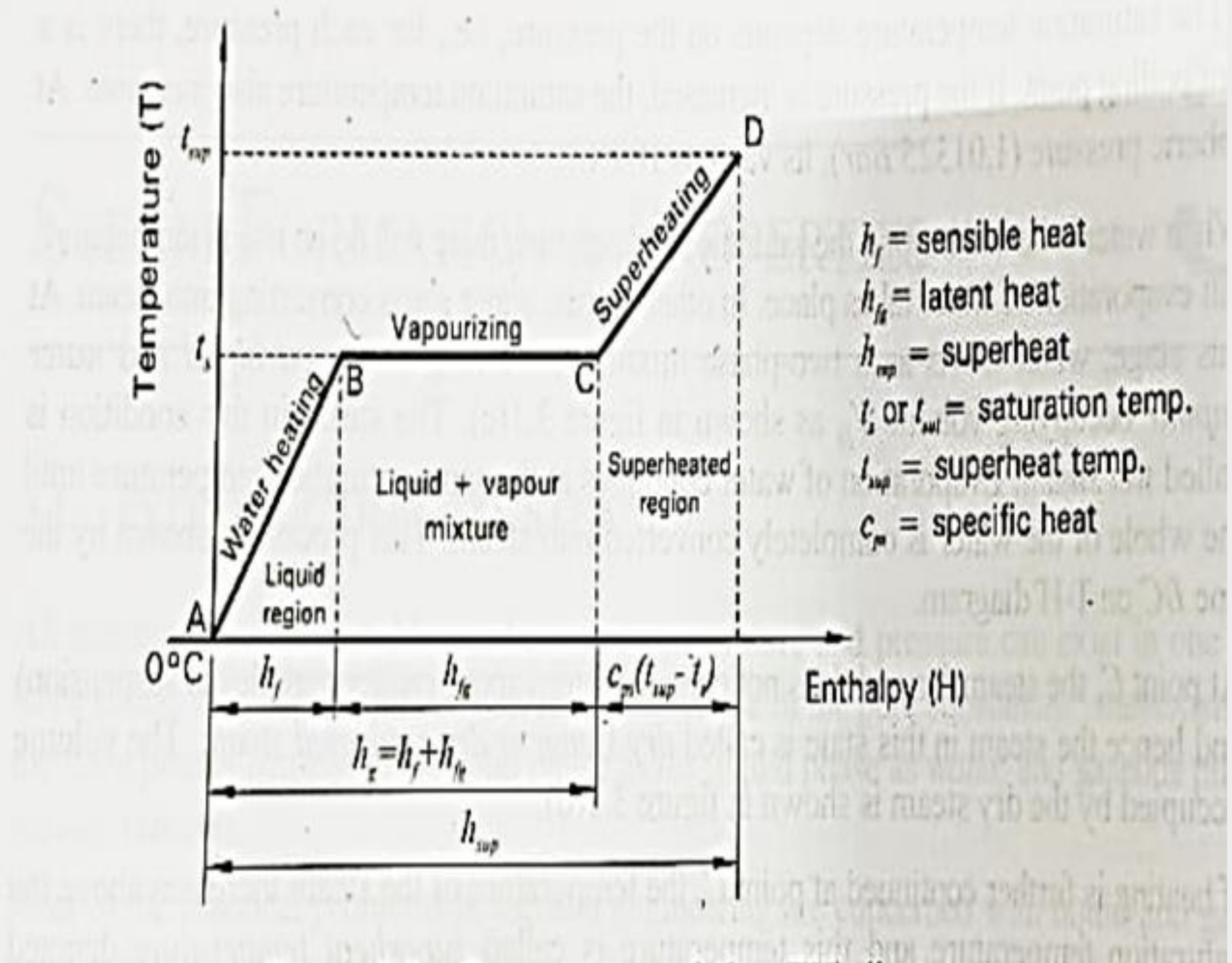



**Figure 3.2** Temperature-enthalpy (TH) diagram

**Latent heat of evaporation ($h_{fg}$):** It is the amount of heat required to convert 1kg of saturated water at saturation temperature **($T_s$)** to 1 kg of dry saturated steam at the same saturation temperature **($T_s$)** at constant pressure. Also known as enthalpy of evaporation.

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

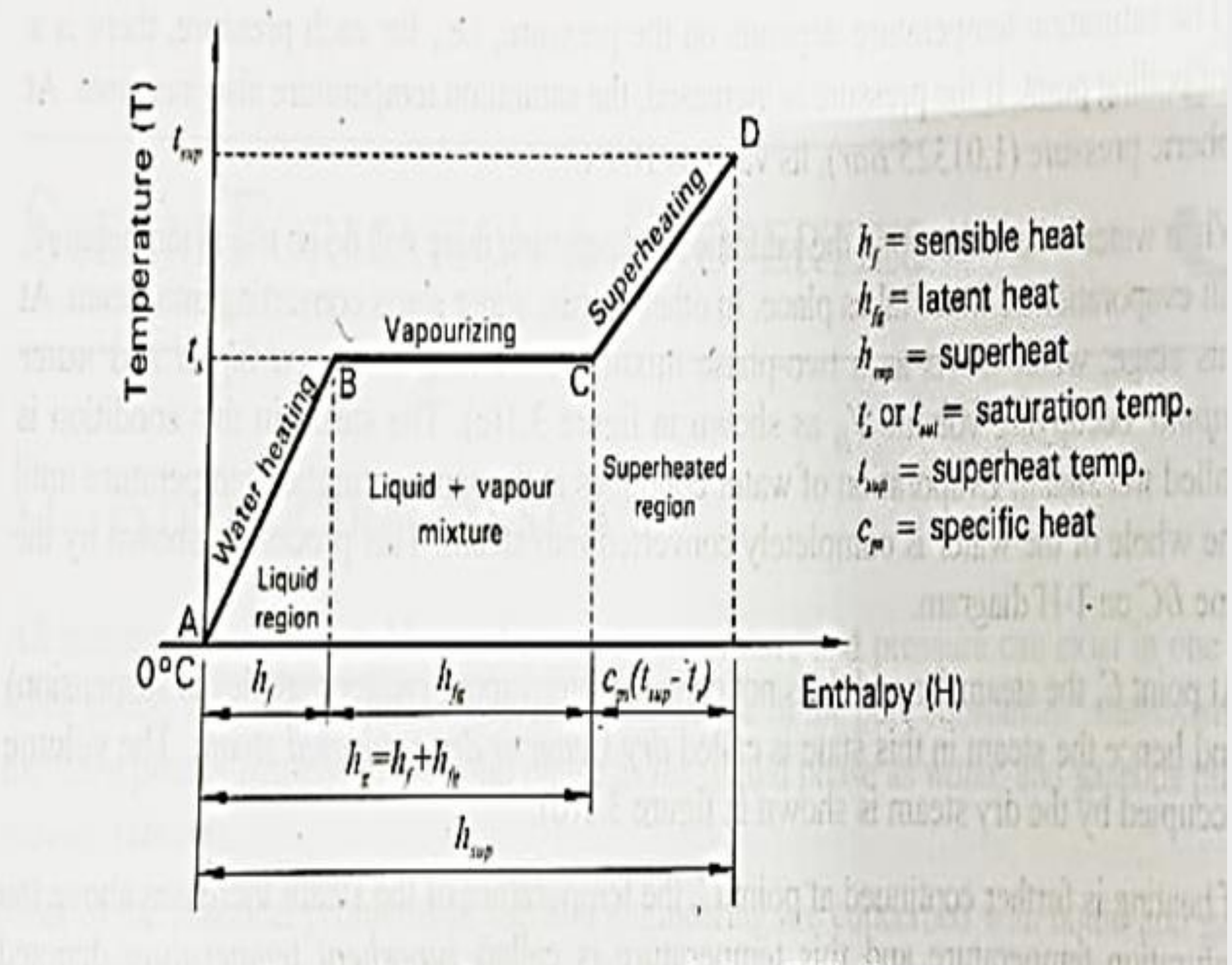



Figure 3.2 Temperature-enthalpy (TH) diagram

**Enthalpy of Dry Saturated Steam (hg):** It is the amount of heat required to convert 1 kg of water from $0^0$C to 1 kg of dry saturated steam at the saturation temperature (boiling point - **($T_s$)**) at constant pressure.

$$h_g = h_f + h_{fg} \quad \text{KJ/Kg}$$

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

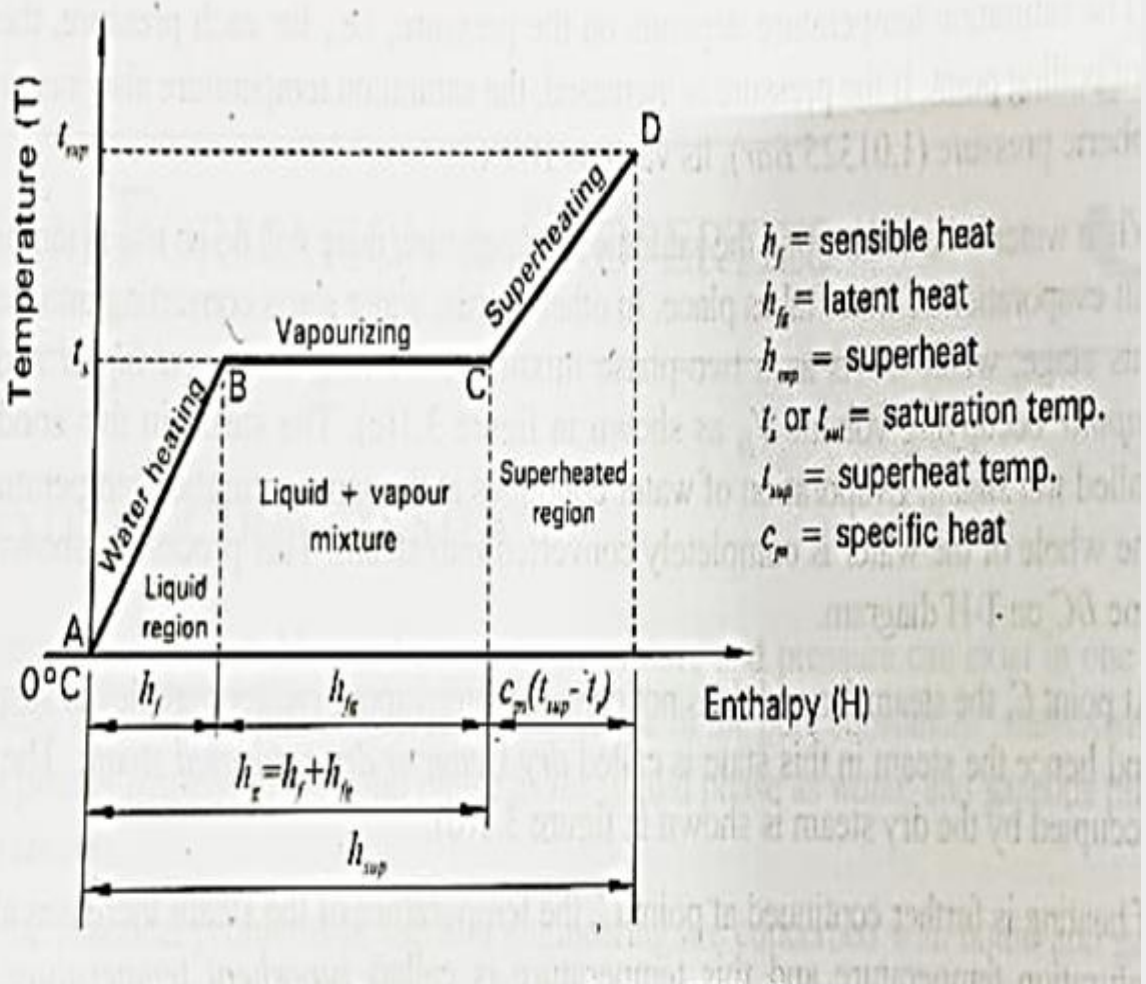


Figure 3.2 Temperature-enthalpy (TH) diagram

**Enthalpy of Wet Steam (h):** It is the amount of heat required convert 1 kg of water from $0^0$C to 1kg of wet steam to the specified dryness fraction at saturation temperature **($T_s$)** and at constant pressure.

$$h = hf + x*hfg \quad KJ/Kg$$

**Dryness fraction of steam (x):** the ratio of mass of dry steam in a given quantity of wet steam to the total mass of wet steam.

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

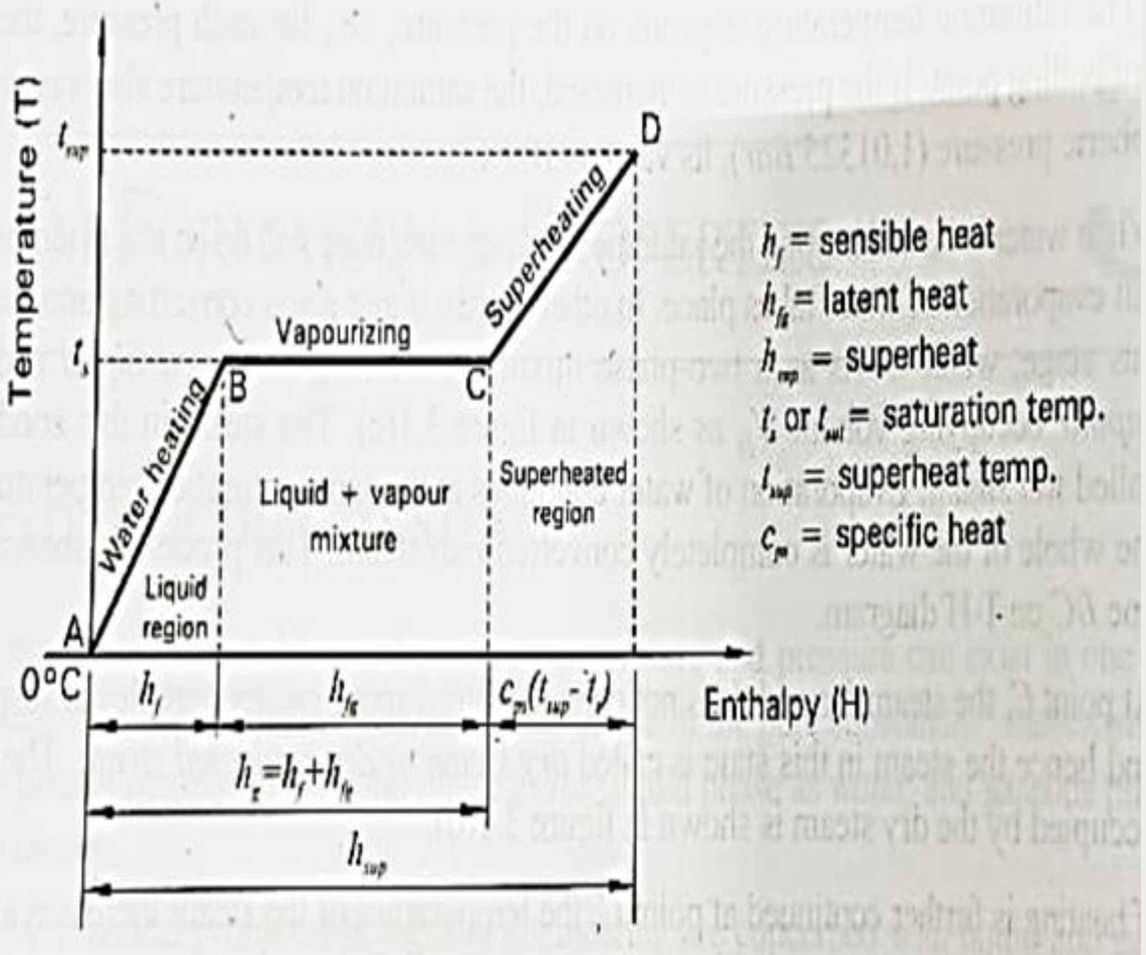



Figure 3.2 Temperature-enthalpy (TH) diagram

$h = hf + x * hfg$ *KJ/Kg*

**Dryness fraction of steam (x):** the ratio of mass of dry steam in a given quantity of wet steam to the total mass of wet steam.

Dryness fraction($x$) = $\frac{m_g}{m_g+mf}$

*Where*

$m_g$ = mass of dry steam

$m_f$ = mass of water molecules

*The x for wet steam is less than 1.*

*The x for dry steam is equal to 1*

# STEAM FORMATION AND PROPERTIES

**Formation of steam at constant pressure:**

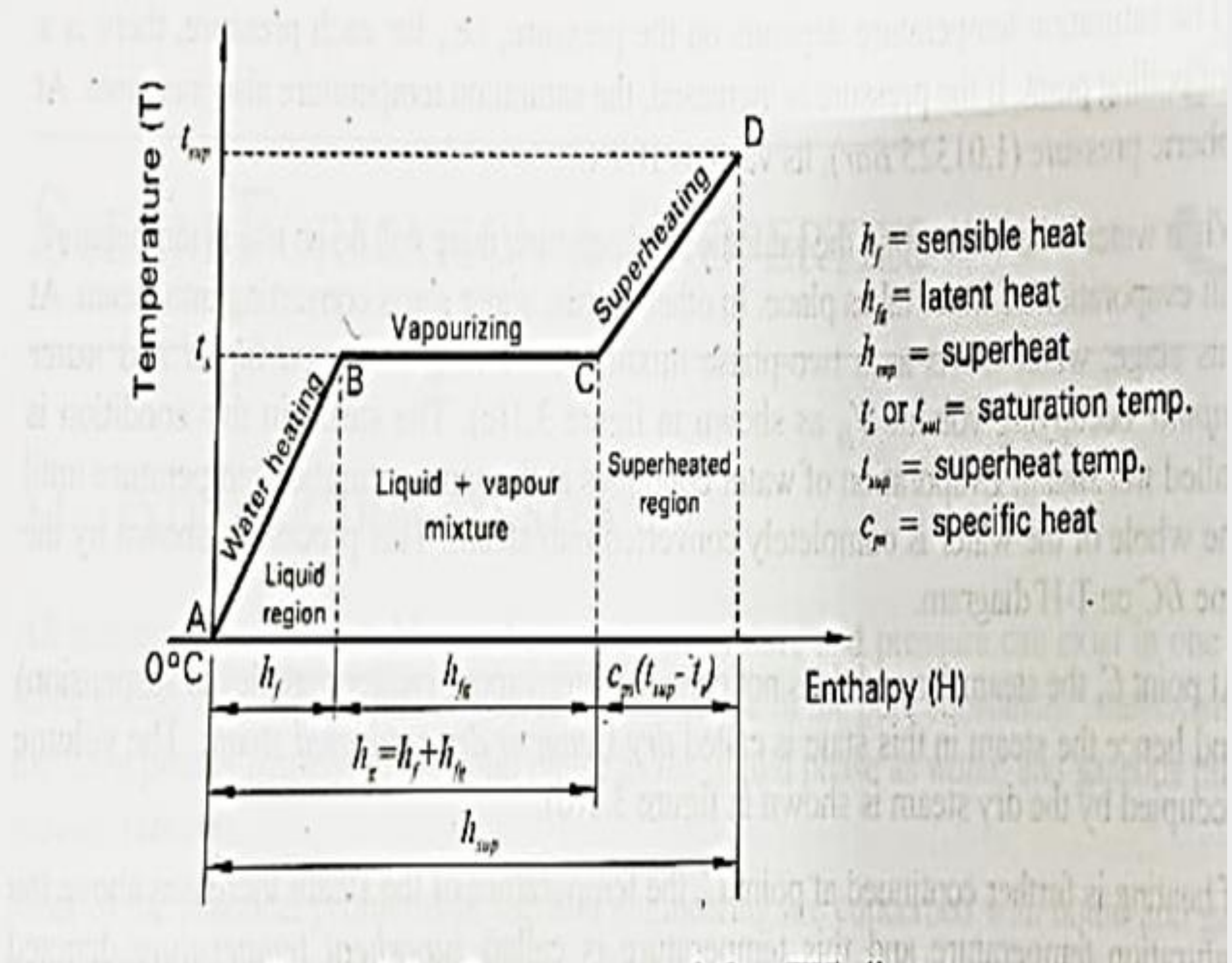


Figure 3.2 Temperature-enthalpy (TH) diagram

**Degree of superheated steam:** The amount of heat required to increase the temperature of dry steam from its saturation temperature **($T_s$)** to any desired higher temperature **($T_{sup}$)** at constant pressure. It is given by

$$C_{ps}(T_{sup}-T_s) \text{ KJ/Kg}$$

# STEAM FORMATION AND PROPERTIES

## Formation of steam at constant pressure:

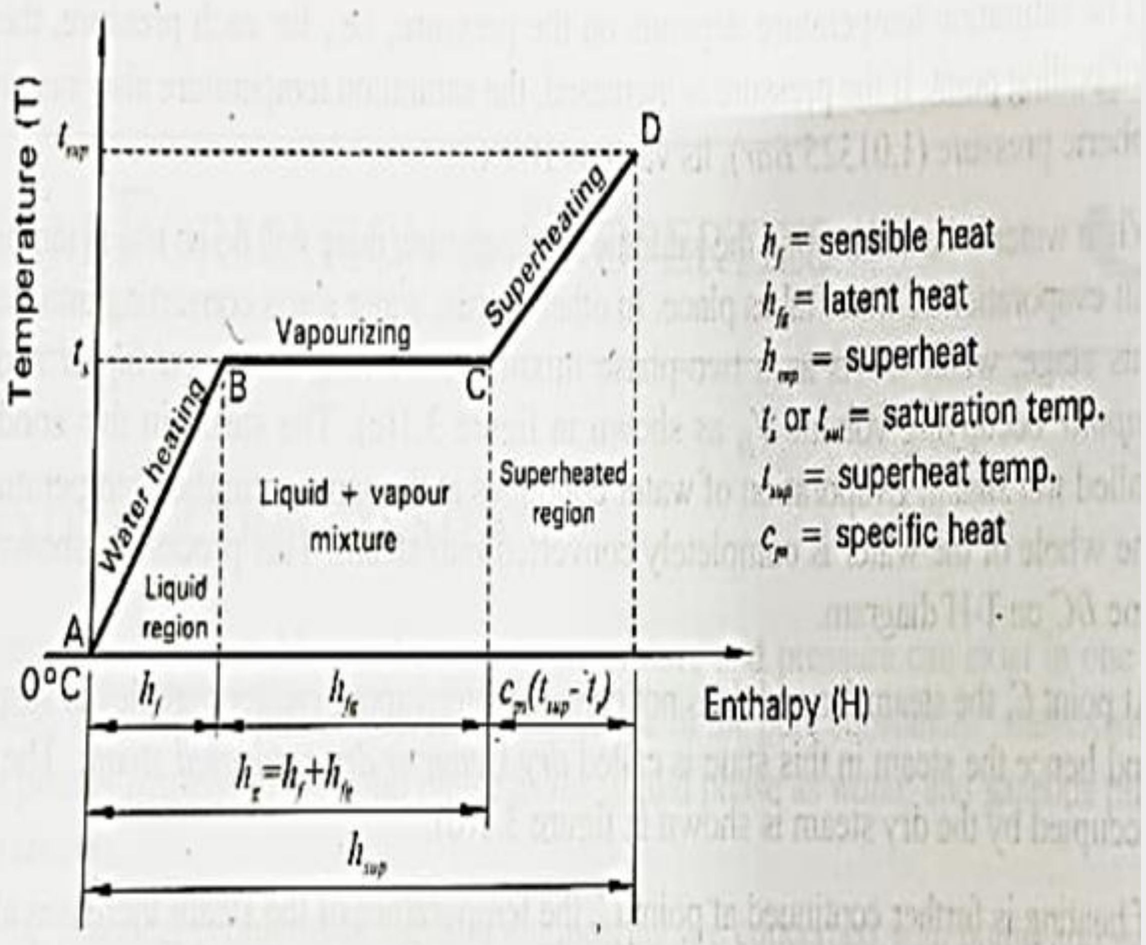



Figure 3.2 Temperature-enthalpy (TH) diagram

**Enthalpy of superheated steam:** The amount of heat required convert 1 kg of water from $0^0$C to 1kg of superheated steam of any desired higher temperature **($T_{sup}$)** at constant pressure is called enthalpy of superheated steam.

$$h_{sup}=h_g+C_{ps}(T_{sup}-T_s) \text{ KJ/Kg}$$

$$h_{sup}=h_f+h_{fg}+C_{ps}(T_{sup}-T_s) \text{ KJ/Kg}$$

# STEAM FORMATION AND PROPERTIES

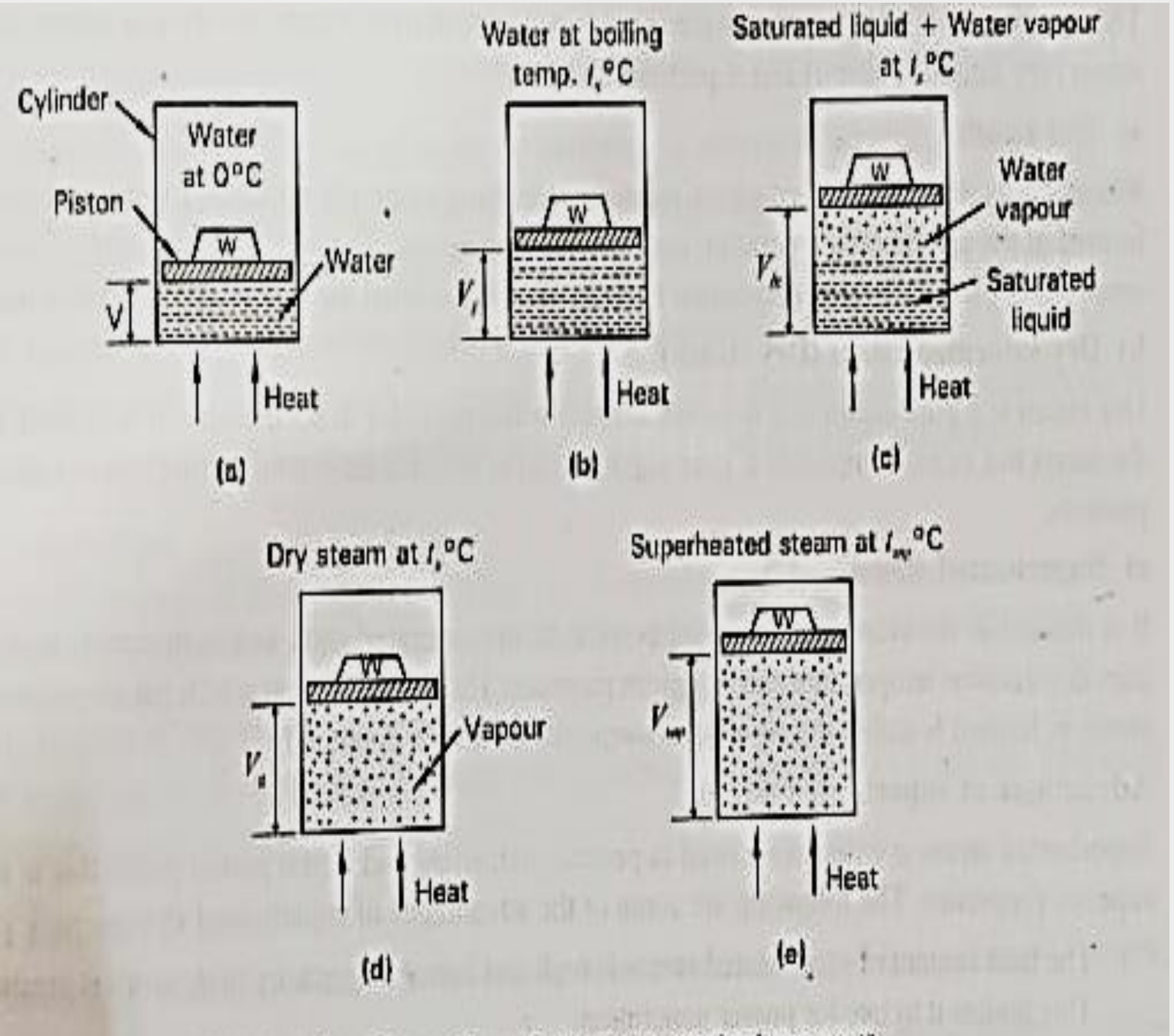



Figure 3.1 Formation of steam at constant pressure

**Specific volume (v) in m$^3$ /kg:** It is the volume occupied by the unit mass of a substance.

**Specific Volume of Saturated water ($V_{f)}$:** It is the volume occupied by 1 kg of saturated water at saturation temperature **($T_s$)** at a given pressure. (Can get this value from steam table)

**Specific Volume of Dry Saturated Steam ($V_{g)}$:** It is the volume occupied by 1 kg of dry saturated steam at saturation temperature **($T_s$)** at a given pressure. (Can get this value from steam table)

# STEAM FORMATION AND PROPERTIES

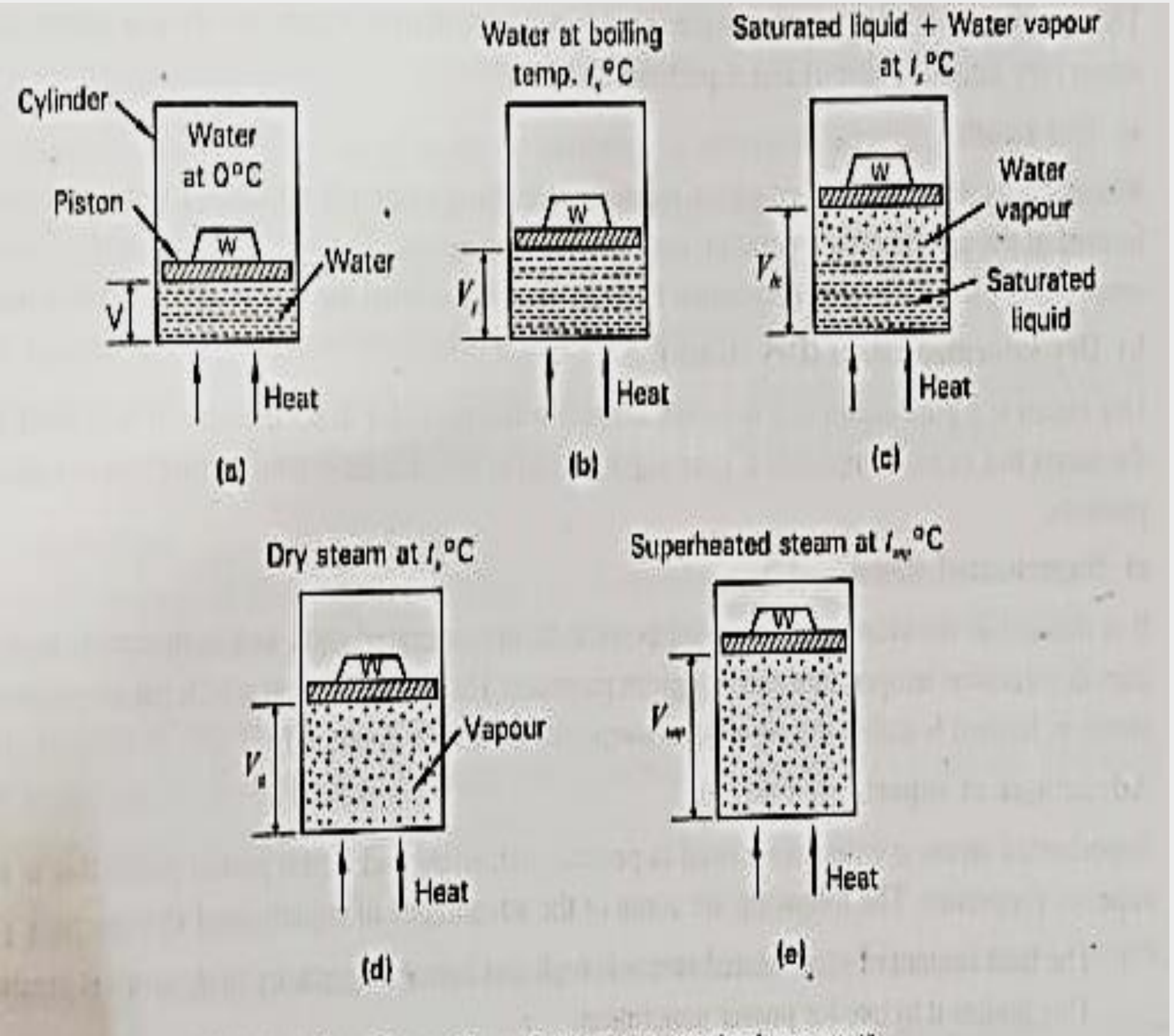



Figure 3.1 Formation of steam at constant pressure

**Specific Volume of Wet Steam ($v_w$):** It is the volume occupied by 1 kg of wet steam to the specified dryness fraction and saturation temperature **($T_s$)** at a given pressure. $\mathbf{v = x * v_g}$

**Specific Volume of Dry Saturated Steam ($V_{sup}$):** It is the volume occupied by 1 kg of super-heated steam at super-heated temperature **($T_{sup}$)** at a given pressure. (Can **NOT** get this value from steam table.) The equation to find **($V_{sup}$)** is

$$\frac{V_g}{V_{sup}} = \frac{T_s}{T_{sup}}$$

# STEAM FORMATION AND PROPERTIES

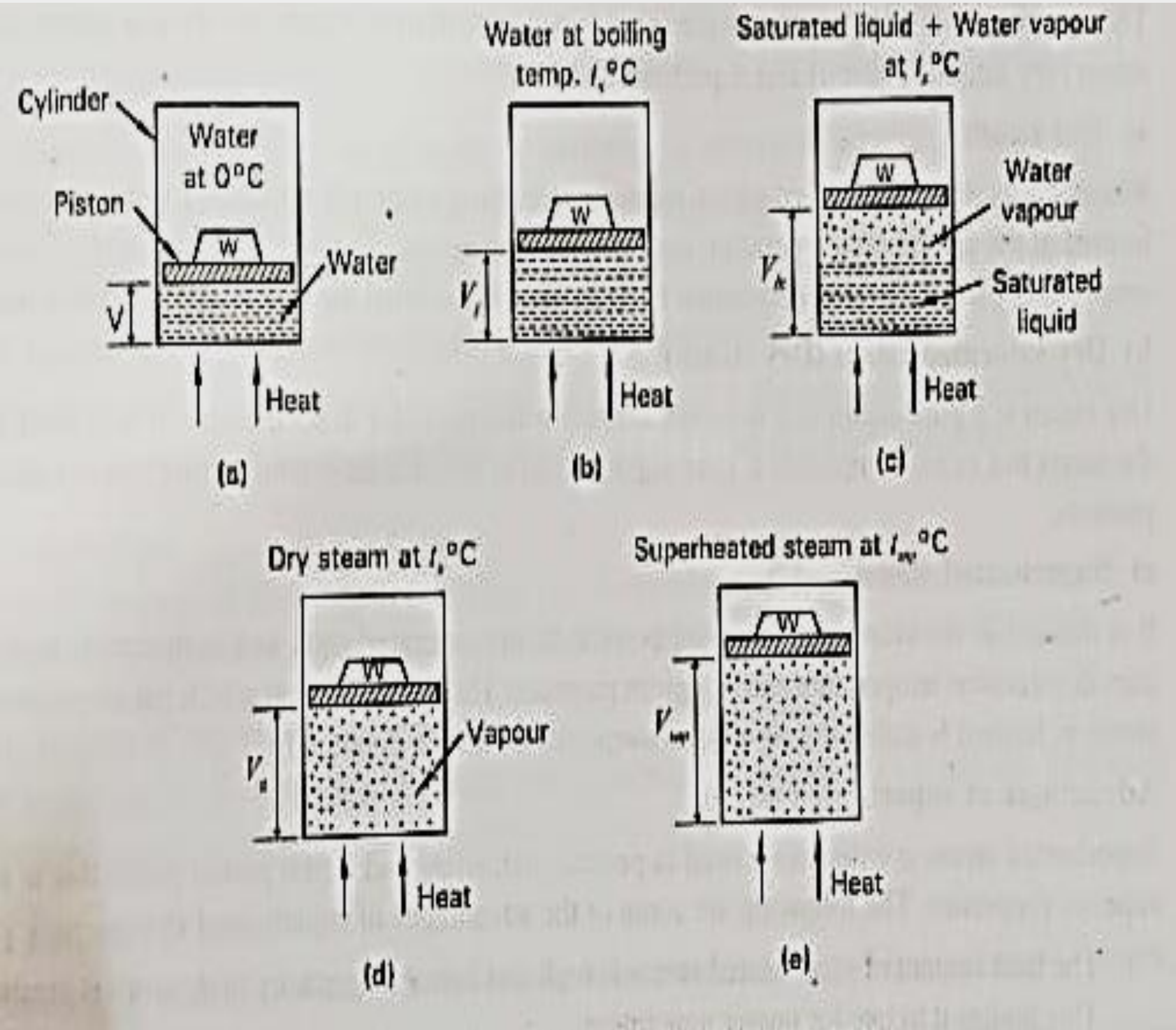



Figure 3.1 Formation of steam at constant pressure

**External work of evaporation (W)** : When water is evaporated to form saturated steam, its volume increases from $\mathbf{V_f}$ to $\mathbf{V_g}$ at a constant pressure, and thus external work is done by steam due to increase in volume. The energy for doing the work is obtained during the absorption of latent heat. This work is called external work of evaporation.

and is given by

**External work of evaporation (W) = 100 P ($\mathbf{V_g - V_f}$)** in kJ

# STEAM FORMATION AND PROPERTIES

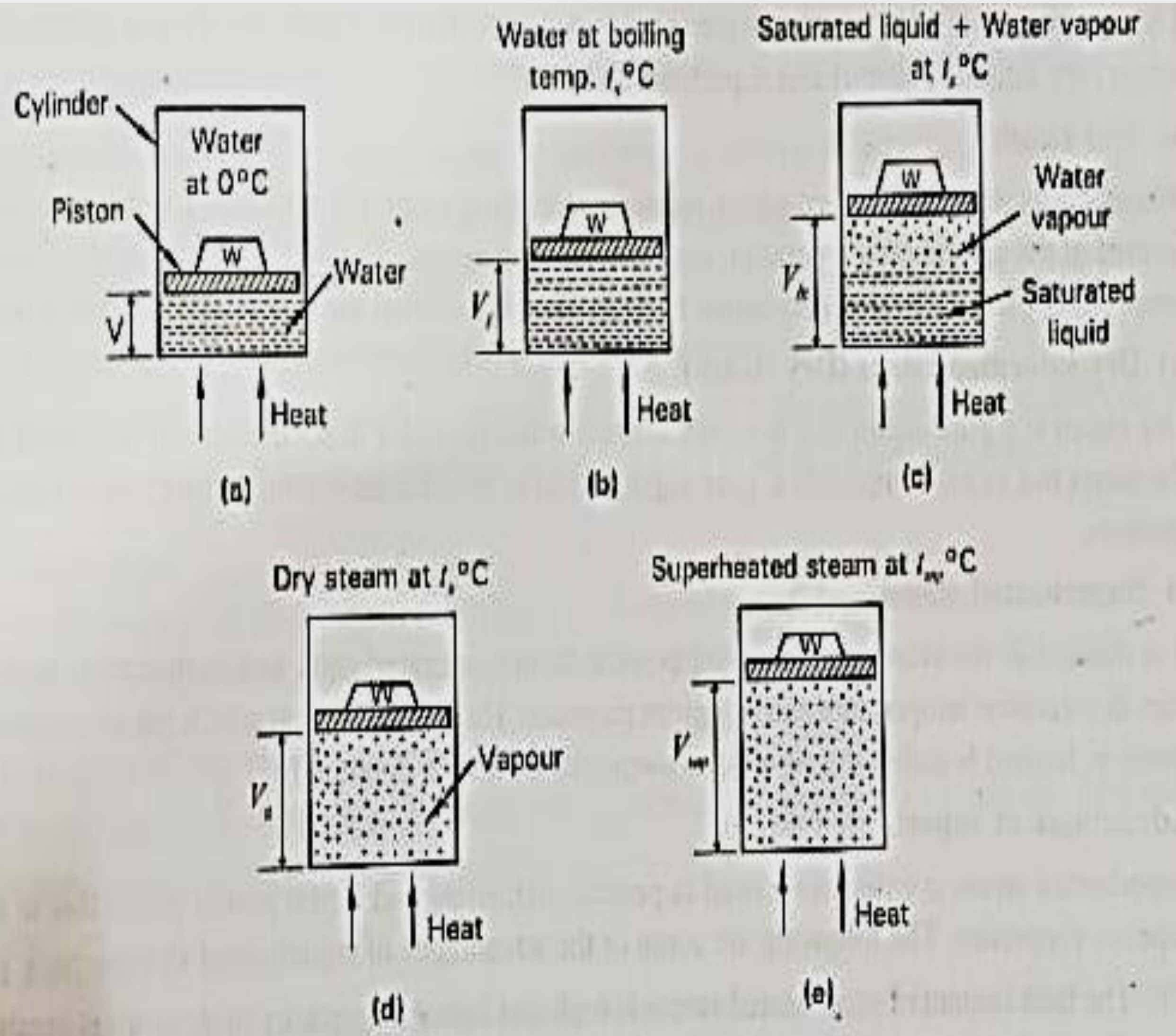



**Figure 3.1** Formation of steam at constant pressure

**External work of evaporation of dry steam**

**(Wg) = 100 P ($V_g$)** in kJ (**$V_f$** is neglected due to its small quantity)

**External work of evaporation of wet steam**

**(Ww) = 100 P (x*$V_g$)** in kJ

**External work of evaporation of super-heated steam (Wsup) = 100 P ($V_{sup}$)** in kJ

# STEAM FORMATION AND PROPERTIES

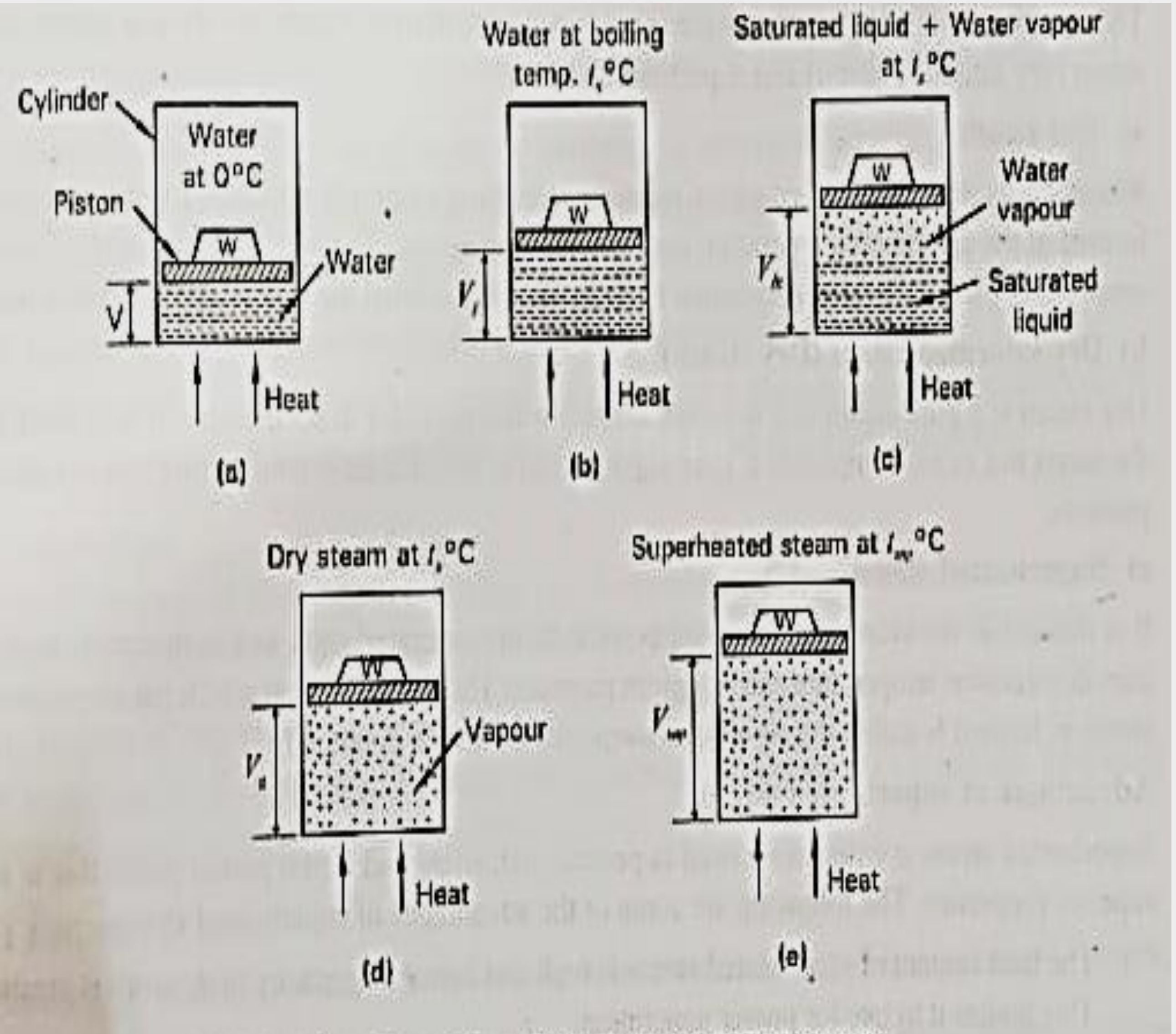



Figure 3.1 Formation of steam at constant pressure

**Internal Latent Heat (U):** The amount of heat required for phase change of 1 kg of water at saturation temperature **($T_s$)** from liquid to vapor at given constant pressure and is given by

**Internal Latent Heat (U):**

**= latent heat - External work of evaporation of dry steam**

= **hg** – **Wg** in kJ/kg

# STEAM FORMATION AND PROPERTIES

**Pressure unit**

1bar = 1 $N/m^2$ = $10^5$ Pascal= 0.1 MPa (Mega Pascal)

**Numericals**

**Determine the dryness fraction of steam if 0-8 of water is in suspension with 45 kg of dry steam.**

**Solution:**

The condition of steam is wet steam, because it is a mixture of water & dry steam

The total Mass of wet steam = mass of dry steam + mass of water molecules = 45 +0.8 = 45.8 kg

Thus, in 45-8 kg of wet steam, the dry steam is 45 kg.

The dryness fraction of wet steam is the ratio of the mass of actual dry steam to the mass of wet steam containing it.

**Dryness fraction, x = 45/45-8 = 0.982 (i.e. Steam is 98.2% dry or 1.8% wet.)**

# STEAM FORMATION AND PROPERTIES

**How much heat is needed to convert 1 kg of feed water at 20$^{o}$C into dry saturated steam at 10 bar (1 MPa or 1000 KPa)? Take specific heat of water as 4.187 kJ/kg K.**

**From steam tables, at 10 bar,**

Saturation temp (Ts) = 179.91'C, Enthalpy of saturated water, $h_f$ = 762.81 kJ/kg and enthalpy of evaporation, $h_{fg}$ - 2,015.3 kJ/kg

**Method1:**

Enthalpy of dry saturated steam at 10 bar (above 0'C), $h_g = h_f + h_{fg}$

= 762.81 + 2,015.3 = 2,778.11 kJ/kg.

Enthalpy of 1 kg of feed water at 20'C above 0'C = $C_{pw}$ ($T_{water}$ - 0) = 4.187 (20-0) = 83.74 kJ/kg.

Heat supplied to convert 1 kg of feed water at 20'C into dry saturated steam at 10 bar

= enthalpy of dry saturated steam - enthalpy of feed water = 2,778.11 - 83.74 = 2,694.37 kJ/kg.

# STEAM FORMATION AND PROPERTIES

**How much heat is needed to convert 1 kg of feed water at 20$^o$C into dry saturated steam at 10 bar (1 MPa or 1000 KPa)? Take specific heat of water as 4.187 kJ/kg K.**

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**Method2:**

Enthalpy of saturated water at 20’C , $h_{f\ at\ 20} = C_{pw}\ (Ts - T_{water})$

= 4.187 (179.91-20) = 669.543

Enthalpy of dry saturated steam = $h_{f\ at\ 20} + h_{fg}$ = 669.543 + 2015.3 = 2684.8 kJ/kg

# STEAM FORMATION AND PROPERTIES

**Find the specific volume and enthalpy of 3 kg of steam at 9bar when the condition of steam is (a) wet with dryness fraction 0.98 (b) dry saturated and (c)super-heated, the temperature of steam 240°C**

**From steam tables, at 9 bar,**

Saturation temp (Ts) = 175.38'C, Enthalpy of saturated water, $h_f$ = 742.83 kJ/kg

enthalpy of evaporation, $h_{fg}$ – 2031.19 kJ/kg, Enthalpy of dry saturated steam ($h_g$) = 2773.9 kJ/kg,

Specific volume of saturated water ($v_f$) = 0.00112 $m^3$/kg,

Specific volume of dry saturated steam ($v_g$) = 0.2150 $m^3$/kg. x= 0.98

(a)

Enthalpy of wet steam ($h_w$) =( $h_f$ +x*$h_{fg}$)*3

= (742.83 + 0.98*2031.19)*3 = (2733.39 kJ/kg)*3 = 8200.18 kJ and

Specific volume of wet steam ($v_f$) =( x* $v_g$)*3 =

(0.98* 0.2150 $m^3$/kg)*3 = (0.2107 $m^3$/kg)*3= 0.6321 $m^3$

# STEAM FORMATION AND PROPERTIES

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Specific volume of saturated water ($v_f$) = 0.00112 $m^3$/kg,

Specific volume of dry saturated steam ($v_g$) = 0.2150 $m^3$/kg. x= 0.98

(b)

Enthalpy of dry saturated steam ($h_g$)= ( $h_f$ +$h_{fg}$)*3 = (742.83 + 2031.19)*3 = (2774.02 kJ/kg)*3 = 8322.06 kJ and

Specific volume of dry steam ($v_g$) = (vg)*3 = (0.2150 $m^3$/kg)*3 = 0.645 $m^3$

# STEAM FORMATION AND PROPERTIES

**Find the specific volume and enthalpy of 3 kg of steam at 9bar when the condition of steam is (a) wet with dryness fraction 0.98 (b) dry saturated and (c)super-heated, the temperature of steam 240°C**

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Specific volume of saturated water ($v_f$) = 0.00112 $m^3$/kg,

Specific volume of dry saturated steam ($v_g$) = 0.2150 $m^3$/kg. x= 0.98

(c)

Enthalpy of super-heated steam ($h_{sup}$)= (hg + $C_{ps}$ (Tsup – $T_s$ ))*3

= (( $h_f$ +$h_{fg}$) +$C_{ps}$ (Tsup – $T_s$ ))*3 = ((742.83 + 2031.19)+2.1(240-175.38))*3 = (2909.72 kJ/kg)*3 = 8729.16 kJ and

Specific volume of super-heated steam ($v_{sup}$) = $\left(v_g * \frac{Tsup}{Ts}\right) * 3$ = (0.2150 * $\frac{240+273}{175.38+273}$ )= (0.2459 $m^3$/kg)*3 = 0.7379 $m^3$

# STEAM FORMATION AND PROPERTIES

**Determine the conditions of steam from the following data:–**

**a) Pressure is 10 bar and temperature 200°C,**

**b) Pressure is 12 bar and enthalpy of 2600 kJ/kg.**

**c) Pressure is 10 bar and the total heat is 2832 kJ/kg**

**d) Pressure is 10 bar and specific volume is 0.23 $m^3$/kg**

Solution:

a) At P= 10 bar, T= 200°C

From steam tables, at pressure of 10 bar,

$T_s$= 179.88°C.

Since the saturation temperature {179.88 °C} is less than given steam temperature of [200°C], therefore the steam is superheated and

Degree of superheated temperature = $T_{sup}$- $T_{sat}$= 20.12 °C

# STEAM FORMATION AND PROPERTIES

**Determine the conditions of steam from the following data:–**

**a) Pressure is 10 bar and temperature 200°C,–**

**b) Pressure is 12 bar and enthalpy of 2600 kJ/kg.**

**c) Pressure is 10 bar and the total heat is 2832 kJ/kg**

**d) Pressure is 10 bar and specific volume is 0.23 $m^3$/kg**

Solution:

b) At Pressure is 12 bar

Enthalpy of saturated water, $h_f$ = 798.65 kJ/kg, enthalpy of evaporation, $h_{fg}$ – 1986.2 kJ/kg,

Enthalpy of dry saturated steam ($h_g$) = 2784.8 kJ/kg,

The given enthalpy 2600 kJ/kg is less than $h_g$= 2784.8 kJ/kg.Therefore the given steam condition is wet steam, the dryness fraction of the steam is

$h_w = h_f + x*h_{fg} = 2600 = 798.65 + x* 1986.2$

x= (2600 -798.65)/1986.2 = 0.906 = 90.6 % dry and 9.4 % wet

# STEAM FORMATION AND PROPERTIES

**Determine the conditions of steam from the following data:–**

**a) Pressure is 10 bar and temperature 200°C,–**

**b) Pressure is 12 bar and enthalpy of 2600 kJ/kg.**

**c) Pressure is 10 bar and the total heat is 2832 kJ/kg**

**d) Pressure is 10 bar and specific volume is 0.23 $m^3$/kg**

Solution:

c) At Pressure is 10 bar

enthalpy of dry saturated steam ($h_g$)= 2778.1 kJ/kg , Ts= 179.91°C

The given enthalpy 2832 kJ/kg is more than $h_g$= 2778.1 kJ/kg

Therefore the given steam condition is super heated steam steam,

the temperature of the super–heated steam is

$h_{sup}$= (hg + $C_{ps}$ (Tsup – $T_s$ )) = 2832 =2778.1+ 2.1(Tsup -179.91)

= 2.1 *Tsup=431.81, Tsup = 205.5°C

# STEAM FORMATION AND PROPERTIES

**Determine the conditions of steam from the following data:–**

**a) Pressure is 10 bar and temperature 200°C,–**

**b) Pressure is 12 bar and enthalpy of 2600 kJ/kg.**

**c) Pressure is 10 bar and the total heat is 2832 kJ/kg**

**d) Pressure is 10 bar and specific volume is 0.23 $m^3$/kg**

Solution:

d) At Pressure is 10 bar

Enthalpy of dry saturated steam ($h_g$)= 2778.1 kJ/kg , Ts= 179.91°C, $v_g$= 0.19444 $m^3$/kg

The given specific volume is 0.23 $m^3$/kg is greater than $v_g$= 0.19444 $m^3$/kg.

Therefore the given steam condition is super heated steam steam,

The temperature of the super–heated steam is

$$\left(\frac{V_{sup}}{Tsup}\right) = \left(\frac{v_g}{Ts}\right) = T_{sup}) = \left(Ts * \frac{Vsup}{v_g}\right) = ((179.91+273)*(\frac{0.23}{0.19444}) = \mathbf{535.74\ K = 262.7}\ °C$$

# STEAM FORMATION AND PROPERTIES

**A mixture of wet steam at a pressure of 1 Mpa is found to have a quality of 85%. Determine its enthalpy, external work of evaporation, internal energy, specific volume & density.**

Solution:

The Pressure is 1 Mpa = $1*10*10^5$ Pa = 10 bar (where $10^5$ Pa = 1bar)

X = 0.85

**From steam tables, at 10 bar,**

Saturation temp (Ts) = 179.91°C, Enthalpy of saturated water, $h_f$ = 762.81 kJ/kg and enthalpy of evaporation, $h_{fg}$ - 2,015.3 kJ/kg, $v_g$= 0.19444 $m^3$/kg

Enthalpy of wet steam ($h_w$) =( $h_f$ +x*$h_{fg}$) = 762.81 + (0.85*2015.3) = 2475.81 kJ

External work of evaporation = (Ww) = 100 P (x*$V_g$) = 100 *10*(0.85*0.19444) = 165.27 kJ

# STEAM FORMATION AND PROPERTIES

**A mixture of wet steam at a pressure of 1 Mpa is found to have a quality of 85%. Determine its enthalpy, external work of evaporation, internal energy, specific volume & density.**

Solution:

The Pressure is 1 Mpa = $1*10*10^5$ Pa = 10 bar (where $10^5$ Pa = 1bar)

X = 0.85

**From steam tables, at 10 bar,**

Saturation temp (Ts) = 179.91°C, Enthalpy of saturated water, $h_f$ = 762.81 kJ/kg and enthalpy of evaporation, $h_{fg}$ - 2,015.3 kJ/kg, $v_g$= 0.19444 $m^3/kg$

Internal energy = Enthalpy of steam – external work of evaporation = $h_w$ - Ww =2475.81 -165.27 =2310.54 kJ

specific volume = $V_w = x*V_g$ = 0.85*0.19444 = 0.165274 $m^3/kg$

Density = (mass/volume) = (1/ $V_w$) = (1/ 0.165274) =6.05 $kg/m^3$

# STEAM FORMATION AND PROPERTIES

**A steam initially will be at 9 bar and dryness fraction 0.98. find the final quality and temperature of the steam at each of the following operations. (a) When steam losses 50 kJ/kg at constant pressure (b) when steam receives 150 kJ/kg at constant pressure.**

Solution:

**From steam tables, at 9 bar,**

Saturation temp (Ts) = 175.38°C, Enthalpy of saturated water, $h_f$ = 742.83 kJ/kg

enthalpy of evaporation, $h_{fg}$ – 2031.19 kJ/kg, Enthalpy of dry saturated steam ($h_g$) = 2773.9 kJ/kg,

Specific volume of saturated water ($v_f$) = 0.00112 $m^3$/kg, Specific volume of dry saturated steam ($v_g$) = 0.2150 $m^3$/kg. x= 0.98

The initial condition of the steam is wet steam with x= 0.98

Enthalpy of wet steam ($h_w$) =( $h_f$ +x*$h_{fg}$) = 742.83 + (0.98*2031.19) = 2733.39 kJ

# STEAM FORMATION AND PROPERTIES

**A steam initially will be at 9 bar and dryness fraction 0.98. find the final quality and temperature of the steam at each of the following operations. (a) When steam losses 50 kJ/kg at constant pressure (b) when steam receives 150 kJ/kg at constant pressure.**

Solution: **From steam tables, at 9 bar,**

Enthalpy of saturated water, $h_f$ = 742.83 kJ/kg    enthalpy of evaporation, $h_{fg}$ – 2031.19 kJ/kg,

Enthalpy of dry saturated steam ($h_g$) = 2773.9 kJ/kg,

Enthalpy of wet steam ($h_w$) =( $h_f$ +x*$h_{fg}$) = 742.83 + (0.98*2031.19) = 2733.39 kJ

**(a) When steam losses 50 kJ/kg at constant pressure**

**New Enthalpy of wet steam** ($h_w$) = 2733.39 – 50 = 2683.39 kJ

2683.39 kJ is less than $h_g$ and more than $h_f$, therefore the new condition of the steam is wet steam with new dryness fraction

$h_w$ = $h_f$ +x*$h_{fg}$= 2683.39 = 742.83 + x* 2031.1

x= (2683.39 -742.83)/2031.1 = 0.955 = 95.5 % Dry and 4.5 % wet

# STEAM FORMATION AND PROPERTIES

**A steam initially will be at 9 bar and dryness fraction 0.98. find the final quality and temperature of the steam at each of the following operations. (a) When steam losses 50 kJ/kg at constant pressure (b) when steam receives 150 kJ/kg at constant pressure.**

Solution: **From steam tables, at 9 bar,**

Enthalpy of saturated water, $h_f$ = 742.83 kJ/kg enthalpy of evaporation, $h_{fg}$ – 2031.19 kJ/kg,

Enthalpy of dry saturated steam ($h_g$) = 2773.9 kJ/kg, Ts= 175.38°C

Enthalpy of wet steam ($h_w$) =( $h_f$ +x*$h_{fg}$) = 742.83 + (0.98*2031.19) = 2733.39 kJ

**(b) when steam receives 150 kJ/kg at constant pressure**

New Enthalpy of wet steam ($h_w$) = 2733.39 + 150 = 2883.39 kJ

2883.39 kJ is more than $h_g$, therefore the new condition of the steam is super heated steam with temperature

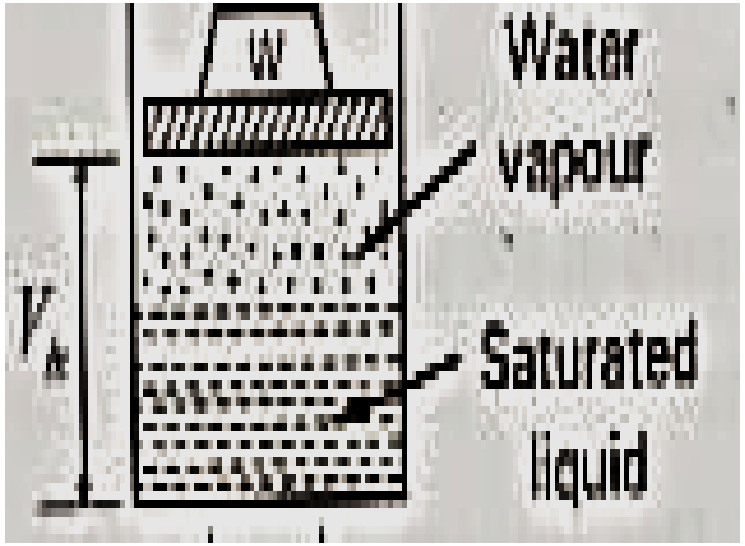
$h_{sup}$= (hg + $C_{ps}$ (Tsup – $T_s$ )) = 2883.9 =2773.9+ 2.1(Tsup -175.38)

= 2.1 *Tsup=478.298, Tsup = 227.7°C

# STEAM FORMATION AND PROPERTIES

**A mixture of saturated water and saturated steam at a temperature of 250°C is contained in a closed vessel of 0.1 m3 capacity. If the mass of saturated water is 2kg, find the mass of the steam in the vessel. Also find the pressure, specific volume, dryness fraction and the enthalpy of the mixture.**

Solution:




**It is a mixture of saturated water and saturated steam at a temperature of 250°C = it is wet steam.**

**Then 250°C is saturation temperature ( pressure is not given)**

# STEAM FORMATION AND PROPERTIES

**A mixture of saturated water and saturated steam at a temperature of 250°C is contained in a closed vessel of 0.1 m3 capacity. If the mass of saturated water is 2kg, find the mass of the steam in the vessel. Also find the pressure, specific volume, dryness fraction and the enthalpy of the mixture.**

Solution: https://drive.google.com/file/d/1GpLIqQJuyqhxAsg9v6P82_jqaZAUbXfe/view?usp=sharing

**From steam tables, at** Ts= **250°C is saturation temperature ,**

Pressure = 39.73 bar, Enthalpy of saturated water, $h_f$ = 1085.36 kJ/kg
Enthalpy of evaporation, $h_{fg}$ – 1716.2 kJ/kg, Enthalpy of dry saturated steam ($h_g$) = 2801.5 kJ/kg,

Specific volume of saturated water= 0.00125 $m^3$/kg, Specific volume of dry steam = 0.05013 $m^3$/kg

Given : Volume of vessel = 0.1 $m^3$, mass of saturated water ($\boldsymbol{mf}$) = 2kg,

Total volume of steam = Volume of vessel = 0.1 $m^3$

0.1 = mass of saturated water* specific volume of saturated water + mass of dry steam* specific volume of dry steam

0.1 = $mf$ * Vf + mg *Vg = 0.1 = 2*0.00125 + mg*0.05013, ==mg=1.945 kg

# STEAM FORMATION AND PROPERTIES

**A mixture of saturated water and saturated steam at a temperature of 250°C is contained in a closed vessel of 0.1 m3 capacity. If the mass of saturated water is 2kg, find the mass of the steam in the vessel. Also find the pressure, specific volume, dryness fraction and the enthalpy of the mixture.**

Solution:

Total mass of the steam in the vessel = mf + mg = 2+1.945 = 3.945 kg

Pressure = 39.73 bar

Dryness fraction$(x) = \frac{m_g}{m_g + mf} = x = \frac{1.945}{3.945} = 0.4930$

specific volume = x * vg = 0.4930 * 0.05013 = 0.0247 $m^3/kg$

Enthalpy of mixture ($h_w$) =( mf * $h_f$ +mg * $h_g$) = (2*1085.36 + 1.945 * 2801.5 ) = 7619.63 kg

# STEAM FORMATION AND PROPERTIES

# Q & A