MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

BASIC MECHANICAL ENGINEERING (BME)

Subject Code: MME 1051

Lectures : 03

Tutorials : 00

Practical's: 00

Credits : 03

L T P C : 3 0 0 3

About the faculty-incharge

- Name of the Faculty : Mr G S S Adithya
- Email Id : srinivas.adithya@manipal.edu

Syllabus:

- Properties of Steam and Boilers: Steam properties Working principle of Babcock & Wilcox Boiler.
- Prime Movers: Classification, working principle of steam, gas and water turbines Power plants: Working principle of thermal, nuclear, hydel and solar power plants
- Refrigeration: Principle and working of vapour compression refrigeration system, I.C. Engines: Classification, Working of 2-stroke, 4 - stroke C.I and S.I Engines
- Power Transmission: Belt drives, Introduction to rope drive and chain drives, Gear Drives.
- Machine Tools: Introduction to Lathe, Drilling Machine and operations Casting and Forging: Two box moulding procedure, moulding sand and its desirable properties, Pattern allowances,
- Introduction to forging & welding: Principle of Resistance spot welding, Electric arc welding and Oxy-acetylene gas welding, Introduction to soldering and brazing

Text books & reference books:

1. K. R.Gopalakrishna, Text book of elements of Mechanical Engineering, Subhash Publications, Bangalore, 2005.
2. Roy & Choudhury, Elements of Mechanical Engineering, Media Promoters & Publishers Pvt. Ltd, Mumbai, 2000.
3. Mishra B.K., Mechanical Engineering Sciences, Kumar & Kumar Publishers (P) Ltd, Bangalore, 1999
4. Trymbaka Murthy S., A text book of elements of Mechanical Engineering, I. K. International Publishing House Pvt. Ltd, 2010.
5. Rajput R. K., Elements of Mechanical Engineering, Fire Wall Media, 2005
6. B.S. Raghuvanshi, A course in Workshop Technology, Vol. 1, Dhanpat Rai & sons, New Delhi, 2005.

First Year: Course Structure (Physics Group)

(Applicable to students admitted

Year	FIRST SEMESTER					
	Sub. Code	Subject Name	L	T	P	C
	MAT 1151	Engineering Mathematics - I	3	1	0	4
	PHY 1051	Engineering Physics	2	1	0	3
	CIE 1051	Mechanics of Solids	2	1	0	3
	ECE 1051	Basic Electronics	3	0	0	3
I	MME 1051	Basic Mechanical Engineering	3	0	0	3
	HUM 1053	Communication skills in English and Human Values	1	0	3	2
	PHY 1061	Engineering Physics Lab	0	0	3	1
	MME 1061	Workshop Practice	0	0	3	1
	MME 1161	Engineering Graphics - 1	1	0	2	2
			14	4	12	22
	Total Contact Hours (L + T + P)		30			

Basic Mechanical Engineering

Part A (Thermal Engg.)

1. Properties of Steam
2. Steam Boilers
3. Turbines - Steam/Water/Gas
4. Power Plants – Thermal/Nuclear/Hydel/Solar
5. Refrigeration systems
6. Internal Combustion (IC) Engines

Part B (Manufacturing Engg.)

1. Power Transmission –Methods & devices
2. Machine Tools – Lathe & Drilling
3. Foundry and Forging operations
4. Fabrication methods – Welding, Brazing and Soldering

Chapter 1:
PROPERTIES OF STEAM

Definition of Pure Substance:

A pure substance is defined as a homogeneous substance which retains its chemical composition, undergoes change in phase (state) during a thermodynamic process.

or

A **pure substance** is a substance that cannot be separated by physical means. eg. filtration, evaporation, distillation or chromatography

Example: Water

Phases in Water

1 Solid ------- ICE

2 Liquid ------ WATER

3 Vapour------ STEAM

STEAM:

Vapour form of water is called STEAM

Steam is produced by heating water to its *saturation temperature*.

Types of steam

Wet Steam : Steam containing fine water particles in equilibrium is called wet steam.

Dry steam : Steam produced on complete transformation of water into gaseous state at the saturation (boiling) temperature is called dry steam. The saturation temperature depends on pressure.

Super heated steam: Steam available at a temperature above the saturation temperature is called superheated steam.

Application of steam

- Food processing industries.
- Cooking: hotels, restaurants etc.
- Used as a working fluid in steam engines and steam turbines.
- Used in process industries. (Paper Mill)
- Petrochemical industries.
- Washing/drying/sterilizing in hospitals.
- Health clinic / gym.

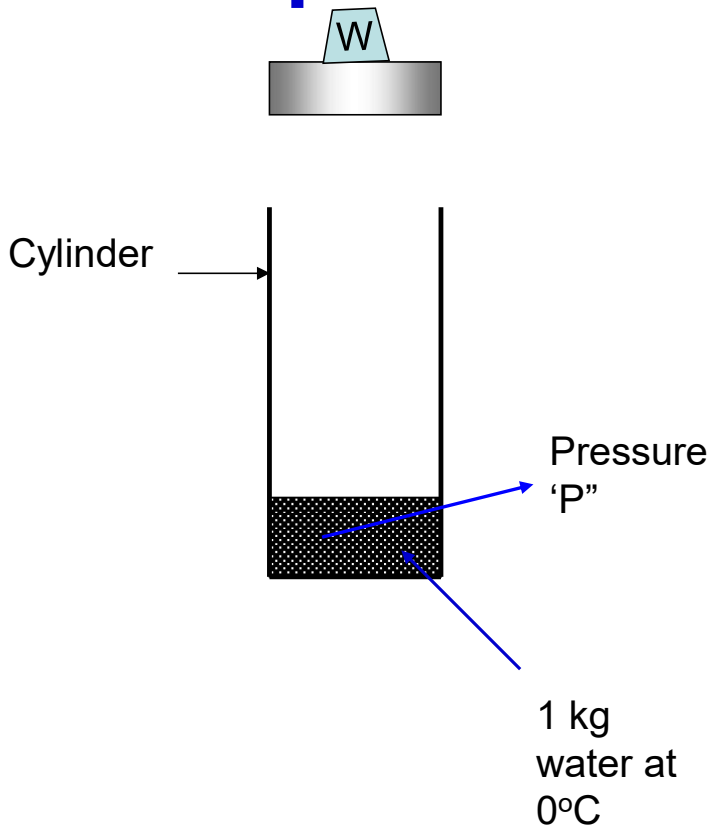
Measure of Heat contained in steam

Enthalpy: The heat absorbed by 1 kg of water at 0^0C to transform into steam (wet, dry or superheated) at constant pressure is called enthalpy of steam.

It is also known as total heat of steam and expressed in kilo joules / kg.

Formation of Steam Experiment

Consider 1 kg of water at 0°C taken in a cylinder fitted with a freely moving frictionless piston as shown in figure.



The initial condition of water at 0°C is represented by the point ***A*** on the temperature-enthalpy graph

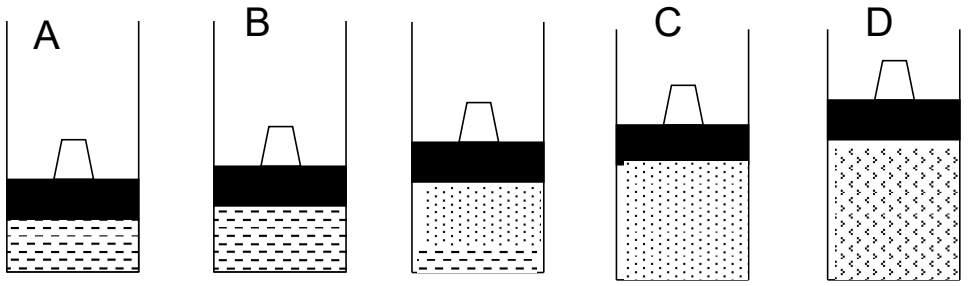
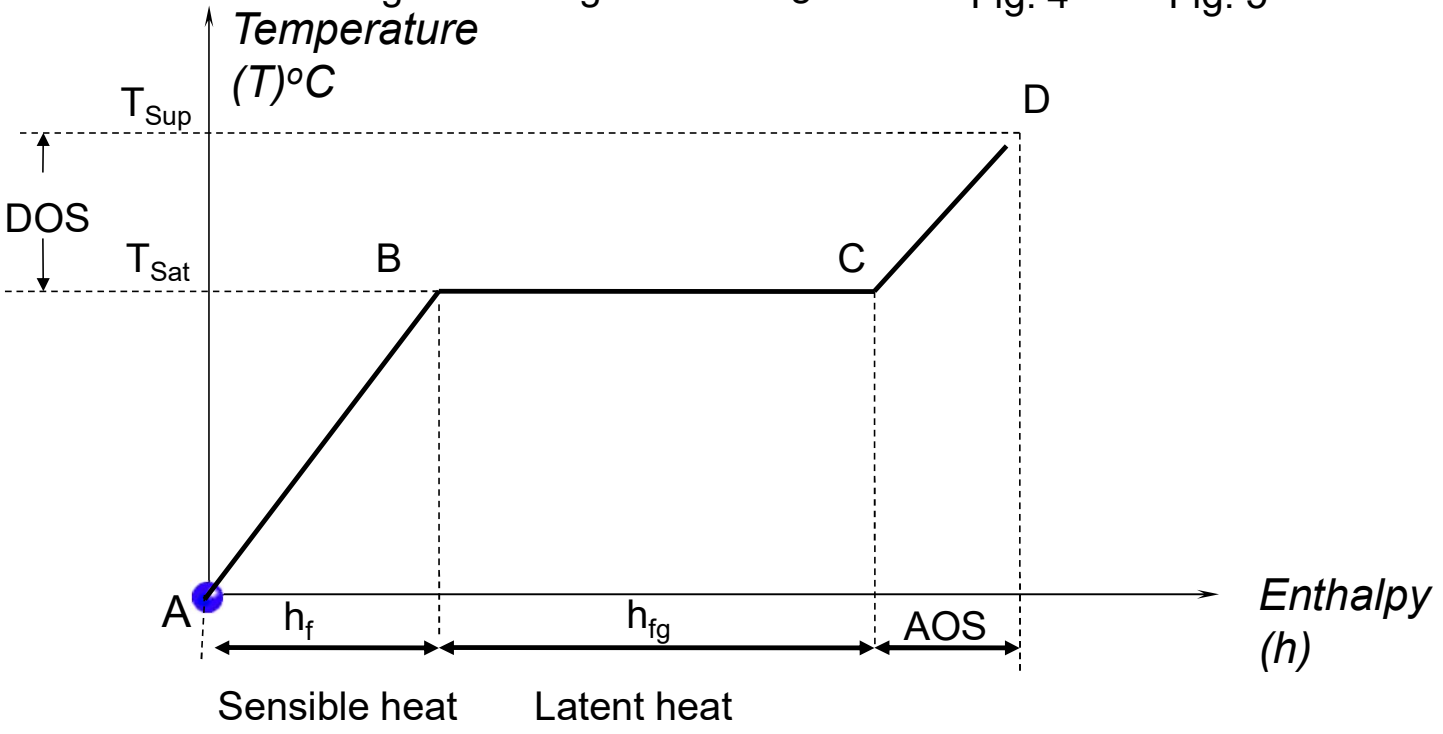


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5



DEFINITIONS

Sensible heat **(h_f)** **:** *It is defined as the amount of heat required to raise the temperature of 1 kg of water from 0^0C to the saturation temperature T_{sat} °C at a given constant pressure.*

Saturation temperature **(T_{sat}):** *It is defined as the temperature at which the water transforms into vapour at the stated pressure*

Latent heat of evaporation **(h_{fg})*:*** *It is defined as the amount of heat required to transform 1 kg of water at saturation temperature into 1 kg of dry steam at the same saturation temperature at given constant pressure.*

Superheated Temperature **(T_{sup}) :** *It is the temperature to which steam is heated above the saturation temperature at a given pressure.*

Amount of superheat (AOS) or enthalpy of superheat: *It is defined as the amount of heat required to increase the temperature of dry steam from its saturation temperature to any desired higher temperature at the given constant pressure.*

Degree of superheat (DOS): *It is the difference between the superheated temperature and the saturation temperature at a given constant pressure.*

Different states of steam

The steam as it is being generated can exist in ***three*** different states,

1. *Wet Steam*
2. *Dry Saturated Steam*
3. *Superheated Steam*

Wet Steam

Wet Steam is defined as a two-phase mixture of finely divided water particles and dry steam in thermal equilibrium at the saturation temperature corresponding to a given pressure.

Dry Saturated Steam

It is defined as the saturated steam at the saturation temperature corresponding to a given pressure and having no water molecules contained in it.

Superheated Steam

Superheated Steam is defined as the steam which is heated to temperature higher than its saturated temperature at the given pressure.

Dryness Fraction

The quality of the wet steam is specified by the ***Dryness Fraction*** which indicates the amount of dry steam present in the given quantity of wet steam and is denoted as ***x***.

The dryness fraction of steam is defined as the ratio of mass of the actual dry steam present in a known quantity of wet steam to the total mass of the wet steam.

$$\text{Dryness fraction, } x = \frac{\text{Mass of Dry Steam present in Wet Steam}}{\text{Total Mass of Wet Steam}}$$

Let m_g = Mass of dry steam present in the sample quantity of wet steam

m_f = Mass of suspended water molecules in the sample quantity of wet steam

$$x = \frac{m_g}{m_f + m_g}$$

The dryness fraction of the wet steam is less than 1.

The dryness fraction of the dry steam and superheated steam is equal to 1.

Advantages of Superheated Steam

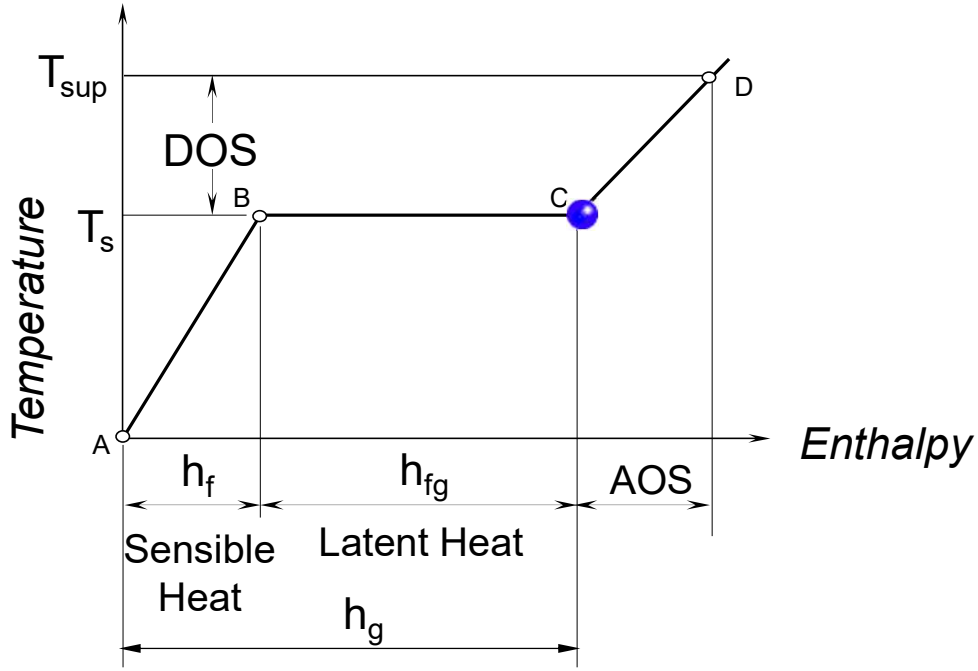
- At a given pressure, the superheated steam possess more heat energy compared to dry saturated steam or wet steam at the same pressure, hence its capacity to do the work will be higher.
- When superheating is done by the exhausting combustion gases in a boiler, there will be a saving of the energy of combustion which improves the thermal efficiency of the boiler.
- While expanding in a steam turbine it reduces and in extreme cases prevents the condensation, thus giving better economy.

Disadvantages of Superheated Steam

- The high superheated temperatures poses problems in the lubrication
- Higher thermal stresses, depreciation and initial cost in case of power generation.

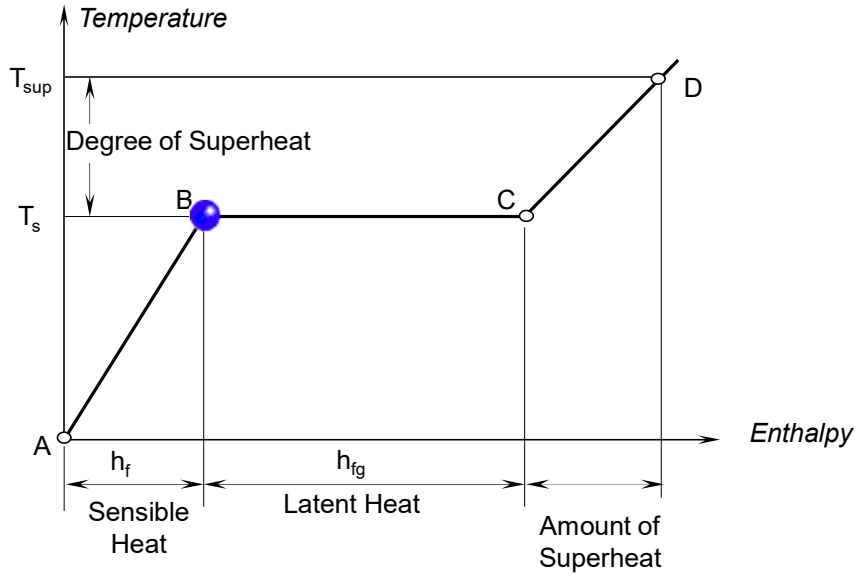
Enthalpy equations for different states of steam

a) Enthalpy of Dry Saturated Steam (h_g):



$$h_g = h_f + h_{fg} \quad \text{kJ/kg}$$

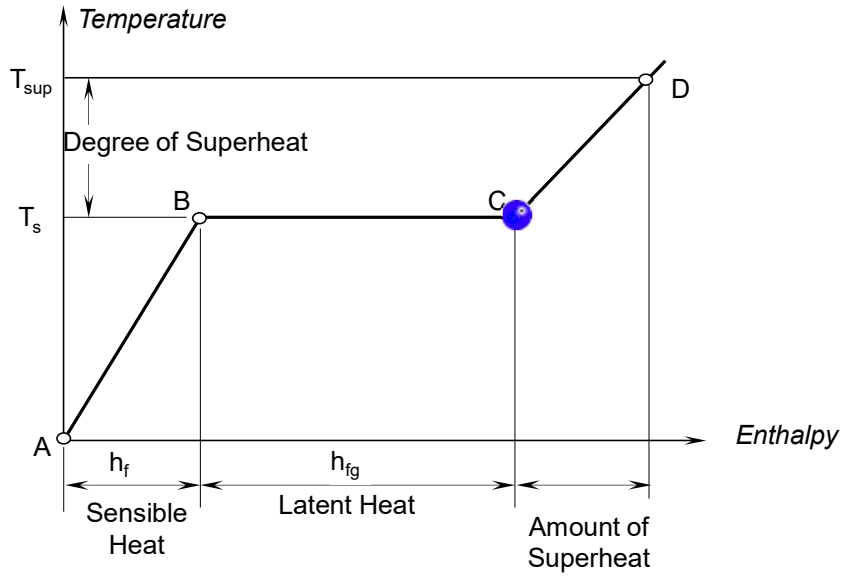
b) Enthalpy of Wet Steam (h_x):



$$h_x = h_f + x\, h_{fg} \quad \text{kJ/kg}$$

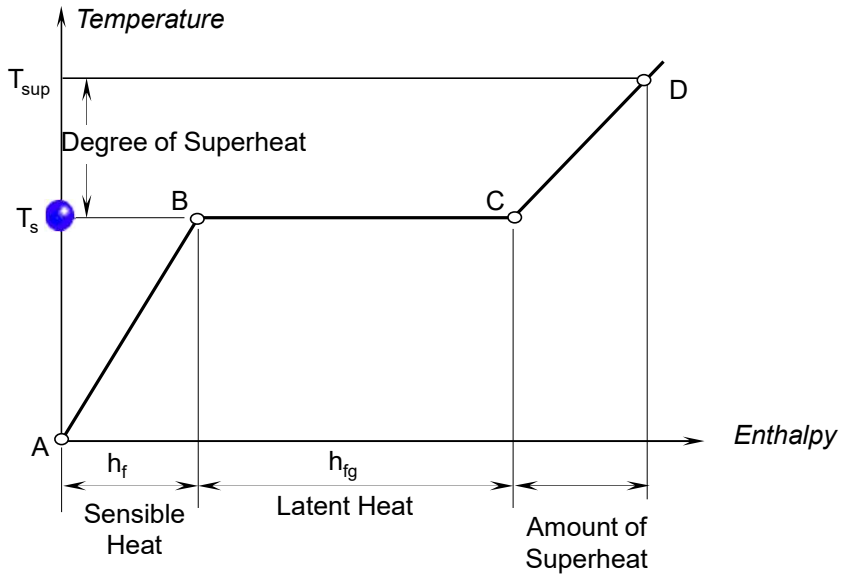
c) Enthalpy of Superheated Steam:

$$h_{sup} = h_f + h_{fg} + C_{sup}(T_{sup} - T_{sat}) \text{ kJ/kg}$$



d) Degree of superheat (DOS):

$$DOS = (T_{sup} - T_{sat})$$



e) Amount of superheat (AOS):

$$AOS = C_{sup} (T_{sup} - T_{sat})$$