CHAPTER SEVEN

<u>HEAT</u>

Introduction to heat, thermometers and the transmission of <u>heat</u>:

Heat is the type of energy which flows from the hot part to the cold part of a body. There are many sources of heat and some of these sources are:

- Solar energy.
- Fossil fuel.
- Hydroelectric power.
- Nuclear energy.
- Geothermal energy.
- Friction.

Temperature:

- This is a number which tells us how hot or cold a body or an environment is.
- Thermometers are devices used in the measuring of temperature.
- There are various types of thermometers and examples are
- (1) the digital thermometer.
- (2) the liquid in glass thermometer.
- (3) the thermocouple thermometer.
- (4) the platinum resistance thermometer.
- (5) the gas thermometer.
- (6) the pyrometer.

Liquid in glass thermometer:

- These are thermometers which contain liquid within glass.

- There are two types and these are the mercury thermometer and the alcohol thermometer.

- In the mercury thermometer, mercury is the liquid found within the glass while with respect to the alcohol thermometer, the liquid within the glass is alcohol.



The liquid in glass thermometer consists of a glass bulb, which contains a liquid which is capable of rising or falling within the bore, as a result of its expansion or contraction.
It also has a temperature scale.

The mode of operation of the liquid in glass thermometer:

- It works on the principle that matter expands when heated and contracts when it cools.

- When the thermometer is brought into contact with a hot body or into a hot surrounding, heat from the hot body or the surrounding moves into the liquid within the thermometer.

- This causes the liquid to expand and rise in the bore to indicate a high temperature.

- If the thermometer is brought into contact with a cold body or brought into a cold environment, the movement of heat will be from the liquid within the bulb into the cold body or the cold surrounding.

- The liquid in the bulb cools and contracts, causing the level of the liquid to fall indicating a low temperature.

The clinical thermometer:



- This is a special type of liquid in glass thermometer, which is designed to measure the temperature of a human being.

- It therefore has a few range of degrees above and below the normal body's temperature.

- It is normally placed beneath the patient's tongue and left there for at least of two minutes.

- When the thermometer is removed from the mouth, the sudden cooling and contraction of the mercury in the bulb causes the thread to break at the construction.

- This causes the mercury thread to remain in the bore or stem, and the temperature can be read at leisure.

- Before it is used again, the mercury in the stem or bore must be returned to the bulb by shaking.

- The average body temperature of a healthy person is about 37°C.

The calibration or graduation of a thermometer (liquid in glass):

- After the construction of a new thermometer, we have to calibrate or graduate it.

- To graduate or calibrate a thermometer, we must choose two fixed points which are the upper and the lower fixed points.

- The lower fixed point is the temperature of pure melting ice, while the upper fixed point is the temperature of steam.

- After the detection and the location of these two fixed points, the distance between them which is called the fundamental interval is divided into a number of equal parts or degrees.



Determination of the lower fixed point (ice point):



- To determine the lower fixed point of an un-graduated thermometer, the thermometer is pushed into pure ice shavings.

- The alcohol or mercury thread in the bore or stem will start to fall.
- At a particular point, the thread will stop falling and remain steady.
- This point is marked as the lower fixed point.

Determination of the upper fixed point:

The hypsometer:



- The thermometer is pushed through a hole in a cork and placed inside the hypsometer.

- Water is boiled at the lower part of the hypsometer and the steam produced is made to surround the bulb.

- The mercury thread begins to rise and stops rising at a particular level.

- This point is marked as the upper fixed point.

- The double wall reduces the loss of heat, and the consequent cooling of the vapour, surrounding the bulb.

- The manometer gives a warning, if the pressure inside the hypsometer becomes different from that of the atmosphere.

Sterilization of clinical thermometers:

Sterilization is the process of destroying the germs found on an object. Since a clinical thermometer is used on several patients, there is the need to subject it to sterilization after each use, so as to stop the passage of disease causing germs from one person unto the other. Clinical thermometers are usually sterilized in alcohol rather than in boiling water. This is mainly due to the fact that alcohol especially those rated 70% and above, are known to be capable of killing almost all micro-organisms or germs. Clinical thermometers are not sterilized in boiling water for two main reasons.

The first reason is that, there are several micro-organisms referred to as hemophilic organisms which are able to survive at the temperature of boiling water. For this reason, sterilization of clinical thermometer in boiling water will not lead to the destruction of these germs. Secondly, since the temperature range on a clinical thermometer lies between 35°C and 43°C, inserting it in boil water at 100°C for sterilization, will lead to the excessive expansion of the alcohol or the mercury within the thermometer, leading to the possible destruction of the glass used in making the thermometer.

Thermometric liquids:

- A thermometric liquid is a liquid which can be used in a liquid in glass themometer.
- For a liquid to be a good thermometric liquid, it must possess the following features:
 - (1) It must have a wide temperature range, between its boiling point and freezing point.
 - (2) It must have a regular volume of expansivity, i.e. its volume must expand in a regular manner.
 - (3) It must not wet glass.
 - (4) It must be a very good conductor of heat.

- (5) It must be coloured and opaque.
- (6) It must not vapourize easily.

Reasons why water is not used as a thermometric liquid:

- (a) Its volume of expansion is not regular.
- (b) It wets glass.
- (c) It easily vaporizes and condenses in tubings.

Choice of liquid for thermometer:

Before a liquid is chosen as thermometric liquid, certain factors must be taken into consideration are the advantages and the disadvantages associated with each liquid.

<u>Reasons why mercury is preferred to alcohol (advantages of mercury</u> over alcohol):

- (1) As in the case of alcohol, mercury does not wet glass.
- (2) It is coloured or opaque and can easily be seen and read when used in thermometer.
- (3) Since it is a better conductor of heat than alcohol, it responds more rapidly to temperature changes than alcohol.
- (4) Unlike alcohol, it does not vapourize to occupy the upper part of the bore.

Advantages of mercury over alcohol:

- (1) As in the case of alcohol, mercury does not wet glass.
- (2) It is coloured or opaque, and can easily be seen and read when used in a thermometer.
- (3) Since it is a better conductor of heat alcohol, it responds more rapidly to temperature changes than alcohol.
- (4) Unlike alcohol, it does not vapourize to occupy the upper part of the bore.

Disadvantages of mercury over alcohol:

- (1) Mercury thermometers cannot be used in extremely cold are.
- (2) Its coefficient of expansion is low.