Combustion and Flame

Flame

❖ Introduction

A flame is a region where combustion of fuel takes place. A flame is the product of a highly exothermic reaction.

Note: Exothermic reactions are those reactions in which energy is released.

A flame is the visible (light-emitting) part of fire.

(i) Colour of Flame: Colour of flame depends on the temperature, amount of air supplied, and the substance burning. e.g. flames produced by hydrocarbon fuels are either blue or yellow.

(ii) Types of Flame: A flame can be of two types:

(a) Luminous flame

(b) Non-luminous flame

Luminous flame	Non luminous flame
This flame is accompanied with sufficient amount of heat and light.	This flame is accompanied with heat but very little light.
This type of flame is observed when there is insufficient oxygen.	This type of flame occurs because of complete combustion of hydrocarbons in the presence of excess of oxygen.
It leaves black soot and other residue.	This type of flame does not leave any residue.
Yellow flame is luminous flame.	Blue flame is non-luminous flame.

Combustion of Wax Candle

Candles are usually made of paraffin wax, which is obtained from petroleum. When a candle is burnt, following observations can be made:

(i) The wick burns and it stands in a pool of liquid wax.

(ii) There is a small portion of unburnt whick between the flame and the liquid wax.

(iii) The liquid wax is trapped in a cup of solid wax.

(iv) The liquid or solid wax never catches fire. Also the flame never travels down to burn either liquid wax or the solid wax.

What actually happens in the process of burning of a candle?

(i) It is only the wax vapours that burn. Neither liquid wax nor solid wax burn.

(ii) When a candle wick is lit, the heat produced from the flame melts the wax.

(iii) The wick soaks or absorbs the molten wax.

(iv) The heat of the flame vapourizes the molten wax in the wick.

(v) The gaseous wax burns in the flame, which keeps the flame alive. This process goes on till the entire wax gets burnt.

Structure of a Candle Flame

According to Berzelius (1822), a candle flame consists of four zones. These are,

(i) Outermost nonluminous (blue) zone of complete combustion.

(ii) Central (or middle) luminous zone of incomplete combustion.

(iii) Inner dark zone of no combustion.

(iv) Lowest blue zone.

These zones are described below:

(i) **Outermost nonluminous zone of complete combustion:** This zone is faintly visible and surrounds the yellow luminous part of the flame. In this zone, the wax vapour undergoes complete combustion because plenty of air is present around it. This zone is the hottest part of the candle flame.

(ii) **Central (or middle) luminous zone of incomplete combustion:** The central luminous zone is the major part of the candle flame. This zone is bright yellow and luminous, and lies below the outermost nonluminous zone. In this zone, wax vapour undergoes incomplete combustion because not enough of air is present here. The incomplete combustion of wax vapour produces carbon particles. These unburnt carbon particles get heated up and start glowing. These glowing carbon particles make the flame luminous. Thus, the central zone of the candle flame is luminous due to the incomplete combustion temperature.

(iii) **Inner dark zone of no combustion:** The dark zone around the wick is called inner dark zone of no combustion. In this zone very little or no combustion takes place because in this zone no air is present. This zone is dark (black) due to the presence of unburnt carbon particles in the wax vapour. This part of the flame is the least hot.

(iv) **The lowest blue zone:** This zone is located at the base of the flame. The blue colour of this zone is due to the burning of the carbon monoxide produced in the dark zone.