Chapter 6

Combustion and Flame

What is Combustion?

Combustion is a chemical process in which a substance reacts with oxygen and generates heat in the process.

♦ *Combustible substances:*

Combustible substances are those substances that undergo combustion reactions. It is also known as fuel. These substances can be solid, liquid or gas and they give off heat and light when they react with oxygen. For example, charcoal is a combustible solid while methane is a combustible gas.

♦ *Ignition temperature:*

The lowest temperature at which a combustible substance catches fire when heated in the air is called its ignition temperature.

♦ *Inflammable substances:*

Inflammable substances are substances that have low ignition temperatures and catch fire easily. They burn with a flame. For example, petrol, LPG, etc.

How do we control Fire?

⇒ We can control the fire by:

- Removing the fuel.
- Cutting off the air supply (or oxygen supply).
- Cutting off heat or lowering the temperature of the fuel.

⇒ When wood, paper, and clothes are on fire, we can use water to extinguish them. Water lowers the temperature of burning material below ignition temperature and thus, the fire stops burning.

⇒ We should not use water when electrical equipment is on fire as water may conduct electricity and give a shock to people dousing the fire.

⇒ Water is lighter than oil and petrol and sinks down so, water should not be used when oil or petrol catches fire. Oil and petrol keep floating on the top and keep burning.

⇒ For fires involving electrical equipment and inflammable materials like petrol, carbon dioxide (CO_2) is the best extinguisher. CO_2, being heavier than oxygen, covers the fire like a blanket. Carbon dioxide control fire by cutting the contact between the fuel and oxygen. The added advantage of CO_2 is that in most cases it does not harm the electrical equipment.

♦ ***How do we get the supply of carbon dioxide?***

⇒ It can be stored at high pressure as a liquid in cylinders. When released from the cylinder, CO_2 expands enormously in volume and cools down. So, it not only forms a blanket around the fire, but it also brings down the temperature of the fuel.

Fire extinguisher

⇒ That is why it is an excellent fire extinguisher. Another way to get CO_2 is to release a lot of dry powder of chemicals like sodium bicarbonate (baking soda) or potassium bicarbonate. Near the fire, these chemicals give off CO_2.

Types of Combustion

• The types of combustion differ depending on the type of fuel. Based on nature and intensity combustion is classified into three types. They are:

(a) Rapid combustion:

Rapid combustion is a type of combustion in which a gas burns quickly producing heat and light in the process. For example, combustion of LPG.

(b) Spontaneous Combustion:

It is a type of combustion in which a material bursts into flames suddenly without applying heat. For example, the combustion of phosphorus burns at room temperature. The accidental fires in coal mines occur due to the spontaneous combustion of coal dust. Spontaneous forest fires cause due to heat from the sun or lighting.

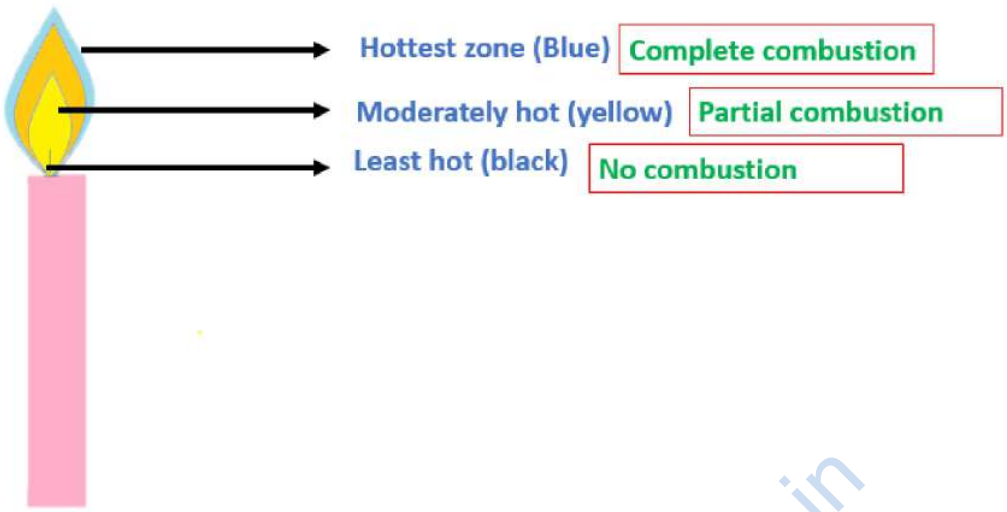
(c) Explosion:

It is a type of combustion in which the material bursts suddenly to produce heat, light, and sound when heat or pressure is applied to it. For example, the burning of crackers and fireworks is a type of explosion which releases a large amount of gas too.

Flame

⇒ Flame is a hot glowing body of ignited gas that is produced when something is on fire.

♦ *Structure of Flame:*



A flame has three zones:

⇒ *The <u>Outermost zone</u>* of the flame is blue in color and it is the hottest part of the flame. Complete combustion takes place at this zone.

⇒ *The <u>Middle zone</u>* of the flame is yellow in color and it is moderately hot. The partial combustion takes place at this zone.

⇒ *The <u>Innermost zone</u>* of the flame is black in color and least hot. At this zone, no combustion takes place and unburned wax vapors of a candle.

* Kerosene oil and molten wax vapourize during burning and form flames but charcoal is solid fuel and it does not produce flame or vapourize when it burns.

* Goldsmiths blow at the outermost zone of a candle flame for melting gold and silver this is because the outermost zone of a flame is its hottest part. Gold and silver have high melting points and hence, goldsmiths blow at the outermost zone of the flame to melt gold and silver quickly.

* A circular blackish ring is formed on the back side of the cooking vessel. It indicates the deposition of unburnt carbon particles present in the luminous zone of the flame

What is a Fuel?

⇒ The substance that undergoes combustion is said to be combustible or fuel. The fuel can be any physical state, solid, liquid, or gas. For example, charcoal is a solid fuel.

Charcoal

⇒ The good fuel should have the following properties:

- Proper ignition temperature (neither too high nor too low).
- Does not produce undesirable or poisonous substances.
- Non-polluting.
- Does not leave behind much ash.
- Cheap.
- Readily available.
- Produces a large amount of heat or has high calorific value.
- Moderate rate of consumption.
- Easily controllable (can be started or stopped as needed).
- Easy to handle and transport.
- Low moisture content (so that it burns easily).

Fuel Efficiency

• Fuel efficiency of a fuel depends on its calorific value.

• The calorific value of a fuel depends on the amount of heat produced by the complete combustion of 1 kg of the fuel. The unit used to measure the calorific value of a fuel is kilojoule per kg (kJ/kg).

♦ *Harmful effects of burning fuels:*

• Carbon fuels like wood, coal and petroleum release ash and fine unburnt carbon particles in the air. These fine particles are referred to as Suspended Particulate Matter (SPM) which can lead to respiratory diseases.

• Incomplete combustion of fuels can release poisonous gases like carbon monoxide which can kill people sleeping in the room where coal is burning.

• The combustion of fuel releases carbon dioxide which causes an imbalance in the atmosphere. The increased concentration of carbon dioxide in the air can lead to global warming.

• The sulphur dioxide gas is produced when coal and diesel are burned. This gas can cause irritation in the nose, throat, and airways and also causes shortness of breath, wheezing, and a feeling of tightness around the chest. When sulphur and nitrogen oxides dissolve in rainwater to form acids and cause acid rain.

• Acid Rain refers to the rain of acids that is very harmful to crops, soil, animals, and buildings. Acid rains can damage trees at high elevation, causes acidification of lake or stream water, and damage forest soils.

• Wood is a low-cost fuel and is easily available but burning it, releases a lot of smoke which causes respiratory problems. Moreover, cutting trees for wood (as fuel) also leads to deforestation. Hence, people now prefer to use coal or LPG as fuel instead.

We should conserve fuels by following the measures given below:

- Collect all material required while cooking in one place before switching on the gas.
- Check the pressure of tyres regularly
- Choose walking over using cars or motorbikes for short distances.
- Use public transportation for traveling instead of private vehicles.