

Combustion And Flame

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In the previous chapter we have studied about coal and petroleum. We have also read about petrol, diesel, coke etc. Substance is an important part of combustion and flame. Different types of fuels are used for different purposes. Now a days combustion and flame are needed in large industries and factories to prepare finished goods from raw materials, substances like dung, wood, coal, charcoal, petrol, diesel, CNG etc. are used for this purpose. During the light shading we use candles for generating light. We use LPG to cook food in our homes, by which food can be cooked easily. A new fuel is obtained by burning some fuels. For example, charcoal is obtained by burning wood. Charcoal is also a fuel.

What is Combustion?

The word combustion means a process in which heat and light is produced. Magnesium burns to produce magnesium oxide, heat and light.



Activity Time



Take a piece of charcoal. Hold it with a tongue of a burning candle. It starts to burn and the tongue gets heated. The charcoal piece burns in air, produces carbon di-oxide gas, heat and light.

A chemical process in which a substance reacts with oxygen and gives heat, is called **combustion**. The



substance which under goes the process of combustion is called a fuel or combustible. In the above examples magnesium and charcoal are combustible substances. Fuels may be solid, liquid or gas. Combustion takes place rapidly in presence of air. Combustible substance is essential for air combustion. Wood, coal, paper, hydrogen, methane etc. are essential for air combustion.

Necessary conditions for combustion : Following conditions are necessary for combustion :

- (i) Presence of a combustible substance
- (ii) Regular supply of supporting substances
- (iii) The temperature at which the combustible substance catches fire.

Types of combustion : On the basis of rate and capacity of production of heat and light the combustion is divided broadly in two types :

1. **Spontaneous combustion :** The combustion in which the substance catches fire on its own suddenly with the application of any apparent cause, is called spontaneous combustion. For example, phosphorus burns in air at room temperature.
2. **Non spontaneous combustion :** The combustion in which a substance catches fire with the help of an external agent or source is called non-spontaneous combustion. Non-spontaneous combustion may further be divided in three categories :
 - (i) **Rapid combustion :** In such combustion the substance burns rapidly, a large amount of heat and light is produced. Burning of match stick, candle, gases, kerosene in stove etc. are the example of this type of combustion.
 - (ii) **Slow combustion :** In such combustion the speed of burning is very slow. Rusting of iron, burning of dung etc. are examples of such burning.
 - (iii) **Explosion :** A combustion in which sudden evolution of heat, light and sound in quantity takes place, is called explosion.

We have fireworks on festivals. When a cracker is ignited, a sudden reaction take place, with the evolution of heat, light and sound. In this reaction a large amount of gas is liberated. It is a good example of explosion.



Activity Time

Place three lighting candles on a table. Cover these candles by three glass jars or chimneys in such a way that in first jar air may enter completely, in the second very little and in the third not at all. After some time you will find that the first two candles are glowing but the third got put off. It is due to the reason that air was available to first two candles where as no air was available to the third candle, so it got put off. It shows that air is necessary for combustion.

Some materials are given in the table below, classify them as combustible or non-combustible

Table combustible and non-combustible materials

S.No.	Material	Combustible	Non-combustible
1.	Wood	_____	_____
2.	Paper	_____	_____
3.	Iron nails	_____	_____
4.	Kerosene	_____	_____
5.	Piece of stone	_____	_____
6.	Straw	_____	_____
7.	Charcoal	_____	_____
8.	Match stick	_____	_____
9.	Glass	_____	_____

Ignition Temperature and Inflammable Substances

The lowest temperature at which a substance catches fire is called its **ignition temperature**. By experiments it is found that different substances catch fire at different temperatures. So we can say that for different substance the ignition temperature is different. It should be remembered that a substance burns when it reaches to its ignition temperature.

Some substances like petrol, alcohol, liquefied petroleum Gas (LPG) etc. have very low ignition temperature. These substances catch fire with a flame very easily. Such substances are called **inflammable** substances.



Breaking out of Fire

You must have heard of fire breaking out in homes, shops, factories, cinema halls etc. The cause of fire breaking out may be short circuiting, overloading of electric line or some other reason. On the occasion of Dusshera and Diwali crackers shops are decorated on large scale, some times fire breaks out in crackers shop due to one or the other reason. The crackers burst out with very loud sound. This process is called



explosion. By bursting of crackers a large amount of heat, light and sound is produced. We should call fire brigade for controlling fire.

How To Control the Fire

If some person catches fire, we should cover the person by blanket to extinguish the fire. The material of blanket acts as insulator. So it prevents air to come in contact of the body of burning person. In absence of air the burning process stops.

If some things catch fire, we should pour water on the combusting substance i.e. on fire. Water brings the temperature combustible material below its ignition temperature. Thus, it prevents fire from spreading. Water vapour surround the combustible material. Thus, it helps in cutting of the supply of air to combusting material. Consequently fire is extinguished.

Most common fire extinguisher is water. But water works only when things like, wood and paper etc. are on fire. Some cities have fire brigade station. When the brigade receives information about fire. Fire brigade arrives at the spot of fire. The fire brigade has water tanks and long pipes. Through these pipes they pour water on the fire. For fires involving electrical equipment and inflammable material like petrol, carbon di-oxide is the best fire extinguisher. In cinema hall, banks and other public places fire extinguisher are installed. These cylinder contain sodium bicarbonate (baking soda) or potassium bicarbonate like substances when these are operated carbon-di-oxide is produced which extinguishes fire. Carbon di-oxide covers the fire like a blanket. Thus, the contact between fuel and oxygen (i.e. air) is cut off consequently the fire is controlled. Thus, the job of a fire extinguisher is to cut off the supply of air or bring down the temperature of fuel below its ignition temperature or both. When fire brigade runs to the spot of fire they ring the cyron on their way. So it is the duty of every one to provide them path so that they may reach the affected place as soon as possible.



Fuel

Wood, charcoal, petrol, kerosene etc. are the main sources of heat energy for domestic and industrial purposes. These substances are called **fuels**.

Characteristics of good/ideal fuel :

1. It must be available at cheap rate.
2. It should not pollute atmosphere.
3. It produces large amount of heat i.e. it must have high calorific value.
4. It burns in air at a moderate and constant rate, which may easily be controlled.
5. It can be easily stored and transported.
6. Its ignition temperature must not be very high.
7. It does not leave behind any undesirable substances after combustion i.e. it must be completely combustible.

There is no such fuel which possess all the above characteristics. Therefore no fuel can be considered as an ideal fuel. So we consider a fuel as good fuel which fulfills most of the above requirements.

Fuel Efficiency or Calorific Value of a Fuel

Every fuel does not produce the same amount of heat energy. The efficiency of a fuel is measured by the amount of heat energy produced on complete combustion of 1 kg of fuel. It is called calorific value of a fuel. The unit for measuring calorific value of a fuel is **kilo joule per kg**. It is expressed k J/kg briefly.

Types of Fuel : On the basis of physical state the fuel may be in solid, liquid or gaseous state. Coal, charcoal, wood, dung and paraffin etc. are solid fuels. Kerosene, diesel, petrol, LPG, spirit etc. are liquid fuels. Storage and use of these liquid fuels is easy and they leave no residue on combustion. Natural gas hydrogen etc. is the example of gaseous fuel.

On the basis of source of availability fuels are primary or natural fuel and artificial or man made fuels.

Calorific Values of Different Fuels

S.No.	Fuel	Calorific Value (kJ/kg)
1.	Dung Cake	6000–8000
2.	Wood	17000–22000
3.	Coal	25000–33000
4.	Petrol	45000
5.	Kerosene	45000
6.	Diesel	45000
7.	Methane	50000
8.	C.N.G.	50000
9.	L.P.G.	55000
10.	Hydrogen	150000

Do You Know ?

Kerosene when burnt in a lamp gives yellow flame because in a lamp, kerosene vapour burns in a limited amount of air and result in an incomplete combustion of kerosene vapour.

Structure of Flame

When a burning match stick is brought in contact of thread of a candle a flame is produced. The substances which vaporise at the time of combustion constitute a flame. For example, kerosene oil and molten wax rise through the wick and are vapourised during burning and form flame. Charcoal does not vapourise. So it does not produce a flame. When a wire of copper is kept in contact of a flame for 30 seconds, the wire turns black. The burner of a stove also turns red due to flame. Smoke is deposited on it in the form of carbon. The goldsmiths blow the outer most zone of a flame with a metallic blowpipe for melting gold and silver to prepare ornaments from them. Thus, a flame has three parts or zones.

- (i) **Outer zone of complete combustion** : It looks blue. It is the hottest part of the flame.
- (ii) **Middle zone of partial combustion** : It looks yellow. It is **moderate hot** part of the flame.
- (iii) **Inner most zone of unburnt fuel** : It looks black. It is the least hot part of the flame.



Activity Time

Prepare two cups of paper. Fill about 50ml water in one of the two cups. Now heat the two cups separately by two different candles. What do you see? If we keep continue to heat the cup containing water, we can heat the water in the cup. It is due to the reason that the heat given to the cup is transmitted to water by conduction and the temperature of paper does not reaches to the ignition temperature of water. So the paper does not burn. On the other hand, the cup having no water gets burn.

Disadvantages of Incomplete Combustion

1. In incomplete combustion the non-combusted portion of the carbon goes to the atmosphere. It causes wastage of fuel as well as pollutes the atmosphere.
2. Carbon di-oxide is produced, which is poisonous. It is harmful for respiration and may be fatal for life.



Burning of Fuels Leads to Harmful Products

The increasing fuel consumption has harmful effects on the environment. Carbon fuels like wood, coal and petrol release unburnt carbon particles. These fine particles are dangerous pollutants, which causes various types of respiratory diseases such as asthma and other respiratory diseases.

1. Since ancient age wood, charcoal are being used as fuel for domestic and industrial purposes. Smoke is produced by these fuels, which is very harmful for our eyes. We feel uncomfortable in respiration. Trees and plants provide us many useful things. But the fuel obtained from trees is harmful for us. It is also harmful for the environment.
2. In winter season during cold night people keep the burning coal in the rooms. Sometimes the doors of the room are shut. The combustion of coal produces carbon mono-oxide gas, which gets spread in the room and can kill the person sleeping in the room.
3. Carbon di-oxide gas is released by combustion of most of the fuels. The excessive amount of carbon di-oxide in the air is causing global warming. It destroys the fertility of the soil and makes the agricultural land unfertile.
4. Sulphur di-oxide gas is produced by the combustion of coal and diesel. It is an extremely suffocating and corrosive gas. Besides these petrol engines give off gaseous oxides of nitrogen. The oxides of sulphur and nitrogen dissolve in rain water and cause acid rain.

Now a days CNG and natural gas are being used as fuels in automobiles in place of diesel and petrol. CNG produces the oxides of sulphur and nitrogen in very small amounts.



Know the Keywords :

Combustion : Combustion means a process in which heat and light is produced.

Ignition temperature : The lowest temperature at which a substance catches fire is called its ignition temperature.

Fuel : Wood, charcoal, petrol, kerosene etc. are the main sources of heat energy for domestic and industrial purposes. These substance are called fuels.



Point to Remember

- Heat and light is produced in combustion.
- Magnesium, charcoal etc. are combustible substances.
- The chemical processes in which substances react with oxygen and produce heat and light are called combustion.
- The substances which easily catch fire and burns with a flame are called inflammable substances.
- The carbon particles produced due incomplete combustion are dangerous pollutants.
- The efficiency and calorific values of different fuels may be different.
- An ideal fuel is that, which is cheap and easily available. It has high calorific value and leaves no gases or residue which may pollute the environment.
- Diesel and petrol are costly fuels, which are used in rail engines, cars etc.
- Incomplete combustion of fuels releases carbon mono-oxide, a poisonous gas, which cause asthma and other respiratory diseases.

EXERCISE TIME

A. Answer the following questions :

1. How the coal was originated?
2. State the conditions necessary for combustion.
3. What are charcoal and bio gas?
4. State the harmful effects of combustion of fuel.
5. What are parts of a flame? Describe each part with the help of a diagram.
6. How the fire can be controlled?
7. Explain the spontaneous combustion.
8. Write the name of same substances, which are used as fuel. Classify them in solid, liquid and gaseous fuels.

B. Fill in the blanks :

1. The substance which burn in air are called _____
2. _____ is essential for combustion.
3. A fuel which is cheap and has high calorific value is called a /an _____ fuel.
4. If a person catches fire, he should be covered by a _____.
5. _____ must be informed on breaking out fire.
6. Natural gas and biogas are _____ fuels.

C. Write 'T' for true and 'F' for false statement :

1. Coal is a liquid fuel.
2. Coal and water gas burn together.
3. Coke cause more pollution than coal.
4. Crackers have explosive substances.
5. Water should be poured on fire broken out due to electricity.
6. Fuel is a natural resource.
7. Sand must be poured on fire to extinguish it.

D. Tick (✓) the correct option :

1. Ignition temperature is of :

- (i) solid (ii) liquid
(iii) gas (iv) a fuel

2. Bio gas contains mainly :

- (i) ethane (ii) methane
(iii) butane (iv) all of these

3. The useful products are obtained from coal by the following process :

- (i) effective distillation (ii) combustion
(iii) distillation (iv) fractioned distillation

4. Which one of the following is a property of coal :

- (i) melting (ii) vapourisation
(iii) liquiefaction (iv) producing heat on combustion

5. Liquid fuel is :

- (i) coal (ii) petrol
(iii) soft coal (iv) manganese



Creative Work

- Show the coal-fields on the map of India.