Combustion and Types of Combustion

Combustion is a chemical process or a reaction between Fuel (Hydrocarbon) and Oxygen. When fuel and oxygen react it releases the heat and light energy. Heat and light energy then result in the flame. So, the formula for Combustion reaction is Hydrobcarbon + Oxygen = Heat energy. Combustion is used in car motors and rocket engines and many other machineries. There are 5 different types of combustion. Let us learn about combustion and types of combustion.

What is Combustion?

Combustion is actually a scientific term for burning. We are all aware of burning, but did you know that burning is actually a chemical reaction? Combustion is a chemical process where any fuel has a reaction with air (oxidant) to produce heat energy.

And when this heat energy release it will also produce light in the form of a flame. This is the visible part of the reaction, the flames. The general exothermic reaction of combustion can be expressed as:

$$Hydrocarbon + Oxygen \rightarrow Carbon\ Dioxide + Water + Heat\ Energy$$

Examples of Combustion

- Burning of Wood or Coal to heat your home
- Burning of Petrol or Diesel to run your Car
- Combustion of Natural Gas or LPG to cook for on your stovetop
- For the production of energy in thermal power plants
- Fireworks

Types of Combustion

1] Complete Combustion

One of the types of combustion is Complete Combustion. Complete combustion occurs in an unlimited supply of air, oxygen in particular. Also, complete combustion is also known as clean combustion. Here

the hydrocarbon will burn out completely with the oxygen and leave only two byproducts, water, and carbon dioxide.

An example of this is when a candle burns. The heat from the wick will vaporize the wax which reacts with the oxygen in the air. The two products of the reaction are water and carbon dioxide. In an ideal situation all the wax burns up and complete combustion takes place

2] Incomplete Combustion

Incomplete combustion takes place when the air is in limited supply. And as opposed to complete combustion it is otherwise known as dirty combustion. Due to lack of oxygen, the fuel will not react completely. This, in turn, produces carbon monoxide and soot instead of carbon dioxide.

An example is burning of paper. It leaves behind ash (a form of soot) as a byproduct. In a complete combustion, the only products are water and carbon dioxide. Also, incomplete combustion produces less energy than complete combustion.

3] Rapid Combustion

Another type of combustion is Rapid Combustion. Rapid energy needs external heat energy for the reaction to occur. The combustion produces a large amount of heat and light energy and does so rapidly. The combustion will carry on as long as the fuel is available.

An example is when you light a candle. The heat energy is provided when we light the candle with a matchstick. And it will carry on till the wax burns out. Hence it is a rapid combustion

4] Spontaneous Combustion

As the name suggests the combustion occurs spontaneously. This means that it requires no external energy for the combustion to start. It happens due to self-heating. A substance with low-ignition temperatures gets heated and this heat is unable to escape.

The temperature rises above ignition point and in the presence of sufficient oxygen combustion will happen. The reaction of alkali metals with water is an example.

5] Explosive Combustion

Explosive Combustion happens when the reaction occurs very rapidly. The reaction occurs when something ignites to produce heat, light and

sound energy, The simple way to describe is it to call it an explosion. Some classic examples are firecrackers or blowing up of dynamite.

Solved Question for You

Q: When sand is poured over some burning material, the fire goes off. It is because:

a. Ignition temperature is brought down
b. Air Supply is cut off
c. Sand is a band conductor of heat
d. All of the above

Sol: The correct option is “B”. When sand is poured over any burning substance it cuts off the air supply. Without air, combustion cannot occur and so the flames disappear.

Flame and Structure of a Flame

Have you ever seen a flame? Actually seen it keenly? If you have you will notice the various colors in it, the unique shape it takes, its

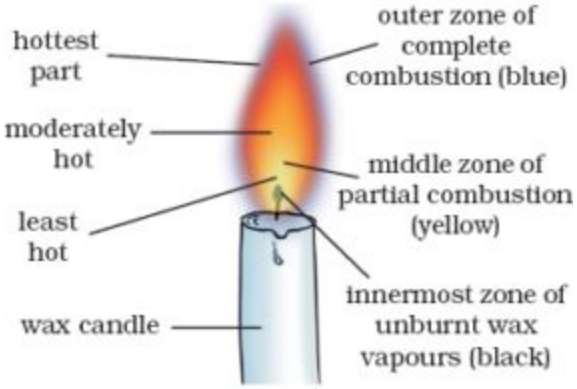
mesmerizing movement. Let us take a closer look at flames and the various types of flames.

What is a Flame?

The word “flame’ itself comes from the Latin word “flamma”. Very simply put flames are the visible part of a combustion reaction. During combustion, the fuel reacts with the oxygen and produces a huge amount of heat energy. Due to this heat, the atoms of the reactants get superheated. And as these atoms are leaving the combustion zone they bleed of this excess energy in form of light.

Now as you saw to see flames some combustion reaction must occur of a fuel in presence of oxygen. A fuel is any substance that is burned as a source of heat or a source of power. Some examples of a fuel are coal or petrol or natural gas. The wax of a candle is also a fuel actually. An ideal fuel is one that is inexpensive and easily available with a high calorific value.

Understand the Flame of a Candle



Let us now understand the structure of flames with the context of the flames of a candle. For this, you will need to closely observe the flames of an ordinary candle. You will notice its shape, the way it burns and most importantly the various colors of the flames.

When you light a candle a combustion reaction takes place with the wax of the candle which is the fuel and the air which contains oxygen. The flames are the are in which this combustion reaction is taking place. The release of heat and light energy from this exothermic reaction happens through the flame.

Now if you observe you will see three distinct colors in the flames. This helps us to classify the parts of a flame which are as following:

- *Inner Part*: This is the innermost part of the flame. It is the part closest to the wick. You might assume that this is the hottest part of the flame. However, it is the least hot. This is the black part of the flames that contains unburnt particles of the carbon from the wick i.e. unburnt fuel.
- *Middle Part*: This is the biggest part of the flame. The colors in this are varying shades of yellow and orange. This is the luminous flame because it emits light. This part is also not extremely hot. This is because this part gets a limited supply of oxygen. So incomplete combustion takes place here. Which is why it burns orange and is luminous.
- *Outer Part*: Now this is the hottest part of the flame. This part has an unlimited supply of oxygen. So complete combustion takes place here. Hence it is the hottest part of the flame. Also, this part of the flames burns with a blue color. It is the non-luminous, i.e. does not emit light

Solved Question for You

Q: The substances which vapourize during burning, give flame. True or False?

Ans: This statement is False. Not all substances produce flames when burning. Some substances produce Smoke. An example of this is the process of burning charcoal.

Introduction to Fuel and Fuel Efficiency

Fuel meaning: Meaning of fuel is a substance that is burned to provide nuclear energy, heat or power. Materials like coal, wood, oil, or gas can provide heat when burned. Methanol, Gasoline, Diesel, Propane, Natural gas, Hydrogen are types of fuel. Nuclear energy is produced by burning plutonium. From fuel efficiency or fuel economy, we can measure how long any vehicle could travel, which is the opposite of fuel consumption. Fuel consumption is the amount of fuel vehicle uses to travel a particular distance. Fuel efficiency is measured in kilometers per liter. The efficiency with which the fuel does a conversion of energy is known as fuel efficiency. Let us understand the definition of Fuel, Fuel Efficiency, and Types of Fuel in greater detail.

What is Fuel?

Definition of fuel is any substance that can provide heat and produce energy when it is burned. This energy that releases is generally in the form of chemical energy or heat energy. The recent invention of nuclear technology means now even nuclear energy may be released due to nuclear fission or fusion.

This heat energy that fuels release is used for various purposes such as cooking, in heaters, for many industrial and manufacturing purposes. At other times we use an engine to convert this heat energy into mechanical energy. Like when we use petrol to run our cars. The oil which is used to as fuel in the engine is known as Fuel oil.

And then there is the fuel our bodies use. Every cell requires energy to perform its functions. They get this energy from organic molecules such as carbohydrates, fats etc. This process of using fuels is known as cellular respiration. And these organic molecules are obtained via nutrition, which is why we call food as the fuel of our bodies.

Learn more about Fuel cell here. A fuel cell is a device which can generate electricity by force of chemical reaction.

Examples of Fuel

- Methanol.
- Gasoline.
- Diesel.
- Natural gas.
- Hydrogen.
- Biodiesel.

Types of Fuel

- Solid Fuel
- Liquid Fuel
- Fuel Gas
- Biofuel
- Fossil Fuel

Let us discuss them one by one:

Solid Fuel

These are solid materials that combust to produce energy. Some examples of Solid fuel are coal, charcoal, soot, wood etc. These were most likely the first fuels utilized by mankind. They were the fuels responsible for the invention of fire. Even today they have very widespread household and industrial uses. Charcoal is still a very important fuel source for all manufacturing products and power industry, And wood is still widely used in houses to cook food and provide warmth.

Learn about Fuel injection here.

Liquid Fuel

These are the fuels we burn to produce mechanical energy and kinetic energy. Most liquid fuels such as crude oil form due to exposure to intense heat and pressure to fossilized remains of plants and animals. Then there are biofuels in liquid form such as ethanol and hydrogen fuel. These fuels are easy to transport and relatively easy to use,

Fuel Gas

Fuel Gas as the name suggests are fuels that are in a gaseous state under normal conditions. Some examples are methane, carbon monoxide, propane etc. They have an advantage that they can be

easily transported to the place of consumption. However, they also tend to leak from pipes and every precaution must be taken to avoid this. The best example would be the CNG gas that comes to your kitchen via pipes that you utilize for cooking. This is also known as Domestic fuel.

Biofuel

Biofuel can be solid, liquid or a gas. The only condition is that it must be derived from Biomass. So essentially it is fuel derived from living matter that can be replenished. One such example is ethanol made from sugarcane wastes

Fossil Fuel

These are conventional fuels. They are also non-replenishable. They have formed over thousands of years in the earth's core where fossilized remains of animals and plants have been exposed to high pressure and temperatures. These are fast depleting and our dependence on them is a major concern for all of humanity.

Fuel Efficiency

Now you know that energy cannot be created or destroyed, All energy can only be transferred. Fuel also do not create energy. They only convert the chemical energy of the fuel to the kinetic energy with the help of the thermal energy supplied to them. The efficiency with which the fuel does this conversion of energy is known as fuel efficiency.

Now let us take a look at how we measure this fuel efficiency. Fuel efficiency is measured as the amount of heat that 1 kg of fuel (any fuel) produces on combustion. This is known as the calorific value of

the fuel. The unit of measurement of fuel efficiency is kilojoules per kg, i.e. kJ/kg.

Solved Questions for You

Q: What is a calorific value?

a. The Amount of heat energy produced on complete combustion of 1 Kg of fuel
b. Amount of heat energy produced on complete combustion of 100 Kg of fuel
c. The Amount of heat energy produced on complete combustion of 1 g of fuel
d. Amount of heat energy lost on complete combustion of 1 Kg of fuel

Solution: The correct option is “A”. Calorific value is the quantity of heat produced by the complete combustion of a given mass of a fuel, usually expressed in joules per kilogram. It can be defined as the amount of heat energy produced on complete combustion of 1 Kg of fuel.

Q: What are the characteristics of an ideal fuel?

Ans: The characteristics of good fuel are as follows

- High calorific value.
- Proper ignition temperature (neither be too low nor too high)
- Cause no pollution to the atmosphere on combustion.
- A controllable rate of combustion.
- Easily available in plenty and cheap in cost.
- Easy to handle and transport.