UNIT IV
FUELS AND COMBUSTION
4.1 Fuels :Introduction, Classification, Proximate Analysis

Fuels: Introduction

Fuel meaning: Meaning of fuel is a substance that is burned toprovide nuclear energy, heat or power. Materials like coal, wood, oil, orgas 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 fuelconsumption. 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 isknown as fuel efficiency.

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 toperform its functions. They get this energy from organic molecules such as carbohydrates, fats etc. This process of using fuels is known ascellular respiration. And these organic molecules are obtained via nutrition, which is why we call food as the fuel of our bodies.

$$Fuel + O_2 \xrightarrow[\text{heat}]{} CO_2\uparrow + H_2O + \text{(combustion products)}$$

Examples of Fuel

Methanol.

Gasoline.

Diesel.

Natural gas.

Hydrogen.

Biodiesel.

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.

Characteristics of a good fuel

A good fuel should have, High calorific value.

Moderate ignition temperature and velocity of combustion.

Low moisture content, non-combustible matter.

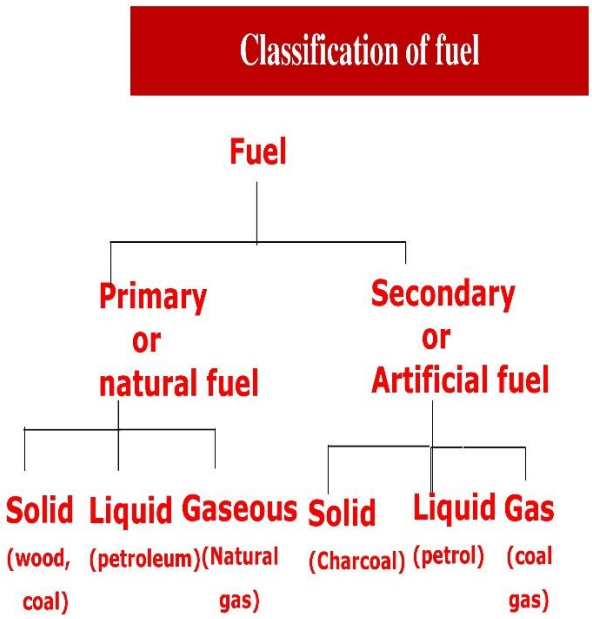
Easy to transport.

The products of combustion must be harmless.

Combustion must be easily controllable.

Must not burn with much smoke.

Classification of fuels



Solid fuel

Solid fuel refers to various types of solid material that are used as fuel to produce energy and provide heating, usually released through combustion.

Solid fuels include wood , charcoal, peat, coal, hexamine fuel tablets, and pellets made from wood (see wood pellets), corn, wheat, rye and other grains.

Solid-fuel rocket technology also uses solid fuel (see solid propellants).

Solid fuels have been used by humanity for many years to create fire. Coal was the fuel source which enabled the industrial revolution,from firing furnaces, to running steam engines.

Wood was also extensively used to run steam locomotives. Both peat and coal are still used in electricity generation today.

The use of some solid fuels (e.g. coal) is restricted or prohibited in some urban areas, due to unsafe levels of toxic emissions.

The use of other solid fuels as wood is decreasing as heating technology and the availability of good quality fuel improves.

In some areas, smokeless coal is often the only solid fuel used. In Ireland, peat briquettes are used as smokeless fuel. They are also used

to start a coal fire.

Coal

Coal is a fossil fuel which mainly contains carbon and is formed as a result of alteration of vegetable matter under favourable conditions (high temperature and pressure) under the earth.

It consists of C, H, N, O & non-combustible inorganic matter.

Coalification or Metamorphism

The process of conversion of vegetable matter (wood) into coal is called Coalification. The flowchart showing the sequential conversion of wood into coal is given as,

Wood → Peat → Lignite → Bituminous coal → Anthracite

Classification of coal (Varieties of coal)

Fuel	Property	% of carbon	C.V(k.cal/kg)	Applications
Wood	-	50	4000-4500	Domestic fuel
Peat	Brown fibrous jelly like mass	50-60	4125- 5400	Soil amendement
Lignite	Soft, brown coloured coal	60-70	6500-7100	Steam generation
Bituminous	Dark grey coloured coal	80-90	8000-8500	Making coal gas & metallurgical coal
Anthracite	Black of dark brown coloured high rank coal	90-98	8650-8700	Smithing coal, Coking coal, Power generation

Analysis of coal

To assess the quality of coal two types of analysis are made,

1.Proximate analysis

2.Ultimate analysis

1. **Proximate analysis**

Proximate analysis is a qualitative analysis which involves the determination of percentage of moisture content, volatile matter, ash content and fixed carbon in coal. Based on the results obtained the coal can be ranked as best or least variety.

(i) Moisture content

About 1g of powdered, air dried coal sample is taken in a crucible and heated to 100 - 105˚C in an electric hot air oven for 1 hour. The loss in weight of the sample isfound out and the percentage of moisture is calculated as,

% of moisture = loss in weight of coal / weight of coal taken x 100

(ii) Volatile matter

After analyzing moisture content, the crucible with residual Coal sample is converted with a lid and is heated to 950 + 20ºC for 7 minutes in an electric furnace .The loss in weight of the sample is found out and percentage of volatile matter is calculated as

% of volatile moisture = Loss in weight of coal/ Weight of moisture free coal X100

(iii) Ash content

After analyzing volatile matter, the crucible with residual coal sampleis heated without lid at 700+50ºC for 30 minutes in an electric furnace. The loss in weight of the sample is found out and the percentage of ash is calculated.

% of ash = Weight of ash formed / Weight of air dried coal X100

(iv) Fixed carbon

It is determined by subtracting the sum of moisture, volatile matterand ash contents from 100.

% of fixed carbon = 100- % of (moisture + volatile matter + ash)