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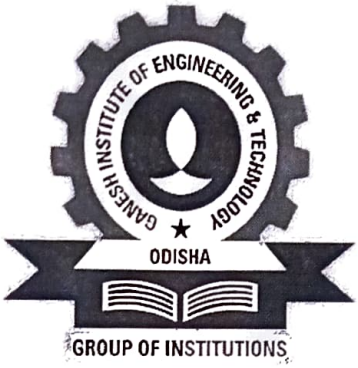

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3/4/25

Unit - 4

Chemistry of Fuel and lubricants

Fuels and Combustion Fuels

Fuel is a combustible substance containing carbon as main constituent, which on proper burning gives large amount of heat and can be used economically for domestic and industrial purpose.

Ex- wood, coal, kerosene

During combustion carbon and hydrogen present in fuel combine with oxygen to form product while releasing heat.

$$C + O_2 \longrightarrow CO_2 + Heat$$

$$2H_2 + O_2 \longrightarrow 2H_2O + Heat$$

Combustion of Fuel – It is a temperature rising exothermic reaction between fuel and oxygen.

Classification of Fuel

Fuels are classified into three categories :-

i) Solid - Coal, wood
ii) Liquid - kerosene, petroleum
iii) Gaseous - Natural gas (CNG)

Calorific Value

The Calorific value of fuel is the amount of heat obtained by complete combustion of unit mass of fuel.

Higher Calorific Value (HCV) (Gross) CV
It is the net heat generated when a unit quantity of Fuel is completely burn and the product of Combustion are cooled down to 15°C

Lower Calorific Value (LCV) (Net) CV
It is the net heat produced when a unit quantity of Fuel is completely burnt and the product of Combustion are allow to escape

LCV - HCV - Latent heat of Water Vapour present in the Fuel

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Calculation of HCV and LCV using dulong's For
The oxygen present in fuel is assumed to be present in a combined Form with hydrogen this combined hydrogen is refferred to as fixed hydrogen.
Hence, amount of hydrogen available For combustion equals to = Total mass of hydrogen in Fuel - Fixed hydrogen.

Since, eight parts of oxygen combine with 1 part of hydrogen to form H_2O,
Available Hydrogen = Total mass of hydrogen in Fuel - 1/8 mass of oxygen in Fuel

Dulong's Formula :-

$$HCV = \frac{1}{100}\left[(8080C + 34500)\left(H - \frac{O}{8}\right) + 2240S\right] \text{ kcal/kg}$$

=> Capital

Here (C, H, O and S) are carbon, Hydrogen, Oxygen, sulphur respectively.

LCV = HCV - (latent heat of condensation of water vapour produced)

- HCV (mass of H per unit weight of the fuel burnt x 9 x latent heat of vaporisation of water.

$$I = HCV - \left[\frac{H}{100} \times 9 \times 587\right] \text{ Kcal/kg}$$

Proximate analysis of Ore

Proximate analysis of ore to determine its practical utility involves determination of moisture, volatile matter, ash and Fixed Carbon

1) Determination of Moisture

The Moisture content of coal is determined by heating the coal sample in an electric hot air oven at temperature ranging from 105°C to 110°C for 1hour by knowing loss in weight of Coal percentage of moisture can be calculated as follows.

$$\% \text{ Moisture} = \frac{\text{loss in weight}}{\text{weight of sample taken}} \times 100$$

2) Determination of Volatile matter

The moisture content of coal is determined by heating the coal sample in an electric MUFFLE Furnesh at ~~900~~ 925°C for 7 min. The percentage of Voldile matter can be calculated as follows :-

$$\% \text{ Volatile Matter} = \frac{\text{Loss in weight}}{\text{weight of the sample taken}} \times 100$$

3) Determination of Ash

The ash content of coal can be determined by heating the sample in a muffle furnesh at 750°C for 1/2 hr. The percentage of ash can be calculated as follows :-

$$\% \text{ Ash} = \frac{\text{weight of Ash}}{\text{weight of the sample taken}} \times 100$$

$$\text{Fixed Carbon} = 100 - (\% \text{ moisture} + \% \text{ volatile matter} + \% \text{ ash})$$

Fuel Rating of Petrol and diesel (obtain and ~~Carbon~~ ctane numbers ctane)

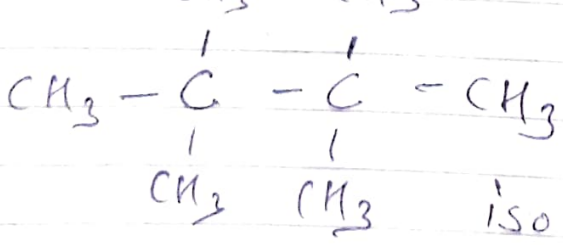
- In an Internal Combustion engine a mixture of gasoline (petrol) vapour of and air is used as Fuel.
- After the initiation of Combustion reaction by a spark in the cylinder the Flame should spread rapidly and smoothly through the gaseous mixture thereby expanding the gas that drives the piston down the cylinder

- The ratio of gaseous volume in the cylinder at the end of suction stroke to the volume at the end of compression stroke of piston is known as compression ratio.
- The Efficiency of an internal combustion engine increases with increase in compression ratio which is dependant on the nature of constituent present in gasoline use.
- In certain situation the oxidation rate becomes so great that the last portion of the fuel air mixture region ignites instateneously producing explosion known as knocking.
- This means during compression of Piston pre-ignition of explosive mixture started combusting spontaneously just before spark
- The ~~nothing~~ knocking result pinging or detnating sound which is arising due to uneven combustion which results in loss of efficiency.
- It has been found that n-heptene knocks very badly while iso octane gives very little knocking.

$H_3C-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

n-heptane

Octane no = 0



iso butane

octane no = 100

- The Octane no of gasoline is the percentage of Isoctane in a mixture of Isoctane and nheptane which just matches with the the knocking characteristics of the fuel under consideration.
- Cetane number is the ignition value of diesel that represents the percentage by volume of Cetane in centane and liquid alpha-methyl napthalene which exactly matches in its knocking characteristics with oil under test.

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Lubricant

Any substance introduced between two moving or sliding surface with a view to reduce Friction or Frictional resistance between them is called a lubricant. The process of reducing Friction between moving or sliding surface by the introduction of lubricants is called lubrication.

Functions of lubricants

- Prevent overheating of bearings by radiating the generated heat to outside.
- Prevent foreign material penetration, Rust and Corrosion.
- Reduce wear and tear of surface by avoiding direct metal to metal contact between the rubbing surface.

Application - Lubricants are used in source, Paint, Medicine, cutting Fluid.

Classification

Lubricants are classified into following two categories.

① Liquid lubricant

Liquids lubricant include natural oil, animal oil or vegetable oil as well as synthetic or blended oil and petroleum oil.

② Semi solid lubricants

It is formed by adding thickaners such as greese, to liquid lubricants. Semi solid lubricants content soap of lithium, sodium, Calcium Beronium, aluminium etc.

Ex - gr

Classification

4 ① L) Soda based - These contain source of sodium they are slightly soluble in water and can withstand temp upto 175 °C

② Lithium based - These are water resistant and are used for temperature upto 15°C.

③ Calcium based - These are also water resistant and can withstand temperature upto 80°C.

③ Solid lubricants

Ex - graphite, MoS_2

④ Immultion lubricants

They are divided into two main categories

→ Oil in water - These are cutting Fluids

→ water in oil - These are cooling Fluids

Mechanisms of lubricants

When we analyse a surface in microscopic level the surface appears rough. When two rough surfaces slide on each other they interlock and adhere this causes friction. Lubricants reduce friction by providing even surface. This phenomenon can be explained by two mechanism.

1. Thick Film or hydrodynamic mechanism
2. Thin Film.

Thick Film Mechanism

When two moving surfaces are placed apart 10^3 A° apart by a lubricant with minimum viscocity, the frictional resistance between the two surfaces is lowered. The lubricants used here are low molecular weight hydro carbon.

Thin Film Mechanism

This is applied for surfaces operating at low speed with heavy loading. In this case lubricants with low viscocity cannot persist. The thin film applied here gets absorbed by the moving surface.

Physical properties of lubricants

1. Visocity - It is the property of fluid that determines its own resistance to flow.

It is the force applied in dyne acting on an area of $1 cm^2$ moving with a velocity of 1 cm/sec

(2) Viscosity Index - It is the variation in viscosity with temperature

(3) Oilness - It is the ability of a Fluid to stick on a surface.

(4) Flash point - It is the lowest temperature at which liquid vapour will ignite For a moment with ignition source is brought near to it.

(5) Fire point - It is the lowest temperature at which vapour will continue to burn For at least 5 sec.

(6) Cloud point - It is the temperature at which lubricants become cloudy.

(7) Pour point - It is the temperature at which lubricants convert into semi-solid.

Chemical properties of lubricants

(1) Carbon residue / Colee number
It is the tendency of an oil to Form carbon deposit under high temperature in an inert atmosphere.

(2) Total Acid Number
It is the amount of pottassium hydroxide required to neutralize 1ml of oil sample.

(3) Saponification value
It is the amount of potassium hydroxide required