CHEMISTRY IN AGRICULTURE

Pesticides

Pesticides are substances that are meant to control pests, including weeds.

In general, a pesticide is a chemical or biological agent (such as a virus, bacterium, or fungus) that kills or otherwise discourages pests.

The term pesticide includes all of the following: herbicides, insecticides, fungicides.

Most pesticides are intended to serve as plant protection products (also known as crop protection products), which in general, protect plants from weeds, fungi, or insects`

Along with these benefits, pesticides also have drawbacks, such as potential toxicity to humans and other species.

Examples of specific synthetic chemical pesticides are glyphosate, Acephate, Deet, Propoxur, Metaldehyde, Boric Acid, Diazinon, Dursban, DDT, Malathion, etc.

Herbicides

Herbicides also commonly known as weedkillers, are substances used to control unwanted plants.

Selective herbicides control specific weed species, while leaving the desired crop relatively unharmed, while non-selective herbicides (sometimes called total weedkillers in commercial products) can be used to clear waste ground, industrial and construction sites, railways and railway embankments as they kill all plant material with which they come into contact.

Examples of contact herbicides are diclofop, dinoseb, diquat, and paraquat.

Certain contact herbicides, like diquat and paraquat, are deactivated by soil particles. They must be mixed with clear water and applied directly to the vegetation.

Insecticides

Insecticides are substances used to kill insects.

They include ovicides and larvicides used against insect eggs and larvae, respectively.

Insecticides are used in agriculture, medicine, industry and by consumers.

Insecticides are claimed to be a major factor behind the increase in the 20th-century's agricultural productivity.

Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans and/or animals.

Fungicides

Fungicides are biological organisms used to kill parasitic fungi or their spores.

A fungistatic inhibits their growth.

Fungi can cause serious damage in agriculture, resulting in critical losses of yield, quality, and profit.

Fungicides are used both in agriculture and to fight fungal infections in animals.

Examples of broad-spectrum fungicides include captan, sulfur, and mancozeb.

Bio-fertilizer

A biofertilizer is a substance which contains living microorganisms which, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.

Biofertilizers can be expected to reduce the use of synthetic fertilizers and pesticides.

The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter.

Through the use of biofertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil.

They are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients through microorganism and their byproducts. Hence, biofertilizers do not contain any chemicals which are harmful to the living soil.

Biofertilizers such as Rhizobium, Azotobacter, Azospirilium and blue green algae (BGA) have been in use a long time.

FUEL

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FUEL

- A fuel is a substance, which on proper burning gives large amount of heat energy on combustion. It is used for domestic and industrial purposes. They contain carbon as a main constituent.

Calorific value of a fuel

- Calorific value of a fuel is the total quantity of heat liberated when a unit mass or volume of the fuel is completely burnt.

Unit of heat

- Heat energy is measured in terms of calorie or kilocalorie.

CLASSIFICATION OF FUELS

Sl. No.	State of fuel	Natural	Artificial
1	Solid	Wood, peat, lignite, coal	Wood charcoal, coke
2	Liquid	Crude petroleum	Kerosene, petrol, diesel, alcohol
3	Gaseous	Natural gas	Water gas, producer gas, biogas, coal gas, LPG

SOLID FUELS

COAL

- Coal is a natural fuel formed by the slow carbonization of vegetable matter buried under the earth some thousands of years ago. It is classified into four kinds based on the carbon content and the calorific value.

1. Peat 2. Lignite 3. Bituminous coal 4. Anthracite coal

1. Peat

- It is the first stage of formation of coal from wood. It is brown, fibrous jelly-like mass. It contains 80-90% moisture. The composition of peat is C = 57%; H_2 = 6%; O_2 = 35% and ash = 2.5%. The calorific value of peat is 5400 kcal/kg. It is a low-grade fuel due to high water content.
- It is used as fertilizer.
- It is used as packing material.

2. Lignite

- Lignite is immature form of coal. It contains 20-60% moisture. Air- dried lignite contains C = 60-70% and O_2 = 20%. It burns with a long smoky flame. The calorific value of lignite is 6500-7100 kcal/kg.
- It is used as a domestic fuel.
- It is used as a boiler fuel for steam production.
- It is used in the manufacture of producer gas.

3. Bituminous coal

- It is a high quality fuel. Its moisture content is 4%. Its composition is C = 83%; O_2 = 10%; H_2 = 5% and N_2 = 2%. Its calorific value is 8500 kcal/kg.
- It is used in metallurgy.
- It is used in steam production.
- It is used for making coal gas.
- It is also used for domestic heating.

4. Anthracite coal

- It is the superior form of coal. It contains C = 92-98%; O_2 = 3%; H_2 = 3% and N_2 = 0.7%. It burns without smoke. Its calorific value is 8700 kcal/kg**.**
- It is used for steam production and house hold purposes.
- It is used for direct burning in boilers and in metallurgy.
- It is used in thermal power plant.
- It is used in coal tar distillation.
- It is used in glass furnaces.

LIQUID FUELS

Liquid hydrogen

- Hydrogen is a colourless and odourless gas composed of diatomic molecules. It holds greater role as fuel in future.
- Liquid hydrogen is a favourable rocket fuel.
- On combustion, it produces more heat per gram than any other fuel.
- Further, it produces only water on combustion whereas the fossil fuels produce gases like SO_2, NO_2 and CO_2 causing environmental pollution. Hence, hydrogen as a fuel has more advantages than any other fossil fuels.

Petroleum

- Petroleum (Crude oil) is a naturally available liquid fuel. It is a dark greenish-brown viscous oil found deep in earth's crust. It is composed of various hydrocarbons with small amount of other organic compounds as impurities.

Refining of petroleum

- The process of purification and separation of various fractions present in petroleum by fractional distillation is called refining of petroleum. Refining is carried out in oil refineries.

Fractional distillation

- It is the process of separation of various components of a liquid mixture based on the difference in their boiling points by repeated evaporation and condensation.

Products of fractional distillation of petroleum and their uses:

SL. No.	Fractions	Temperature	Uses
1	Gases	Below 30°C	Used as industrial and domestic fuel
2	Petroleum ether	30°C to 80°C	Used as a solvent
3	Gasoline or petrol	40°C to 180°C	Used as a solvent, fuel and in dry cleaning
4	Kerosene oil	180°Cto 250°C	Used as illuminant and fuel
5	Diesel oil or gas oil	250°C to 320°C	Used as fuel for diesel engine
6	Heavy oil or lubricating oil	320°Cto 400°C	Used for lubrication, cosmetics and in medicines
7	Residue or asphalt or pitch	Above 400°C	Used for road making and water proofing of roofs

GASEOUS FUELS

PRODUCER GAS

- Producer gas is a mixture of carbon monoxide and nitrogen. It also contains traces of hydrogen and carbon dioxide.
- The average composition of producer gas is CO = 22-30%; H_2 = 8-12%; N_2 = 52-55% and CO_2 = 3%.Its calorific value is about 1300 kcal/m^3.
- It is used as a fuel in the extraction of metal.
- It is used in the manufacture of glass.
- It is used as a reducing agent in metallurgy.

WATER GAS

- Water gas is a mixture of carbon monoxide and hydrogen.
- It also contains traces of carbon dioxide and nitrogen.
- The average composition of water gas is CO = 41%; H_2 = 51%; N_2 = 4% and CO_2 = 4%. Its calorific value is 2800 kcal/m^3.
- It is used as a source of hydrogen gas.
- It is used as an illuminating gas.
- It is used as a fuel in ceramic industries

CNG (COMPRESSED NATURAL GAS)

- CNG is a good alternative fossil fuel. It mainly contains methane.
- CNG is made by compressing natural gas which is found in oil deposits landfills and waste water treatment plants to less than 1% of its volume, it occupies at standard atmospheric pressure.
- It is stored and distributed in hard containers at a pressure of 2900-3600 psi.
- It is cheaper than petrol or diesel.
- It emits fewer pollutants like CO_2, CO, etc. In New Delhi, it is used as a fuel for entire city bus fleet, taxis and three wheelers.
- It is safer than other fuels. In the event of a spill, it disperses quickly in air because, it lighter than air.

LPG (LIQUEFIED PETROLEUM GAS)

- It is a mixture of propane and butane.
- It is stored in steel cylinder under high pressure. When the cylinder is opened, it comes out in the form of gas.
- Commercially, it is supplied under various trade names.
- Its calorific value is 27,800 kcal/m^3.
- It is mainly used as a domestic fuel.
- It is used as a fuel in diesel engines.
- It is used as a motor fuel.

QUESTIONS

- Define calorific value of a fuel.
- How are fuels classified?
- Give two examples for solid fuels.
- Give two examples for liquid fuels.
- Give two examples for gaseous fuels.
- What are the varieties of coal? Explain .
- What is petroleum? What is refining of petroleum?
- Write a note on liquid hydrogen as fuel.
- Give the composition and uses of producer gas.
- Give the composition and uses of water gas.
- Give the composition and uses of CNG.
- Give the composition and uses of LPG.

LUBRICANTS

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LUBRICANTS

- **Lubricant may be defined as the substance which reduces the friction between the two moving surfaces or parts of a machine.**
- The process of applying the lubricant in between the two moving or sliding surfaces is called as lubrication.

Purpose of a lubrication

- To reduce the loss of energy due to friction
- Increase the efficiency of a machine
- Reduce the maintainance cost of machine
- Reduce large amount of energy is dissipated in the form of heat
- Reduce surface deformation

Classification of lubricants

Lubricants may be broadly classified as follows.

- Solid lubricants
- Semi-solid lubricants
- Liquid lubricants

Solid lubricants

- The most widely used solid lubricants are graphite and molybdenum sulphide.

Solid lubricants are used in the following areas.

- For heavy machinery working as a crude job at very high loads.
- When the operating temperature or load is very high.
- Where a liquid or semi-solid lubricant film cannot be maintained.

1. Graphite

- Graphite is an allotrope of carbon.
- Graphite has a layered structure of carbon atoms. The carbon atoms are joined together by strong covalent bonds. The adjacent layers are held together by the weak Vanderwall's force.
- It is used as a lubricant in the form of powder or as suspension in oil or water. It fills the cavities and prevents the friction.
- It is used as a lubricant in IC engines, air compressors, lathes, food- stuff industry, railway track joints, general machine job works, etc.

2. Molybdenum sulphide

- Fine powder of molybdenum sulphide is used as lubricant. It has the capacity to withstand very high temperature. It is stable in air upto 500°C.
- It is used as lubricant in high-speed machines.

Semi-solid lubricant

Grease

- It is a mixture of mineral oil and soap. It is used for heavy load and low speed machines. It is mainly used in bearing and gears.
- Grease is a semi- solid lubricant obtained by thickening of lubricating oil by the addition of a metallic soap. The thickener is usually sodium, calcium, and lithium or aluminium soap.
- Greases are manufactured by saponification of fats with alkali followed by adding hot lubricant oil under severe agitation.
- Their properties depend on both the base used for saponification and the fatty acid present in the oil.

Liquid lubricants

Vegetable oils

- They are commonly used liquid lubricants. Examples: Castor oil, coconut oil, etc.
- They are classified as drying and semi-drying oils. They are easily oxidized by atmosphere.

Animal oils

- They are oils of animal origin. They are mainly animal fats.
- Examples: Tallow oil, whale oil, lards oil, coconut oil and olive oil etc.,
- They are very costly. Hence, they find little use as lubricants. They are also easily oxidized by atmosphere.

Mineral oil

- Hydrocarbons with higher molecular mass obtained by the fractional distillation of petroleum are used as lubricants. They are obtained from the paraffin residue.
- Examples: Paraffin oil, lubricating oil, etc.

Blended oils

- They are mixture of vegetable oils and petroleum products. They show improved properties. Different oils are suitably mixed depending on the requirement. They are synthetic lubricants

QUESTIONS

- What is a lubricant?
- How are lubricants classified? Give examples.
- Write a note on semi-solid lubricant.
- List the purposes of lubrication.
- Write a note on solid lubricants.
- Write a note on liquid lubricants
- Mention the uses of graphite.
- Mention the uses of molybdenum sulphide.

POLYMERS

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Polymer & Monomer

- Polymerization is the process of converting small, low molecular weight organic molecules into long, high molecular weight organic molecules either by addition reaction or by condensation reaction. The small molecules are called monomers and the products are called polymers.

Homo-polymer & Co-polymer

- Homopolymers are formed by the polymerisation of a single monomer. The repeating units of homopolymers are derived only from one monomer. Examples includes polythene which is a homopolymer of ethene.
- In copolymers, the repeating units are derived from two types of monomers. Example includes *Buna−S*, which is a copolymer of 1,3−*butadiene* and *styrene*.

Degree of polymerization

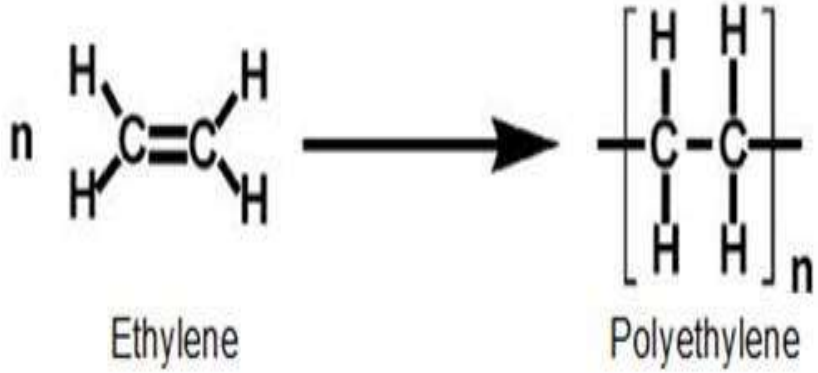
- The degree of polymerization, or DP, is the number of monomeric units in a macromolecule or polymer molecule. For most industrial purposes, degrees of polymerization in the thousands or tens of thousands are desired. This number does not reflect the variation in molecule size of the polymer , it only represents the mean number of monomeric units.

There are two types of polymerization.

- Addition polymerization
- Condensation polymerization

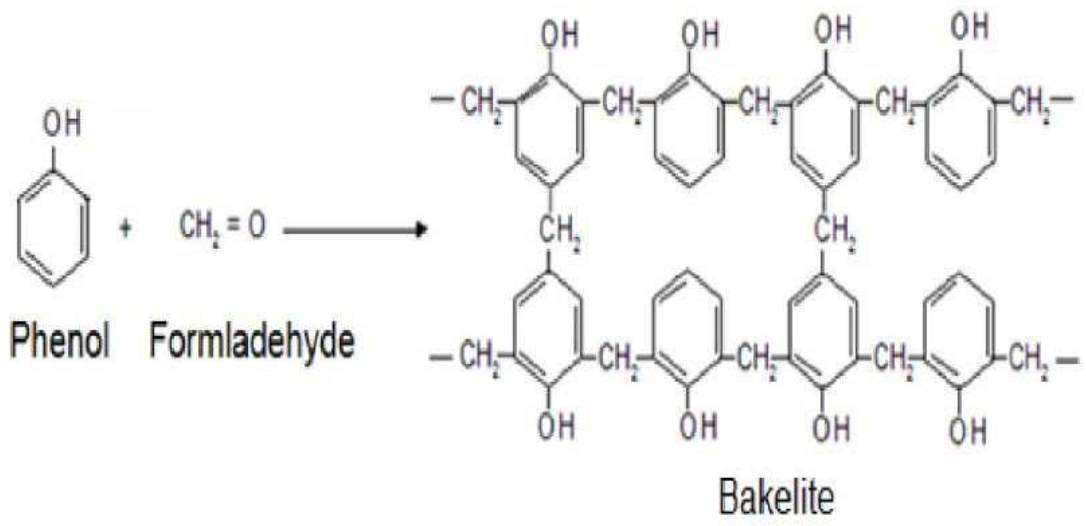
Addition polymerization

- In this type of polymerization, polymers are formed by simple addition reaction between small molecules containing double or triple bonds.
- Example: Formation of polyethylene or polythene.



Condensation polymerization

- In this type of polymerization, polymers are formed by the reaction between small molecules with elimination of molecules like H_2O, H_2S, NH_3, etc.
- Example: Formation of Bakelite



Types of plastics

- Plastics are classified into two types.

Thermoplastics

- They are the resins which soften on heating and set on cooling. Thus, they can be remoulded any number of times and used.
- Example: Polythene, PVC, nylon, etc.

Thermosetting plastics

- They are the resins which set on heating and cannot be resoftened. Hence, their scrap cannot be reused.
- Example: Bakelite (Phenol-formaldehyde resin), urea-formaldehyde resin, etc.

Differences between thermoplastics and thermosetting plastics

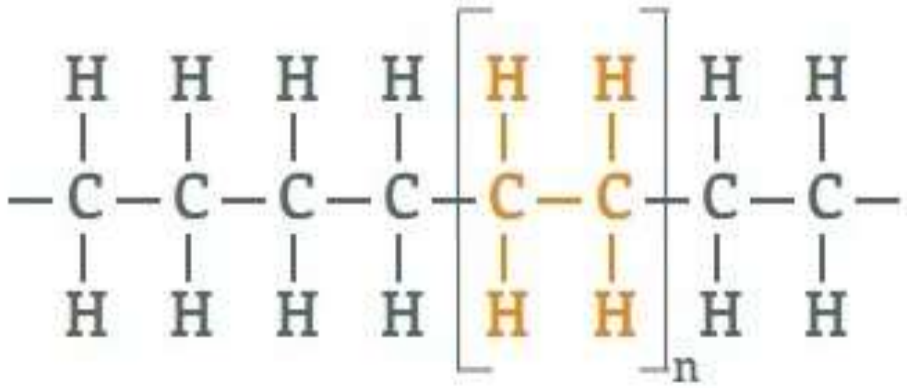
Sl. No.	Property	Thermoplastics	Thermosetting plastics
1	Action of heat	They soften on heating and set on cooling every time	**They set on heating and cannot be resoftened**
2	Type of bonding between adjacent polymer chains	The polymer chains are held together by weak force called Vander Waal's force of attraction	**The polymer chains are linked by strong chemical bonds (covalent bonds)**
3	Solubility	They are soluble IN organic solvents	They are insoluble IN organic solvents
4	Expansion due to heating	They expand very much on heating	**Their expansion is only marginally on heating**
5	Type of polymerization	They are formed by addition polymerization	They are formed by condensation polymerization
6	Scrap recovery	Scrap can be reused	**Scrap cannot be reused**
7	**Example**	**Polythene, PVC, nylon**	**Bakelite**

POLYTHENE

- Polythene is made from the polymerization of ethylene (or ethene) monomer. It's chemical formula is $(C_2H_4)n$.

- It is a lightweight, durable thermoplastic with variable crystalline structure. It is one of the most widely produced plastics in the world.

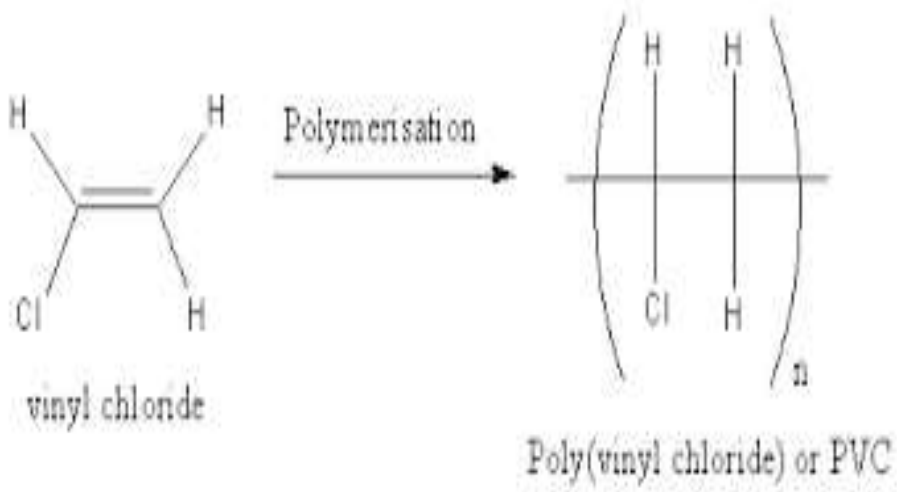
- Polyethylene is used in applications ranging for films, tubes, plastic parts, laminates, etc. in several markets (packaging, automotive, electrical, etc.).



Molecular Structure of Polyethylene

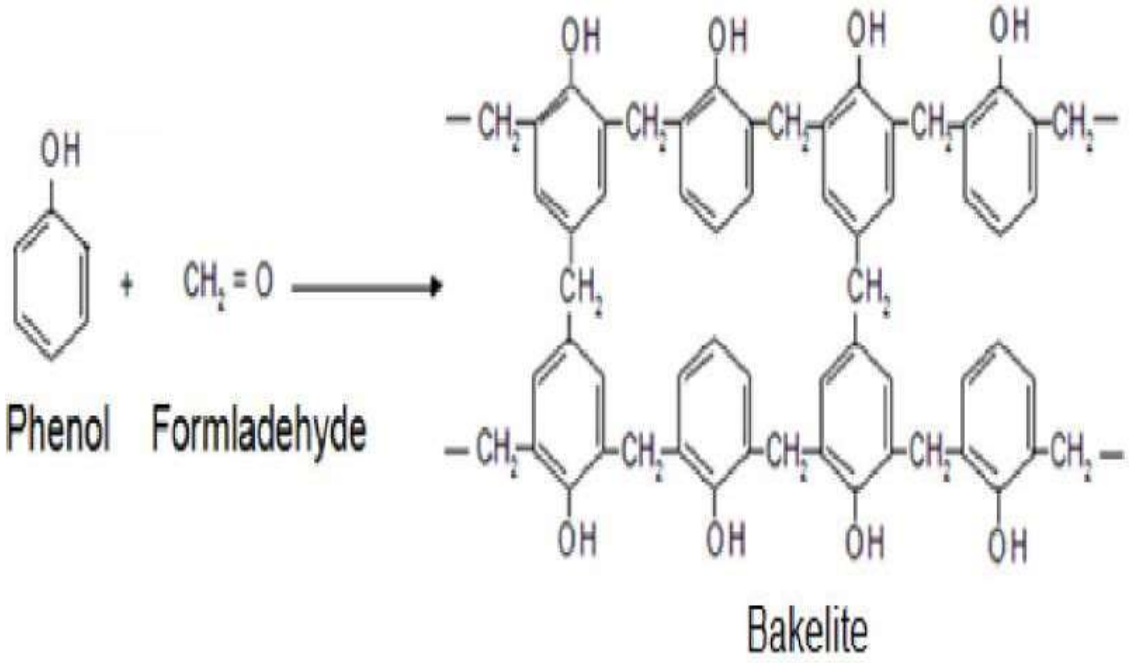
POLYVINYL CHLORIDE(PVC)

- PVC is produced by polymerization of vinyl chloride monomer (VCM).
- It is a white, brittle solid material available in powder form or granules.
- Due to its versatile properties, such as lightweight, durable, low cost and easy processability, PVC is now replacing traditional building materials like wood, metal, concrete, rubber, ceramics, etc.
- PVC is an thermoplastic polymer widely used in building and construction industry to produce door and window profiles, pipes (drinking and wastewater), wire and cable insulation, medical devices.



BAKELITE

- Bakelite is formed by the condensation reaction between phenol and formaldehyde. This polymer is known as novolac .Water is eliminated as by product.
- Bakelite due to its high resistance to electricity and heat is used in automotive components and industrial applications.
- Due to its excellent insulating properties it is used for making switches and other electrical appliances.
- It is also used to make various kitchenware products like frying pans etc.
- It is also used to make jewelry articles and toys.

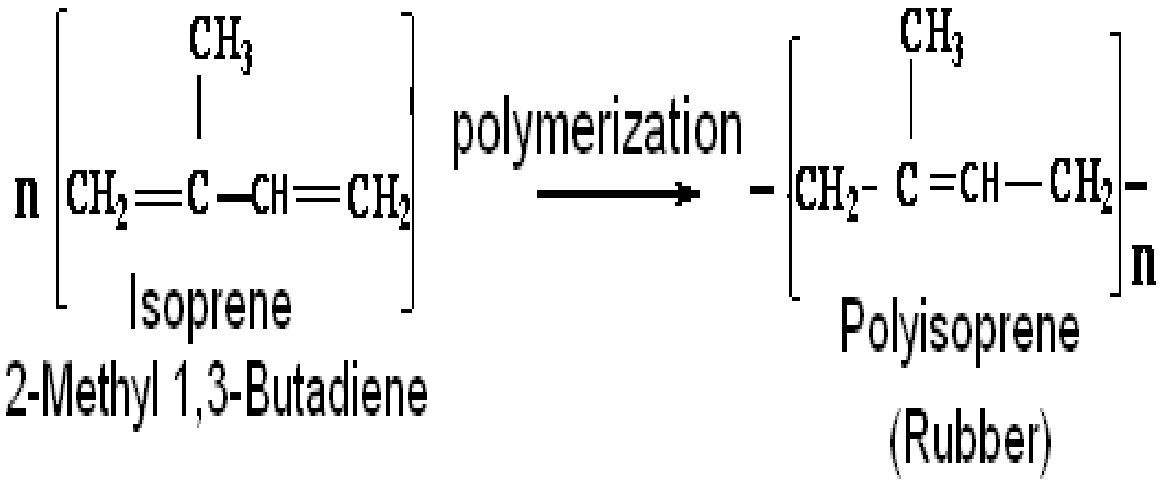


RUBBER

- Rubber is a natural elastic polymer of isoprene (C_5H_8). It is obtained from the milk of rubber called 'Latex'.

The natural rubber cannot be used in industries because it has the following defects.

- It becomes soft and sticky during summer.
- It becomes hard and brittle during winter.
- It swells up in oils.
- It flows plastically due to prolonged stress.
- Chemicals easily affect natural rubber.



Vulcanization

- Vulcanization is compounding of rubber with sulphur.
- Vulcanization is process of heating the natural rubber with sulphur at 140°C in CO_2 atmosphere.
- The double bonds present in rubber chain opened and cross linked through sulphur atoms. Hence it becomes very hard.

Properties of vulcanized rubber

- Vulcanized rubber has very little electrical and thermal conductivity. Hence, it is mainly used for electrical insulation purposes.
- It has high elasticity and tensile strength.
- Corrosive chemicals and oils do not affect it.
- It is also not affected by atmosphere.

Advantage of vulcanised rubber over raw rubber

- Uncured natural rubber is sticky and can easily deform when warm, and is brittle when cold. So it cannot be used to make articles with a good level of elasticity.
- The reason for un-elastic deformation of un-vulcanized rubber can be found in the chemical nature: rubber is made of long polymer chains. These polymer chains can move independently towards each other, and this will result in an irreversible change of shape.
- By the process of vulcanization, crosslinks are formed between the polymer chains, so the chains cannot move independently anymore. As a result, when stress is applied the vulcanized rubber will deform, but upon release of the stress, the rubber article will go back to its original shape.

QUESTIONS

- What is polymerization? What are the types of polymerization?
- How polythene is formed?
- What are Homo-polymer and Co-polymer?
- List the differences between thermoplastics and thermosetting plastics.
- What is rubber?
- What is vulcanization?
- Give any two defects of natural rubber?
- What is the Advantage of vulcanised rubber over raw rubber?
- Write preparation, structure and uses of Bakelite?
- Write the composition and uses of PVC ?