



BVRIT HYDERABAD
College of Engineering for Women
Department of Basic Sciences & Humanities
Course Handout

Subject Name: Chemistry

Prepared by: Faculty of Chemistry

Year, Semester, Regulation: I BTech (R22)

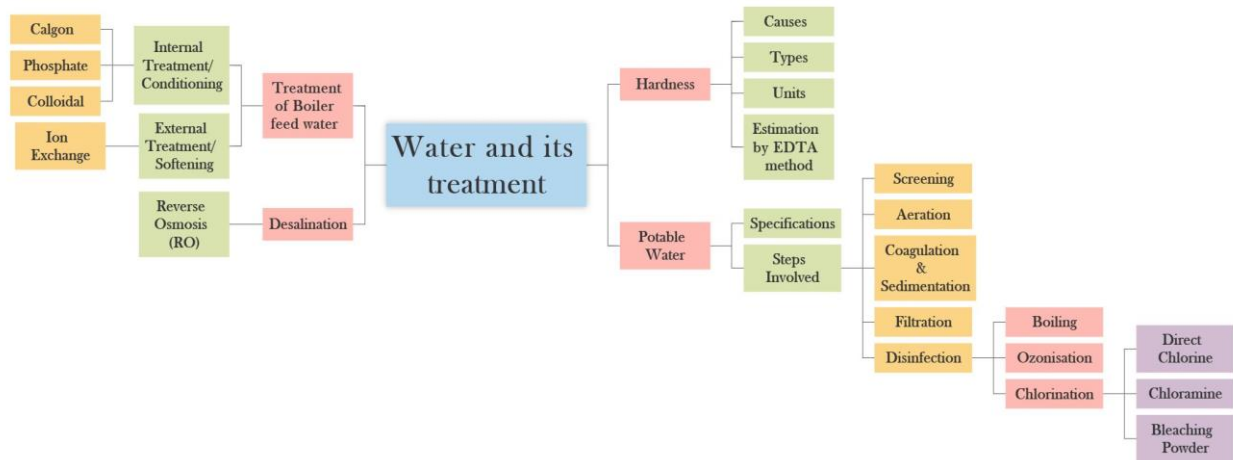
Course Objectives:

1. To bring adaptability to new developments in Engineering Chemistry and to acquire the skills required to become a perfect engineer.
2. To include the importance of water in industrial usage, fundamental aspects of battery chemistry, significance of corrosion it's control to protect the structures.
3. To imbibe the basic concepts of petroleum and its products.
4. To acquire required knowledge about engineering materials like cement, smart materials and Lubricants.

Course Outcomes:

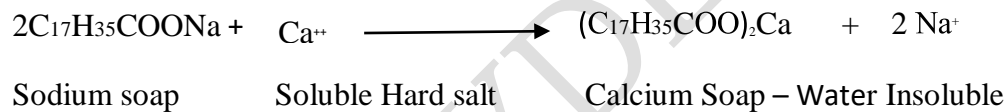
1. Analyze the basic properties of water and its usage in domestic and industrial purposes.
2. Inspect the working principles and reaction mechanisms of various energy storage devices
3. Acquire the basic knowledge of electrochemical procedures related to corrosion and its control.
4. Compare metals with conducting polymers and also discover cheaper biodegradable polymers to reduce environmental pollution.
5. Distinguish various energy sources to prioritise eco friendly fuels for environmental sustainable development.
6. Discriminate the limitations of conventional basic engineering materials for developing multiphase materials.

UNIT I Water and its treatment



➤ Hard water

Water which does not produce lather with soap solution, but produces white precipitate (scum) is called hard water.



➤ Two types of water

Soft water Hard water

➤ Hardness:

Types of hardness

Depending upon the types of dissolved salts present in water, hardness of water can be classified into two types:

Temporary Hardness Permanent Hardness

Expression of hardness in terms of equivalents of $CaCO_3$ = $\frac{\text{Amount} \times 100}{\text{M.Wt of hard salt}}$

➤ Units of Hardness

1. Parts per million (ppm)
2. Milligrams per litre (mg/lit)
3. Clarke's degree (oCl)
4. French degree (oFr)

➤ Relationship between various units

1ppm = 1 mg/lit = 0.10 Fr = 0.070 Cl

➤ Portable water

Water free from contaminants or water that safe for human consumption is called **Portable Water**.

TREATMENT OF MUNICIPAL WATER

The treatment of water for drinking purposes mainly includes the removal of suspended impurities, colloidal impurities and harmful pathogenic bacteria.

➤ **Boiler Feed water Treatment:**

➤ **Internal conditioning OR Internal treatment OR Boiler compounds**

It involves the removal of scale forming substance by adding chemicals directly into the boiler. These chemicals are also called boiler compounds.

Carbonate conditioning

Phosphate conditioning

Calgon conditioning

➤ External conditioning

Demineralization or Ion Exchange Process

Desalination of Brackish water: Reverse osmosis

SHORT ANSWER QUESTIONS

1. Define the hardness of water with its expression & units?
2. Why Calgon conditioning is better than phosphate conditioning?
3. What is meant by reverse osmosis?
4. Explain the following a) priming b) Foaming
5. What are the advantages of break point chlorination?

ESSAY ANSWER QUESTIONS

1. Write a note on complexometric titration used for estimation of hardness of water by EDTA?
2. Discuss the various boiler troubles with their causes & prevention?
3. Write short note on Calgon conditioning b) phosphate conditioning c) colloidal conditioning d) ion exchange
4. Briefly describe disinfection of potable water?

OBJECTIVE ANSWER QUESTIONS

1. Calgon is a trade name given to []
A) Sodium salt B) Sodium hexa meta phosphate C) Sodium phosphate D) Calcium phosphate
2. The process of wet steam formation is called []
A) Foaming B) Priming C) Scale formation D) Caustic embrittlement
3. Disinfection by ozone is due to liberation of []
A) Oxygen B) nascent Oxygen C) molecular oxygen D) Oxide
4. Temporary hardness in water is removed by []
A) Filtration B) sedimentation C) boiling D) coagulation
5. Blow –down operation causes the removal of []

A) Scales B) sludge's C) acidity D) sodium chloride

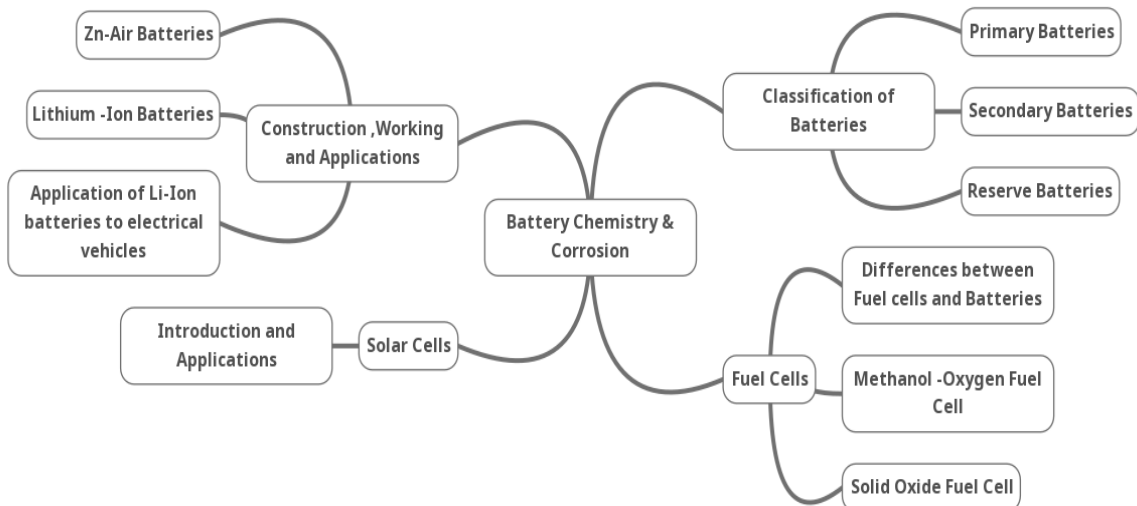
6. Permanent hardness of water cannot be removed by []

A) Treatment with lime soda B) by permutite process
C) Boiling D) ion –exchange process

7. Formation of _____ causes caustic embrittlement

8. Ca (HCO₃) CAUSES _____ hardness.

UNIT –II Battery Chemistry & Corrosion

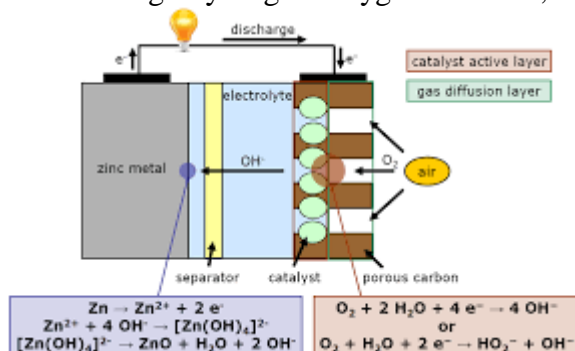


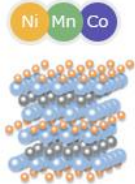
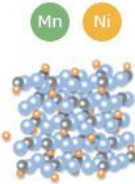



➤ BATTERIES

Battery is an electrochemical cell or often several electrochemical cells connected in series that can be used as a source of direct electric current at a constant voltage.

Batteries are 3 types

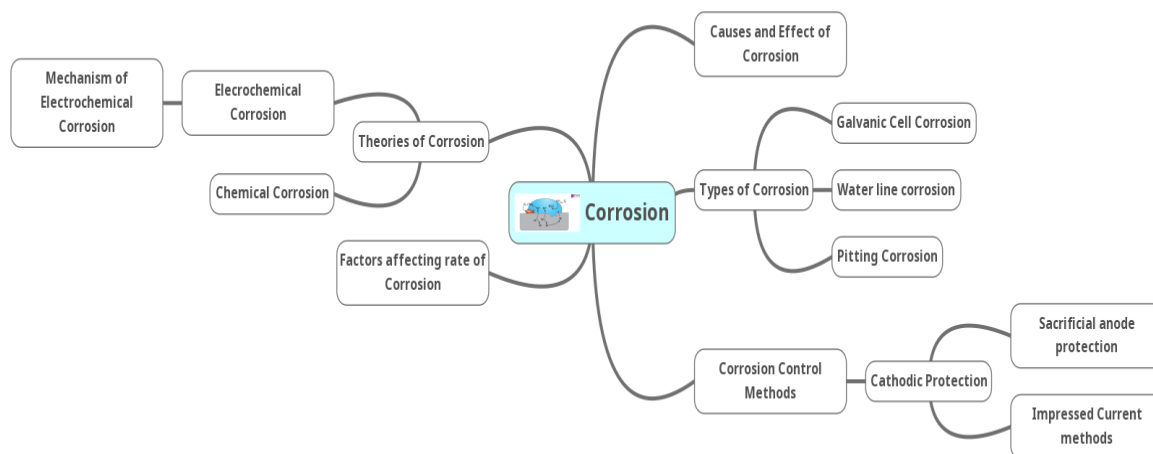
- Primary cells eg: Leclanche cell, Lithium cells and alkaline cells.
- Secondary cells eg: Lead acid storage cell , Li ion batteries
- Fuel cells eg: Hydrogen-Oxygen Fuel cell, Methanol-Oxygen fuel cell



	LEAF e+ (62kWh) Newly-introduced	LEAF (40kWh) Second generation	LEAF (24kWh) First generation
Cathode material	 <p>Layer structure (NMC*) Lithium: ● Metal: ● Oxygen: ●</p>	<p>Optimized storage of Lithium ions</p>  <p>Spinel structure (LMO**) Lithium: ● Metal: ● Oxygen: ●</p>	
Module	<p>New module layout allows configuration flexibility to minimize battery pack size</p>  <p>Cell amount can be customized, resulting in a compact module</p>	<p>Optimize structure to include 2 modules</p>  <p>8-cell module</p>	 <p>4-cell module</p>

*Lithium Nickel Cobalt Manganese Oxide
**Lithium Manganese Oxide

CORROSION



➤ It is the gradual deterioration of metals by chemical, electrochemical or biochemical interaction with the environment.

➤ Causes of Corrosion

Metals occur in nature as their oxides, sulphides carbonates etc. The chemically combined state is thermodynamically more stable. When we extract a metal from its ore, the metal is in a higher energy state, which is thermodynamically unstable. So it tries to go back to to the stable state by chemical or electrochemical interaction with the environment.

➤ Consequences or effects of Corrosion

1. Efficiency of the machine decreases.
2. Plant has to be shut down due to failure.
3. Product is contaminated.
4. The toxic products of corrosion cause health hazards.
5. There is a necessity to over design to allow for corrosion.

➤ **Classification or Theories of Corrosion**

- I. Dry or Chemical Corrosion
- II. Wet or Electrochemical Corrosion

➤ **Factors influencing corrosion**

Nature of Metal	Nature of Environment
Position in emf series Areas of anode and cathode Purity Over Voltage Nature of the Film Nature of corrosion product	Temperature Humidity Corrosive gases Presence of suspended particles Effect of pH

➤ **Types of Corrosion:**

- Galvanic corrosion
- Water line corrosion
- Pitting Corrosion

➤ **Cathodic Protection:**

- Sacrificial anodic protection
- Impressed current cathodic protection method
- Protective coatings

SHORT ANSWER QUESTIONS

1. Give the classification of batteries with examples.
2. Explain the applications of Zn-air and Li-ion batteries.
3. Differentiate fuel cells and batteries.
4. Give the applications of Solar cells.
5. Define Corrosion. Give the classification.

ESSAY ANSWER QUESTIONS

1. Explain the construction, working and applications of Zn-air batteries.
2. Explain the construction, working and applications of Li-ion batteries.
3. Explain the construction and applications of Methanol-Oxygen Fuel cells.
4. Explain the construction and applications of Solid- oxide fuel cells.
5. Define Solar Cells. Give its components and applications.
6. Explain the mechanism of wet corrosion.
7. Explain the factors affecting Corrosion.
8. Describe Corrosion control methods.

OBJECTIVE ANSWER QUESTIONS

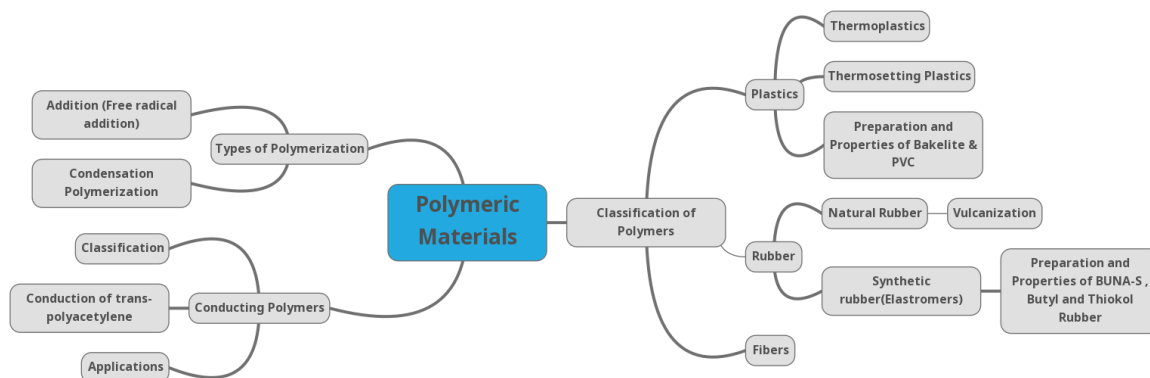
1. The anode used in Zn-air batteries
 - a) Zn b) ZnO c) air d) Oxygen
2. The electrolyte used in Zn-air batteries
 - a) Acid b) alkali c) salt d) organic solvent
3. Li-Ion battery is

- a) Primary battery b) Secondary battery c) Fuel cell d) Reserve battery
4. _____ fuel cell converts the chemical energy of liquid methanol into electrical energy directly.
- a) Solid -Oxide b) H_2-O_2 c) CH_3OH-O_2 d) Li
5. In wet corrosion, corrosion product is formed at/nearby
- a) Anode b) electrolyte c) emf device d) cathode
6. Corrosion enhances with _____ in temperature.
7. The rate of Corrosion increases when the solubility of corrosion product is _____.
8. The base metal behaves as _____ in cathodic protection corrosion control method.
9. Corrosion is less when relative areas of cathode and anode are _____ and _____.

UNIT – III

Polymeric materials

➤ Polymers:



Polymers are high molecular weight giant molecules formed by linking together of small molecules, monomers, by means of covalent bond/chemical bond.

Examples: Polyethylene, Poly(vinylchloride), Bakelite, etc.

➤ Polymerization:

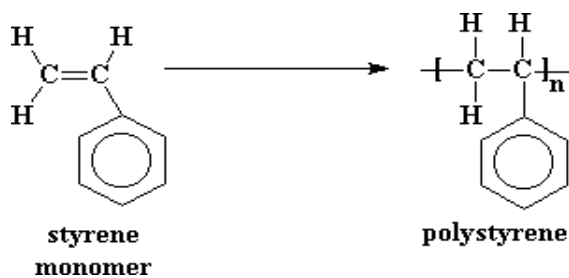
The process of joining together of small molecules by means of covalent bonds to form extremely large molecule is called polymerization

➤ Types of polymerization:

1. Addition polymerization/Chain growth polymerization:

- ✓ Addition polymerization is a reaction that yields a polymer which is an exact multiple of monomers, without the elimination of by-products.
- ✓ Monomers having double bonds such as alkenes, alkynes, undergo addition polymerization.

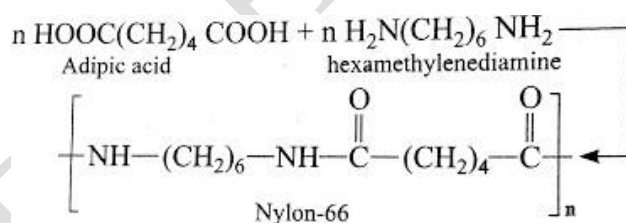
Examples: i. PolyStyrene



1. Condensation polymerization/step polymerization:

- ✓ Condensation polymerization is a reaction occurring between two bi – or poly functional monomers having polar functional groups.
- ✓ It always accompanies with elimination of small molecules like H₂O, HCl, NH₃, etc.
- ✓ For example, >C=O, -COOH, -OH and -NH₂ carrying monomers undergo condensation polymerization.

i. Nylon6,6:



➤ Plastics:

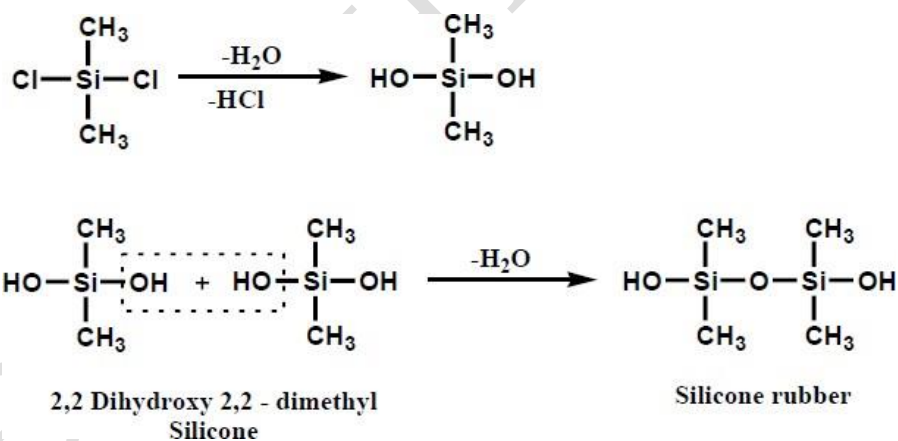
The polymers which can be shaped into hard and tough utility articles are known as plastics.

Examples: 1. PVC

Thermoplastics	Thermosetting polymers
They soften on heating and harden on cooling reversibly.	They are not softened on heating once set. Prolonged heating leads to charring.
They are formed by addition or condensation polymerization.	They are formed by condensation polymerization.
They have either linear or branched structures.	These have 3D cross linked structures.
They can be recycled, re-moulded, re-shaped and re-used.	They can't be re-cycled, re-moulded, reshaped.
They are soluble in some organic solvents	They are insoluble in organic solvents.
They are tough & less brittle	They are tough but more brittle.
Ex: PE, PP, PVC, PMMA, Teflon.	Ex: PF, UF, MF

➤ **Silicone Rubber/Silicones:**

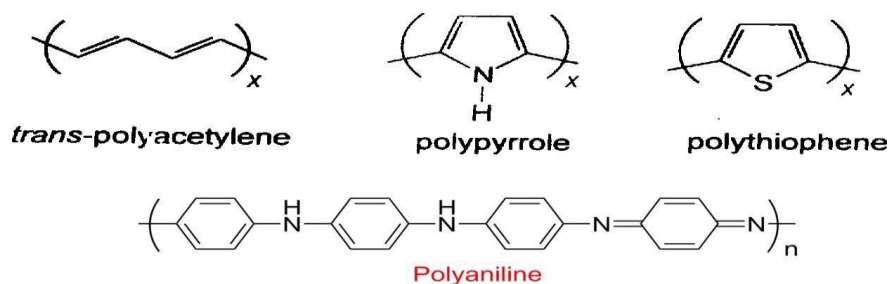
These polymers contain Siloxane (-Si-O-Si-O-) units with each tetravalent Si atom linked to one or two organic groups.



➤ **Conducting Polymers:**

The polymers which can conduct electricity due to extensive conjugation are called as conducting/conductive polymers.

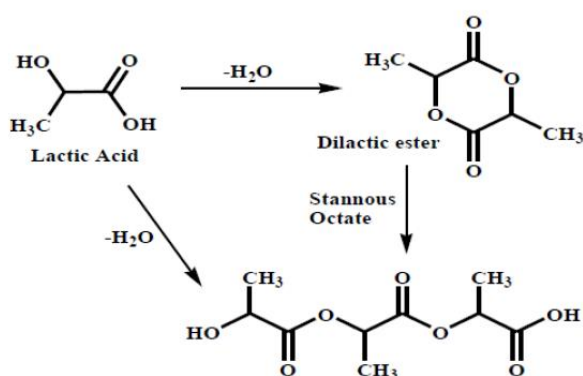
Usually, the extensive conjugation present in the polymer back bone is responsible



➤ **Biodegradable polymers:**

Biodegradable polymers are defined as “the polymeric materials that undergo degradation by environmental factors like sunlight, temperature changes or by the action of microorganisms like algae, fungi and bacteria”

Example: Polylactic acid.



SHORT ANSWER QUESTIONS

1. Define polymer? Explain classification of polymers?
2. Explain polymerization with suitable examples?
3. Distinguish between the thermoplastic and thermosetting plastics?
4. Difference between the natural polymer and synthetic polymer ?
5. Preparation, properties and applications of PVC?
6. Explain the procedure used to the processing of natural rubber?
7. Define Elastomers? Give the preparation, properties and applications of Buna-S?
8. Write a short note on synthetic rubbers?
9. Write about the conducting polymers?

10. Explain the applications of poly lactic acid?

ESSAY ANSWER QUESTIONS

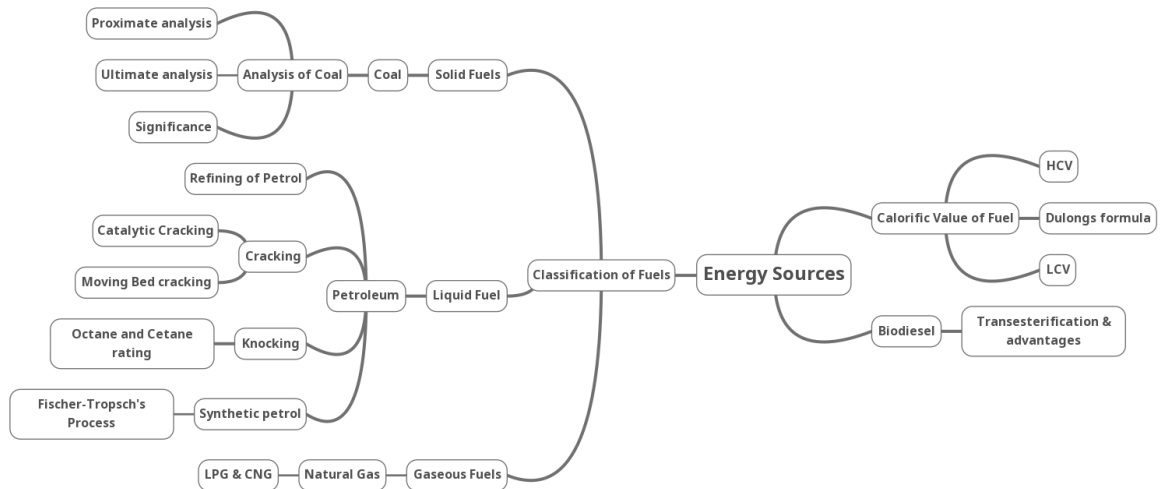
1. Distinguish between addition and condensation polymerization?
2. Discuss the mechanism of addition polymerizations with suitable examples?
3. Explain preparation, properties and uses of bakelite?
4. write the properties and uses of different types of silicones?
5. Discuss about mechanism of conducting polymers with transpolyacetylene?

OBJECTIVE ANSWER QUESTIONS

1. Polymer obtained by the condensation polymerization is []
a) Teflon b) PVC c) Nitrite rubber d) Bakelite
2. Bakelite is prepared by the condensation of []
a) Phenol-acetaldehyde b) Cresol-Formaldehyde
c) Phenol-formaldehyde d) Urea-formaldehyde
3. The structural unit of polymers are called []
a) Fibers b) Monomers c) Fabrics d) Thermo units
4. Latex is the dispersion of _____ molecules.
5. The monomers used in Buna- S are _____ and _____.
6. An example for conducting polymer is _____.
7. PVA is an example for _____ polymers.

UNIT – IV

Energy Sources



HCV: It is the total amount of heat produced, when unit mass/volume of the fuel has been burnt completely and the products of combustion have been cooled to room temperature (15°C or 60°F).

LCV: It is the net heat produced, when unit mass/volume of the fuel is burnt completely and the products are permitted to escape.

The primary component in **CNG** is methane.

The primary component in **LPG** is propane and butane.

Biodiesel is a renewable, biodegradable fuel manufactured domestically from vegetable oils, animal fats, or recycled restaurant grease.

SHORT ANSWER QUESTIONS

1. Write the characteristic of good fuel?
2. Distinguish between gross & net calorific value of fuel
3. Why gasoline containing TEL is used in IC engines?
4. Why are gaseous fuels more advantageous than solid fuels?
5. Write a short note on Knocking?

ESSAY ANSWER QUESTIONS

1. Give an account of classification of coal & proximate analysis?
2. Write a short note on a) Octane number b) cracking c) Cetane number
3. Explain the methods of preparation of synthetic petrol?
4. How the calorific value is experimentally determined?
5. Explain the following a) Refining b) CNG c) LPG

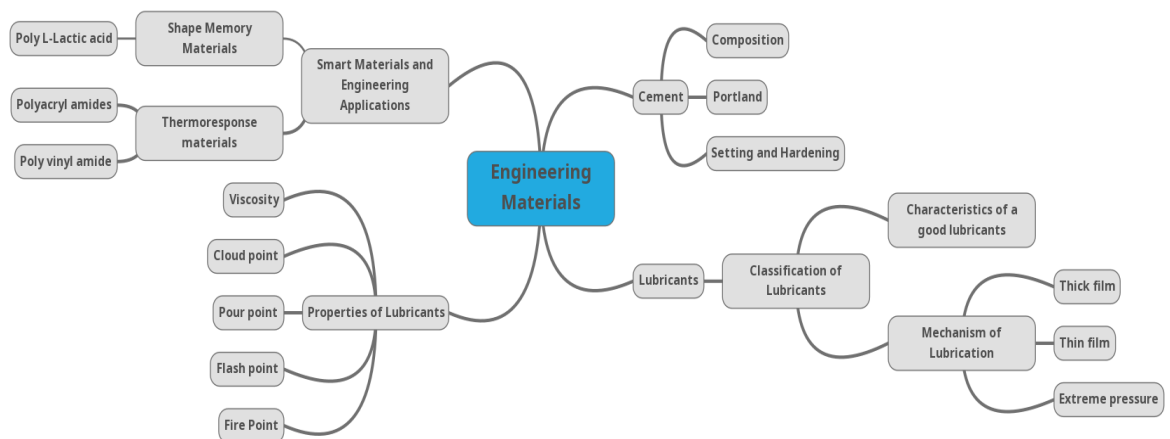
OBJECTIVE ANSWER QUESTIONS

1. The calorific value of fuel depends upon the percentage of []
A) Volatile matter B) ash C) fixed carbon D) moisture
2. Natural gas is composed primarily of []

- A) CH₄ B) n-butane C) n-octane D) a mixture of propane and octane
3. The amount of nitrogen in coal is determined by []
 A) proximate analysis B) heating in the absence of air C) ultimate analysis D) burning it completely in air
4. Orsats apparatus is used to estimate []
 A) Volumetric analysis of flue gases
 B) Gravimetric analysis of gas mixture
 C) Specific heat of components
 D) Ash content is high
5. A Combustible substance containing carbon as the main constituent, which on burning liberates large amount of heat is _____.
6. The total quantity of heat liberated when a unit mass of fuel is burnt in presence of air / oxygen is _____
7. The lowest temperature at which the fuel must be heated is _____
8. _____ is the highest ranking coal.
9. Cock, Charcoal, diesel are _____ fuels.
10. A good fuel should possess _____ moisture content.

UNIT – V

Engineering Materials



Portland Cement (PC) is a fine powder which is produced by heating limestone and clay minerals in a kiln and forms clinker.

Shape-memory polymers (SMPs) are polymeric **smart materials** that have the ability to return from a deformed state (temporary shape) to their original (permanent) shape when induced by an external stimulus (trigger), such as temperature change

Temperature-responsive polymers or **thermoresponsive polymers** are polymers that exhibit a drastic and discontinuous change of their physical properties with temperature.

A substance which is capable of reducing friction between two surfaces which are sliding over each other is called **Lubricant**. Lubricants can be broadly classified, on the basis of their physical state, as follows: (1) Liquid lubricants or lubricating oils; (2) Semi-solid lubricants or greases, and (3) Solid lubricants.

SHORT ANSWER QUESTIONS

1. Describe the effect of temperature on viscosity?
2. Define shape memory materials. Give examples.
3. Give the classification of lubricants.
4. Give the composition of Portland Cement.
5. Define cloud point, pour point, flash point & fire point.

ESSAY ANSWER QUESTIONS

1. Explain the properties of lubricants with significance?
2. Write a note on setting & hardening of cement?
3. Give an account on thermoresponsive materials with their engineering applications.
4. Explain the mechanism of thin film and thick film lubrication.

OBJECTIVE ANSWER QUESTIONS

1. Viscosity of liquids _____ with increasing temperature.
2. In case of liquid lubricants generally fire point is _____ than the flash point.
3. Poly acryl amide is formed by _____ monomers.
4. An example of semi-solid lubricant is _____.
5. Iron oxide provides _____ to the cement.
6. Setting causes _____ and hardening cause _____ in cement.
7. Poly lactic acid is a type of _____ kind of engineering materials.
8. The cloud point should be _____ for ideal lubricant.