UNIT – I WATER TECHNOLOGY

01. Define boiler feed water.

The water fed into the boiler for the production of steam is known as boiler feed water.

02. What are the requirements of boiler feed water?

It should free from

- Suspended solids.
- Dissolved salts like $MgCl_2$.
- Hardness.
- Alkalinity.
- Dissolved gases like O_2 and CO_2.

03. What are the disadvantages using hard water in boiler?

- Scale and sludge formation.
- Caustic Embrittlement.
- Priming and Foaming.
- Boiler corrosion.

04. What are the disadvantages formation of deposits in steam boilers and heat exchangers?

- Wastage of fuels.
- Decrease in efficiency.
- Boiler explosion.

05. Define Boiler explosion.

When thick scales crack due to uneven expansion, the water comes suddenly in contact with over-heated iron plates. This causes in formation of a large amount of steam suddenly. So sudden high-pressure is developed, which may even cause explosion of the boiler

06. What are the methods used to be prevention of scale formation?

- Prevention of scales formation:
  - External Treatment – zeolite process
  - Internal Treatment - carbonate conditioning.

07. What are the methods used to be softening hard water?

- External Treatment – zeolite process, Demineralization process
- Internal Treatment - carbonate conditioning, calgon conditioning.

08. What is meant by internal conditioning of water? Give one example.

Treating the boiler water in the boiler itself by adding chemicals to remove scale forming substance is called internal conditioning.

Ex: carbonate conditioning, phosphate conditioning, calgon conditioning.

09. What is meant by external conditioning of water? Give one example.

Treating the boiler water before feeding it into boiler is called external conditioning.
Ex: De mineralization Process & Zeolite process.

10. **Distinguish between internal conditioning and external conditioning methods.**

Internal conditioning	External conditioning
To remove hardness producing salts, chemicals were added to the boiler water in the boiler itself and that treatment is known as internal conditioning.	Treating the boiler water before feeding it into boiler is called external conditioning.

11. What is meant by caustic embrittlement? How is it prevented?

Caustic embrittlement means inter crystalline cracking of boiler metal. It is prevented by using softening agent like sodium phosphate and by adding tannin and lignin.

12. **What is desalination?**

The process of removing common salt (NaCl) from the water is known as desalination. The water contains dissolved salts with brackish taste is called brackish water.

Desalination = Removal of common salt (NaCl) from water

13. **What are boiler compounds? Mention two different boiler compounds and their actions.**

The chemicals directly added into the boiler for removing scale forming substances is known as boiler compounds. Ex: Sodium carbonate and Sodium phosphate.

14. **What is Calgon? How does it function in water treatment?**

Calgon – Sodium Hexa Meta Phosphate

It interacts with calcium ions forming a highly soluble complex and thus prevents the precipitation of scale forming salt.

15. **What is Reverse osmosis?**

When two solutions of different concentrations are separated by a semipermeable membrane, when a pressure is applied on the concentrated side, the solvent flow from higher concentration to lower concentration.

16. **What are the advantages of reverse osmosis method?**

- Low capital cost, easy operating.
- RO method is used for converting sea water into drinking water.
- It removes all types of impurities like non-ionic and colloidal.
- The life time of membrane is high and it can be replaced within few minutes.

UNIT – II ELECTRO CHEMISTRY AND CORROSION

01. Define an Electrochemical cell. Give one example.

A cell which converts chemical energy into electrical energy is known as electrochemical cell. Example: Daniel cell, Batteries.

02. What do you mean by redox reaction?

Both reduction and oxidation takes place simultaneously in a cell reaction then it is known as redox reaction of an electrochemical cell.

03. What is electrode potential?

It is the measure of tendency of a metallic electrode to lose or gain electrons, when it is in Contact with its own salt solution. It is denoted as "E"

04. Define an origin of electrode potential.

When a metallic electrode is placed in its own salt solution, two types of reaction takes place.1. +ve ions may pass into the solution. $M \rightarrow M^{n+} + ne^-$ (oxidation)

2. +ve ions from the solution may deposit over the metal. $M^{n+} + ne^- \rightarrow M$ (reduction)

The above reaction takes place in an electrode then it is known as an origin of electrode potential.

05. Define oxidation potential and reduction potential.

Oxidation potential: The tendency of a metallic electrode to lose electrons, Reduction potential: The tendency of a metallic electrode to gain electrons.

06. How an electrochemical is measured? Define EMF of an electrochemical cell.

It is measured by EMF: "**The difference of potential which causes flow of electrons from one electrode of higher potential to the other electrode of lower electrode potential".** EMF= E_R-E_L

07. What are the applications of electrochemical cell?

- Determination of sparingly soluble salt.,Determination of the valency ion.
- Determination of standard free energy change and K.
- Potentiometric titrations can be carried out. Hydrolysis constant can be determined.

08. Define electrochemical series.

When various types of metallic electrodes are arranged in their increasing order of standard reduction potential on the basis of hydrogen scale is known as emf series.

09. Write the significance of electrochemical series.

- To calculate the standard emf of the cell., Relative ease of oxidation or reduction.
- Displacement of one element by the other. Hydrogen displacement behavior.
- Determination of equilibrium constant (K) for the reaction.

10. Write the mathematical form of Nernst equation and give one application.

$E = E^{o} + 0.0591/n \log [M^{n+}]$

Application: 1.It is used to calculate electrode potential of unknown metal.

2. Corrosion tendency of metals can be predicted.3. Applications of emf series.

11. Define corrosion.

The gradual destruction of the metal or an alloy surface by the chemical or electrochemical reaction with its environment. (i.e) metal into metal oxide.

12. What are the types of corrosion?

- Chemical corrosion.
- Electrochemical corrosion.

13. What are the factors which affect corrosion?

- Air and moisture.
- Electrolytes in water
- Presence of impurities in metal.
- Presence of gases like CO_2 and SO_2
- Differential aeration.

14. Define chemical corrosion. What are the types of chemical corrosion?

It is known as dry corrosion. It is due to the local attack of metal surfaces by the atmospheric gases like oxygen, H_2S, SO_2, N_2, etc. **3 types.** 1. Oxidation Corrosion. 2. Corrosion by other gases. 3. Liquid-metal corrosion.

15. Define an Electrochemical corrosion. What are the types of Electrochemical corrosion?

It occurs due to the existence of separate “anodic” and “cathodic” areas between which current flows through the conducting solution. At anodic area

oxidation occurs and anodic part of metal is destroyed. (i). Galvanic corrosion. (ii). Concentration cell / Differential aeration corrosion.

16. What are the differences between chemical and electrochemical corrosion?

Chemical corrosion	Electrochemical corrosion
1) It occurs dry state	Wet state (i.e) presence in moisture
2) Local attack to metal by environment	Large number of cathodic and anodic areas
3) Chemical corrosion is self-controlled	It is continuous process
4) It follows adsorption mechanism	It follows electrochemical reaction
5) Ex: formation of mild scale on iron surface	Ex: rusting of iron in moisture

17. What is Pilling Bed worth rule?

The ratio of the volume of the oxide formed to the volume of the metal consumed is pilling bed worth rule

18. Bolt and Nut made of the same metal is preferred in practice . Why?

Because such a combination will not permit galvanic corrosion to take place.

19. What are the methods used to control the corrosion?

1. Sacrificial anodic method 2.Impressed current cathodic method

20. What is paint?

Paint is a mechanical dispersion of one or more finely divided pigments in a medium (thinner + vehicle) .When paint is applied to a metal surface; the thinner evaporates, while the vehicle undergoes slow oxidation forming a pigmented film.

21. Differentiate Electroplating and Electro less plating

Electroplating	Electro less plating
It is carried out by passing current	Used reducing agent
Separate anode is employed	Catalytic surface of the substrate acts as anode
Anodic reaction is $M \rightarrow M^{n+} + ne^-$	Anodic reaction is $R \rightarrow 0 + ne^-$
Thickness of the plating is 1-100μm	It has a thickness of 1-100μm

22. Define Electro plating and Electro less plating

- **Electro plating:**
  It's a process in which the coating metal is deposited on the base metal by passing a direct current through an electrolytic solution containing the soluble salt of the coating metal.

- **Electro less plating:**
  It is a technique of depositing of a noble metal from its salt solution on a catalytically active surface of a base metal by using a suitable reducing agent.

UNIT – III ENERGY SOURCES

1. What is nuclear energy?

The energy released by the nuclear fission reaction is called nuclear energy.

2. What is nuclear fission reaction?

The process of splitting of heavy nucleus into two or smaller nuclei with Simultaneous liberation of large amount of energy in the form of heat is known as nuclear fission reaction.

$$_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{56}Ba^{140} + {}_{36}Kr^{93} + 3{}_{0}n^{1}$$

3. What is nuclear fusion reaction? Give one example.

The process of combination of two or more lighter nuclei into heavier nuclei, with simultaneous liberation of large amount of energy is known as nuclear fusion reaction.

Ex: $_{1}H^{1} + {}_{1}H^{1} \square {}_{2}H^{4}$ **+energy**

4. Differentiate nuclear fission and fusion reaction.

Nuclear fission	Nuclear fusion
It is the process of breaking the heavier nucleus.	It is the process of combination of lighter nuclei.
It emits radioactive rays	Does not emit radioactive rays.
Occurs at ordinary temperature	At high temperature($>10^6$K)
Chain reaction takes place	No chain reaction.
Emits neutrons	Emits positrons
It can be controlled	Cannot be controlled

5. Define nuclear chain reaction.

It is a nuclear reaction, in which neutrons from a previous step propagate and repeat the reaction. It takes place only nuclear fission reaction.

6. What are fissile and fertile nuclides?

- Fissile – Fissionable materials like U^{235}
- Fertile – Non- Fissionable materials like U^{238}

7. What are solar cells? Give one example./What is a photo galvanic cells?

It is a device, Converting solar energy directly into electrical energy. It provides power supply for space satellites. Ex: solar water heater, photovoltaic cell

8. What is solar energy conversion?

It is the process of conversion of direct sunlight into more useful forms. It undergoes mainly two types of mechanisms. 1. Thermal conversion. 2. Photo conversion.

9. What are the merits of wind energy?

- Nonpolluting and sustainable energy source.
- The scope of wind energy is enormous.
- It is a renewable and sustainable energy source.
- It is available in many offshore, onshore and remote areas.

10. What are batteries?

It is a device, converted chemical energy into electrical energy. It is an arrangement of electrochemical cells connected in series, and it can be used as a source of direct electric current.

11. Define breeder reactor.

Breeder reactor is one which converts non-fissionable material into fissionable material. Non-fissionable material ====➔ fissionable material.

Ex: $_{92}U^{238} + {}_{0}n^{1} \rightarrow {}_{94}Pu^{239} + 2\ e^{-}$

Non-fissionable fissionable

$_{94}Pu^{239} + + {}_{0}n^{1} \rightarrow$ **fission products +** $3\ {}_{0}n^{1}$

12. What are non-conventional energy sources? Give two examples.

Non-conventional energy sources are those energy sources which are exposed to use from modern technological advancements; rather than the normal use of conventional fuels as energy sources like gas or oil.

Ex: 1. Wind energy 2. Solar energy 3.Tidal energy 4. Hydropower energy

13. What is a fuel cell?

It is a device in which the chemical energy of the fuel hydrogen is directly converted into electrical energy without combustion. Fuel + Oxygen → Oxidation products + Electricity.

14. **What are the advantages of fuel cell? Or what are the advantages of H_2-O_2 fuel cell?**

It is used as an auxiliary energy source in space vehicles, submarines. Used in military vehicles. It is a pollution free one. The product is water, so it is a valuable source of fresh water by the astronauts.

15. What are the applications of lithium batteries?

Used in cell phones, Digital cameras, Watches, Remote cars, Calculators, Toys, Backup batteries in computers, etc.

16. List any two advantages of lithium batteries.

Its cell voltage is high, 3V. **Li** is a light-weight metal, only 7g (1 mole) material is required to produce 1 mole of electrons. It contains solid material so there is no leakage from battery. This battery can be made in a variety of sizes and shapes.

17. Define alkaline battery.

- It is called as a dry cell.>It has the electrolyte of KOH
- A zinc cylinder is filled with an electrolyte of Zn, KOH and MnO_2
- A carbon rod acts as a cathode and zinc body acts as a anode.

18. What are the general components in nuclear reactor?

The components are fuel rods, control rods, moderators, reflectors, coolants and pressure vessel, Turbine.

UNIT – IV ENGINEERING MATERIALS

1. **What are abrasives?**
   Abrasives are hard substances used for Grinding, cutting, Shaping, drilling, polishing and sharpening operations. Ex: Diamond, Talc

   Property of an Abrasive = Hardness
2. **How abrasives are classified? Give example for each.**
   Abrasives are classified into two types.
   - Natural abrasive Ex: Talc, Diamond.
   - Synthetic abrasive Ex: SiC and B_4C.

3. **What are natural abrasives?**
   Abrasives are obtained from nature is called natural abrasives. Ex: Talc, Diamond, Topaz.

4. **What are synthetic abrasives?**
   Abrasives are prepared from man - made and obtained some chemical reactions. Ex: silicon carbide (SiC)

5. **What is moh's scale of hardness?**
   It is a scale in which common abrasives are arranged in their increasing order of hardness. In this scale, lowest: talc (hardness number is 1) highest: diamond(hardness number is 10)

6. **Define Refractories.**
   Refractories are materials that can withstand very high temperature without softening or deformation in shape.Ex: Alumina bricks, Magnesite bricks, Zirconia bricks.

7. **How refractories are classified? Give example for each.**
   Refractories are classified into three types.
   - Acidic refractories Ex:Alumina bricks.
   - Basic refractories Ex: Magnesite bricks.
   - Neutral refractories Ex: Zirconia bricks

8. **What are the properties of Refractories?**
   - Refractoriness
   - RUL- Refractoriness Under Load
   - Porosity
   - Thermal spalling
   - Dimensional stability.

9. **What is RUL?**
   The temperature at which the refractory deforms by 10% is called RUL. i.e the load bearing capacity of a refractory can be measured by RUL Test.

10. **Define refractoriness of a refractory. [Jan'10]**
    It is the ability of a refractory material to withstand very high temperature without softening or deformation under the working conditions.

11. **What is meant by thermal spalling with respect to a refractory? [Jun'10]**
    It is the property of a refractory breaking, cracking or peeling of refractory material under high temperature. It is mainly due to (i).rapid change in temperature. (ii) Slag penetration

12. **What is Porosity?**
    It is defined as the ratio of its pore volume to the bulk volume.
    Porosity = W-D / W-A X100

13. **How SiC is prepared?**
    It is prepared by heating a mixture of 60% sand (i.e) SiO_2 and 40% coke with a small amount of saw dust and a little salt in an electric furnace to about 1650^oC for 36 hours.
    SiO2 + 3C ====➔ SiC + 2CO

14. **What do you mean by Portland cement?**
    A paste of cement with water on setting and hardening resembles in colour and hardness to Portland stone, a lime stone quarried in Dorset. It is obtained by heating clay containing material and lime containing material to about 1500^oC and mixed with gypsum.

15. What are the properties of Portland cement?
Setting and hardening and Heat of Hydration.

16. What do you mean by hardening and setting of cement?
Setting: Stiffening of the original plastic mass, due to initial gel formation. Hardening: Development of strength, due to crystallization.

17. Give two examples of special cement.
White cement, water proof cement.

18. Name 2 water proofing agents added to make water proof cements?
Calcium stearate and Aluminum stearate.

19. Give any 2 uses of waterproof cement.
Used in the construction bridges and structures under water.

20. Give any 2 uses of white cement.
- Repairing and joining marble pillars and blocks, manufacture of tiles and mosaic works.
- Used in the construction bridges and structures under water.

21. What is glass?
It is an amorphous, hard, brittle, transparent or translucent, super cooled liquid obtained by fusing a mixture of a number of silicates. Silicates of Na, Ca, Pb are mostly used.

22. Mention some types of glass.
Soft glass, hard glass, laminated glass, glass wool, flint glass, silica glass.

23. How is bullet resistant glass prepared?
By pressing together several thin layers of glass with vinyl resin in alternate layers.

24. What is the chemical difference between soft glass and hard glass?
$Na_2O.CaO.6SiO_2$ & $K_2O.CaO.6SiO_2$

UNIT – V FUELS AND COMBUSTION

1. Why coke is prepared to coal for metallurgical purpose?
- higher strength
- higher porosity
- lesser sulphur content and
- Short flame burning characteristics.

2. What is Cottrell's process in crude oil refining?

The removal of salt water from crude oil in an electrical method is known as Cottrell's process in crude oil refining.

3. Distinguish between straight run gasoline and derived gasoline.

Straight run gasoline: It is obtained from fractional distillation of crude petroleum oil. Derived gasoline: It is obtained from cracking and polymerization of coal.

4. Define Cetane number of a diesel fuel.

% of cetane in a mixture of cetane and α-methyl naphthalene having the same ignition delay as the test oil.

5. What is meant by octane number of a gasoline?

% of octane in a mixture of iso-octane and n-heptane which matches the fuel under test in knocking characteristics.

6. Define coal.

- It is an example for solid fuel.
- It has been formed as a result of alteration of vegetable matter under some favorable conditions.

7. Define metallurgical coke.

When bituminous coal is heated strongly in the absence of air, the volatile matter escapes out and the mass becomes hard, strong, porous which is called metallurgical coke.

8. What is knocking? How is it to be reduced?

It is a kind of explosion sound due to rapid pressure raise occurring in an internal combustion engine. It is reduced by adding anti-knocking agents like TEL.

9. What is CNG? Give its uses.

- It means Compressed Natural Gas.
- When natural gas is compressed to a pressure of about 1000 atm is known as CNG.
- It contains fully of methane and derived from natural gas.
- Its composition is as follows; CH_4=70-90% , C_2H_2=5-10% , H_2=3% Uses: CNG is a cheapest, cleanest and the least polluting fuel for automobiles.

10. What is Power Alcohol?

When ethyl alcohol is blended with petrol at concentration of 5-10%, called as power alcohol.

11. Define GCV and NCV

GCV: The total amount of heat is produced, when a unit quantity of the fuel is completely burnt and the products of combustion are cooled to room temperature is known as GCV.

NCV: The total amount of heat is produced, when a unit quantity of the fuel is completely burnt and the products of combustion are allowed to escape is known as NCV.

12. What is Water gas? Give its uses.

- It is a mixture of CO and H_2 with small amount of N_2.
- Its composition is CO=41%,H_2=51%,N_2=4% and CO_2=4%

Uses:

- It is used for preparation of power alcohol, for the production of H_2 and in synthesis of ammonia, to manufacture synthetic petrol in Fischer-Tropsch process.

13. What is Producer gas? Give its uses.

- It is a mixture of CO and N_2 with small amount of H_2.&Its calorific value is 1300 kcal/m^3
- Its composition is CO=30%, N_2=51-56%, H_2=10-15%, and others=rest.

Uses:

- It is used as a reducing agent in metallurgical operations, Used for heating muffle furnaces and open-hearth furnaces.

14. How fuels are classified? Give one example.

a) Solid Fuel – Coal. b). Liquid Fuel – Crude Oil. c). Gaseous fuel – Natural Gas.

15. Define Carbonization.

The process of converting coal into coke is known as carbonization. [When coal is heated strongly in the absence of air it is converted into dense, porous and coherent known as coke.]

16. What is LPG? Give its uses.

- It is obtained as a byproduct during the cracking of heavy oil.
- Its composition is Butane= 27% , Isobutane=25%,Butylene=43%,Propane =5%
- **Uses:**
- It is used as a domestic fuel.
- It is used as a fuel in vehicles (i.e) motor fuel
- It is used in Industries and laboratories.

17. What is Bio-Diesel?

A biofuel intended as a substitute for diesel. **Biodiesel** refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl esters. Biodiesel is typically made by chemically reacting lipids with an alcohol producing fatty acid esters.

18. What do you mean by ignition temperature?

The lowest temperature at which combustion begins and continues in a substance when it is heated in air. Also known as autogenous ignition temperature.

19. Define explosive range.

The range between the lower explosive limit (LEL) and the upper explosive limit (UEL) is known as explosive range.

20. What do you mean by combustion of fuels?

Combustion is a chemical reaction chemical that occurs between a fuel and an oxidizing agent that produces energy, usually in the form of heat and light.