Applied Chemistry II
(Dec 2019)

Q.P. Code – 67598

Q 1 Answer any 5 of the following **15M**

a. What is passivity? With an example explain how it affects the rate of corrosion.

- "Phenomenon in which a metal or an alloy exhibits a much higher corrosion resistance than expected from its position in the electrochemical series".
- Passivity is the result of the formation of highly protective but very thin and quite invisible film on the surface of metal or of an alloy, which make it noble.
- Such film is considered to be insoluble, nonporous and of "Self heating nature" that when broken will repair itself.
- Examples of passive metals and alloys are: Ti, Al, Cr, stainless steel containing Cr.
- This material exhibit corrosion resistance in oxidizing environments, but in reducing environment they become active

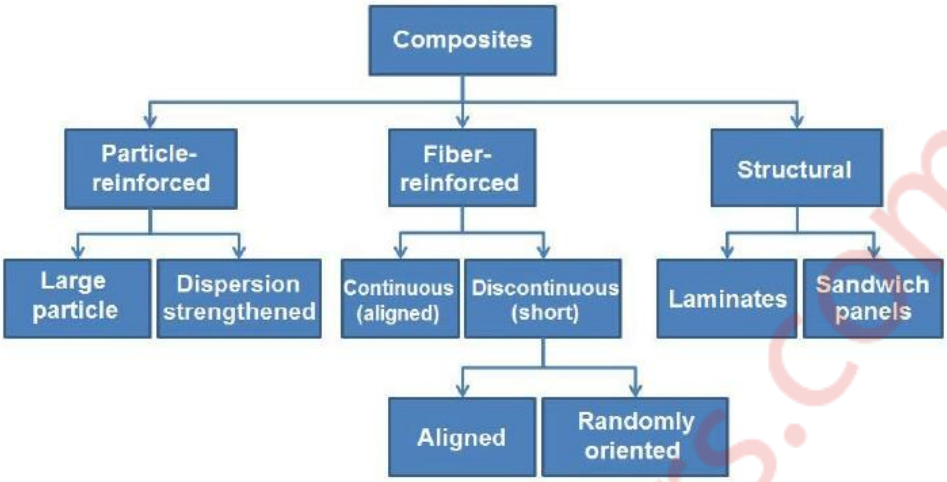
b. Name a Green Solvent and explain its properties.

The solvents which are not harmful to the environment are called green solvents.

- **Super critical fluid** possesses properties of gases and liquids in an intriguing manner, which could offer range of applications/possibilities in both synthetic and analytical chemistry.
- **PEG (polyethylene glycol)** is rightfully called a green chemical, because it is inflammable, non-volatile, non-toxic to humans, animals and aqueous environment. Additionally, the polymer is biodegradable by bacteria found in sewage and soil.
- **Supercritical CO_2** is a fluid heated above the critical temperature and compressed to above critical temperature is known as super critical fluid. Supercritical CO2 is non-toxic, non-flammable and inexpensive.
- **Supercritical ionic liquid carbon dioxide** has found to be an energy conserving, selective and waste reducing alternatives to organic solvents and therefore is viewed as promising environmentally benign solvents. In addition, supercritical fluids can lead to reaction, which are difficult or even impossible to achieve conventional solvents.
- Some green solvent is also Ethanol, diethyl ether, toluene, etc.

c. Give the detailed classification of composites with Example.

- Composite Material: It is considered to be any multiphase materials that exhibits a significant proportion of the properties of both constituents of properties is realized. Example – Concrete, polymers, etc.
- Composites material are classified into 3 types particle reinforced, Fiber reinforced and Structural as shown below.
- Particle reinforced are further classified into 2 sub class that is large particle and Dispersion strengthened.
- Fiber reinforced is further classified into 2 sub class that is continuous which is aligned and discontinuous which is short.



- Discontinuous are further classified into aligned and random oriented.
- Structural also have 2 types that is laminates and sandwich panel

d. A coal sample was found to contain the following constituents: C=81%, H=6%, S=1%, N=2%, Ash=4% and rest is oxygen. Calculate the minimum weight of air requested at STP for complete combustion of 1 kg of the coal sample.

O% = 100 – [C% + H% + S% + N% + Ash%]
= 100 – [81 + 6 + 1 + 2 + 4]
= 100 – 94
O% = 6%

Constituents	% by weight	Weight per kg
C	81	0.81
H	6	0.06
S	1	0.01
N	2	0.02
Ash	4	0.04
O	6	0.06

Weight of Air = $\frac{100}{23}$ [2.67 C + 8 H + S - O]
= $\frac{100}{23}$ [2.67 X 0.81 + 8 X 0.06 + 0.01 – 0.06]
Weight of Air = 11.27 kg

e. State and explain the Pilling Bedsworth rule.

- Pilling-Bedworth rule: According to it "an oxide is protective or non-porous, if the volume of the oxide is at least as great as the volume of the metal from which it is formed".
- On the other hand, "if the volume of the oxide is less than the volume of metal, the oxide layer is porous (or non-continuous) and hence, non-protective, because it cannot prevent the access of oxygen to the fresh metal surface below".
- Thus, alkali and alkaline earth metals (like Li, K, Na, Mg) form oxides of volume less than the volume of metals.
- Consequently, the oxide layer faces stress and strains, thereby developing cracks and pores in its structure. Porous oxide scale permits free access of oxygen to the underlying metal surface (through cracks and pores) for fresh action and thus, corrosion continues non-stop.
- Metals like Aluminum forms oxide, whose volume is greater than the volume of metal.
- Consequently, an extremely tightly-adhering non-porous layer is formed. Due to the absence of any pores or cracks in the oxide film, the rate of oxidation rapidly decreases to zero.
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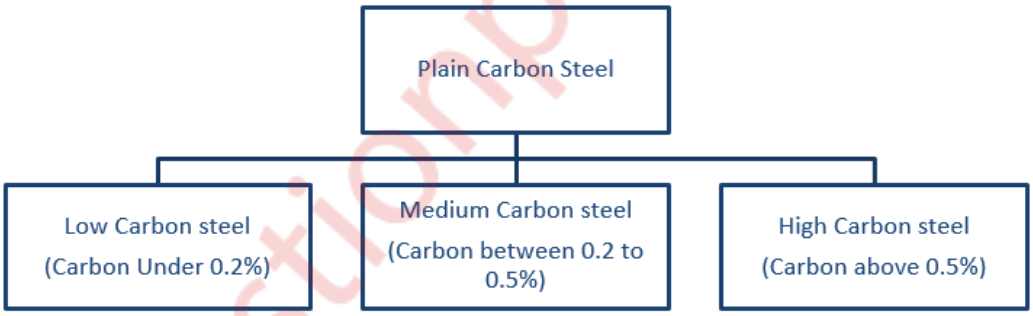
f. Give the classification and composition of plain carbon steels.

Plain Carbon steels are classified into three types as shown below:



1. Low Carbon Steel:

- It contains carbon under 0.2%
- It contains Sulphur and phosphorous of 0.055%.
- It is also known as mild carbon steel.
- They undergo corrosion and they are tough and ductile.
- It is used in roof covering, railway tracks, cranes, etc.

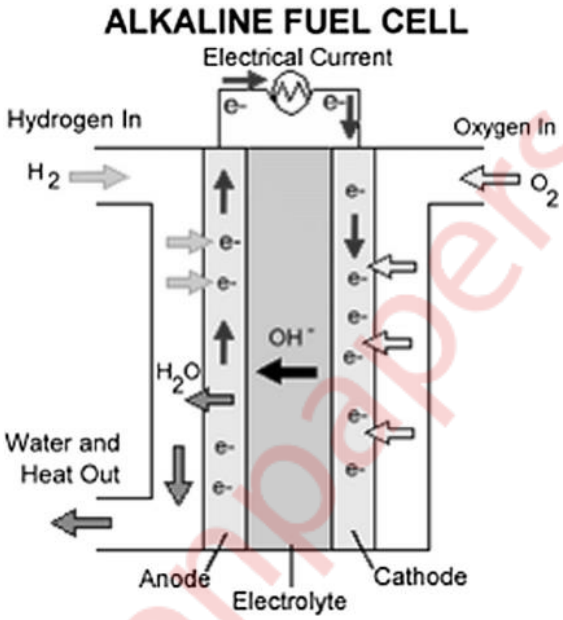
2. Medium Carbon Steel:

- It contains carbon between 0.2% to 0.5%
- It is shock resistance.
- It is tough and hard then mild steel.
- It is used in wheel gears, wires, wire ropes, etc.

3. High Carbon Steel:

- It contains carbon above 0.5%
- It is also known as hard steel.
- It is resistance to wear.
- It is tough and hard.
- It is used in blades, hammer, screw driver, etc.

g. Draw the diagram of the alkaline fuel cell, and write the reactions taking place at the anode and cathode.



Chemical Reaction

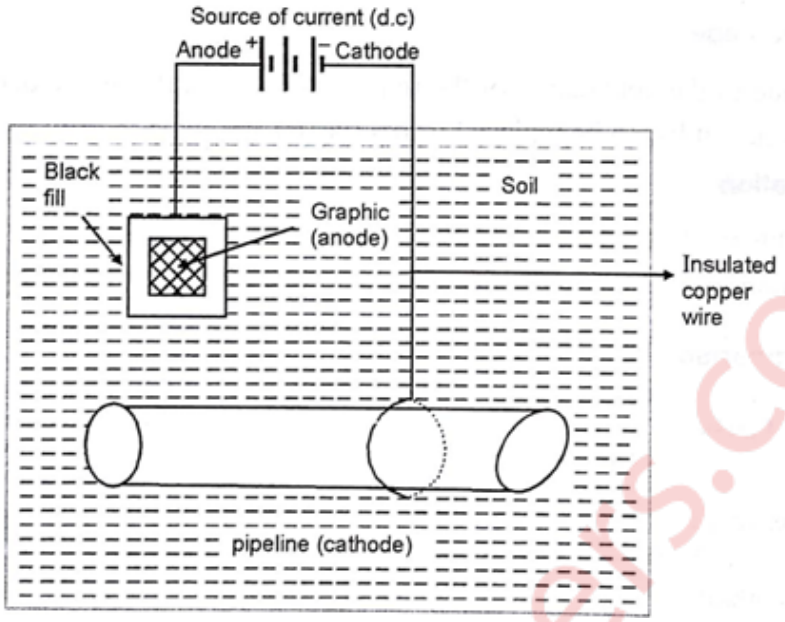
Anode: $2H_2 + 4OH \rightarrow 4H_2O + 4e^-$
Cathode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$
Net Cell: $2H_2 + O_2 \rightarrow 2H_2O$

Q 2.a. Explain the impressed current cathode protection method with the help of following points: -

1) **Principle and diagram** **6M**
2) **Explanation of process**
3) **Application**

Principle and diagram

Impressed Cathodic protection is a means to prevent corrosion by applying a flow of electrical current from an external source (anode) through the environment and on to the metallic structure that is being protected. This protective current changes the environment around the metal thus halting the corrosion reaction.



Explanation of process

- Current is applied in opposite direction to that of the corrosion current, thereby nullifying the effect of the later one on the base metal i.e. converting the base metal to cathode from an anode.
- Such impressed current obtained by using dc source such as battery or dry cell along with an insoluble anode such as platinum, stainless steel, graphite, etc.
- In this method as shown in figure the insoluble metal used is normally embedded underground to this with the help of dc current source.
- The impressed current is applied and whole of this assembly is connected to the metallic structure to be protected. The connection is done by using wires.
- The insoluble anodes are kept inside backfill made up of gypsum or any such material which can help in increasing.
- The electrical contact with soil such an anode can be single if the area of the metallic structure to be protected is small or there can be many such anodes which can be connected in series if the area of the metallic structure to be protected is wider i.e. a long pipeline.
- Due to application of impressed current anode deteriorates and hence it is to be replaced from time to time. Application of this method are seen in care of water tanks, buried pipelines, carrying water or oil condenser and transmission lines and ships.
- This method is highly useful because it can protect the long length structure for longer time. Thereby reducing the frequency if monitoring as well as maintenance cost. This both method is widely used because protection provided to the base metal is long term and maintenance is easy.

Application

- Pipelines
- Boat hulls
- Storage tank

b. i) 1.5gm of coal sample was kjeldahlised and the ammonia evolved was absorbed in 49ml N/10 H_2SO_4. After absorption the access H_2SO_4 required 32.5ml of 0.1N NaOH for neutralization. 0.5gm of the same coal sample was burnt in a bomb calorimeter and on treatment with $BaCl_2$ produced 0.08gm of $BaSO_4$. Calculate the percentage of nitrogen and Sulphur in the given coal sample. 3M

$$\text{Percentage of Nitrogen} = \frac{Volume\ of\ H_2SO_4 + NH_2SO_4 \ \ X\ 1.4}{Weight\ of\ coal}$$

$$= \frac{(49 - 32.5)\ \text{X}\ 0.1 \ \ X\ 1.4}{1.5}$$

$$= \frac{16.5\ \text{X}\ 0.1 \ \ X\ 1.4}{1.5}$$

Percentage of Nitrogen = 1.54 %

$$\text{Percentage of Sulphur} = \frac{Weight\ of\ BaSO_4\ \text{X}\ 32 \ \ X\ 100}{Weight\ of\ coal\ X\ 233}$$

$$= \frac{0.08\ \text{X}\ 32 \ \ X\ 100}{0.5\ X\ 233}$$

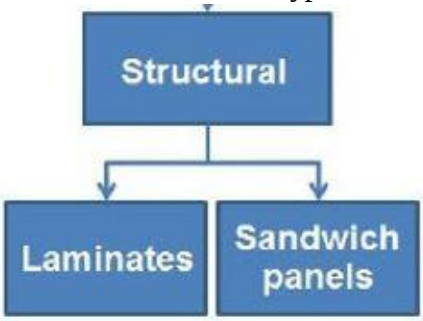
Percentage of Sulphur = 2.197 %

ii) Give an example to explain why it is beneficial to prevent waste formation in chemical processes rather than treat waste? 2M

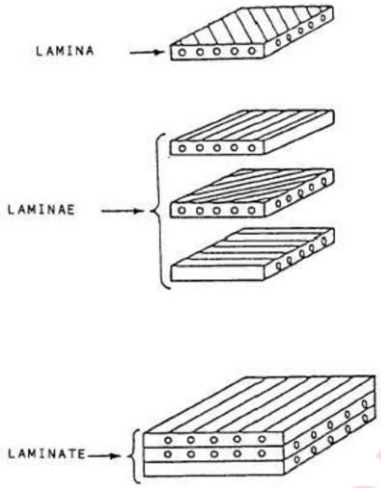
- It is best to prevent waste rather than to clean the waste after it is formed,
- It is best to design a new path to reduce or avoid the waste by doing new chemical synthesis.
- The waste treatment & disposal cost is added to the total cost production.
- The disposal of harmful gases, chemical into the atmosphere like flue gases, CO_2, etc. Which affects human health, birds, fishes, etc.
- The fertility od land is also decreased.
- Hence, the prevention of waste is must as we know, prevention is better than cure.
- Example – In synthesis of biodiesel waste formed is glycerin. One can convert glycerin into propylene glycol which is useful.

c. Classify structural composites and explain their properties and uses along with diagram. 4M

- Structural Composites are classified into two types as shown below:



- **Laminates**: Laminates are layers of materials joined by an organic adhesive.

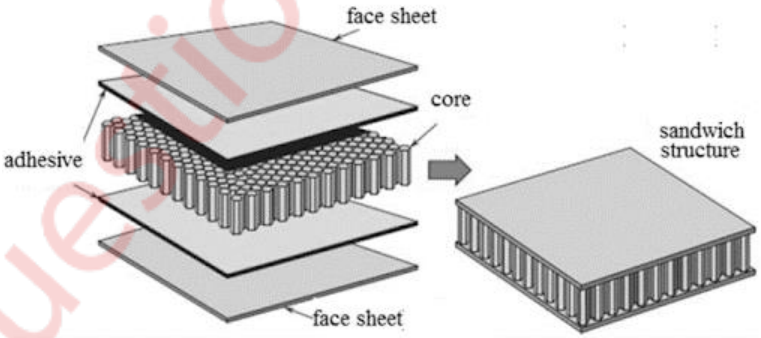


Properties:

- Resistance to creep, Have low coefficient of thermal expansion, High thermal conductivity.

Uses:

- Cladding - A laminar composite produced when a corrosion-resistant or high-hardness layer of a laminar composite formed onto a less expensive or higher-strength backing.
- Bimetallic - A laminar composite material produced by joining two strips of metal with different thermal expansion coefficients, making the material sensitive to temperature changes.
- **Sandwich:** sandwich is layered structure in which one layer is sandwich by other two.



Properties:

- Light weight, low density, hard

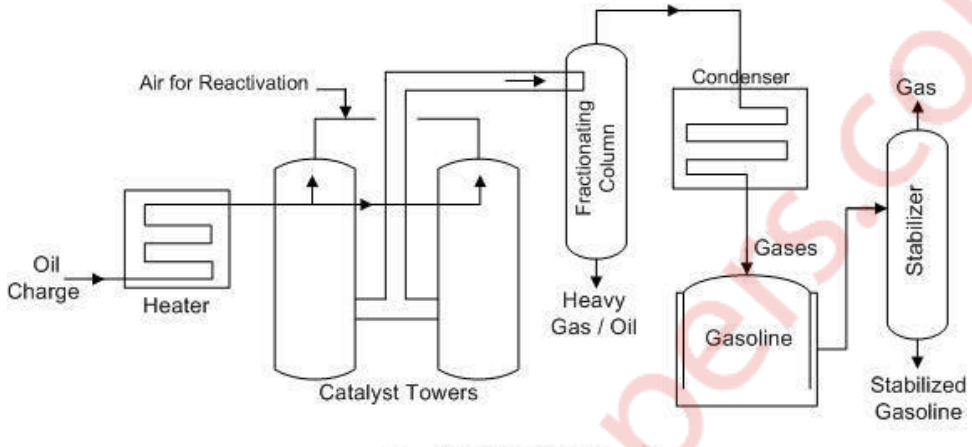
Uses:

- Aircraft: used in outer covering of rocket, aero plane, etc. due to its light weight.
- Transportation applications: including cars, subway cars and trains with an aim of reducing weight, emissions, and to integrate details for reduced manufacturing costs, acoustical and thermal insulation.

Q.3.a. Explain fixed bed catalytic cracking with the help of the following points: -
i) Principle ii) Labelled Diagram iii) Flow chart of process. 6M

Principle: The process of less volatile higher hydrocarbon molecule into more volatile lower molecular weight hydrocarbon by the application of fixed catalyst is called as fixed bed catalytic cracking.

Labelled Diagram



Fixed Bed Catalytic Cracking

Flow chart of process

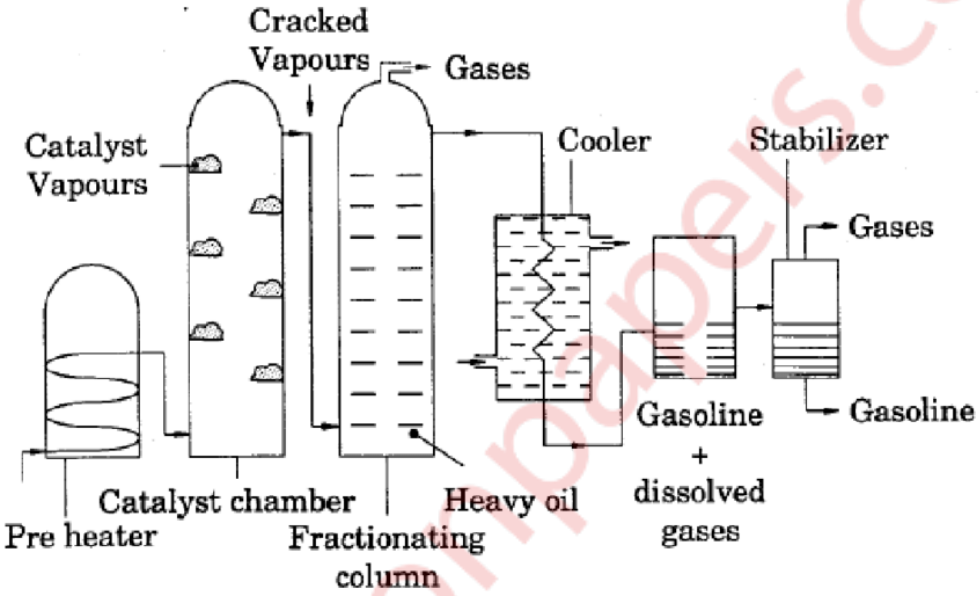
Fixed bed cracking

- In this method, vapors of the heavy oil are heated in the presence of catalyst due to which better yield of petrol is obtained.
- Heavy oil is vaporized by heating in an electrical heater. Then the vapors are passed over a series of trays containing catalyst. Generally, catalysts used are bauxite, zeolite, crystalline alumina silicate. And bentonite etc.
- The reaction chamber is maintained at –
  TP=425–5400C=1.5 kg/cm2T=425–5400CP=1.5 kg/cm2
- The cracked gases are taken out from the top of the reaction chamber and allowed to pass into fractionating tower, where gasoline fraction is collected. The octane value of Gasoline is about 80-85.
- During the cracking free carbon is also formed which deposits on catalyst then flow of vapors of heavy oil is passed over the second set of reaction chamber and the catalyst in earlier chamber is regenerated by burning the carbon deposits with the help of air and reused.

Detailed Process

- Heavy oil is in preheated to a temperature of about 425-4500C. the resulting vapours oil is charge is then forced through the catalytic chamber.
- The catalytic chamber is maintained at a temperature of 425-4500C and 1-5 kg/cm2pressure. Artificial clay mixed with zirconium oxide is used as a catalyst.
- About 40% of the charge is converted to gasoline and 2-4 is deposited over the catalyst bed as carbon.
- The vapor's containing heavy oil as well as cracked gasoline pass into the fractionating column where heavy oil condenses.

- The uncondensed vapor containing the cracked fraction is led to the coolers where some of the vapor condense to form uncondensed gases dissolved in gasoline.
- Gasoline containing dissolved gases is then sent through stabilizer where dissolved gases are removed and pure gasoline is obtained.
- After 8-10 hours of operation, the catalyst gets deactivated and has to be reactivated the catalyst tower is heated to about 5000C whereby the carbon deposited burns reactivating the catalyst.
- The process can be converted to a continues one by having catalyst towers. While the first tower in operation the second tower is being regenerated and vice-versa.



b. i) What are special steels? Explain the properties and applications of any one type of special steel. 3M

- Special steel is a unique alloy or chemical composition formed via distinct and superior production process. It possesses higher strength, more toughness, better physical & chemical properties, biocompatibility, and performance compared to ordinary steel.
- Different type of special steels is heat resisting steel, Nichrome, stainless steel, non-heat treatable stainless steel, non-magnetic, etc.
- Heat Resisting Steel: (Mo=3.5%, Cr=12%, C=0.5%)
  Properties: - Heat resistance
  - tougher and harder
  Application: - manufacturing of equipment's boiler part, furnace part and gas turbine.
- Nichrome: (Ni=60%, Cr=12%)
  Properties: - High resistance to oxidation.
  - high bearing ability.
  Application: - manufacturing of dental instrument and surgical instrument.

ii) Name the type of microscopic corrosion affecting Alpha brass and explain the conditions under which it occurs. 2M

- Dezincification can be caused by water containing sulfur, carbon dioxide, and oxygen. Stagnant or low velocity waters tend to promote dezincification. To combat this, arsenic or tin can be added to brass, or gunmetal can be used instead.

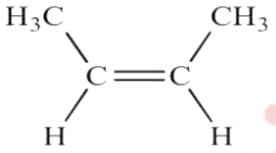
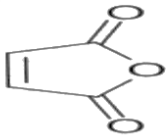
Condition

- The service conditions generally present where dezincification occurs include: Water with high levels of oxygen and carbon dioxide (uniform attack). Stagnant or slow moving waters (uniform attack). Slightly acidic water, low in salt content and at room temperature (uniform attack).
- Dezincification can be caused by water containing Sulphur, carbon dioxide, and oxygen. Stagnant or low velocity waters tend to promote dezincification. To combat this, arsenic or tin can be added to brass, or gunmetal can be used instead.

c. Calculate the percentage atom economy of the following reactions with respect to the target product maleic anhydride and state which is the greener reaction. 4M

a) $C_6H_6 + 4.5\ O_2 \rightarrow$  $+ 2\ H_2O + 2CO_2$

Maleic Anhydride

b)  $+ 3O_2 \rightarrow$  $+ 3\ H_2O$

Maleic Anhydride

a) % Atom economy = $\frac{\text{Molecular weight of desired product}}{\text{Total molecular weight of reactant}} \boldsymbol{X\ 100}$

Molecular weight of desired product (Maleic Anhydride) = 98 g/mol

Total molecular weight of reactant = $C_6H_6 + 4.5\ O_2$

= 12 X 6 + 1 X 6 + 4.5(16 X 2)

= 72 + 6 + 144

= 222 g/mol

% Atom economy = $\frac{\text{Molecular weight of desired product}}{\text{Total molecular weight of reactant}} \boldsymbol{X\ 100}$

$= \frac{98}{222} \boldsymbol{X\ 100}$

% Atom economy = 44.14%

b) % Atom economy = $\frac{\text{Molecular weight of desired product}}{\text{Total molecular weight of reactant}} \boldsymbol{X\ 100}$

Molecular weight of desired product (Maleic Anhydride) = 98 g/mol

Total molecular weight of reactant = C_4H_8(cis-2-butene) + 3 O_2

= 12 X 4 + 1 X 8 + 3(16 X 2)

= 48 + 8 + 96

= 152 g/mol

% Atom economy = $\frac{\text{Molecular weight of desired product}}{\text{Total molecular weight of reactant}} \boldsymbol{X\ 100}$

= $\frac{98}{152} \boldsymbol{X\ 100}$

% Atom economy = 64.47 %

Q.4.a. How do the following factors affect the rate of corrosion:
i) Conductance of corroding medium ii) Relative area of anode and cathode iii) temperature **6M**

- **Conductance of corroding medium**

Metals with higher conductivity corrode easily. The increase in conductance of the medium leads to increase in the diffusion rate. which again leads to an increase in the corrosion rate. The noble metals like gold, platinum and silver whereas the metals with lower reduction potentials readily undergo corrosion. Example= Zn, Mg, Al etc.

$$\text{Rate of Corrosion } \alpha \text{ conductance of the corroding medium}$$

- **Relative area of anode and cathode**

When 2 dissimilar metals are in contact, the corrosion of the anode part is directly proportional to the ratio of areas of the cathodic part and anodic part.

$$\text{Rate of Corrosion } \alpha \frac{cathode}{Anode}$$

This is because when the cathode area is larger than the anode area, then the demand for electrons by the cathode area will be more which can only be met by the anodic area by undergoing faster corrosion. Thus smaller the area of the anode, faster the rate of corrosion.

- **Temperature**

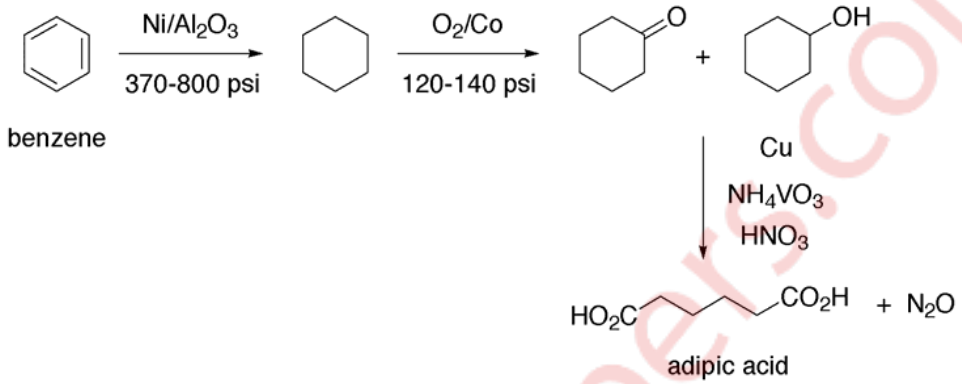
Rate of corrosion increases with increase in temperature. This due to the increase in conductance of the medium with increase in temperature and hence an increase in the diffusion rate. As a consequence, corrosion progresses faster at higher temperatures. In some cases, rise in temperature decreases passivity, which again leads to an increase in the corrosion rate.

$$\text{Rate of Corrosion } \alpha \text{ Temperature}$$

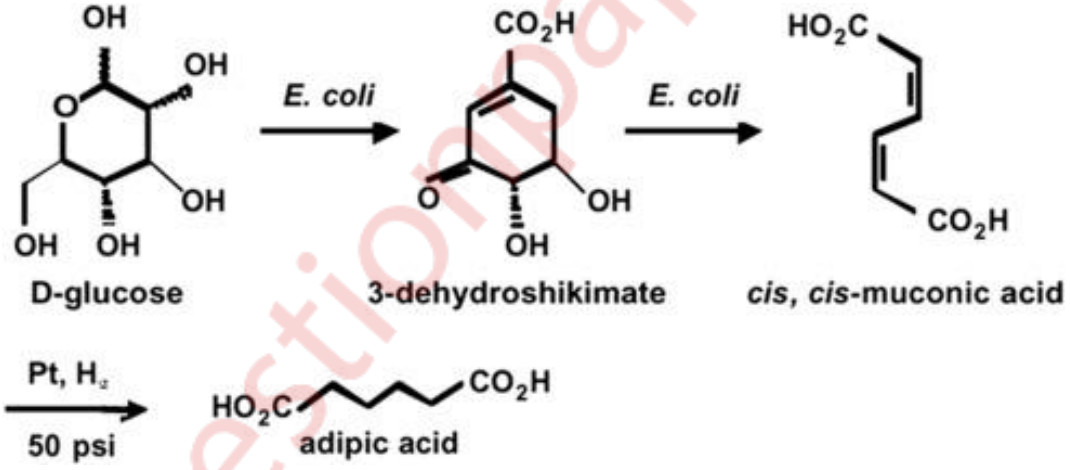
b. i) Give the traditional and green synthesis of adipic acid and compare the starting materials used. 3M

- The commercial method makes use of benzene for synthesis whereas green synthesis use D-glucose.
- It is used in preparation of Nylon-66 & other reagents.

Commercial Routes / traditional



Green Chemistry Routes



- Benzene is used as starting compound in traditional route which is carcinogenic (Cancer causing substance) and carbon monoxide is poisonous gas to avoid this green chemistry routes are used. In which D-glucose is used as stating compound which is not dangerous.

ii) What are the properties of composites which make them popular engineering material. 2M

Properties of Composites

- Tensile strength of composites is 4-6 times greater than that of conventional materials like steel, aluminum, etc.
- Improved torsion stiffness and impact properties.
- Higher fatigue endurance limit (up to 60% of the ultimate tensile strength)

- 30-40% lighter than aluminum structures designed for the same functional requirements.
- Lower embedded energy.
- Composites are less noisy while in operation and provide lower vibration transmission.
- Composites are more versatile and can be tailored to meet performance needs and complex design requirements.

c. Give the composition and properties of any two:
i) German Silver ii) Magnalium iii) Woods Metal **4M**

i) German Silver
- Composition – Cu = 25-50%, Zn = 10-35%, Sn = 5-35%.
- Properties – Possesses good strength, high resistance to electrolyte, high ductility, malleability, appears like silver.
- Uses – Decorative articles, utensils, table wares, ornaments, cutlery etc.

ii) Magnalium
- Composition – Al = 70-90%, Mg = 10-30%.
- Properties – It is strong, tough, lighter than duralumin.
- Uses – scientific instruments, aeroplane parts.

iii) Woods Metal
- Composition – Bi = 50%, Pb = 25%, Sn = 12.5%, Cd=12.5%.
- Properties – Stable, low Melting Point, density 9.7, harmful by inhalation.
- Uses – useful as a low melting solder, casting metal, repairing antiques, etc.

Q.5.a. A gas has following composition by volume: H_2=10%, C_2H_6=25%, CO=16%, H_2O=20%, C_2H_2=15%, CH_4=4%, O_2=4% and the rest is CO_2. Calculate the volume of air to be supplied at STP per 2m^3 of the gas. (Average molar mass of air at STP = 28.94gm) **6M**

Sr No.	Constituents	% by weight	Weight per kg
1	H_2	10	0.1
2	C_2H_6	25	0.25
3	CO	16	0.16
4	H_2O	20	0.2
5	C_2H_2	15	0.15
6	CH_4	4	0.04
7	O_2	4	0.04
8	CO_2	6	0.06

1) $H_2 + \frac{1}{2} O_2 \rightarrow H_2O$
   1 volume of H_2 = 0.5 volume of O_2
   0.1 volume of H_2 = 0.05 volume of O_2
   O_2 for H_2 = 0.05 m^3

2) $C_2H_6 + 3.5\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$
   1 volume of C_2H_6 = 3.5 volume of O_2
   0.25 volume of C_2H_6 = 0.875 volume of O_2
   O_2 for C_2H_6 = 0.875 m^3

3) $CO + \frac{1}{2} O_2 \rightarrow CO_2$
   1 volume of CO = 0.5 volume of O_2
   0.16 volume of CO = 0.08 volume of O_2
   O_2 for CO = 0.08 m^3

4) Not Applicable
5) $C_2H_2 + 2.5\ O_2 \rightarrow 2\ CO_2 + 1\ H_2O$
   1 volume of C_2H_2 = 2.5 volume of O_2
   0.15 volume of C_2H_2 = 0.375 volume of O_2
   O_2 for C_2H_2 = 0.375 m^3

6) $CH_4 + 2\ O_2 \rightarrow CO_2 + 2H_2O$
   1 volume of CH_4 = 2 volume of O_2
   0.04 volume of CH_4 = 0.08 volume of O_2
   O_2 for CH_4 = 0.08 m^3

7) O_2 Already present
8) Not Applicable

Total O_2 required = 0.05 + 0.875 + 0.08+ 0.375 + 0.08
= 1.46 m^3
O_2 already present = 0.04 m^3
Actual O_2 required = Total O_2 required – already O_2 present
= 1.46 – 0.04
= 1.42 m^3

Volume of air
As we know, 1000 m^3 of air = 21 m^3 of O_2

2 m^3 of air = 0.42 m^3 of O_2
Volume of air = 1.42 m^3

$$\text{Volume of air} = \frac{1.42\ X\ 2}{0.42}$$

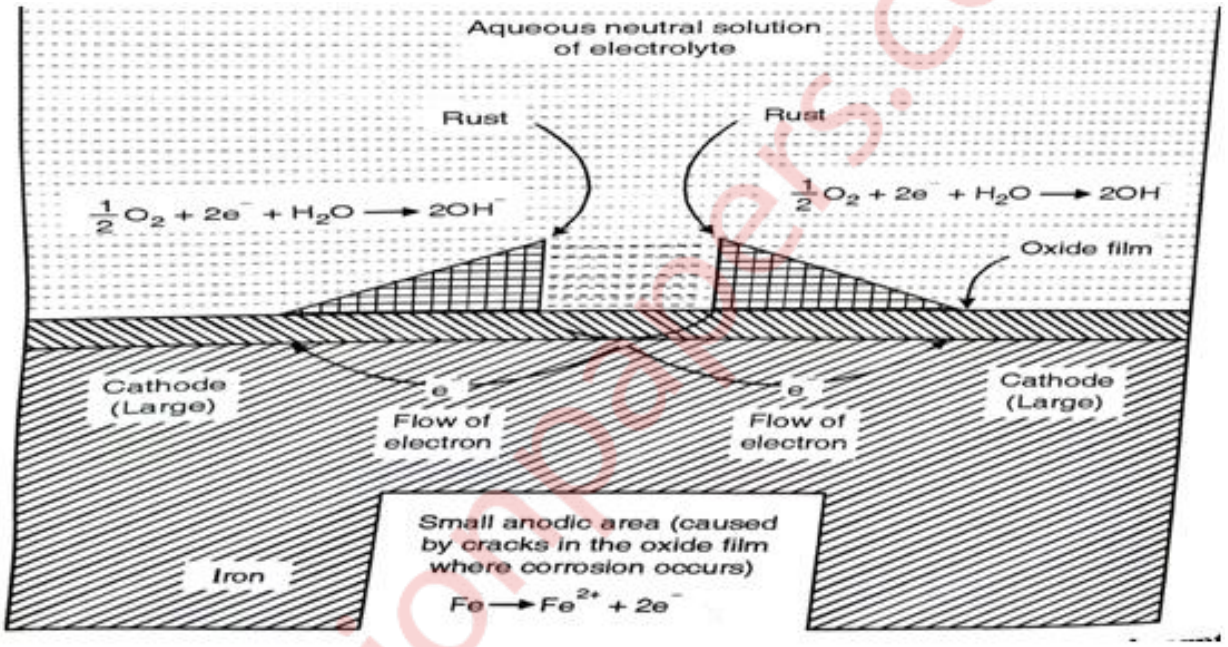
Volume of air = 6.76 m^3

b. i) Part of an iron nail corrodes inside a piece of wood. Identify the type of corrosion and explain the mechanism with a labelled diagram and reactions. 3M

- Wood is a hygroscopic material.
- hygroscopic means the material which absorb and release water.
- Thus, iron nail inside the wood is continuously in contact with water which leads to corrosion.
- This type of corrosion is called wet corrosion.

Wet Corrosion

- The wet corrosion in neutral and alkaline media take place by O2 absorption mechanism.



- Fe covered with oxide film acts as cathode and a crack in coating acts as an anode.
- At room temperature the water consists of 8ppm of O_2.
- Being larger area of cathode, protected layer of Fe^{2+} ions.
- At crack, anode Fe sheds e^- & goes into water as Fe^{2+} ions..

At anode (Oxidation)

$$Fe \rightarrow Fe^{2+} + 2e^-$$

- O_2 in water accepts e^- and OH^- is formed.

At Cathode (Reduction)

$$\frac{1}{2}O_2 + H_2O + 2e^- \rightarrow 2OH^-$$

- **Net Cell reaction** $H_2O + \frac{1}{2}O_2 + 2e^- \rightarrow Fe^{2+} + 2OH^-$
- $Fe^{2+} + 2OH^-$ combines to form $Fe(OH)_2$ & further precipitates $Fe(OH)_2$ Ferric hydroxide.

$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$$

ii) What is shape memory effect? 2M

- Shape memory effect (SME) is a phenomenon, in which a material recovers to its original size and shape when heated above a certain characteristic transformation temperature.
- This phenomenon results from a crystalline phase change known as thermoplastics martensitic transformation.
- At temperatures below the transformation temperature, shape memory alloys are martensitic. In this condition, their microstructure is characterized by self-accommodating twins.
- The martensitic is soft and can be deformed quite by de-twinning.
- Heating above the transformation temperature recovers the original shape and converts the material to its high strength, austenitic, condition.

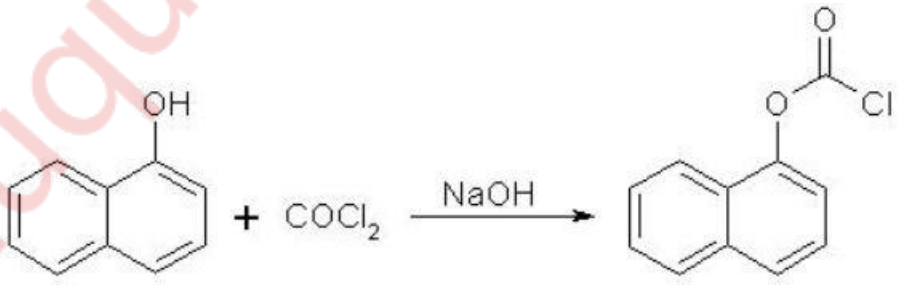
c. The Bhopal gas tragedy was one of the worst industrial disasters. With reactions explain the synthesis of the intermediate which caused the tragedy and the final product. Also give the alternative route of synthesis of the final product explaining the green chemistry principle being adhered to. 4M

Traditional Method

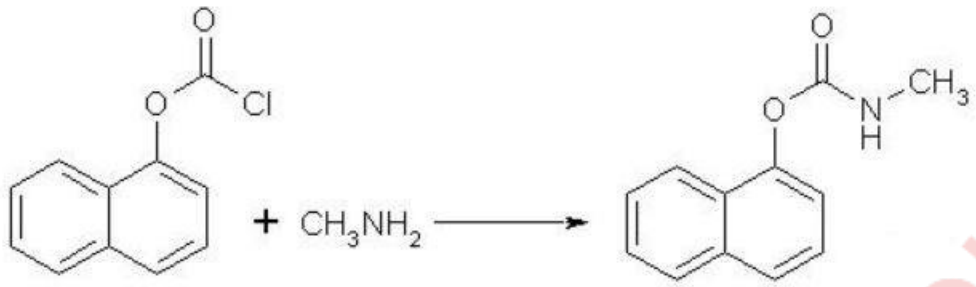
Methylamine phosgene Methyl isocyanate

1-naphthol Methyl isocyanate carbaryl

Green Chemistry Method



naphtol-1 phosgene 1-naphthalenyl chloroformate



1-naphthalenyl chloroformate Carbaryl

- Chemical products should be designed in such a way that it should not harm the environment.
- In traditional method Methylamine and phosgene is used which are dangerous. To avoid these methylamine is replaced by naphtol-1 in green chemistry which is not dangerious.
- Thus green chemistry emphasizes to design chemical products to be fully effective, yet have little or no toxicity.

Q.6.a. What are the steps involved in powder metallurgy? Name the different moulding techniques used. Explain any one method of moulding with detailed diagram. 6M

Steps involved in Powder Metallurgy

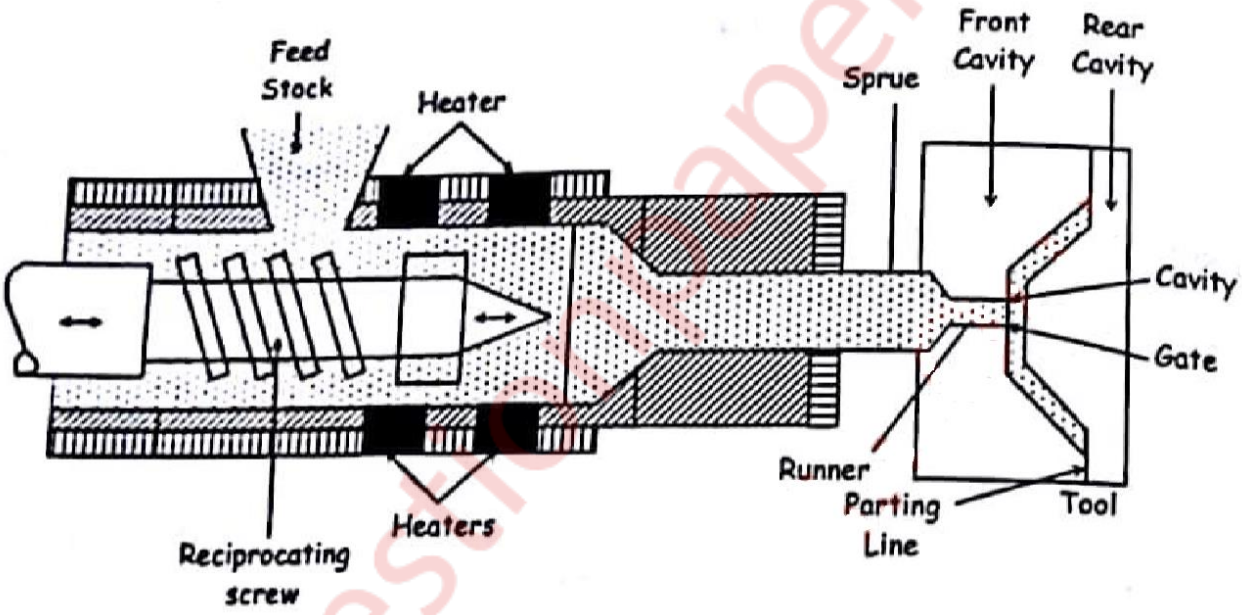
1. **Metallic powders**: Metals are converted in fine powder.
2. **Blending powders**: The fine powders are mixed along with a lubricant. The lubricant helps in imparting good fluidity to the powders.
3. **Filling Mould with mixture:** The mould is filled with above mixture of powder and lubricant.
4. **Compacting**: The blended powder is compacted in a mold or die.
5. **Sintering:** The compacted mass is sintered at a high temperature in a furnace in a controlled atmosphere.
6. **Sizing:** The sintered component is passed in a mold or dies to trim the component and achieve high dimensional accuracy.
7. **Machining:** If required final machining is done on some specific locations including drilling very small holes.
8. **Treatment:** Parts are subjected to deburring and tumbling to remove any small projections and other treatments like oil impregnation tec., are given.
9. **Inspection**: Finally, parts are inspected to check the quality.

Different Moulding Techniques are

- Cold Pressing
- Hot compaction
- Powder Injection Moulding.

Powder injection moulding

- The powder is mixed with 30-40 % of binder.
- The mixture is heated up with heater.
- It is injected into mould by screw.
- Mould is cooled and debinding is done.
- This method gives good stability and green strength of moulded product.
- User: This process creates very complex shapes from cemented carbides, tungsten, alloys, ceramics, etc.



b. i) How are particle reinforced composite different from fiber reinforced composite? **3M**

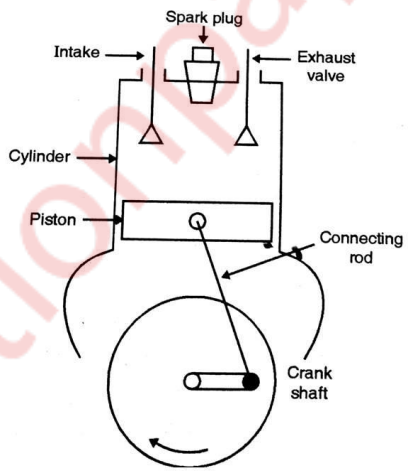
- Particle reinforced composites are less effective in strengthening the material than Fiber reinforced composites.
- Particle reinforced composites are usually used where high levels of wear resistance is required whereas this is not the case with fiber reinforced composites.
- Particle reinforced composites are cheaper and easy to produce than fiber reinforced composites.
- Particulate reinforced composites achieve gains in stiffness primarily, but also can achieve increases in strength and toughness.

ii) Distinguish between galvanizing and tinning. **2M**

Galvanizing	Tinning
1) Zn coating on iron/steel.	1) Tin coating on iron/steel/brass/copper.
2) In Galvanizing, Water bath is required.	2) In Tinning, Water bath is not required.
3) It cannot be used in acidic food stuff.	3) It can be used in acidic food stuff.
4) Galvanizing is cheaper.	4) Tinning is more expensive.
5) Highly effective for corrosion.	5) Less effective for corrosion.
6) They have high toughness. It cannot be moulded into machine.	6) They can be mechanized easily.

c. What is knocking? Explain the role of antiknocking agents. **4M**

- Knocking: A sharp metallic sound produces in the internal combustion engine due to immature (impurity) ignition of the air-gasoline mixture is called as knocking.
- In certain circumstances due to the compression the fuel air mixture heated to higher temperature their ignition temperature so that there is a spontaneous combustion & large portion fuel air mixture produce explosive sound is known as knocking.



- An antiknock agent is a chemical that, when added to gasoline, raises the octane value of the gasoline which, in turn, raises the temperature and pressure at which gasoline will auto-ignite. It allows the gasoline/air mixture to wait until the spark plug ignites the fuel, reducing pre-detonation which can be harmful to the engine.
- The octane rating of many fuel can be increased by adding certain antiknock agents to petrol. These compound which are added to vehicular or aviation petrol to improve their knocking property are called antiknock agents. The commonly used antiknock agents are Tetraethyl lead, Tetra methyl lead, etc.

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