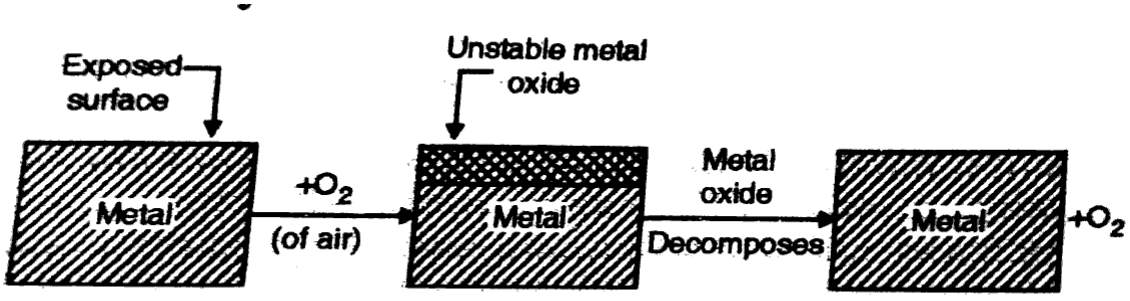
Chemistry-II

Q.1)Answer any five of following: (15 Marks)

a)Gold does not get corroded due to oxidation.Why?

Gold forms an **unstable oxide film** on metal surface.They get **decomposed** on metal **surfaces back to metal & oxygen**.Consequently,oxidation corrosion is not possible such a case.**Thus Pt,Au and Ag don't go under corrosion**

Metal+Oxygen →Metal oxide →Metal+Oxygen.



b) Give the composition,propoerties and uses of Duralumin.

- **Element Composition of Duralumina**
  - Al=95%
  - Cu=4%
  - Mn=0.5%
  - Mg=0.5%
- **Properties of Duralumina**
  - It is light weighted

- Highly ductile
- Easily castable
- Good conductor of heat and electricity
- Its tensile strength can be increased by heat treatment
- **It approaches steel in strength and yet its density is one third that of steel.**

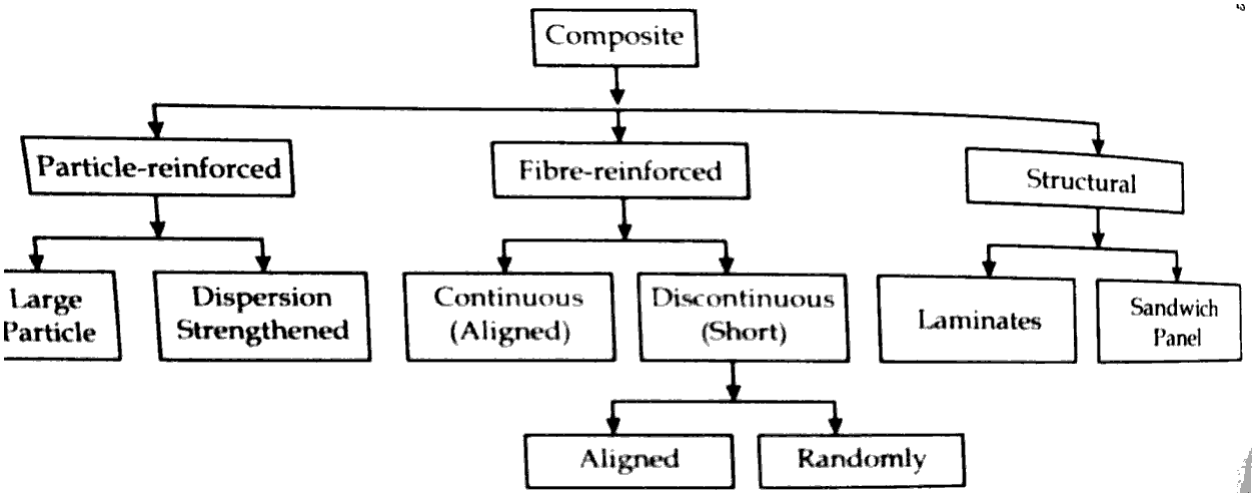
➢ **Uses**

- It is also used in making surgical instruments,cables,fluorescent tube caps etc.
- It is also used in making automobile and locomotive parts because of its high ductility and good electrical conductivity.

c)Define octane number and cetane number.

- **Octane No:-**The octane number can be defined as the **proportion by volume of isooctane** in a **mixture** of i**sooctane and n-heptane** which **shows** the **same knocking property** as the fuel under test.
- **Cetane No:**-The **percentage by volume of cetane** in a **mixture** of **cetane and α-methylnaphthalene** which just **matches** the **knocking characteristics of diesel oil** under test is called as cetane number.

- **d)Give classification of composite materials.** The composites are classified on the basis of reinforcing material or structure as follows:



e)List any Six principles of Green Chemistry.

1. Prevention of waste.
2. Non-hazardous chemicals.
3. Auxiliary substances.
4. Renewable feedstocks.
5. New analytical methods.
6. Safer chemicals.

f)Explain the advantages of galvanizing over tinning.

Metallic coatings are either anodic or cathodic depending upon the electrode potential of base method & coating metal.**They are used for the prevention of corrosion of metals**.Metallic coatings can be divided into anodic and cathodic coating.**Galvanising is a coating of Zinc over iron,here zinc acting as anode and exposed area of iron acting as cathode**.***It means area of anode is larger***.Comparatively **in tinning coating of tin is acting as cathode(large area)and exposed area of iron(small) acting as anode**.Here a***rea of anode is small therefore***

corrosion will be faster in tinned article as compared to galvanized article.Therefore,*galvanizing is more preferred than tinning.*

g)A coal sample contains C=70%,O=23%,H=5%,N=0.4%,Ash=0.1%.Calculate GCV and NCV of the fuel.

HCV=$\frac{1}{100}$[8080C+3500(H-O/8)+2240S)

=$\frac{1}{100}$[8080X70+34500(5-23/8)+2240X0)

=$\frac{1}{100}$[565600+73312.5]

=6389.12Kcal/kg.

LCV=[HCV-$\frac{9}{100}$ X H X 587]

=[6389.12-$\frac{9}{100}$ X 5 X 587]

=[6389.12-264.15]

=6124.97 Kcal/kg.

Q.2)a)Explain the following factors affecting the rate of corrosion.(15 marks)

i)Relative areas of anode and cathode:If the **anodic area** is **very small** as compared to **cathodic area**,**corrosion occurs**.The **reason** is **current density** at a **smaller anodic** area is **much greater** and the demand for electron by the cathodic area.

ii)Effect of pH:**Acidic mediums** are **more corrosive** than **neutral or alkaline mediums**.All the metals have a **particular pH value** at which it

has highest corrosion resistance,**below and above that value** it **corrodes** faster.

iii)Purity of Metal:**If** metals are **impure**,then **impurities** present in them **cause heterogeneity** which **gives rise to small electro chemical cells** at the sites where **metal & impurities are exposed** top environment,& **thus corrosion starts affecting the entire metal**.

b)i)0.5gm of coal sample was burnt in Bomb Calorimeter experiment produced 0.06gm of $BaSO_4$.Calculate percentage of sulphur.

Data:

Weight of $BaSO_4$=0.06gm

Weight of coal=0.5gm

To find: %S

Solution:

$$\%S=\frac{\text{Weight of BaSO4 X 32 X 100}}{\text{Weight of coal X 233}}$$

$$=\frac{0.06\ X\ 32\ X\ 100}{0.5\ X\ 233}$$

=1.64%

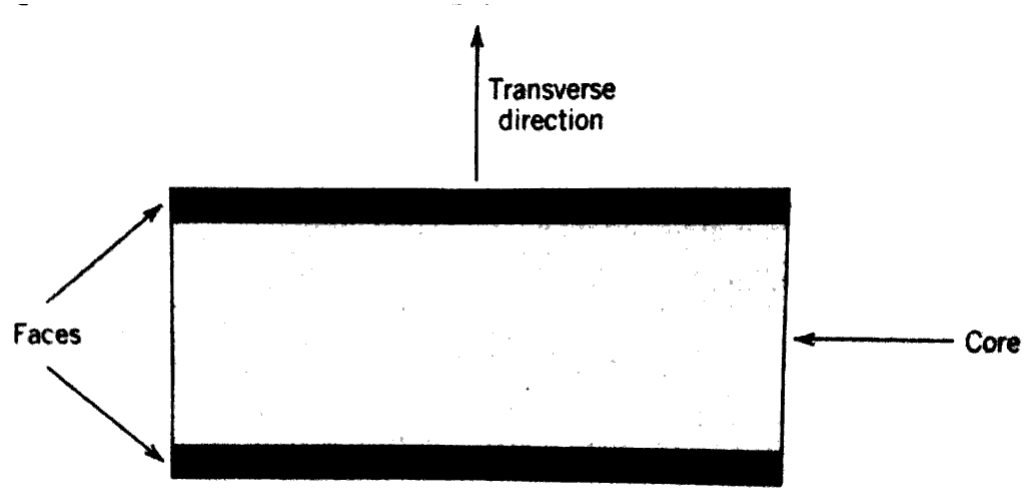
b)ii)What is supercritical CO_2?Give one application of it.

Supercritical Fluids:- **A fluid heated to above the critical temperature and compressed to above critical pressure is known as supercritical fluid**.Supercritical carbon dioxide is **non-flammable,non toxic and inexpensive**.As the **solubility** of **most of the solute changes** near the

critical point,they can be **recovered from** the **solvent** by **reducing** the **pressure/temperature to below critical point**.

c)Write a note on sandwich panel type layered composites.

Sandwich Panels:Sandwich panels are designed to be light-weight beams or panels **having relative high stiffness and strengths**.A sandwich panel **consists of two outer sheets or faces** that are separated by and adhesively binded to a thicker core.**Faces are made of a relatively stiff and strong material,typically aluminium alloys,fiber-reinforced plastics,titanium,steel or plywood.**



Schematic diagram showing cross section of a sandwich panel

Functions:

i)**They impart high stiffness and strength** to the **structure**.

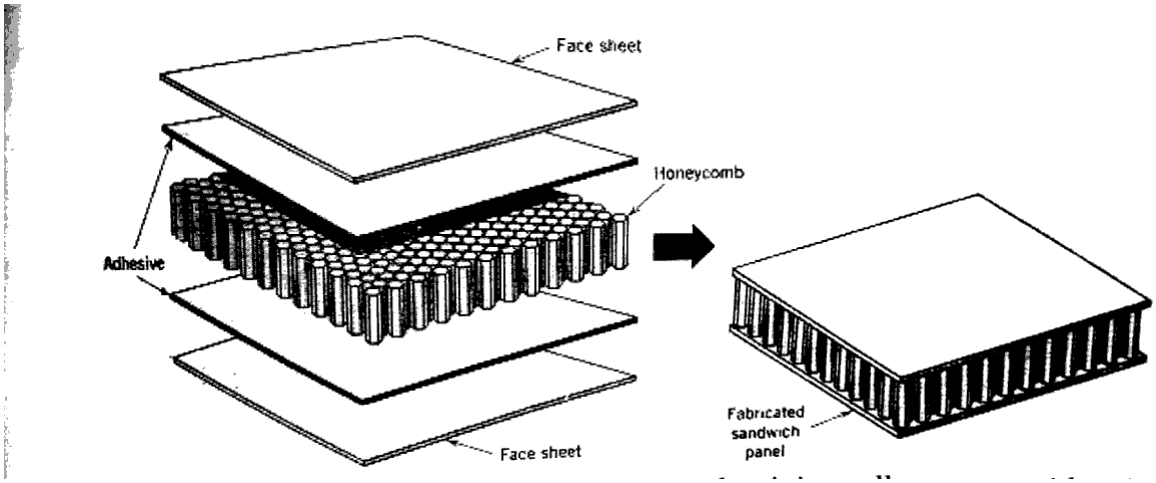
ii)They **must** be **thick** enough **to withstand tensile and compressive stresses** that result from loading.The **core** material is **light-weight** has a **low modulus of elasticity**.Typical "core" materials include **synthetic rubbers**,**formed polymers,balsa wood and inorganic cements**.

Core servers the following two structural functions:

i)It **separates the "faces"** and **provides continuous support** fit the faces.

ii)They **resist** any **deformations perpendicular to the face plane**.

iii)It **provides** a certain **degree of shear rigidity** along the planes **which are perpendicular** to the **"faces"**.**Another** popular **core** consists of a **"honeycomb" structure** thin foils that have been formed into **interlocking hexagonal cells**,with axes oriented perpendicular to the face plane.

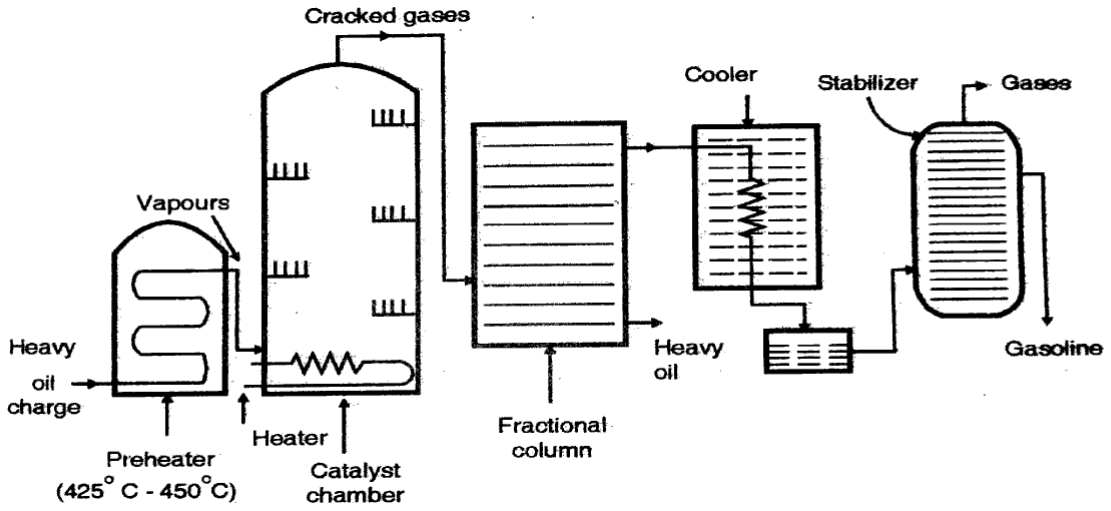


The **honeycomb material** is normally either an **aluminium alloy or aramid polymer**.**Strength and stiffness** of **honeycomb structures depend** on **cell size,cell wall thickness,and the material** from which the honeycomb is made.

Sandwich panels are **used** in a wide variety of applications including **roofs,floors,and walls of buildings,and in aeroplanes and aircraft(i.e for wings,fuselage and tailplane skins.)**

Q.3)a)With neat and labeled diagram explain fixed bed catalytic cracking.(15 marks)

Fixed Bed catalytic cracking: **Heavy oil** is **vapourised** by **heating in an electrical heater**.The **vapors** are **passed** over a series of trays containing **catalysts** such as **crystalline aluminium silicate,silicate benzoate,bauxite and zeolites.**The reaction chamber is maintained at **425° C to 540^{0}C** and **under pressure of 1.5kg/cm^2**.The cracked gases **are taken out** from **the top of the reaction chamber** and **allowed to pass into fractionating tower**.



b)i)Write short note on atomization.

In this method,**liquid metal** is forced through a **small orifice** and **jet of liquid** is broken down by blast of compressed gas.Now a days in advanced/modified atomization process,**the metal is atomized by striking a rapidly rotating disc**

ii)What is pigment?Give its two functions. I

PigmentsPigments:Pigments are the **inorganic materials** which **produces color to the materials**.

Functions:

a) It imparts an **aesthetic appeal to the film**.
b) It imparts **strength to the paint film**.
c) It gives **opacity and color to the film**.
d) It protects the film by **reflecting the destructive U.V. light**.

3)c)Calculate the percentage atom economy for the following reaction.

CH_3NH_2+$COCL_2$ → CH_3N=C=O+2HCL

Solution:

CH_3NH_2 + $COCL_2$ → CH_3N=C=O + 2HCL
(41) (99) (57)

$$\textbf{\textit{\%Atom Economy}} = \frac{\text{Molecular weight of the product}}{\text{Total molecular weight of reactant}} X100$$

$$= \frac{57X100}{41+99}$$

= 43.86%

CH_3NH_2=12+13+14+2
=41
$COCL_2$=12+16+2X35.5
=99

CH_3=C=O=12+3+14+16

=57

Q.4)a)Explain with the help of diagram wet corrosion in neutral medium.(15 marks)

Electrochemical corrosion occurs:

i)**When conducting liquid** is in **contact** with **metal**.

ii)Two dissimilar metals or alloys are dipped in electrolyte.

- The **corrosion** can **take place by H_2** evolution mechanism or **O_2 absorption,mechanism**.
- **The wet corrosion in neutral medium takes place by O_2 absorption mechanism.**

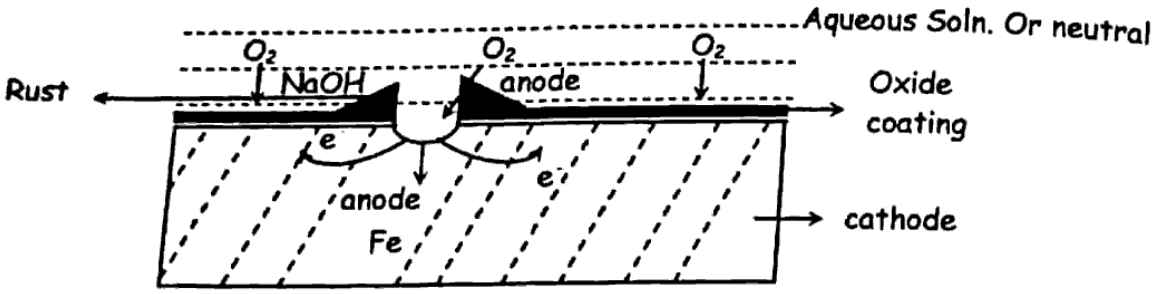


Fig. : Wet corrosion by absorption of Oxygen

Take an example of Fe in contact with water.

- **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 the water as Fe^{2+} ions.
  $Fe \rightarrow Fe^{2+}+2e^-$

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

$\frac{1}{2}O_2H_2O+2e^- \rightarrow 2OH^-$

$Fe^{2+}+2OH^-$ combine to form $Fe(OH)_2$ & further precipitates

$Fe(OH)_2$ Ferric hydroxide.

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

$Fe(OH)_2+\frac{1}{2}O_2H_2O \rightarrow 2Fe(OH)_2\downarrow$

Ferric Hydroxide

Q.4)b)

i)Explain the green chemistry principle "prevention of waste".

- **The ability of chemists to redesign chemical transformations to minimize the generation of hazardous waste is an important step in pollution prevention.**
- By **preventing** waste **generation** we **minimize** hazards associated with **waste storage,transportation & treatment**.
- **Greener route of indigo creates very less wastage due to renewable feedstock and enzymes used in conventional synthesis such as aniline,chloroacetic acid are avoided**.Overall atom economy increases.
- Other **example** include green synthesis of **Ibuprofen & adipic acid**.

ii)Write a note on 'Matrix phase' of composite material

- **Composite materials are combination of two or more materials with significantly different properties than the original materials.**
- Composites are **made** up of **Matrix & Reinforcement**.
- **Matrix** is a **continuous phase** which holds the reinforcement.

- Matrix is **more ductile,soft phase**.
- It **holds dispersed phase and share load**.
- It phases the stress to reinforcement via interface but protects the reinforcement fibers.
- **Ex.Concrete**:Where **cement is matrix** and **sand,stones** are the **dispersed phase**.

Q.4)c)Mention four drawbacks of plain carbon steel.

1) **Increase in C content decreases ductility and increases brittleness**.
2) **Carbon steel cannot be deep hardened**.
3) At **high temperatures PCS lose their hardness and mechanical properties deteriorate at higher temperatures**.
4) They do **not** have **corrosion resistance**.

Q.5)a)Calculate weight of air needed for complete combustion of 2kg of coal containing C=70%,H=10%,O=10%,N=5% and remaining ash.(15 marks)

1kg of coal contains 0.7kg C,0.1kg H & 0.1kg O_2

Combustion reactions	Weight of O_2 required(kg)
1) $C + O \rightarrow CO_2$	$0.7 \times \frac{32}{12}=1.86$
2) $H_2+\frac{1}{2}O_2 \rightarrow H_2O$	$0.1\times \frac{16}{2}=0.8$

Weight of O_2=1.86+0.8=2.66

Available O_2=0.10

Total O_2=2.56

Air contains 23% O_2 by weight

$\therefore$Min quantity of air required=$2.56\times \frac{100}{23}$

=11.13 kg.

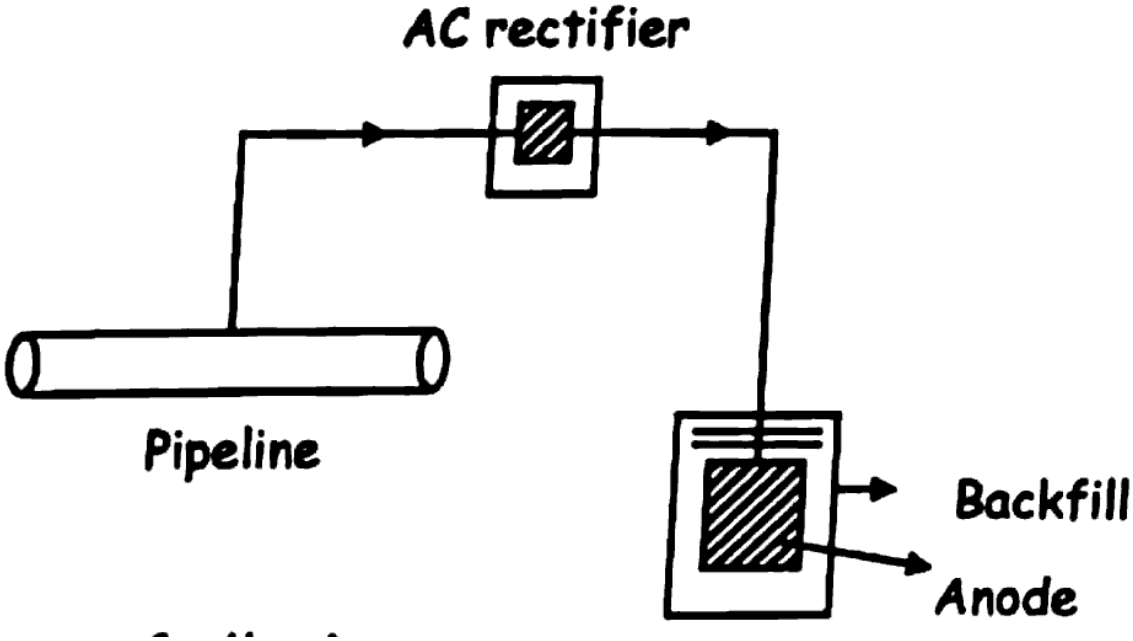
For 2kg of coal air needed=11.32×2

=22.26kg.

b)i)Explain the method of impressed current cathodic protection.

i)Impressed current cathodic protection is to convert anode to cathode by **nullifying the rate of corrosion**.The structure is connected to D.C.

- This is **done by rectifying a.c ensuring the connection between anode and new electrode.**
- **Anode** used **is** an **inert material such as graphite,pt etc**.
- **Anode** is **buried** in **backfill** such as **gysum to increase the electrical contact between soil and metal.**
- This protection is used for underground structures like water tanks,pipelines,transmission towers etc.
- The method is better and more efficient than sacrificial anode method.



ii)Give two purposes of alloying

1) **To enhance the hardness of metal.**

Ex.Pure Fe is soft but PCS is hard

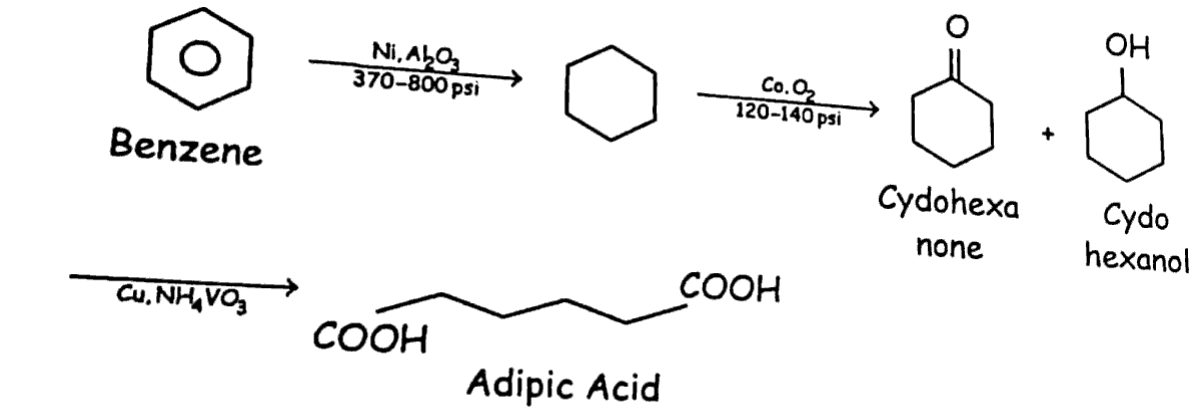
2)**To lower melting point**

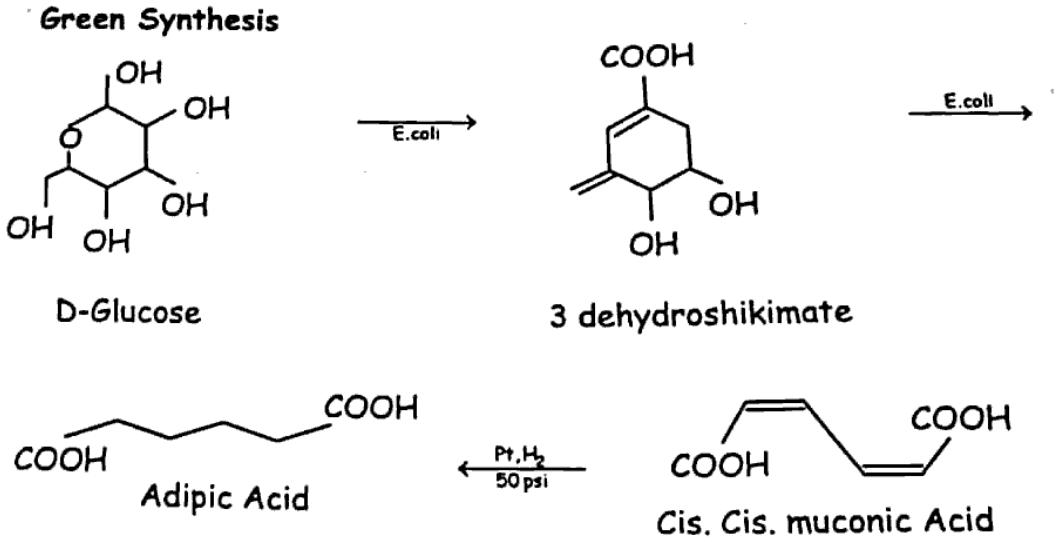
Wood's metal (Bi,Sn,Cd,Pb have high melting pointer but wood's metal has m-p-71^{o}C that's why used to make safety fuses.)

C)Explain conventional and green route of manufacturing of Adipic acid.

The traditional starting material for adicpic acid synthesis is benzene & green synthesis uses D-glucose.

Conventional Synthesis:





Q.6)a)What is compaction in powder metallurgy?(15 marks)
Explain powder injection moulding method with suitable diagram.

Compacting is the operation of obtaining object produced by the compression of a metal powder generally while confined in a die.

- **Compaction is done without the application of heat**.
- Loose powders are converted into required shape with sufficient strength to withstand ejection from tools and sintering process.
- In case like **cemented carbide,hot compaction is done followed by sintering.**

- Methods of compacting

a) **Cold pressing.**
b) **Powder injection moulding.**
c) **Hot compaction.**

a)***Cold pressing***

The powder with lubricant or binder and compacted in rigid dies by axially loaded punch.

b)***Powder injection moulding***

The powder is mixed with 30-40% binder and moulding is done by injection into mould by screw.

c)***Hot compaction***

Hot compaction mechanism is activated by higher processing temperatures and external pressure.

- The hot compaction include Axial & Isotactic hot pressing,hot forging,hot extrusion etc.
- The compact obtained by any above processes is known as green compact & further sintered.

Powder Injection Moulding

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

Powder Injection Moulding

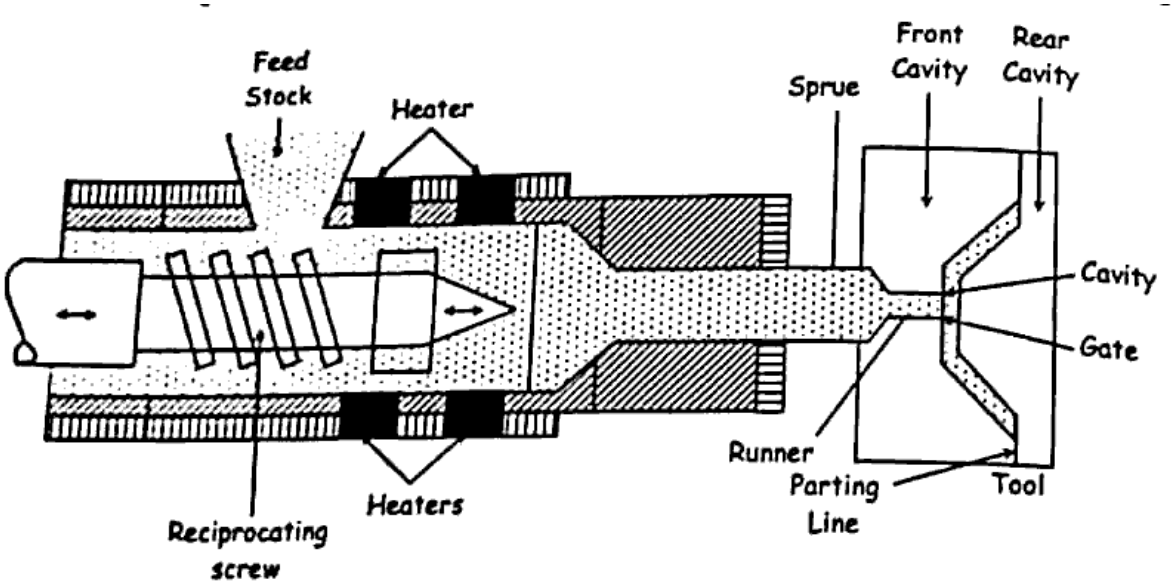


Fig. B : Schematic representation of PIM equipment

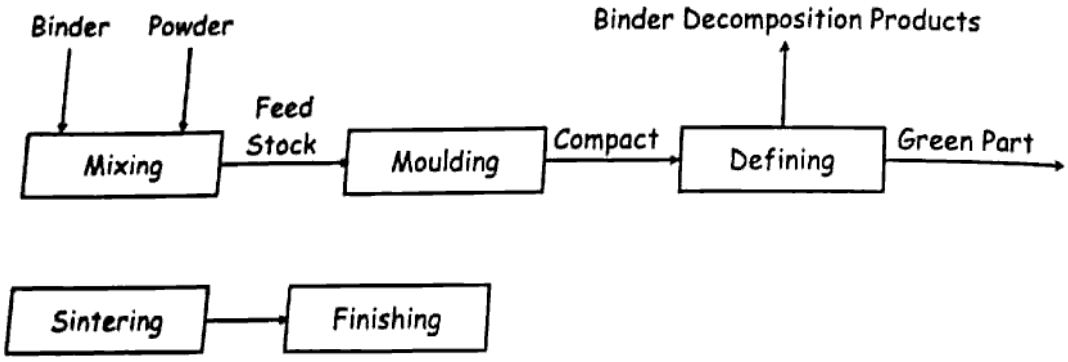


Fig. A : Flow chart of PIM process

Q.6)b)i)Mention the characteristic properties of composite materials.

i)Properties of composites

- ***Stronger & stiffer than metals.***
  -for same strength,lighter than steel by 80% & Al by 60%.
- ***Highly corrosion resistant***
- **Tailorablethermal** expansion properties.
  Can be compounded to closely match surrounding structures to minimize thermal stress.
- **Exceptional Formability**

Composites can be formed into many complex shapes during fabrication

- **Stealth property**
  It can be made low observable by radar by seeding appropriate materials.

ii)Distinguish between Cathodic Protection and Anodic Protection

	Cathodic Protection	Anodic Protection
i)	This can be applied to **all metals**.	This can be applied to the metals **showing the active passive behaviour.**
ii)	This does **not required** use if **electricity**	This **requires electricity**.
iii)	Standard & Simple	Can be used under server condition and specific

Q.6)c)Define fuel.Give the characteristics of good fuel.

Definition:

A fuel is a substance which generates energy when burnt & can be used for various purposes.

Characteristics of a good fuel:

- A good fuel should **have high calorific value**.
- A good fuel should **have moderate ignition temperature.**
- A good fuel should **have good availability,easy to store and handle.**
- A good fuel should **have moderate velocity of combustion**
- It should have **low S, low ash and high C & H content**.