APPLIED CHEMISTRY 1

(CBCGS MAY 2018)

Q1](a) Discuss the drawback of natural rubber. (3)

Ans:- *The drawbacks of natural rubber are as follows:*

- *It swells considerably in organic solvents and gradually disintegrates.*
- *It has little durability.*
- *When stretched to a greater extent , it suffers permanent deformation, because of the 'sliding' or slippage of some molecular chains over each other.*
- *It is weak: its tensile strength is only 200 kg/cm^2.*
- *Natural rubber is brittle below 10 °C and above 50 °C, it becomes soft. Hence it is useful only in limited temperature ranges.*

Q1](b) Explain the disinfection of water by addition of bleaching powder. (3)

Ans:- *In small water-works, about 1 kg of bleaching powder per 1,000 kilolitres of water is mixed and water is allowed to stand undisturbed for several hours the chemical action produces hypochlorous acid*

$$CaOCl_2 + H_2O \rightarrow Ca(OH)_2 + Cl_2$$

$$Cl_2 + H_2O \rightarrow HCl + HOCl$$

$$\text{germs} + HOCl \rightarrow \text{germs are killed}$$

The disinfecting action of bleaching powder is due to the chlorine made available by it.

Drawbacks:

1. *Bleaching powder introduces calcium in water , thereby making it more hard.*
2. *Bleaching powder deteriorates, due to its continuous decomposition during storage. So whenever it is added , it has to be analysed for its effective chlorine content.*
3. *Only a calculated quantity of bleaching powder should be used , since an excess of it gives a bad taste and smell to treated-water.*

Q1](c) What are the limitations of Phase rule ? (3)

Ans:- *The limitations of phase rule are as follows:*

1. *It can be applied to system in equilibrium. It is not of much help when system attain equilibrium very slowly.*

2. *It applies only to single equilibrium state. It does not indicate other possible equilibrium in the system.*
3. *Phase rule consider only the number of phase ,but not their quantities .Even a minute quantity of phases when present accounts towards number of phases.*
4. *All phases must be present under the same condition of the temperature , pressure and gravitational forces.*

Solid and liquid phases must not be in finely-divided state, otherwise deviations occur

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Q1](d) Discuss fullerenes. Give its applications. (3)

Ans:- :- *One of the nano-forms of the carbon is Buckminster fullerene (C_{60}). A fullerene is a molecule of carbon in the form of a hollow sphere, ellipsoid, tube and many other shapes. Spherical fullerene are also called as bucky balls and resembles football. Fullerene have 12 pentagons and 20 hexagons. A common method used to produce fullerene is to send a large current between two nearby graphite electrodes in an inert atmosphere of Argon. The resulting carbon plasma arc between the electrodes cools into sooty residues from which many fullerenes can be isolated.*

PROPERTIES OF FULLERENE:

- *It is mustard coloured solid, which appears brown to black with increasing thickness of its film.*
- *On sublimation , it forms translucent magenta face-centered cubic crystals.*
- *It is moderately soluble in aromatic hydrocarbons giving magenta solution.*
- *As a pure solid , it is electrically insulating. With proper impurity addition , it can be made highly conductive and super conductive.*

USES OF FULLERENE:

- *It is used for the preparation of electronic and microelectronic devices.*
- *It is used for the preparation of non-linear optical devices.*
- *It is used for the preparation of batteries as charge carriers.*
- *It is used for the preparation of super conductors.*
- *It is used for the preparation of soft ferromagnet with zero remanence.*

Q1](e) Write a note on Greases. (3)

Ans:- *lubricating grease is a semisolid consisting of thickening agent such as metallic soaps, dispersed throughout liquid lubricating oil. The liquid lubricant may be petroleum oil or even synthetic oil and it may contain any of the additives for specific requirement.*

GREASES ARE USED UNDER FOLLOWING CONDITION:-

- *In situations where the oil cannot remain in place due to high load, low speed, intermittent operations , sudden jerks etc.*
- *When the machine is worked at slow speed and high pressure.*
- *In situations where bearing has to be protected against entry of dirt , dust, moisture etc because greases are less liable to contamination by these.*
- *In situations where dripping or spurting of oil is undesirable because unlike oils , greases if used do not splash or drip over articles being prepared by the machines e.g., machines used in paper, food, textile and dying industry.*

Q1](f) A 10ml of sample of water was refluxed with 20ml potassium dichromate solution and after refluxing the excess unreacted dichromate required 26.2ml of 0.1M FAS solution. A blank 10ml of distilled water on refluxing with 20ml of dichromate solution required 36ml of 0.1M FAS solution. Calculate the COD of waste water. ***(3)***

Ans:- *Given data :- Vb = 36ml Vt = 26.2ml*

N = 0.1M Ve = 10ml

To find :- COD

Solution :- $COD = \frac{(Vb-Vt)\times Normality \times 8000}{Ve}$

$= \frac{(36-26.2)\times 0.1 \times 8000}{10}$

= 784 ppm

Hence the COD value is 784 ppm.

Q1](g) Discuss the role of polymer in medicine and surgery . ***(3)***

Ans:- *Materials which are not causing adverse effect on blood and other tissues can be used in diagnostic, surgical and can be implanted in the body. They can be developed from metals, ceramics and polymers. Uses of polymers in the field of medicine and surgery are increasing day by day. Characteristics of biomedical polymers are:*

1.should be bio-compatible, can be fabricated into desire shape or form without being degraded.

2.can be easily sterilized with no alteration in properties, should have optimum physical and chemical properties.

Examples are as follows:

POLYMER	***APPLICATION***

1. PMMA.	*Contact lenses.*
2. silicon rubber, polyurethane.	*Heart walls, drain tubes.*
3. Polyvinyl chloride.	*Disposable syringes.*
4. polyalkyl sulphone.	*Membrane oxygenator.*

Q2](a) Calculate the amount of lime (85% pure) and soda (95% pure) required to soften one million litre of water which contains $CaCO_3$ ***= 12.5ppm,*** $MgCO_3$ ***= 8.4ppm,*** $CaCl_2$ ***= 22.2ppm,*** $MgCl_2$ ***= 9.5ppm,*** CO_2 ***= 33ppm, HCl = 7.3ppm, organic matter= 16.8ppm*** ***(6)***

Ans:-

Impurities(mg/lit)	*Multiplication factor*	$CaCO_3$ *equivalent (mg/lit)*	*Requirement*
$CaCO_3$*=12.5*	$\frac{100}{100}$	$12.5\times\frac{100}{100} = 12.5$	*L*
$MgCO_3$*=8.4*	$\frac{100}{84}$	$8.4\times\frac{100}{84} = 10$	*2L*
$CaCl_2$ *= 22.2*	$\frac{100}{111}$	$22.2\times\frac{100}{111} = 20$	*S*
$MgCl_2$ *= 9.5*	$\frac{100}{95}$	$9.5\times\frac{100}{95} = 10$	*L+ S*
CO_2 *= 33*	$\frac{100}{44}$	$33\times\frac{100}{44} = 75$	*L*
HCl = 7.3	$\frac{100}{73}$	$7.3\times\frac{100}{73} = 10$	*L+S*

NaCl does not react with lime and soda.

LIME = $\frac{74}{100}\left[CaCO_3 \text{ equivalent of } 2\times MgC0_3+CaCO_3+MgCl_2+HCl+CO_2\right]\times \frac{\text{Volume of water}}{1000}\times\frac{100}{\%\text{ purity}}$

$= \frac{74}{100}\times[2\times10 + 12.5 + 10 + 10 + 75]\times\frac{10^6}{1000}\times\frac{100}{85}$

= 111000 gms.

SODA = $\frac{106}{100}\left[CaCO_3 \text{ equivalent of } CaCl_2+MgCl_2\right]\times\frac{\text{Volume of water}}{1000}\times\frac{100}{\%\text{purity}}.$

$= \frac{106}{100}[20+10] \times \frac{10^6}{1000} \times \frac{100}{95}.$

= 33473.68 gms.

The lime requirement is 111000 gms and soda requirement is 33473.68 gms.

Q2](b) (i) Give the preparations, properties and uses of Kevlar. (3)

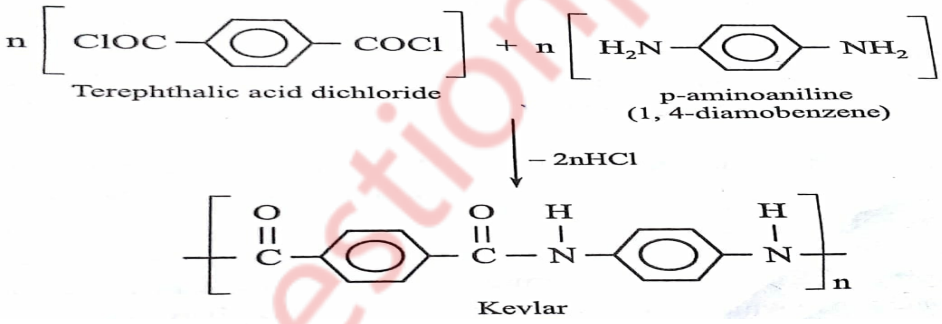
Ans:- :-*It is an aromatic polyamide with benzene rings linked to the amide group, -CONH- group.*

1.PREPARATION.

It is prepared by polycondensation between aromatic dichloride like terephthalic acid dichloride (terephthaloyl chloride) and aromatic diamines like 1,4-phenylene diamine (1,4-diamine benzene).

2.PROPERTIES.

- *It is exceptionally strong, 5 times stronger than steel and 10 times stronger than aluminium.*
- *It has high heat stability and flexibility.*
- *It has resistance against almost all the solvents except some powerful acids.*
- *It does not lose its strength at -196°C .*



3.USES.

- *It is used in aerospace and aircraft industries.*
- *It is used for the preparation pf car parts such as tyres, brakes, clutch, lining etc.*
- *Used for the preparation of ropes ,cables, helmets etc.*

Q2](b)(ii) Define Cloud point and Pour point of a lubricant. (2)

Ans:- *i) CLOUD POINT.*

When oil is cooled slowly , the temperature at which it become cloudy or hazy in appearance is called its cloud point.

ii)POUR POINT.

After cooling oil, the temperature at which it ceases to flow is called its pour point.

Good lubricant should have low POUR POINT.

Cloud and pour point indicates the suitability of the lubricating oil in cold conditions. Lubricant used in a machine working at low temperature should possess low pour point. Otherwise solidification of the lubricant will cause the jamming of the machine.it has been found that presence of waxes in the oil raises the pour point.

Good lubricating oil should have low cloud and pour point.

Q2](c) Write a note on decay of concrete. (4)

Ans:- *The cement concrete although mechanically strong , but due to the presence of free lime it become susceptible to the attack of acidic water. Alkaline water do not have marked effect on concrete strength. Also lime is more soluble in soft water than hard water and hence deterioration of concrete in contact with soft water is more. Presence of sulphates cause maximum damage because it reacts with tricalcium aluminate to form sulpho aluminates which occupies more volume and hence undergo expansion making the cement structure weak.*

PROTECTION OF CONCRETE

- *By giving a coating of bituminous material. This prevents direct contact between concrete and water. This is a very inexpensive method.*
- *By coating the surface with silicon fluoride in a soluble form together with oxides of Zn, Mg or Al. the precipitate of calcium fluoride so-formed in the capillaries prevents dissolution of lime.*

Q3](a) Define Moulding. List the different techniques of moulding. Explain injection moulding with the help of neat diagram. (6)

Ans:- *Fabrication of plastic is the technique of giving any desired shape to the plastics by the use of mould. Because of the properties of polymers it is possible to mould them and change their shape using a number of different repetitions manufacturing processes. A proper method is to be selected depending upon the shape and type of resin being used. The most important of these are compression moulding, transfer moulding, extrusion and injection moulding.*

INJECTION MOULDING:

This method is only applicable to Thermoplastic resin. The moulding plastic powder is fed into a heated cylinder . From there it is injected into the tightly locked mould at a controlled rate by means of a screw arrangement or by a piston plunger. The mould is kept cold to allow the hot plastic to cure and become rigid. When the material have been cured sufficiently , half of the mould is opened to allow the injection of the finished article without any deformation . heating is done by oil or electricity.

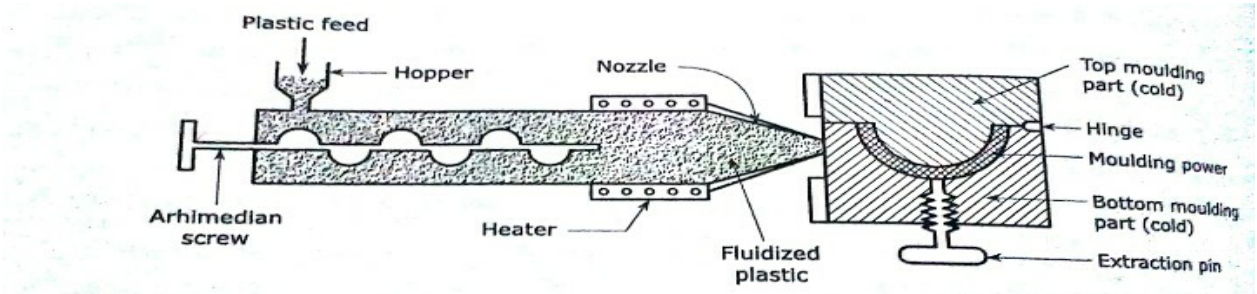


Fig. 2.10 : Injection moulding of plastics.

1.ADVANTAGE:-This method has high speed production, low mould cost , very low cost of material and low finishing cost. Hence it is the most widely used method for moulding of thermoplastics.

2:-DISADVANTAGE:-Since a large amount of cavities cannot be filled simultaneously , there is limitation of design of articles to be moulded.

Q3](b)(i) Explain the term 'phase' with appropriate examples. (3)

Ans:- *1. PHASE: A phase is defined as any homogenous , physically distinct and mechanically separable portion of a system , which is separated from other parts of the system by definite surface. Example:-*

- *In a freezing water system ice, water and water vapour are the three phases which are physically distinct and homogenous.*
- *A gaseous mixture which is thoroughly miscible in all proportion consists of a single phase.*
- *If two liquids are miscible they will form one liquid phase only.*
- *Thermal decomposition of* $CaCO_3$ *consists of three phases namely, two solids and one gaseous.*
- *A mixture of* CaO *and* $CaCO_3$ *consists of two phases.*
- *Two immiscible liquids like water and oil will form two separate phases.*

Q3](b)(ii) Discuss the role of gypsum during the manufacturing of Portland cement . (2)

Ans:- C_3A *readily combines with water and liberates a large amount of heat. The added gypsum retards the dissolution of* C_3A *by forming insoluble calcium sulpho-aluminate* $3CaO.Al_2O_3.xCaSO_4.7H_2O$. *This reaction prevents high concentration of alumina in the cement solution which retards the early initial set of the cement.*

Q3](c) Calculate the total hardness in ppm in given water sample.

: 50ml of standard hard water ,containing 1mg pure $CaCO_3$ ***per ml consumed 20ml EDTA solution.***

: 50ml of water sample consumed 30ml EDTA solution using EBT indicator. ***(4)***

Ans:- *1 ml SHW* ≡ *1 mg of* $CaCO_3$ *eq.*

∴ *50 ml SHW* ≡ *50 mg of* $CaCO_3$ *eq.*

50 ml of SHW ≡ *20 ml of EDTA solution.*

20 ml of EDTA ≡ *50 mg of* $CaCO_3$ *eq.*

∴ *1 ml of EDTA* ≡ $\frac{50}{20}$ *mg of* $CaCO_3$ *eq.*

= *2.5 mg of* $CaCO_3$ *eq.*

50 ml of water sample ≡ *30 ml of EDTA solution.*

∴ *1000 ml of water sample* ≡ $\frac{1000 \times 30}{50}$

= *600 ml of EDTA solution*

1 ml of EDTA ≡ *2.5 mg of* $CaCO_3$ *eq.*

∴ *600 ml of EDTA* ≡ *2.5 × 600*

= *1500 mg of* $CaCO_3$ *eq.*

∴ *Total hardness of water sample = 1500 mg/L*

= 1500 ppm.

Q4](a) Explain the zeolite method for softening of water giving suitable diagram and reactions. What are the limitations of this method. ***(6)***

Ans:- *Zeolite is chemically hydrated sodium alumino silicate* $Na_2O.Al_2O_3.xSiO_2.yH_2O$ *where x= 2 to 10 and y= 2 to 6 . there are two types of zeolite (1) Natural zeolite (2) Synthetic zeolite.*

PROCESS:-

Zeolite softener is made up of a cylinder in which there is a bed of zeolite. Hard water is percolated through the bed of zeolite at a specific rate. The hardness producing ions like Ca^{2+}, Mg^{2+} *etc are retained by the zeolite forming* $CaZe$ and $MgZe$. *The outgoing water contains sodium salts.*

The reactions taking place during the softening process are:-

$$Na_2Ze + Ca(HCO_3)_2 \rightarrow CaZe + 2NaHCO_3$$

$$Na_2Ze + Mg(HCO_3)_2 \rightarrow MgZe + 2NaHCO_3$$

$$Na_2Ze + CaCl_2(\text{or } CaSO_4) \rightarrow CaZe + 2NaCl \text{ (or } Na_2SO_4)$$

$$Na_2Ze + MgCl_2(\text{or } MgSO_4) \rightarrow MgZe + 2NaCl \text{ (or } Na_2SO_4)$$

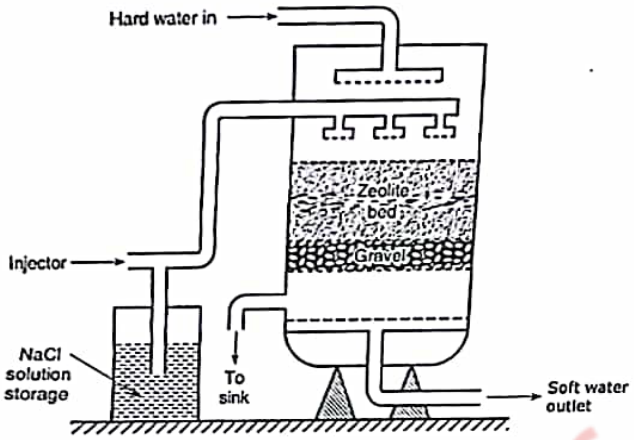


Fig. 1.3 : Zeolite softener.

REGENERATION OF ZEOLITE:-

During softening of water Ca^{2+} and Mg^{2+} *ions are retained by zeolite forming CaZe and MgZe i.e., calcium zeolite and magnesium zeolite. Once all the zeolite gets completely converted to CaZe and MgZe it is said to be exhausted. At this stage zeolite is unable to soften more of the hard water. The supply of hard water is then stopped. They exhausted zeolite which is CaZe and MgZe is treated with concentrated brine solution i.e., NaCl solution.*

$$CaZe + 2NaCl \rightarrow Na_2Ze + CaCl_2$$

$$MgZe + 2NaCl \rightarrow Na_2Ze + MgCl_2$$

The washing containing $CaCl_2$ *and* $MgCl_2$ *are discarded and the regenerated zeolite is used again for softening of water.*

LIMITATIONS OF ZEOLITE :-

1. *If the supply of water is turbid , the suspended matter must be removed before the water is admitted to the zeolite bed. Otherwise the turbidity will clog the pores of zeolite bed thereby making it inactive.*
2. *If water contain large quantities of coloured ions such as* Mn^{2+} and Fe^{2+}*, they must be removed first because these ions produce manganese and iron zeolites, which cannot be easily regenerated.*
3. *Mineral acids, if present in water destroy the zeolite bed and therefore they must be neutralised with soda before admitting the water to the zeolite softening plant.*

Q4](b)(i) 6gms of oil was saponified with 50ml of 0.5N alcoholic KOH solution. After refluxing for 2 hours the mixture was titrated with 25ml 0.5N HCl. Find the saponification value of Oil. (3)

Ans:- *Given Data :- Weight of oil = 6 mgs Blank titration reading = 50ml = V2*

Back titration reading = 25ml = V1

Solution :- Volume of 0.5N KOH required for saponification in terms of 0.5N HCl

= V2 – V1 = 50 – 25 = 25 ml

$$\text{Saponification value of oil} = \frac{\text{Volume of KOH} \times \text{Normality of KOH} \times 56}{\text{weight of oil}}$$

$$= \frac{25 \times 0.5 \times 56}{6} = 116.66 \text{ mg of KOH}$$

Therefore the Saponification value of the oil is 116.66 mg of oil.

Q4](b)(ii) Distinguish between the wet and dry process for manufacturing of Portland cement. (2)

Ans:-

DRY PROCESS	***WET PROCESS***
1. *This is used when the raw material are hard.*	***1.*** *This is used for any type of raw material.*
2.*Fuel consumed is less.*	***2.****Fuel consumed is more.*
3.*Process is slow.*	***3.****Process is faster.*
4.*Cement produced is of inferior quality.*	***4.****Cement produced is of superior quality.*
5.*Costly process.*	***5.****Cheaper process.*

Q4](c) Discuss the following additives in compounding of plastics

(a)Fillers (b) Plasticizers. (4)

Ans:- :- *1.FILLERS (or EXTENDERS).*

Fillers are added to a base polymer to lower the manufacturing cast of a product made from it. Functions of fillers are as follows:

- *Reducing the cost of plastic.*
- *Increases the tensile strength and hardness.*
- *Reduces the flexiblity.*
- *Decreases the shrinkage during moulding.*
- *Gives opacity to the product.*
- *Examples:-mica, talc, asbestos , saw dust ,chalk etc.*

2.PLASTICIZERS.

The Plasticizer molecule occupies between the polymeric chains and neutralizes the intermolecular forces of attraction and thus allows freedom of movement. The functions of plasticizers are as follows:-

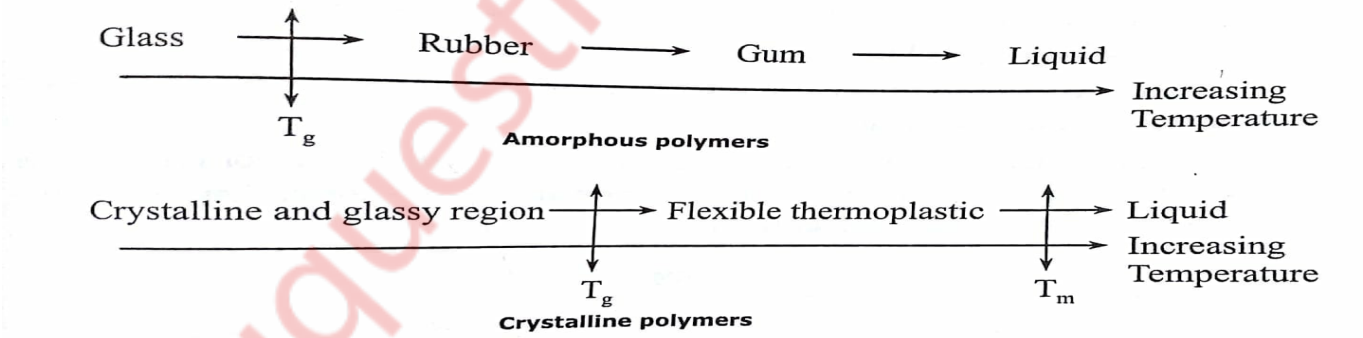
- *Increases the plasticity of the plastics.*
- *Lowers the softening temperature and hence moulding and remoulding can be done at low temperature.*
- *Imparts flames proofness.*
- *Reduces resistance towards chemical , solvents etc.*
- *Examples:- esters of fatty acids, vegetables oils etc.*

Q5](a)Write note on (any two):-

(a)Glass transition temperature (b) Buna-S (c) Vulcanisation (6)

Ans:- *1.GLASS TRANSITION TEMPERATURE :-*

The temperature at which polymer experience the transition from rubbery to rigid state is termed as the 'Glass transition temperature'(T_g).The behaviour of a polymer is temperature sensitive. Glass transition temperature is also defined as the lowest temperature below which the polymer becomes hard and brittle and above which it becomes soft and flexible. The polymer becomes too soft, that it behaves like a fluid called as the visco fluid state. The temperature at which the soft, flexible polymer goes to the visco fluid state is called the melting temperature T_m.



Factors Influencing T_g:

1.Cross linking increases the T_g value.

2.Presence of bulky groups increases the T_g value.

3.Addition of plasticizer decreases the T_g value.

4.Polymers having strong intermolecular forces of attraction increases T_g value.

5.Polar side atoms or groups of atoms increases the T_g value.

2. <u>BUNA-S (or STYRENE RUBBER)</u>

- *<u>PREPARATION:</u>*

This is the most important type of synthetic rubber which is produced by copolymerization of butadiene , $CH_2 = CH - CH = CH_2 (75\%$ by weight$)$ *and styrene ,* $C_6H_5CH = CH_2 (25\%$ by weight$)$.

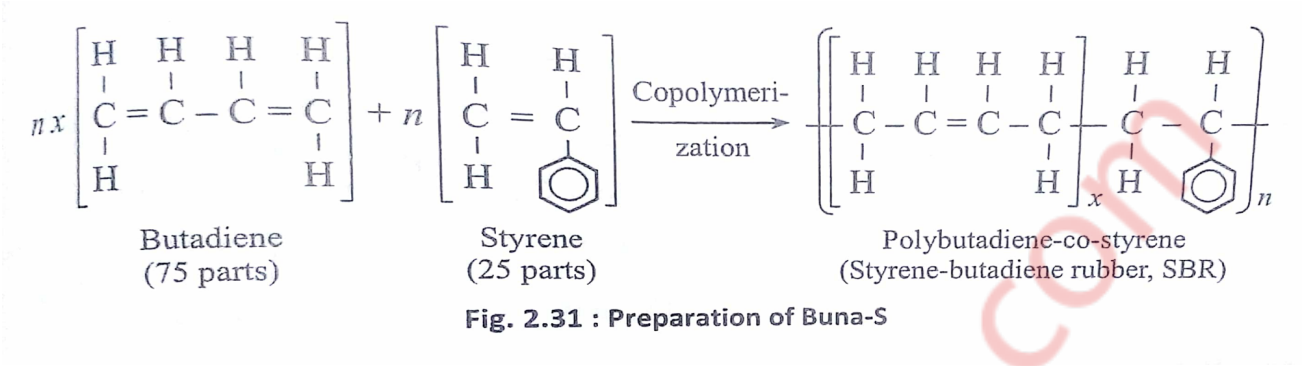


Fig. 2.31 : Preparation of Buna-S

- *<u>PROPERTIES</u>*

1.Styrene rubber resembles natural rubber in processing characteristics as well as quality of finished products.

2.It posses high abrasion-resistance, high load-bearing capacity and resilience

3.It swells in oils and solvents.

- *<u>USES</u>*

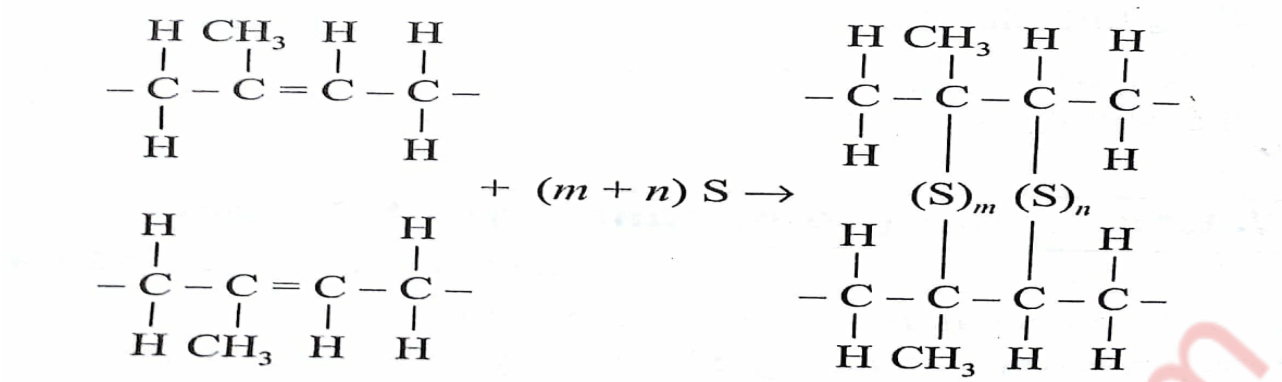
1.Mainly used for the manufacture of motor tyres.

2.Other uses of this elastomer are floor tiles , shoe soles, gaskets, foot-wear components, wire and cable insulations, carpet backing , adhesive , tank-lining, etc.

3. <u>VULCANIZATION:-</u>

When rubber is heated with sulphur, its tensile strength , elasticity and resistance to swelling are increased tremendously. This process is named as <u>Vulcanization.</u> Vulcanization brings about a stiffness of the rubber by anchoring and restricting the intermolecular movement of the rubber springs. The vulcanization can be carried out in several ways:-

1. *The article to be vulcanised is heated with a steam under pressure.*
2. *The article is immersed in hot water under pressure.*
3. *By heating the article in air or in carbon dioxide.*
4. *By vulcanizing the article in the mould in which it is shaped.*



PROPERTIES OF VULCANIZED RUBBER.

- *High tensile strength.*
- *Elastic to lesser extent.*
- *Water absorption is small.*
- *Do not swell much in organic solvents.*
- *Better abrasion resistance.*

Q5](b)(i) Distinguish between BOD and COD . *(3)*

Ans:-

BOD	***COD***
1.*It means the oxygen demand of bio-degradable pollutants only.*	***1.****It measures the oxygen demand for bio-degradable pollutants along with non-biodegradable pollutants.*
2.*Less stable measurement method as it uses micro-organism which are susceptible to pH , temperature and other variable in the water.*	***2.****More stable measurement method as it uses potassium dichromate which oxidises regardless of water condition.*
3.*Slow process. It takes 5 days.*	***3.****Fast process. It takes 2-3 hours.*
4.*BOD values are generally less than COD values.*	***4.****COD values are generally greater than BOD values.*
5. $\text{BOD} = (\text{DO}_b - \text{DO}_i) \times \frac{\text{Volume of undiluted sample}}{\text{Volume of diluted sample.}}$	***5.***$\text{COD} = \frac{(V_1 - V_2) \times N \times 8000}{Y}$

Q5](b)(ii) Define Oiliness. What is its significance *(2)*

Ans:- *Oiliness of a lubricant is the measure of its capacity to stick on to the surface of machine parts under condition of pressure or load. When a lubricating oil of poor oiliness is applied under*

high pressure , it gets squeezed out from the surface and the lubrication stops. If the oil has good oiliness it can remain in place and can give lubrication even under pressure. Mineral oil has very poor oiliness whereas vegetable oils possess good oiliness. No direct test are available for measuring oiliness.

Q5](c) Discuss the application of Phase rule to the one component system based on:Diagram, triple point. *(4)*

Ans:- *Phase rule helps to study different equilibria and classify them accordingly. It indicates behaviour of the system under a particular set of conditions. Different systems with the same degree of freedom behave in a similar manner. Helps to find out under a set of conditions whether all substances involved in an equilibrium can exist or a particular phases ceases to exist or whether any transformation has taken place.*

<u>One component system with the phase diagram.</u>

In water there is only one component i.e., water and its three phases : ice, water, steam which are solid, liquid, and gaseous respectively. Figure below represents phase diagram or pressure v/s temperature diagram for the water system.

Three curves OA, OB, and OC represents the equilibrium conditions between two phases solid

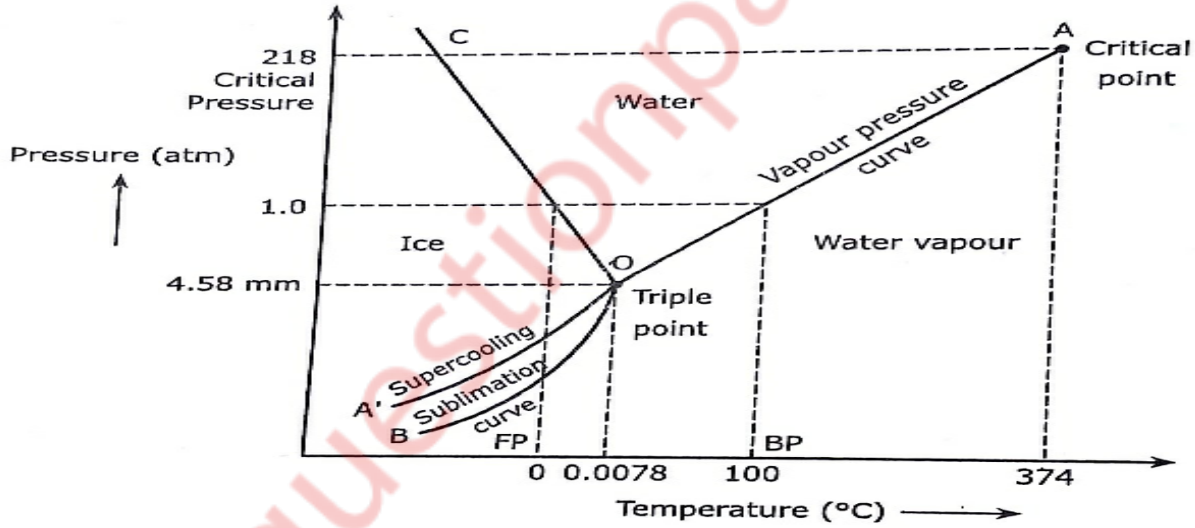


Fig. 4.1 : Phase diagram of water system

with vapour , vapour with liquid and liquid with solid phase of water.

Curve OB represents the equilibrium between liquid and vapour. It is known as vaporization curve. Here also it is necessary to state either temperature or pressure. E.g., at atmospheric pressure , water and vapour can exist in equilibrium only at 1 temperature i.e., the boiling point of water. Water -vapour system has one degree of freedom F=C-P+2=1.

Curve OC represents the equilibrium between solid and liquid phase of the water. This curve is known as fusion pressure or melting point curve. Along this curve there are two phases in equilibrium that is ice and water. At atmospheric pressure, ice and water can be in equilibrium only at one temperature i.e., the freezing point of water.

We have C=1, P=2 thus,

F=C-P+2=1.

TRIPLE POINT:- The three curves OA, OB, and OC meet at O at which solid, liquid and vapour co-exist in equilibrium. This point at 273.16K (0.0075°C) and 4.58 mm of Hg pressure is called Triple point. The system is invariant.

F=C-P+2 ∴ F=3-P=3-3=0 ∴ F=0

This means the degree of freedom is zero therefore neither pressure nor temperature can be changed without causing the disappearance of one of the phases. If either temperature or pressure is changed even slightly , one of the three phases disappears and the system changes from non-varient to univariant.

Q6](a) Define lubricants and lubrication. Mention the various mechanisms involved in lubrication of machine. Discuss boundary lubrication. (6)

Ans:- *Any substance placed between two moving or sliding surfaces with a view to reduce the frictional resistance between them is known as lubricant.*

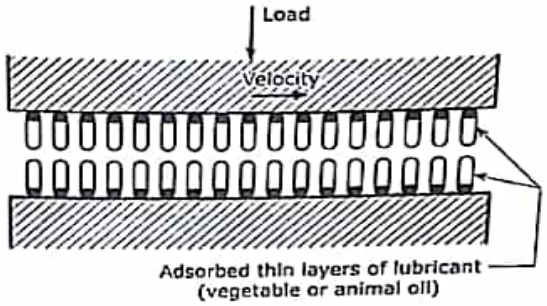
Lubricants may be used in solid, liquid or semi solid form. The process of reducing friction between two metallic sliding surfaces by the introduction of lubricants is called as lubrication.

BOUNDARY or THIN- FILM LUBRICATION.

Boundary lubrication occurs when the film thickness between two surfaces in relative motion is so thin so that the formation hydrodynamic oil film is not possible and result in direct metal-metal contact. Such a situation may arise when.

1. *The load is very high.*
2. *A shaft starts from rest.*
3. *Low speed resulting in insufficient supply of oil.*
4. *Viscosity of the oil is too low.*

In boundary lubrication the space between the metal surface is lubricated with oil lubricants a thin layer of which is absorbed chemically or physically and avoid direct metal to metal contact. The thin film will have thickness around 10 A° and consists of one or two molecular layers. The coefficient of friction is about 0.05 to 0.15. the load is carried by the layer of the absorbed lubricant or both metal surfaces. The extent with which the lubricant gets adhered to the metal surface depends on oiliness of lubricant.



Mineral oils blended with vegetables and animal oils, graphite molybdenum disulphide etc are useful for boundary lubrication.

Gears , railways track joints , tractors, rollers etc are provided with this type of lubrication.

For boundary lubrication to be effective molecules should have:-

1. *Long hydrocarbon chains.*
2. *Polar groups to promote spreading and orientation over the metallic surfaces at high pressure.*
3. *Lateral attraction between the chains.*
4. *Active groups or atoms that can form chemical linkages with the metals or other sufaces.*

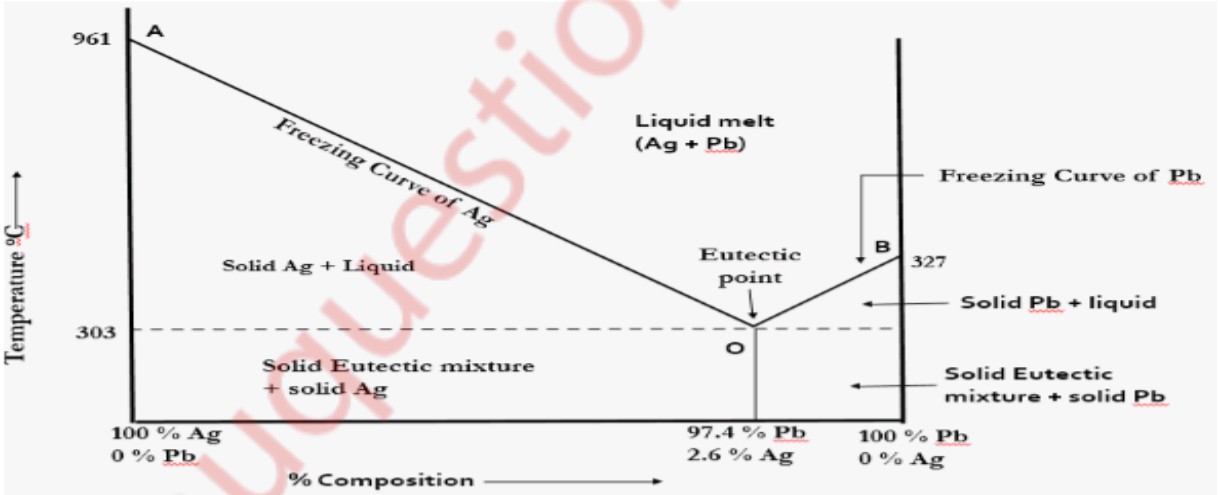
Q6](b)(i) What is reduced or condensed phase rule. *(3)*

Ans:- *In some systems , an equilibrium exists between solid – liquid phases and gaseous phase is practically absent . Hence the effect of pressure on such system can be neglected . Then it is*

Necessary to take into account only two variables viz. temperature and concentration.

Such system showing solid – liquid equilibrium is called condensed system and phase rule applied to such system is as follows:-

F = C – P + 1 … known as condensed phase rule.



Q6](b)(ii) Discuss Reverse Osmosis. *(2)*

Ans:- *When two solutions of unequal concentrations are separated by a semipermeable membrane which selectively does not permit the passage of dissolved solute particles, i.e., molecules , ions etc flow of solvent takes place from dilute to concentrated sides due to osmosis. If a hydrostatic pressure in excess of osmotic pressure is applied on the concentrated side to dilute side across the membrane.*

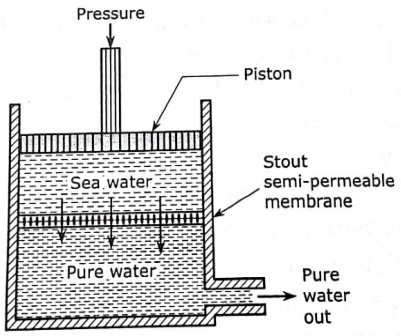


Fig. 1.14 : Reverse osmosis cell

This process is called as reverse osmosis. Thus in reverse osmosis methods pure solvent is separated from its contaminates, rather than removing contaminants from the water.

Q6](c) What are carbon nanotubes . what are its types. Discuss the laser method for its production. *(4)*

Ans:- *Carbon nanotubes represents one of the best examples of the novel nanostructures derived by bottom-up chemical synthesis approaches. Nanotubes have the simplest chemical composition and atomic bonding configuration but exhibit perhaps the most extreme diversity and richness among nanomaterial in structure and structure-property relations. The different types of carbon nanotubes are as follows;*

1. *SINGLE WALLED NANOTUBES.*
2. *MULTIWALLED NANOTUBES.*

LASER VAPORIZATION METHOD.

This method is used to produce CNT's with 70% purity. In this process , a graphite rod with 50:50 catalyst mixtures of cobalt and nickel at 1200 °C in flowing argon is used to prepare sample. The uniform vaporization of the target can be achieved by using the initial laser vaporization pulse followed by a second pulse. The amount of deposition of carbon soot is primarily minimized by the usage of these two successive laser pulses. The large particles are broken by applying the second laser pulse. The CNT's produced through this process are 10-20nm in dia and 100μm or more in length. The average nanotube diameter and size distribution can vary for different growth temperature, catalyst composition , and other process parameters.

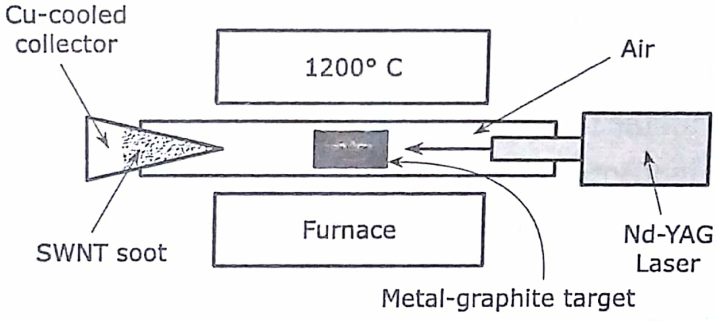


Fig. 5.7 : Schematics of experimental setup for laser ablation process

DRAWBACKS.

1. *This method involves evaporation of carbon source, so it is unclear to scale up the production to industrial level.*
2. *Vaporisation methods grow CNT's in highly tangled form, mixed with unwanted forms of C and metal species.*
3. *CNT's produced are difficult to purify.*
