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Mid Term (Sec:B, Branch: CSE)

B.Tech. II Sem.2017-18 (Common to all Branches) **08.03.2018**

Time: 1 hr. **Maximum marks: 20**

Instruction to Candidates:

Attempt any ***five questions***, including **Question no. 1 which is compulsory.** Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/ calculated must be stated clearly.

Q.1 Compulsory, Answer for each sub-question be given in about 25 words- **[4x2=8]**

(a) Why hard water does not form lather with soap? Define Temporary hardness of water.

(b) What is the difference between higher and lower calorific value of fuel.

(c) How many types of polymers on the basis of intermolecular forces

OR

What is EDTA? Give one of its applications.

(d) Define Disinfection of municipal water supply. Name any two chemicals used for disinfection purpose.

Q.2 Write short note on Beehive Coke oven method. **[3]**

Q.3 A water sample has the analytical report as under (in ppm):

Ca^{2+} =380, Mg^{2+} =144, HCO_3^- = 150, CO_2 = 120, $FeSO_4.7H_2O$ =278. Calculate the amount of lime (90%pure) and Soda (85%pure) for softening of 10,000 litre of water. **[3]**

OR

A sample of coal contains C=93%,H=6% and ash = 1%,the following data were obtained when the above coal sample was tested in Bomb Calorimeter: (i) Weight of coal =0.92g, Weight of water taken=550g,Water Equivalent=2200g, Rise in Temperature= 2.5^0C,fuse Wire Correction =10 Cal., Acid correction=50 Cal. Calculate HCV and LCV assuming latent heat of condensation of steam is 580 Cal/g

Q.4 Write short note on Break point Chlorination. **[3]**

Q.5 What is the purpose of Vulcanization of Rubber? How it is done **[3]**

Q.6 Describe Zeolite method of water softening with its limitations. **[3]**

ANSWERS

Ans:1 (a) Hard Water when treated with soap it does not produce lather, but form insoluble white scum/precipitates of calcium or magnesium salts, which do not possess any soap action.

$$\underset{\text{(Soap)}}{2C_{17}H_{35}COO^-Na^+} + \underset{\text{(Ca2+/Mg2+)}}{M^{2+}} \rightarrow \underset{\text{Scum/ppt.}}{M(C_{17}H_{35}COO)_2 \downarrow} + 2\,Na^+$$

Temporary Hardness: It is due to soluble bicarbonates of calcium and magnesium in water. It is easily removed by boiling.

Ans:1 (b) Higher Calorific Value: It is the amount of heat released when unit mass/volume of fuel is completely burnt and gaseous products **are condensed at room temperature**.

Lower Calorific Value: It is the amount of heat released when unit mass/volume of fuel is completely burnt and gaseous products **are allowed to escape into atmosphere**.

Ans:1 (c) Polymers are of 04 types on the basis of intermolecular forces i.e.(i) Elastomer (ii) Fibres (iii) Thermoplastic (iv) Thermosetting polymers

OR

EDTA is chelating hexadentate ligand used in the estimation of Calcium and Magnesium hardness of water. It is Ethylene diamine tetra acetate ion.

Ans:1 (d) The process of destroying/killing the pathogenic micro-organisms from water is called disinfection. The chemicals which are used are disinfectants; these are Chlorine, Bleaching Powder, Chloramine, Ozone etc.

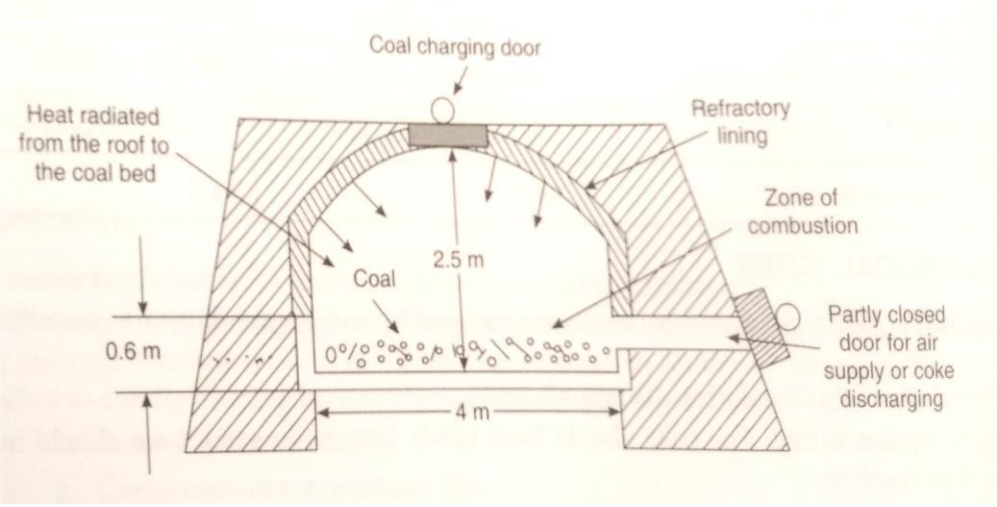
Ans:2 Beehive Coke Oven Method : The Coke required for metallurgical purpose can be prepared by two methods: (i) **Beehive Coke Oven Method (ii) Otto-Hoffmann's by product oven method.**

a) Beehive Coke oven method is earliest and economical method for the manufacturing of metallurgical coke.

b) The Beehive oven is dome shaped structure made up of firebricks. It is about 4m wide and 2.5m high. It has two openings, one at top for charging the coal and another at the side through which coke is removed. This side opening also acts as an inlet for air supply.

c) Process: From the top opening the coal is charged to give a layer of about 06-0.75m thick coal. Some air is supplied in, from the side opening and the coal is ignited. This partial combustion furnishes heat which melts or fuses the coal and evolved volatile matter burns at the partially closed side opening. Combustion is allowed to proceed in a gradually diminishing supply of air so that slow carbonization from the top layer to the bottom layer takes place. This process of carbonization completes in about 3-4 days. The hard metallurgical coke formed is quenched with water and taken out from the discharge opening. The yield of coke is about 60-70 %

d) **Limitations**: No recovery of by-products because most of the volatile matter having plenty of valuable chemicals escape out as waste, also released gases causes air pollution.



Ans:3

Constituent	Amount (ppm)	Amount in $CaCO_3$Eq.	Chemical Reactions	Requirement
Ca^{2+}	380	380*100/40=950	$Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3 + 2Na^+$	**S**
Mg^{2+}	144	144*100/24=600	$Mg^{2+} + Ca(OH)_2 \rightarrow Mg(OH)_2 + Ca^{2+}$ $Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3 + 2Na^+$	**L+S**
HCO_3^-	150	150*100/61*2=122.95	$2\ HCO_3^- + Ca(OH)_2 \rightarrow CaCO_3 + H_2O + CO_3^{-2}$	**L – S**
CO_2	120	120*100/44= 272.72	$CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$	**L**
$FeSO_4.7H_2O$	278	278*100/278=100	$Fe^{2+} + Ca(OH)_2 \rightarrow Fe(OH)_2 + Ca^{2+}$ $Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3 + 2Na^+$	**L + S**

Lime required = 74/100[Mg^{2+} + HCO_3^- + CO_2 + $FeSO_4.7H_2O$ all in $CaCO_3$ equivalent] x volume of water x purity factor

Lime required = 74/100[600+122.95+272.72+100] x 10000 x 100/90 = 9008842.22 mg or 9.00 Kg

Soda required = 106/100[Ca^{2+} +Mg^{2+} - HCO_3^- + $FeSO_4.7H_2O$ all in $CaCO_3$ equivalent] x volume of water x purity factor

Soda required = 106/100[950+600-122.9 +100] x 10000 x 100/85 = 19043835.29 mg or 19.04 Kg

OR

In Bomb Calorimeter:

HCV = (Weight of Water + Water Equivalent)(Δ T + cooling correction) – fuse wire – acid correction)

Weight of coal taken

HCV = (550 + 2200) (2.5) – 10 – 50 = 7407.60 Cal/g

0.92

LCV = HCV - 0.09 H x latent heat of condensation

LCV = 7407.60 - .09 x 6 x 580 = 7094.40 cal/g

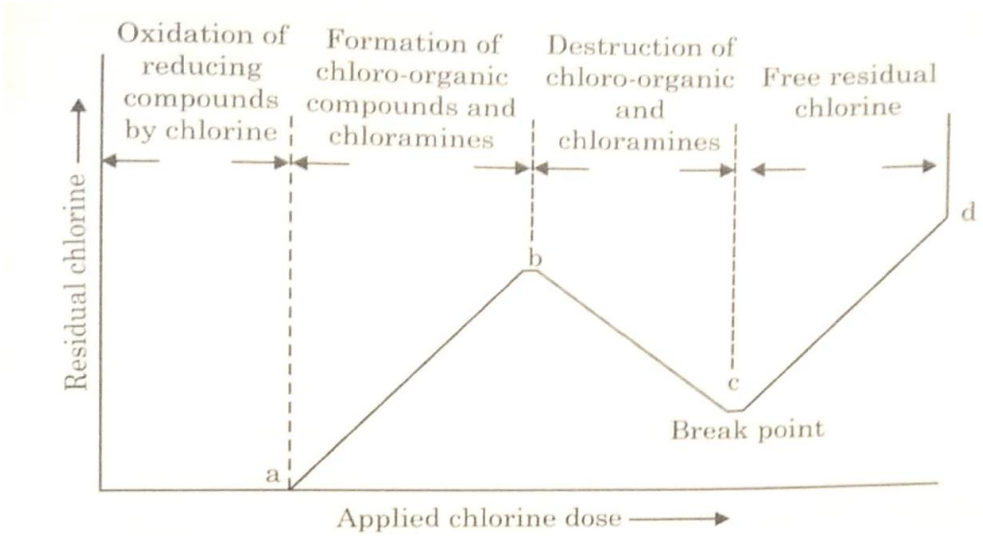
Ans: 4 Break point chlorination: is the chlorination of water to such an extent that not only living organisms but also organic impurities present in water are destroyed. When chlorine is added in water following stages occur:

Stage: 1 for lower doses of chlorine all the amount of chlorine added is consumed and no residual chlorine is observed. Initially, Chlorine reacts with reducing substances and oxidizes them.

Stage: 2 In this stage, it is observed that as the amount of chlorine added is increased due to formation of chloroorganic compounds and chloramines. Chloramines so formed contributes in the test for estimation of chlorine same as done by free chlorine i.e. they act as chlorine reserve hence the curve represents the residual chlorine available from chloramines. The formation of chloro-organic compounds is responsible for bad odour and unpleasant taste in water.

Stage: 3 When the amount of chlorine is further increased, the complete destruction of chloroorganic compounds and chloramines take place. It shows decrease in curve and curve reaches at **minima, which is known as break point chlorination, which ensures the complete killing of pathogens as well as destruction of organic impurities.**

Stage: 4 After, break point the quantity of residual chorine fairly increases, in practice upto 0.2 ppm residual chlorine in water does not cause any harm.



Ans: 5 Although natural rubber has good wear resistance, high elasticity, tensile strength and elongation. But still it has some drawbacks like:

1. Get damaged under the action of strong acid, ozone, oils, greases and fats.

2. Not recommended for use in alcohols, esters, or among the aromatic solution.

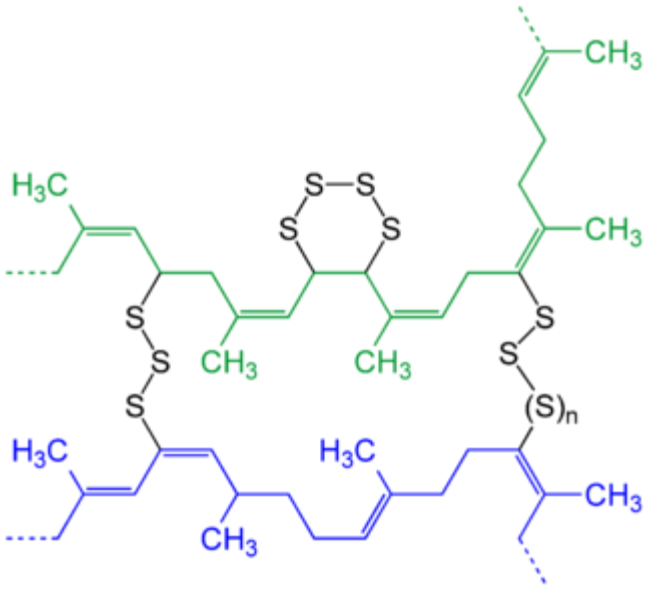
3. Natural rubber becomes soft at high temperature (>335 K) and brittle at low temperatures (<283 K)

4. Does not apply to hot water being.

5. Show high water absorption capacity. It is soluble in non-polar solvents and is non-resistant to attack by oxidizing agents.

To improve the properties of natural rubber it is compounded with many ingredients especially sulphur.

Vulcanization is a chemical process for converting natural rubber or related polymers into more durable materials by the addition of sulfur, other equivalent curatives. These additives modify the polymer by forming cross-links (bridges) between individual polymer chains.Vulcanized materials are less sticky and have superior mechanical properties.



Process: This process consists of heating a mixture of raw rubber with sulphur and an appropriate additive at a temperature range between 373 K to 415 K. On vulcanization, sulphur forms cross links at the reactive sites of double bonds and thus the rubber gets stiffened. In the manufacture of tyre rubber, 5% of sulphur is used as a crosslinking agent.

Advantage of vulcanization:

1. The tensile strength of vulcanized rubber is very good than natural rubber. It has about 10 times more tensile strength than natural rubber.
2. It has excellent resilience (after the removal of deforming force, the articles made from vulcanized rubber regain its original shape)
3. It has wide working temperature range i.e. from -40^0Cto 100^0C compared to the natural rubber (10 to 60^0C)
4. It has better resistance to moisture, oxidation and abrasion.
5. It is resistant to organic solvents and chemical attack.

Ans: 6 Zeolite method: Zeolite are shape selective catalyst. Chemically these are hydrated sodium alumino silicates. The general formula is $Na_2O.Al_2O_3.xSiO_2.yH_2O$ where x = 2-10 and y = 2-6. These are capable to exchange its sodium ions reversibly with Ca^{2+} and Mg^{2+} **.**

Structure of Zeolite: Zeoilite consist of SiO_4 tetrahedron units in which oxygen atoms linked together to give large three dimensional network. Some Si^{4+} may be isomorphously replaced by Al^{3+} and in order to maintain electrical neutrality Na^+ ions also incorporated in skeleton. It look like honey comb like structure. The porous nature of structure permits the free movement of water molecules and ions.

Types of Zeolite: **Natural** $Na_2O.Al_2O_3.4SiO_2.2H_2O$. It is derived from green sand. These are non porous, amorphous.

Synthetic: They are prepared by heating together sodium carbonate, alumina and silica. These are porous, crystalline and gel like structure.

Working: When hard water is passed through zeolite bed (Na_2Z), it exchange its sodium ions with Ca^{2+} and Mg^{2+} in following manner:

$$Ca^{2+} + Na_2Z \rightarrow CaZ + 2Na^{+} \qquad Mg^{2+} + Na_2Z \rightarrow MgZ + 2Na^{+}$$

When all the sodium ions get exchanged by hardness producing ions then zeolite get **exhausted.**

Regeneration: Exhausted Zeolite is regenerated by treating it with concentrated brine solution.

$$CaZ + 2NaCl \rightarrow + CaCl_2 + Na_2Z$$

Limitations:

(i) The incoming water must be free from suspended impurities otherwise porous may be clogged.

(ii) If water contain lead, iron, manganese, then this method is not applicable because these salts will block the pores

(iii) If water contains mineral acids or bases then also zeoilte treatment is not successful because these acids and bases will destroy the structure of zeolites.