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Model Paper (Mid Term)
B.Tech. II Sem.2017-18 (Common to all Branches)
Topic: Water & Water Treatment, Polymers

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) Define hardness of water. Give formula of any one chemical responsible for temporary hardness.

(b) What is Priming in boiler water. Give main causes of priming.

(c) How many types of polymers on the basis of occurrence?

(d) What is Buna-S.? Give its chemical components.

Q.2 Write short note on Boiler Corrosion. **[3]**

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

$Mg(HCO_3)_2$=73, $Ca(HCO_3)_2$=81, $CaCl_2$ = 55.5, $Mg(NO_3)_2$ = 37, KCl = 20. Calculate the amount of lime (85%pure) and Soda(80%pure) for softening of 80,000 litre of water. **[3]**

Q.4 Write short note on any one polyamide polymer. **[3]**

Q.5 Give any one classification of polymers with suitable example. **[3]**

Q.6 Give main differences between Cold & Hot Lime Soda Process. **[3]**

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ANSWERS

Ans.1(a) Hardness of water is the property of water to prevent the lathering of soap. In other words it is termed as "soap consuming capacity". Chemical responsible for temporary hardness is $Ca(HCO_3)_2$.

Ans.1(b) When a boiler is producing steam very rapidly some particles of the water carried along with the steam. **This process of 'WetSteam' formation is called priming**.

It is caused by:

- Presence of large amount of dissolved solids such as alkali sulphate and chlorides
- Sudden boiling
- Improper boiler design
- Sudden increase in steam-production rate

Ans.1(c) On the basis of source or occurrence the polymers are classified into 3 categories (i) Natural : Strach, Protiens (ii) Semi-synthetic : Vulcanized rubber (iii) Synthetic : Polyethene, PVC etc.

Ans.1(d) Buna-S is the type of synthetic rubber. It is the polymer of 1,3-butadiene and Styrene (vinyl benzene). Since polymerization is carried out in the presence of sodium hence **na-**abbreviation is also used. (Natrium: sodium)

Ans.2 Destructive attack or decay of boiler material or metal by chemical or electrochemical reaction with its environment. The most common source for boiler corrosion is dissolved gases viz. oxygen, carbon dioxide, ammonia and acidic contaminants. The brief description on boiler corrosion is as follows:

Water usually contains about 8ml D.O/L at room temperature. D.O. in water and presence of high temperature attacks boiler material

$2Fe + 2H_2O + O_2 \rightarrow 2Fe(OH)_2\downarrow$

$4Fe(OH)_2\downarrow + O_2 \rightarrow 2[Fe_2O_3.2H_2O]$

Ferrous hydroxide (Rust)

Removal of Dissolved Oxygen

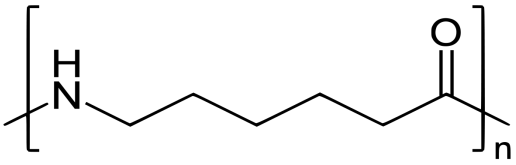
- Chemically, oxygen is removed by adding oxygen scavenger or absorbing chemicals in a calculated amount such as sodium sulphite or hydrazine or sodium sulphide.
- Hydrazine is used in large utility boiler store move dissolved oxygen but not recommended for heating boilers because it must be closely controlled because of explosive nature of hydrazine and if used excess, it decomposes to produce ammonia which again cause corrosion.

Ans.3 First conversion into $CaCO_3$ equivalent:

Constituents	Amt. (ppm)	in $CaCO_3$ eq.	Chemical Reactions	Requirement (L/S)
$Mg(HCO_3)_2$	73	73*100/146=50	$Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow Mg(OH)_2 + 2\,CaCO_3 + 2H_2O$	2L
$Ca(HCO_3)_2$	81	81*100/162=50	$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2\,CaCO_3 + 2H_2O$	L
$CaCl_2$	55.5	55.5*100/111=50	$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$	S
$Mg(NO_3)_2$	37	37*100/148=25	$Mg(NO_3)_2 + Ca(OH)_2 \rightarrow Mg(OH)_2 + Ca(NO_3)_2$ $Ca(NO_3)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaNO_3$	L+S
KCl	20	Doesn't cause hardness	--	--

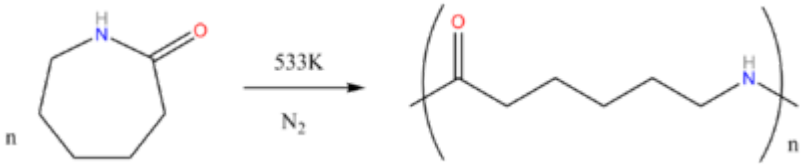
Amount of lime required = 74/100 [2 x $Mg(HCO_3)_2$ + $Ca(HCO_3)_2$ + $Mg(NO_3)_2$ all in terms of $CaCO_3$ equivalent] x volume of water x purity factor
Amount of lime required = 74/100 [2x 50 +50 + 25] x 80000 x 100/85 = 12188235.29mg **=12.19 Kg**
Amount of soda required = 106/100 [$CaCl_2$ + $Mg(NO_3)_2$ all in terms of $CaCO_3$ equivalent] x volume of water x purity factor
Amount of soda required = 106/100 [50+25] x 80000 x 100/80 = 7950000mg= **7.95 Kg**

Ans.4 Nylon 6: is the polyamide fibre



Nylon 6 or polycaprolactam is the self-condensation product of ε-amino capric acid

Nylon 6 is synthesized by ring-opening polymerization of caprolactam. Caprolactam has 6 carbons, hence 'Nylon 6'. When caprolactam is heated at about 533 K in an inert atmosphere of nitrogen for about 4-5 hours, the ring breaks and undergoes polymerization. Then the molten mass is passed through spinnerets to form fibres of nylon 6.



Properties and applications:

1. Nylon-6 fibres are tough, possessing high tensile strength, as well as elasticity and lustre. They are wrinkle proof and highly resistant to abrasion and chemicals such as acids and alkalis. The fibres can absorb up to 2.4% of water, although this lowers tensile strength.

2. It is widely used for gears, fittings, and bearings, in automotive industry for underthehood parts, and as a material for power tools housings.

3. Nylon 6 is used as thread in bristles for toothbrushes, surgical sutures, and strings for acoustic and classical musical instruments, including guitars, sitars, violins, violas, and cellos. It is also used in the manufacture of a large variety of threads, ropes, filaments, nets, and tire cords, as well as hosiery and knitted garments.

Ans: 5 Classification of polymers on the basis of structure:

This category has the following classifications:

1. **Linear polymers**: The structure of polymers containing long and straight chains fall in this category. PVC, i.e. poly-vinyl chloride is largely used for making pipes and electric cables, is an example of a linear polymer. Also high density polyethene lies in this category.
2. **Branched chain polymers**: When linear chains of a polymer form branches, then such polymers are categorized as branched chain polymers. Low-density polythene is an example of branched chain polymers.

3. **Cross-linked or network polymers**: These polymers are composed of bi-functional and tri-functional monomers. They have a stronger covalent bond as compared to various linear polymers. Bakelite and melamine are examples in this category.

Ans: 6

S.N.	Cold L-S Process	Hot L-S Process
1.	Process carried out at room temperature	Process carried out at high temperature
2.	Reactions are slow	Reactions are fast
3.	Softening Capacity is low.	Softening Capacity is high.
4.	Coagulants are used for removal of fine particles.	No requirement of coagulants.
5.	Requirement of lime is as per stoichiometry.	Lesser amount of lime is required because temporary hardness, CO_2, H_2S are removed at elevated temperature.
6.	Steam is not used.	Steam is used hence there is fuel consumption.
7.	Residual hardness of water after treatment is 50-60 ppm.	Residual hardness of water after treatment is 15-30 ppm.

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