Quadrant II – Notes

Programme: Bachelor of Science (F.Y. B.Sc.)

Subject: Industrial Chemistry

Course Code: CHC151

Course Title: General Industrial Chemistry

Unit: III

Module Name: Renewable natural Resources - Cellulose – Properties, modification and Applications

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- Cellulose, a polymer of Glucose, is the most abundant organic material.
- Major structural polysaccharide in plants where it forms the constituent of Cell Wall.
- Over 50 % of the total matter in the living word is Cellulose.
- Dry leaves contains 10-20% cellulose
- wood contains 50%
- Purest natural form of cellulose is cotton contains 90% of Cellulose.

Structure and Properties: Cellulose is $(C_6H_{10}O_5)_n$

- Cellulose is poly (1, 4 β D-glucopyranose).
- Composed of D glucose units linked by β 1,4-glycosidic bond**.**
- Structurally its molecules are made up of large number of β D-glucose units and the chains are arranged to form bundles, held together by hydrogen bond between glucose units.
- The polymer contain free hydroxyl groups at the C2, C3 and C6 atoms.
- Form various types of supramolecular semi-crystalline structures through hydrogen bonding based on OH groups and Oxygen atoms of both pyranose ring and glycosidic bond.
- Dissolves in Ammonical copper hydroxide solutions.
- Controlled hydrolysis gives Cellobiose, which on further hydrolysis gives β D-Glucose.

- A mixture of conc. Sulphuric acid and acetic anhydride converts cellulose into octacetate of cellobiose, which on further hydrolysis gives cellobiose.
- White Solid insoluble in water and usual organic solvents.
- Complete hydrolysis by acid yields β D-glucose as a only monosaccharide

Cellobiose:

- White crystalline solid, soluble in water.
- Prepared by acetylating pure cellulose with acetic anhydride in the presence of Conc. H_2SO_4 and hydrolyzing, formed octaacetate cellobiose with KOH.
- On hydrolysis with dilute acids or by the enzyme emulsin, it gives 2 molecules of β D-glucose.

Cellulose Nitrates:

- **Cellulose** on treatment with nitrating mixture (HNO_3/ H_2SO_4) gives **cellulose trinitrate**.
- Each glucose unit in cellulose has **3 OH groups** and hence the highest nitrate ester is trinitrate.
- Cellulose trinitrate **$[C_6H_7O_2(ONO_2)_3]_n$** is employed under the name **Gun cotton**.
- It is used in propellant, explosives and for blasting.
- Dilute mixture of HNO_3 and H_2SO_4 forms mono and dinitrates of cellulose. Grouped together under the name **pyroxyline**.
- Readily dissolved in a mixture of alcohol and ether, forming solution named as **colloidon.**
- A development of great importance, is the use of gun cotton and pyroxyline in the production of **smokeless powder**.
- Mixture of pyroxylin and camphor in a solvent such as ethanol forms **celluloid**
- Used as a plastic being readily moulded at **80°C**.
- Pyroxylin is also used in the manufacture of Lacquers, particularly for motor cars

Artificial silk: 1. Acetate Silk

Cellulose form triacetate with acetic anhydride and acetic acid in the presence of $H_2SO_4/ZnCl_2$.

Triacetate is then hydrolysed to diacetate, dissolved in a mixture of solvents (acetone). The syrup solution thus formed is forced through a spinneret into a warm chamber, the solvent evaporates leaving behind fine threads of cellulose acetate.

- Cellulose acetate silk possesses a good lustre and insensitive to moisture.

Burns with difficulty and less readily dyed.

2. Cupraammonium silk (Cupra Silk):

Cellulose is dissolved in ammonical copper hydroxide solution.

The solution thus obtained is then forced through a spinneret into a H_2SO_4 bath, cellulose is precipitated as threads.

3. Viscous Silk (Rayon):

Cellulose on treatment with Conc. NaOH and CS_2, Sodium cellulose xanthate or cellulose xanthogenate, soluble in NaOH.

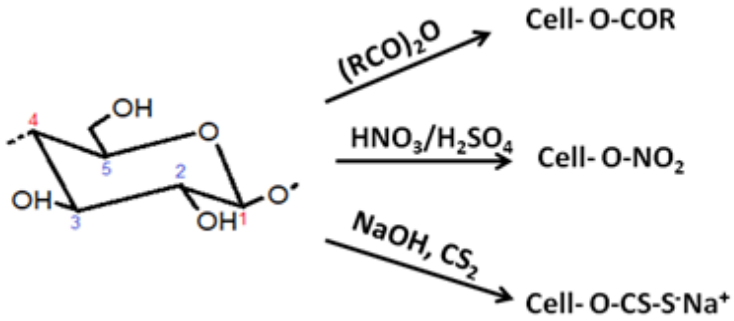
Thus, alkaline cellulose xanthogenate formed has a **high viscosity**.

This alkaline solution is forced through a spinneret in a H_2SO_4 bath, whereupon cellulose is precipitated as fine threads.

Cellophane:

When viscous solution is passed through narrow slits into an acid bath, Cellulose is precipitated as very this sheets.

When these sheets are coated with nitrocellulose lacquer, they become moisture proof.



Paper:

Formally made from linen wastes, now made from wood pulp.

Two Processes of paper synthesis.

1. The caustic soda process
2. The sulphite process