* Common Impurities :-
water is a good solvent due to its ability to acquire acidity or alkalinity. Contamination of water takes place when it comes in contact with ground, rocks or soil and also from sewage or industrial wastes.

Impurities in natural water may be classified as -

Impurities of water

Dissolved

(1) Inorganic : Carbohydrates, bicarbonates, nitrate, sulphates and chloride of calcium, Mg, Na, K, Fe, Mn, Al, Zn & Cu.

(2) Organic

3) Gaseous : CO_2, SO_2, H_2S, NH_3, O_2, N_2 and oxides of nitrogen

Suspended

(1) Organic : vegetables, animal matter, oil globules.

(2) Inorganic : clay and sand

(3) Colloidal Impurities : Finely divided silica, clay, Aluminium Hydroxide [$Al(OH)_3$]. Ferric hydroxide, organic waste products, colouring matter

(4) Microscopic : E Coli & Pathogenic

* Hardness of Water :-

Hardness of water means water which makes cleaning action of soap difficult. The water which does not form lather with soap and is hard to wash.

Causes of Hardness :-

Hard water is defined as the water which contains bicarbonats, chlorides and sulphates, nitrates of calcium and magnesium which does not produce lather readily with soap.

This can be explained as follows :-

When hard water containing Ca^{+2} & Mg^{+2} ions are treated with a soap, does not produce lather but produce a white precipitate of the Ca^{+2} & Mg^{+2} salts of the corresponding fatty acid.

$$2\,C_{17}H_{35}COONa + CaSO_4 \rightarrow (C_{17}H_{35}COO)_2Ca + Na_2SO_4$$

(Sodium Sterate) (Calcium Sterate)

$$2\,C_{17}H_{35}COONa + MgCl_2 \rightarrow (C_{17}H_{35}COO)_2Mg + 2\,NaCl$$

Thus, no lather is formed until all the Ca^{+2} & Mg^{+2} ions get precipitated completely.

Name of Lecturer :

Hardness of water termed as the soap consuming capicity of a water.

* Types of Hardness :-

Temporary Hardness (Carbonate Hardness)

→ due to bicarbonate ions of calcium and magnesium.

→ It is removed by simple boiling of water which converts the bicarbonates into insoluble carbonate or hydroxides.

→ Insoluble carbonates or hydroxides can be removed by filteration. It is called alkaline Hardness.

$Ca(HCO_3)_2 \xrightarrow{boil} CaCO_3 \downarrow + H_2O + CO_2$

→ Can also be removed by adding calculated amount of lime -

$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 \downarrow + 2H_2O$

Permanent Hardness (non Carbonate or non alkaline Hardness)

↓

It is due to dissolved chloride sulphates & nitrates of calcium and magnesium.

→ Cannot be removed by simple boiling process

Total Hardness − temporary Hardness = Permanent Hardness

Hardness due to $CaSO_4$ is more than $MgSO_4$.

* **Determination of Hardness of water :-**
two methods are used to determine Hardness of water.
(a) Clark's Method
(b) EDTA method

(a) **Clark's Method (Soap titration Method) :-**
This method is based on the principle that soluble soap (Na or K salts of fatty acids) when added to hard water (having hardness causing metal ions) firstly form insoluble compounds with the metal ions and doesn't produce any lathes.
But as soon as all such metal ions are precipitated out, addition of further drop of soap solution will produce lathes.

$$2C_{17}H_{35}COONa + MgCl_2 \rightarrow (C_{17}H_{35}COO)_2Mg\downarrow + 2NaCl$$

$$2C_{17}H_{35}COONa + CaSO_4 \rightarrow (C_{17}H_{35}COO)_2Ca\downarrow + Na_2SO_4$$

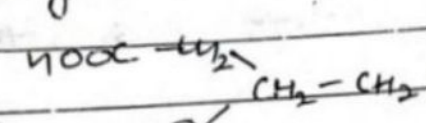
Soluble Soap — Hardness — Stearate (insoluble)

So we can determine total hardness of water by means of its titration against a standard soap solution. The appearance of lathes indicates the end point of titration.

Topic : ..... Unit..... Lecture No.....

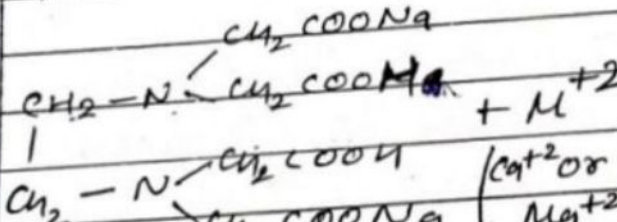
EDTA Method :-

(Ethylene di amine tetra acetic acid)



This method is complexometric titration of water sample with EDTA using Eriochrome Black T as the indicator. EDTA (Ethylene diamine tetra acetic acid) is strong complexing agent.

Since EDTA has limited solubility in waters. The disodium salt of EDTA which is soluble in water is used. In these titrations known as complexometric titrations.



Disodium salt of EDTA

Complex of EDTA with metal ion.

EDTA acts as a tetra / hexa dentate ligand and attaches itself with metal ion (through O or N atoms) to give very stable, soluble and colourless complexes (chelates) (1:1)

DATE / /
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Cement

→ A cement is a binder, a chemical substance used for construction that sets, hardens & adheres to other materials to bind them together.

→ Cement is an anhydrous powder obtained by burning a mixture of various metallic oxides (Ca, Al, Fe & Si etc.) at high temp of about 1500 - 1700°C

Cements are of 4 types

Natural Cement
↓
produced by calcining & pulverizing naturally occuring argillaceous & lime stone at high temp.

Puzzolana Cement
↓
oldest among all types. first made from volcanic ash from mount vesuvius situated around a place called pozzouli in Italy.

Slag Cement
↓
hydrated lime & blast furnance slag (a mixture of calcium & aluminium silicates)

Pontland Cement
↓
'magical power'. It consists primarily of compounds of lime, alumina, silica & iron. It forms a paste when mixed with water.

Composition of Pontland Cement :—

Lime (CaO) → (60-67%), Silica (SiO_2) → (17-25%), Alumina (Al_2O_3) → (3-8%)

, Iron Oxide (Fe_2O_3) → (0.5-6%), Magnesia (MgO) → (1-5%), Sulphur trioxide (SO_3) → (1-2%)

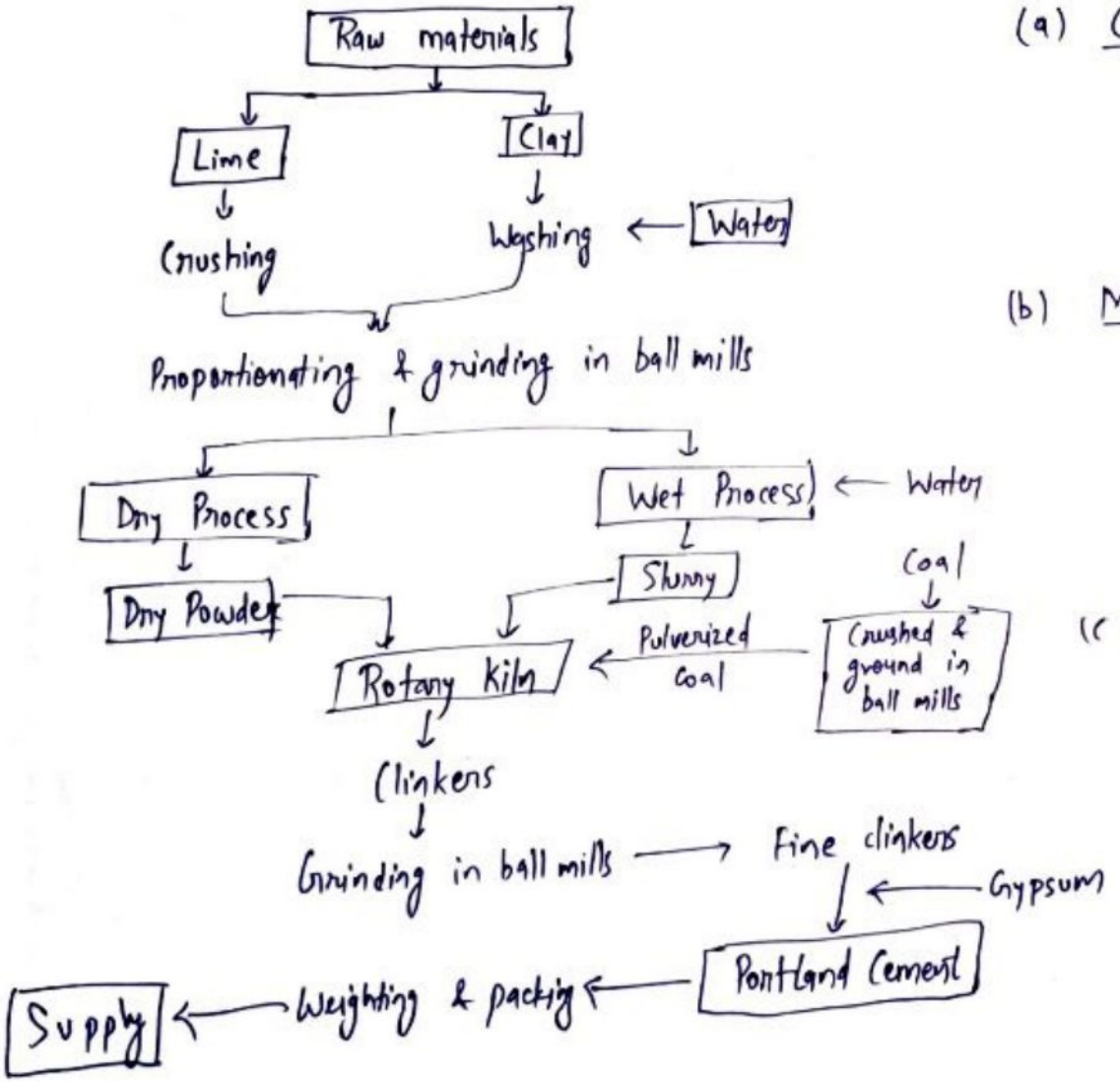
, Soda & Potash ($Na_2O + K_2O$) → (0.5-1.3%), Gypsum ($CaSO_4 \cdot 2H_2O$)
⇓
added during griding

Teacher's Signature

Manufacturing of Portland Cement ⇒ It can be performed by two methods:

(i) Rotary Kiln Method :- It involves following steps :-

(A) Crushing (B) Mixing (C) Burning (D) Grinding (E) Packing



(a) Crushing :- Raw materials are grinded in ball mills & passed to tube mill conveyed through means of screw driver. The material is mixed with 30-40 % water before grinding.

(b) Mixing :- The muddy mixture thus formed is known as slurry, which is generally stored in big tanks. This slurry contains about 38-40% water. The slurry is then pumped into the rotary kiln where it is burnt.

(c) Burning :- Actual chemical changes take place in rotary kiln. Heating of kiln is done by burning of pulverized coal & temp. maintained is 1400-1500°C.

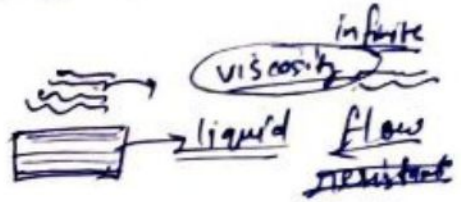
In fact, there are different zones in the rotary kiln viz.

Glass

It is an amorphous, hard, brittle, transparent or translucent, super cooled liquid of infinite viscosity, obtained by fusing a mixture of a number of metallic silicates, most commonly of Na, K, Ca & Pb.

$$XR_2O \cdot YMO \cdot 6SiO_2$$

X, Y = Ca, Pb, Zn, Al, Na, K...



Ordinary glass = $Na_2O \cdot CaO \cdot 6SiO_2$

= $Al_2O_3 \cdot B_2O_3 \cdot P_2O_3$

Manufacturing Process of Glass:- Melting → Shaping → Annealing → Finishing

1. **Melting** ⇒ The raw materials (sand, Na_2CO_3 & limestone) are ground and mixed with cullets & again ground to get finally powdered & intimate mixture called 'batch'.

Melting of glass batch is done by either heating in pot or heating in tank furnace.

→ Batch is heated in tank furnace by producer gas at 1800°c temp. Heating is continued till all the CO_2 & SO_2 air bubbles are removed & finally transparent resulting fused mass is obtained which is known as plain.

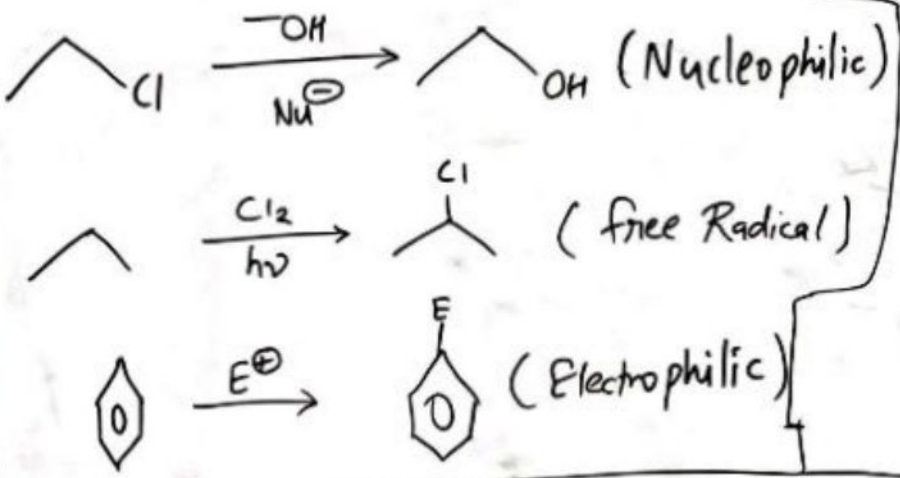
→ Now heating is stoped & plane is allowed to cool. The chlorides & sulphates of Ca, Al & alkali metals which are remained under composed with other impurities separate in form of sum called glass ball. & can be removed easily & then cooled to 800°c. The melt is drawn from working pits for shaping.

2. **Shaping** ⇒ Molten glass is shaped into desired articles by either blowing or

Substitution Reactions ⇒

These reactions involve the displacement of an atom or a group by another atom or group.

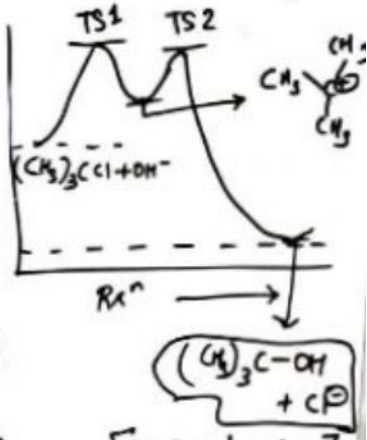
$E^{\oplus}$ $Nu^{\ominus}$ R



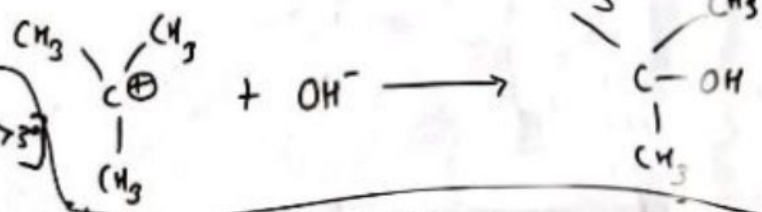
1. Nuclephilic Substitution Reaction :—

1. S_N1 :-

(a) Formation of ⊕ ⇒

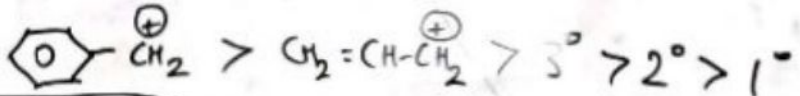


(b) Attack of Nucleophile ⇒



[1° > 2° > 3°]

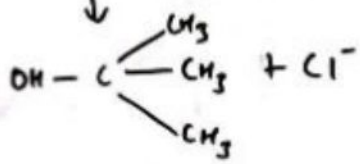
Stability of ⊕ / S_N1 :—



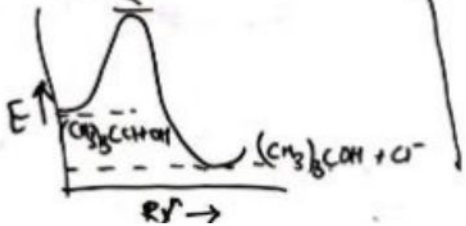
2. S_N2 :-

Steric Hindrance

Intermediate Step



Inversion of configuration



Addition Reaction

[At least one pi bond]

alkene [=], alkynes [≡], C=O, C≡N

$A-B \xrightarrow[\text{reagent}]{X-Y} \underset{X}{\overset{|}{A}}-\underset{Y}{\overset{|}{B}}$

Subtract

(i) Electrophilic Addition Rx^n :-

Step-1 ⇒

$CH_3-CH=CH_2 \longrightarrow CH_3-\overset{\delta+}{C}H=CH_2 \longrightarrow CH_3-\overset{\oplus}{C}H-CH_2 + Br^{\ominus}$

(with $H-\overset{\delta-}{Br}$ at the double bond)

$CH_3-\overset{\oplus}{C}H-CH_3 + Br^{\ominus} \longrightarrow CH_3-\underset{Br}{CH}-CH_3$

Markownikoff's Rule ⇒ negative part of addendum is added to that doubly bonded carbon atom which bears the minimum number of hydrogens.

$CH_3-CH=CH_2 + H^{\oplus} \longrightarrow CH_3-\overset{\oplus}{C}H-CH_3 \xrightarrow{Br^{\ominus}} CH_3-\underset{Br}{CH}-CH_3$ (2-Bromopropane) → [more stable]

$CH_3-CH_2-CH_2^{\oplus} \xrightarrow{Br^{\ominus}} CH_3-CH_2-CH_2Br$ (1-Bromopropane)

(ii) Radical Addition Rx^n :-

(i) Chain Initiation ⇒ $C_6H_5-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-C_6H_5 \xrightarrow{\Delta\ 60-80^\circ C} 2\,C_6H_5CO_2^{\bullet}$

$\xrightarrow{HBr} C_6H_5COOH + Br^{\bullet}$

(ii) Chain Propagation ⇒ $Br^{\bullet} + CH_2=CH-CH_3 \longrightarrow Br-CH_2-\dot{C}H-CH_3 \xrightarrow{HBr} BrCH_2-CH_2-CH_3 + Br^{\bullet}$

(iii) Chain Termination ⇒ $2Br^{\bullet} \longrightarrow Br_2$

$Br-CH_2-\dot{C}H-CH_3 + Br^{\bullet} \longrightarrow Br-CH_2-\underset{Br}{CH}-CH_3$

$2\,Br-CH_2-\dot{C}H-CH_3 \longrightarrow Br-CH_2-\underset{CH_3}{CH}-\underset{CH_3}{CH}-CH_2-Br$

Anti-Markownikoff's Addition or Peroxide Effect :-

$CH_3-\underset{Br}{CH}-CH_3 \xleftarrow[\text{peroxide}]{HBr} CH_3-CH=CH_2 \xrightarrow[\text{peroxide}]{HBr} CH_3-CH_2-CH_2Br$

(Major product)

Because presence of peroxide the addition involves free Radical mechanism.

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