Egyptians
→ Limestone + Gypsum (Primary cement material)

Roman + Greeks
→ Volc. Ash + Tuff (Lava) [Increases workability + stability]

Sillicious content [বালি].

indians
→ Broken bricks

[Pozzuolana cement]

Romans
→ Animal blood, milk, lard [Plasticity + workability +]

haemoglobin
→ oxygen : Absorbs air of the mixture
more stability during contraction and expansion. pores× cracks×.
powerful air-entrainment agent and plasticizer. better workability

1804 first cement factory

21st Oct
→ 1824 Joseph Aspdin

limestone + clay $\xrightarrow{\Delta}$ Portland

blend → burn → powder

Portland Island, England.

Raw Materials : Portland cement
Industrial production

America / Europe / British scientific criteria : 1904

(I) Calcarious materials : Limestone, chalk, alkali waste

(II) Argillaceous material : clay, Shale, slate, blast furnace slag.

$\underbrace{\text{furnace slag.}}$ industrial byproduct

FeS_2 (ধাতুমল)

Grey color, plate আকারে আলাদা হয় on impact

└→ shale, slate

Raw :

Calcarious material : (Limestone)

$CaCO_3$ → 65 – 80% by weight

< 3.3% MgO (3–4% $SiO_2 + Al_2O_3 + Fe_2O_3$)

Argillaceous material : clay

should contain SiO_2 2.5 folds ~~of~~ than that of Al_2O_3

British standard:

[Approximate oxide composition Limit of ordinary portland cement.]

↳ the approx. relative percentage of oxides.

Compound	Formula	Percent by weight
Lime	CaO	60 – 67%
Silica	SiO_2	17 – 25%
Alumina	Al_2O_3	3.0 – 8.0%
Feric oxide	Fe_2O_3	0.5 – 6.0%
Magnetia	MgO	0.1 – 4%
Alkali	Na_2O, K_2O	0.4 – 1.3%
Sulfuric Anhydride	SO_3	1.3 – 3.0%

Argilleceous + calcarious
↓
blend → slurry
(semi-solid mass)

kiln

[grinding raw materials + mixing] $\xrightarrow[\text{partial fusion}]{1300-1500^\circ C}$ nodular clinker $\xrightarrow[\text{ground}]{\text{cooled}}$ powder
↓ (+)
3–5% gypsum → Portland Cement

(dep. on purity & composition)

wet	dry	semi dry (10–14% water)
slurry (35-50% water)	modern dry mixing technique using compressed air	
outdated more fuel 350 kg coal for 1 ton cemet	less fuel needed (100 kg) economic smaller machines	

Production Technology

dimention

fine (3/16")

← 1. Morter [mixture of cement + sand + ~~coarse~~ aggregate]

2. Concrete [" " cement + sand + coarse aggregate]

3. Reinforced concrete [concrete + wiremesh + rod]

morter → compressive strength নেই। fine aggregate is used in masonry work

Concrete → compressive strength increases. (> 3/16")
coarse aggregate. used in roof, basement
No. Tensile strength

cement : sand : coarse aggregate

1 : 1·5 : 3

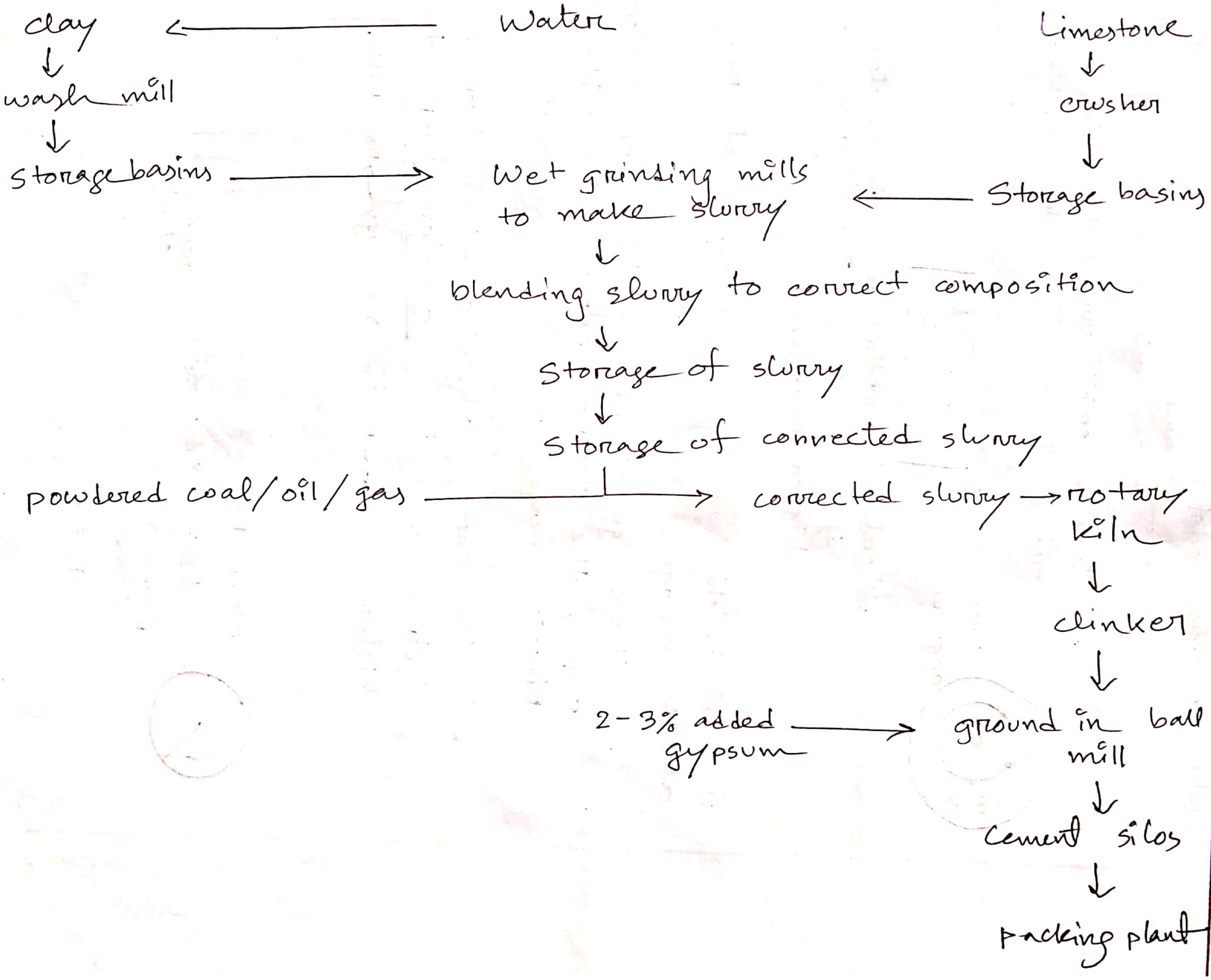
1 : 2 : 4

1 : 3 : 6

Reinforced concrete → compressive strength
+
tensile strength

used in bridges.

Wet Process


clay
wash mill
storage basins
Water
Limestone
crusher
Storage basins
Wet grinding mills to make slurry
blending slurry to correct composition
Storage of slurry
Storage of corrected slurry
powdered coal/oil/gas
corrected slurry
rotary kiln
clinker
2-3% added gypsum
ground in ball mill
Cement silos
Packing plant

17.02.2019

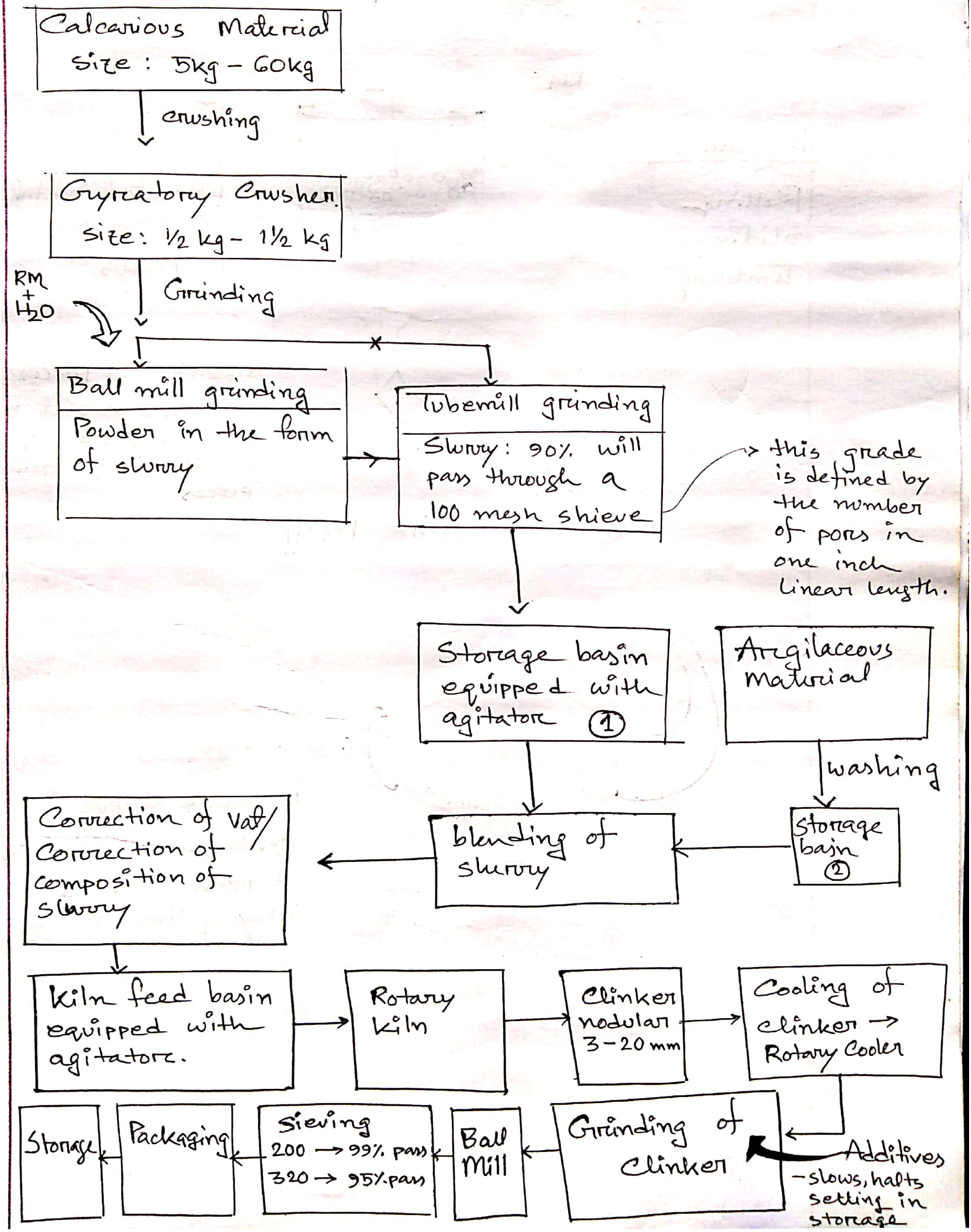
Methods involved in industrial productions of PC

Method	On the basis of H_2O added during production	Priority of selection of method
1. Wet process (universal)	35-46% H_2O by weight of raw material	When the argillecious material is other than blast furnace slag.
2. Dry process	No H_2O added during production	When the argillecious material is blast furnace slag
~~3. 14% H_2O added during production~~		
3. Semi dry	14% H_2O added during production	Unknown

demerits of wet process

- → bigger machine needed
- → more expensive
- → not economical. (water takes up too much space)

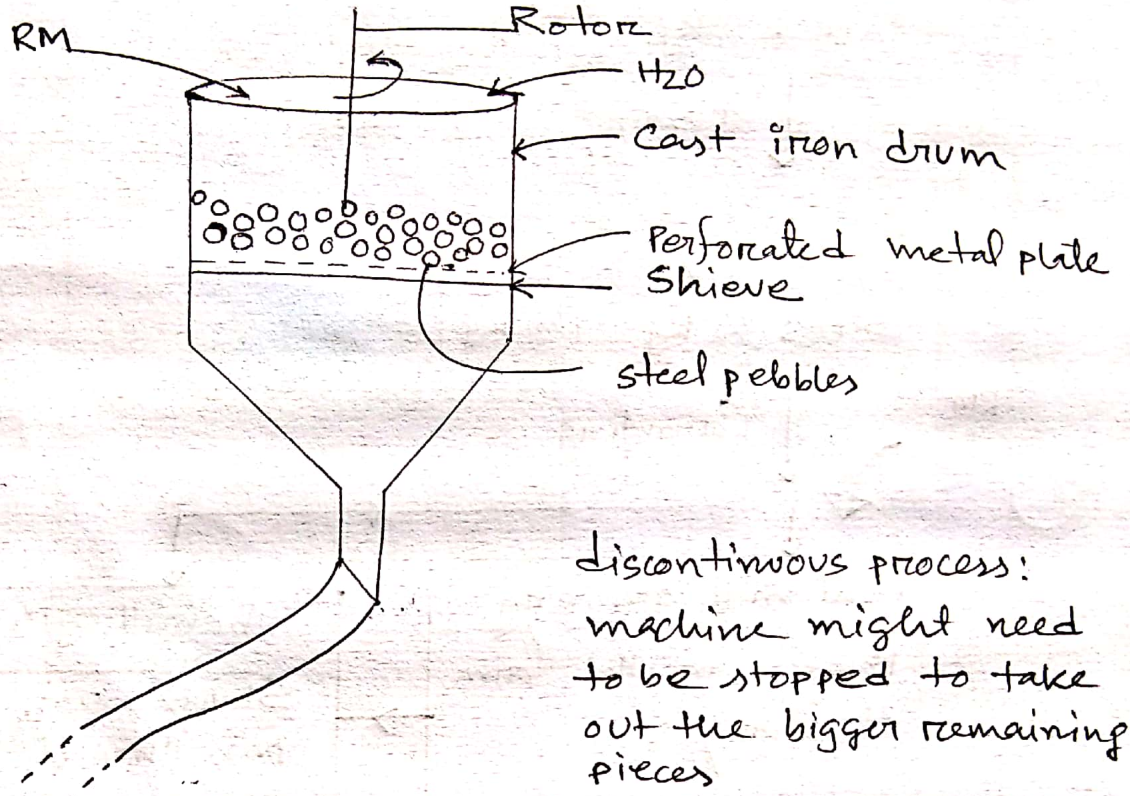
Flow Sheet Diagram



Ball Mill

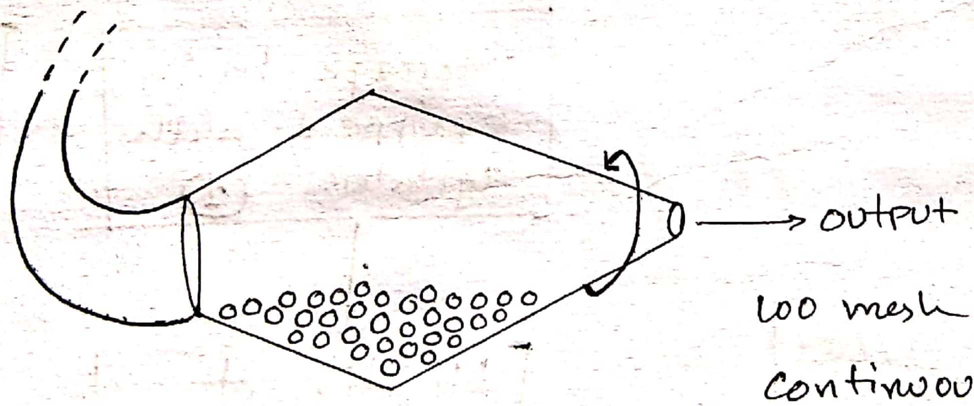
Mechanism

Rolling
Sliding
Tumbling



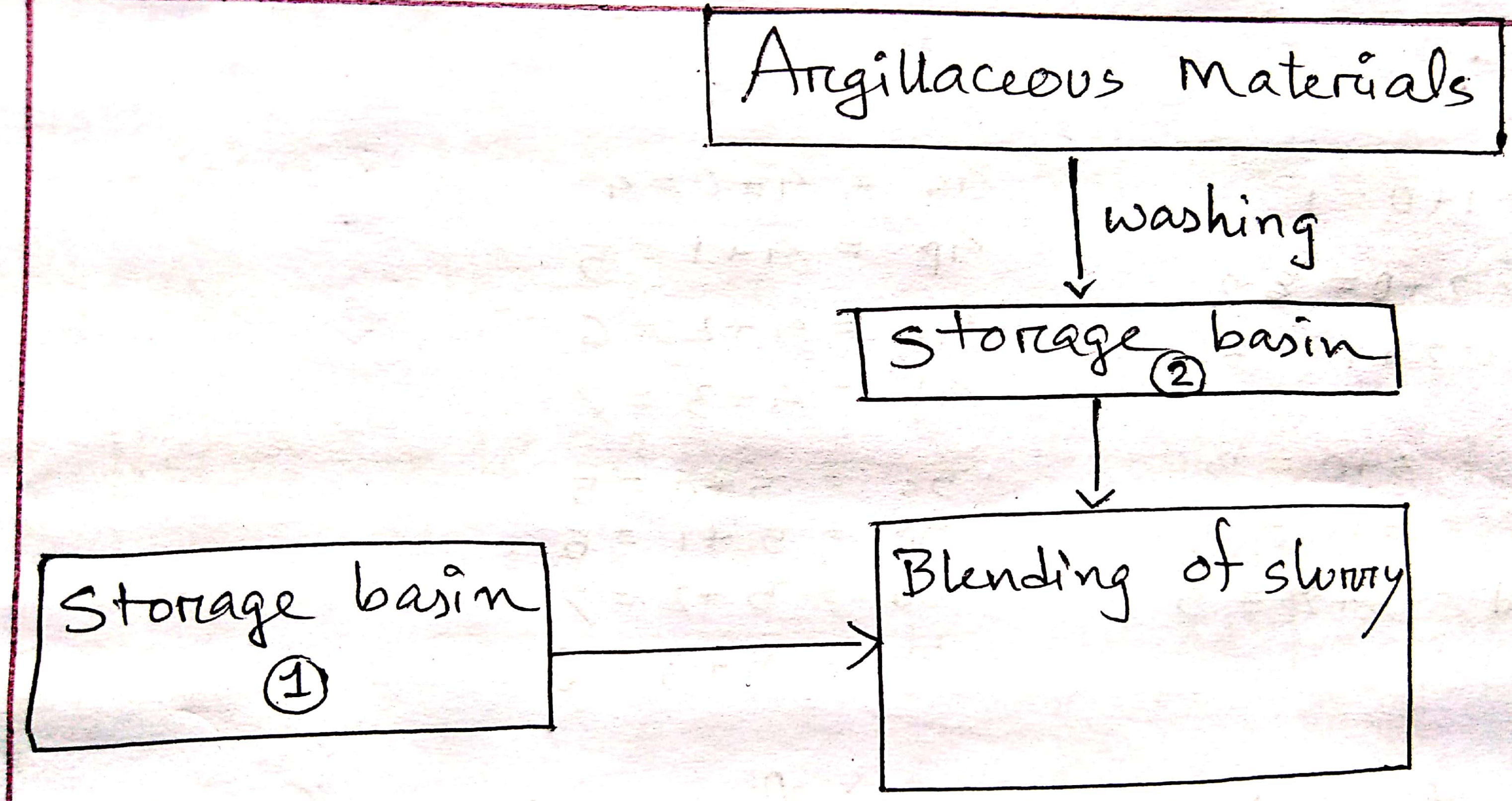
discontinuous process: machine might need to be stopped to take out the bigger remaining pieces

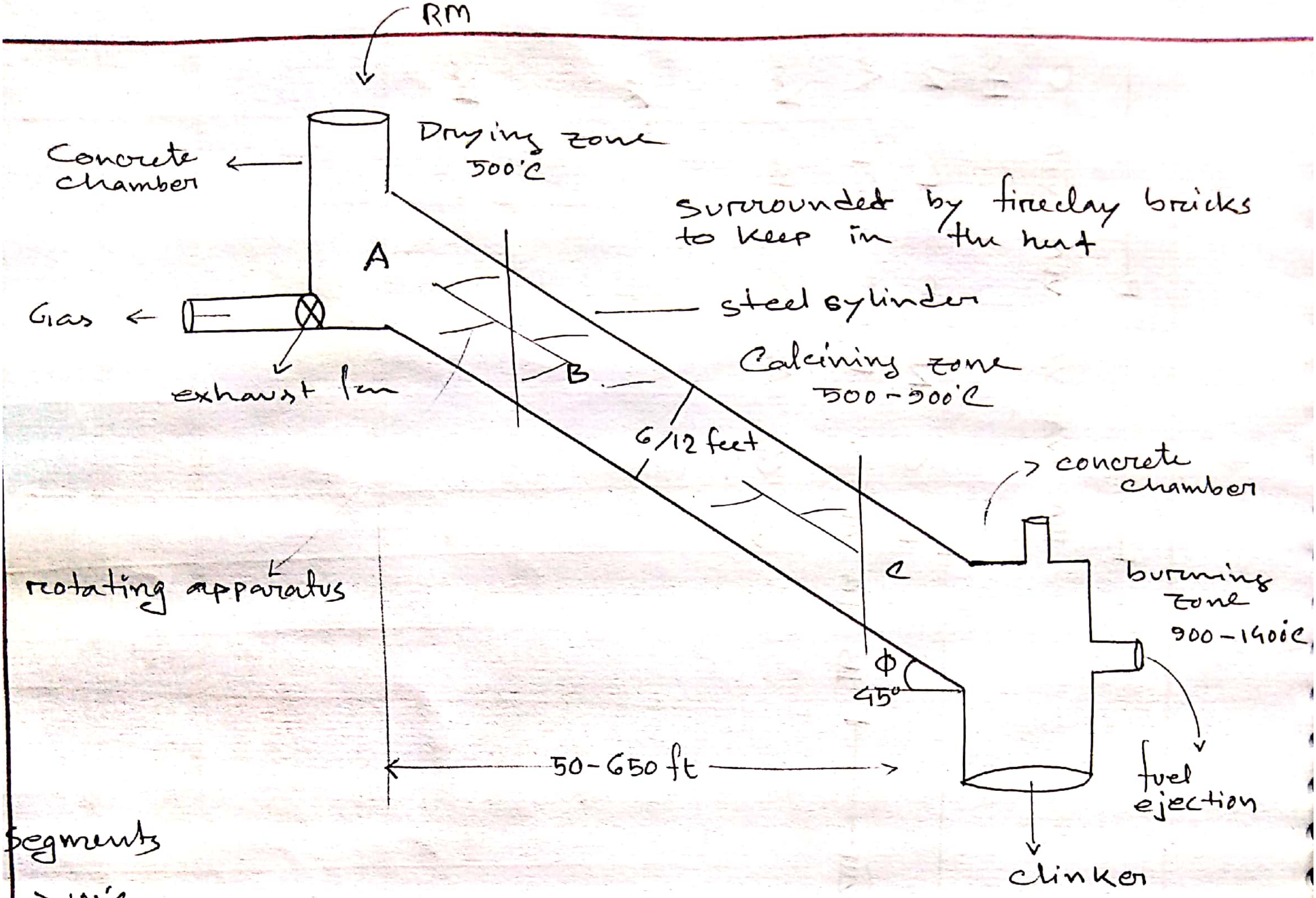
Tube Mill



100 mesh shieve

continuous process. The size of product depends on the staying time in the tube


Argillaceous Materials
washing
storage ② basin
Storage basin ①
Blending of slurry



Segments
>100'C
>200'C - <500'C

Rotary kiln

A

RM $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

exhaust fan prevents reversible reaction

Anhydrous RM

1000 — 1280 →

>1280 — 1400'C

Major reactions and compounds

$3CaO + SiO_2 \longrightarrow$ ~~3CaSiO~~ $3CaOSiO_2 \longrightarrow C_3S$

$2CaO + SiO_2 \longrightarrow 2\,CaO\,SiO_2 \longrightarrow C_2S$

$3\,CaO + Al_2O_3 \longrightarrow 3CaO\,Al_2O_3 \longrightarrow C_3A$

$4\,CaO + Al_2O_3 + Fe_2O_3 \longrightarrow 4CaO.Al_2O_3.Fe_2O_3 \longrightarrow C_4AF$

Bogue's Compound [clinker]

$C_3S \rightarrow 54.1$ tricalcium sillicate

$C_2S \rightarrow 16.6$ dicalcium sillicate

$C_3A \rightarrow 10.8$ tricalcium aluminate

$C_4AF \rightarrow 9.1$

90%

Bogue's equation (page 150)

Scanned by CamScanner

Ordinary Portland Cement
Relative RM Percentage :

$CaO = 63\%$ $Fe_2O_3 = 3$

$SiO_2 = 20\%$ $MgO = 1.5$

$Al_2O_3 = 6\%$

C_3S & C_2S increases the cement compressive strength and overall quality.

C_3A & C_4AF increases the usability in ~~to~~ underwater constructions. As these make the Cement quick setting.

C_3S increases usability in freezing temperature.

C_3S and C_2S must not exceed 80%.

(Page 15)

Effect of relative % of oxide in the RM on the quality of cement.

Nodular Shape : clinker having no particular shape. Ranging from 3-20 mm.

C

Clinker received is 1200-1400°C. It is cooled by cool air. The air becomes extremely hot which is then supplied to A to provide rapid combustion.

baffle plate.

baffle : Controlling the flow of water, liquid and air. Cool Oxygen is supplied by a kiln which rotates and vibrates.

Effect of rate of cooling :

C_2S → hydration reaction is slow. Compressive strength low.

(i) Slow rate cooling → Dusting (Powderization) takes place.

(ii) High rate cooling → ~~Max C_3S & C_2S w~~ glass formation

(iii) Moderate cooling → Max C_3S & C_2S will crystallize
(best method)

C S A
Concred > 1 : 2 : 3 — Aggregate
~~Screed > 1 : 3 : 5~~

Screed 1:(3-5)
c S

Grinding of clinker with additives:

the chemicals added during grinding to the clinker are additives.

3- 50 microns.

Additives:

1. Retarding agent → gypsum / plaster of paris
2. Dispersing agent → Sodium salt of polymers of condensed napthalene, sulphonic acid
3. Air entrainment agent → Vins of resin, Darex
4. waterproofing agent → Tufferete.

Function

1 → C_3A reacts with it. Prevents the flash setting of cement. especially due to C_3A.

2 → To reduce the power cost of grinding of clinker
→ To prevent the formation of lump during transportation and preservation.

3 → Reduces the internal pressure of concrete. during fluxing and thawing.
fluxing ↓ melting
thawing ↓ freezing
→ temperature ranging in a wide spectrum. stress reducing oxygen pores during ↔ & →←

4 → Mechanical property
- flexural strength
- tensile strength
- impact strength

Adhesive property

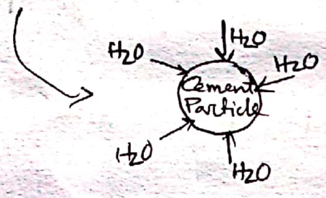
Mechanism of hydration of cement

gel → dispersion medium → solid
Supersaturated → solute বেশি solvent কম

some definitions missed.

→ sufficient water present

- Through solution mechanism. At the initial stage of hydration
- Through solid state mechanism. At the later stage of hydration



this hydration rate depends on the particle size.

Effect of particle size on the hydration of cement.

Specification of particle size of ordinary portland cement

Particle size of opc	Hydration time
$3-4\mu$	24hr
$15-20\mu$	28 days
$<40-<50\mu$	365days

maximum particles are of this range →

↑ compressive strength achieve rate.

compressive strength depends on the hydration rate which in turn, depends on the particle size.

Uneven hydration does not affect the compressive strength as the impervious outer layer created due to hydration stops H_2O permeation. So the dry inner layer remains.

$2(3CaO.SiO_2) + 6H_2O \longrightarrow 3CaO\,2SiO_2\cdot 3H_2O + 3\,Ca(OH)_2$

tricalcium
silicate

⊛

$2C_3S + 6H \longrightarrow C_3S_2H_3 + 3Ca(OH)_2$

tricalcium silicate short

water short

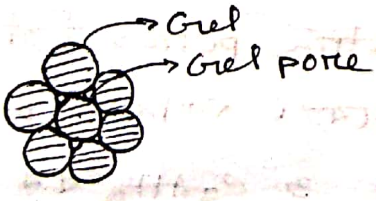
100g 24g 75g 49g

$2(2CaO.SiO_2) + 4H_2O \longrightarrow 3CaO2SiO_2\cdot 3H_2O + Ca(OH)_2$

$2C_3S + 4H \longrightarrow C_3S_2H_3 + Ca(OH)_2$

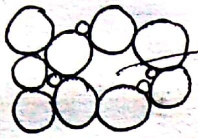
100g 21g 99g 22g

these to principal compounds need (24+21)g water. Considering other compounds, the bound water (necessary water) need to convert cement into hydrated gel is considered to be approx. 23 g. for chem. reaction



an extra 15g water is needed to occupy the gel pores. This (23+15)g = 38g water per 100g cem is needed.

if 38g water is not met. > 38g



→ Capillary Cavity (water filled)
Unexpected and hindering.

<38g

Some pores are kept empty which is also unexpected.

Other Compounds →

$C_3A + nH \longrightarrow C_3AH_6$ → Disadvantageous (doesn't contribute to compressive strength. It is ~~ve~~ vulnerable to sulphate attack.)

$C_4AF + nH \longrightarrow C_3FH_6$ → (little contribution Slightly advantageos. Prevents sulphate attack)

Dicalcium silicate C_2S is most needed for building construction.

⊛ Underwater, saline, basement construction এর
ক্ষেত্রে $Ca(OH)_2$ H_2O তে soluable হওয়ায় Cement থেকে
করে বেরিয়ে আসবে। ফলে যে extra pores তৈরি হবে
তার ধারণক্ষমতার বেশি CaS ঢুকবে। পানিতে Soluable
S ঢুকে CaS তৈরি হয় যা C_3A ও C_3AH_6 এর সাথে
insoluable mass তৈরি হয় যার volume $Ca(OH)_2$ এর
ফাঁকা স্থানের চেয়ে বেশি। ফলে extra-expansion হয়

Calcium Aluminium Sulphate → insoluable mass.

যা cement এর Strength কমায়। যদি? Sulpher attack হলে C_3A এর পরিমাণ <5% রাখতে হবে

freezing temp. এ C_3S বেশি করতে হবে। Heat resolution বেশি হয় যা পানিকে liquified রাখে তাতে hydration বজায় থাকে।

C_2S ও C_3S এর ক্ষেত্রে Hydration, Hydrolysis both হয়

C_3A ও C_4AF এর " only hydration

$2C_3S + 6H \longrightarrow C_3S_2H_3 + \underbrace{3Ca(OH)_2}$ — Slight advantage
PH fixed করে রাখে
(alkyle co. PH)
যা metal corrosion
রোধ করে

$\downarrow SO_4^{2-}$

$CaSO_4$

C_3A $\quad C_3AH_6$ $\quad C_3S_2H_3$

Calcium sulfoaluminate.

Added fly Ash prevents disadvantages of $Ca(OH)_2$.
It converts $Ca(OH)_2$ and thus prevents sulfate attack.

⇒ Sulfate resistant cement

Water treatment plant,
basement construction
Marine/underwater construction
Pipeline coating.

Soundness test

- to test if the cement has volume expansion (which is bad) → unsound.
- Gypsum reacts with $Ca(OH)_2$
- excess magnesium
- rotary kiln ↯ incomplete reaction. Unreacted alumina, silica etc

Lime

$CaCO_3 \xrightarrow[\text{Calcination}]{\Delta} CaO + CO_2\uparrow$

$\boxed{\ngtr 900^\circ C}$ → if temp gets > 900, the impurities themselves start reacting.

Slaking Reaction: $CaO + H_2O \longrightarrow Ca(OH)_2 + \Delta H$

$Ca(OH)_2$ → paste, limewater

→ pest of lime creates unsoundness.

- When water is added to lime, a hissing sound
- Heat → water vaporization.
- Volume expansion.

Classification of lime, their properties and application

Type	Composition	Property
Fat line	$CaO = 95\text{-}98\%$. $\text{rest} = SiO_2 + Al_2O_3 + Fe_2O_3$	① slaking takes place (very fast) with evolution expansion in volume and evolution of large amount of heat.
Lean lime	$CaO = 70\text{-}80\%$. $MgO = 5\%$; Rest: $SiO_2 + Al_2O_3 + Fe_2O_3$	Slaking very slow. exhibit contraction in V. Heat evolution minimum
Hydraulic lime	$CaO = 70-80\%$ $(SiO_2 + Al_2O_3) = 5-30\%$ $MgO = 2\%$	slaking easily not. exhibit no expansion on contraction in V.
Dolomite lime	$MgO = 40-60\%$.	Slaking slow with slight contraction in V and low Heat is evaporated
Quick lime	$CaO = 99\%$.	

Property (Fat line)

② Setting takes place only on drying (not suitable for wet)

(lean lime) ①. The ~~setti~~ slaking slow.

② contraction in V

③ Heat evo. minimum

④ setting takes place only on drying

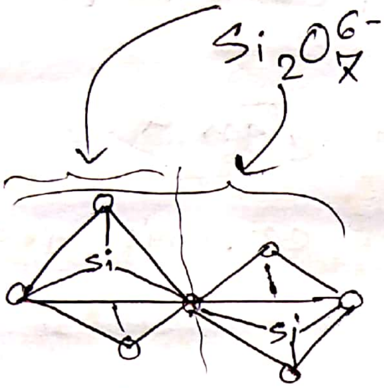
③ Hydraulic setting takes place immersed in water

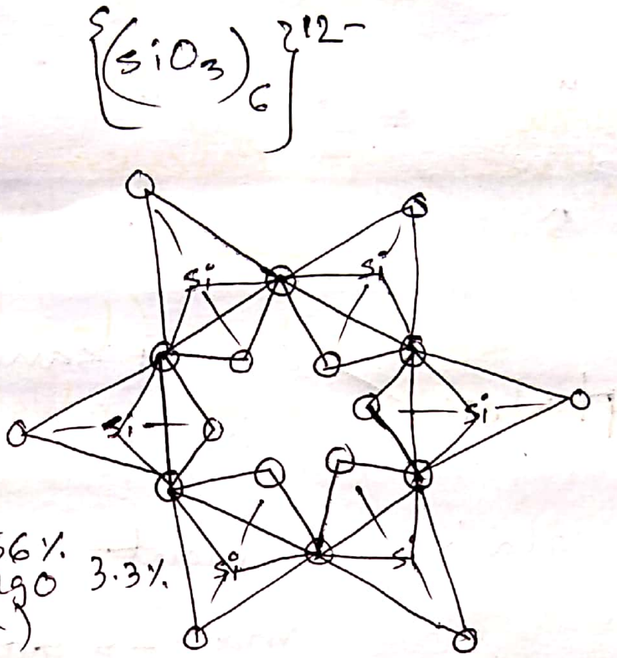
④ Dolomite

⑤ Quick lime → Calcium carbide, calcium sulfate, fertilizer, bleaching powder, water sterilizer, calcium phosphate (for fertilizer), water softening, germicide, paper industry (sizing material)

Silicate

inorganic compound [one ore more metal ion as cation] at least [SiO_4^{4-} as anion]



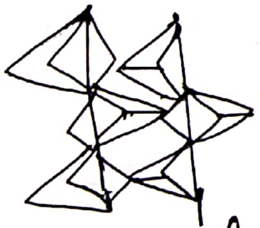


Raw Materials

Limestone : $CaCO_3$ 65 - 86% MgO 3.3%
Chalk : (marine Lifeform)
Marl : $(CaCO_3 + MgCO_3)$ 50-80% + (Clay — 20-50%)
Dolomite
Feldspar
Nephelene
Tuff
Quartzite

6 types of products

Highly stable



stable form as they chain together with increasing oxygen bonds. Melting point is very high and so these can be used as containers in kilns.

Applications of silicate

① Industrial manufacture of cement plaster.

② " " " glass & pyrocerum

③ " " " ceramics and Refractories

plaster — cem + sand
plaster — lime + sand

glass → cement এর RM $\xrightarrow[1600^\circ C]{>1400^\circ C}$ → melted gummy mass → ~~supercooling~~ slow cooling. (clear) amorphous

pyrocerum → same as glass but supercooled. Uniformly crystallised form. Stronger than glass. Harder than High carbon steel. Resists deformation, pressure-force failure.

Refractory → bleach, slab, tiles, ceramic

ceramic — structural ceramic
ceramic — Facing ceramic

Structural → structure construction. Bricks
Facing → Interior decor → tiles

Common Properrties of silicates.

① They are chemically inert and stable
② They can withstand or resists high temperature.
③ Available at low cost
④ Most silicates are insoluble in all solvents except HF
this is why glass is used in labs.

Refractories : 1000°C+ temp এ যেগুলোর property loss [illegible] থাকে। তাই furnace এ use হয়।

Classification of silicates: Based on $\boxed{Si:O}$

Type	Si : O	Groups	Example
Neosilicate	1:4	SiO_4^{4-}	Phenakite → Be_2SiO_4
Sorosilicate	2: 7	$(Si_2O_7)^{6-}$	Hemimorphite → $Zn_4(Si_2O_7)(OH)_2H_2O$
Cyclosilicate	1: 3	$(Si_xO_{3x})^{2x-}$	Bentoite $(BaTi(Si_3O_9))$ Sugilite $(KNa_2(Fe,MnAl)_2Li_3Si_{12}O_{30})$
Inosilicate	1:3	$\frac{SiO_3}{1:3}$ | Si_4O_{11} 4:11	Ferrosilicate → $FeSiO_3$
Phyllosilicate	2:5	Si_2O_5	Talc $Mg_3(Si_4O_{10})(OH)_2$
Tectosilicate	1: 2	SiO_2	Quartz SiO_2
Tridimite	1: 2	SiO_2	~~Tea~~

Modes of expressing the composition of solution

Solution

True solution/ Homogeneous mixture

coarse suspension/ Heterogeneous mixture

Homogeneous mixture

(i) partcle size < 5 mμ

(ii) particles not visible to the naked eye.

(iii) particles can not be separated by simple mechanical method.

(iv) Composition is uniform throughout

(v) single phase (vi) tindal effect ✗

Heterogeneous mixture

(i) particle size > 200 mμ

(ii) discernible to the naked eye

(iii) can be separated by mechanical method.

Colloidal solution

(i) Particle size from 5 mμ – 200 mμ

(ii) seems to be homogeneous to the naked eye but when seen through
appears to be hetero n
ultramicroscope

(iii) tindal effect shows. (light scattered by perticles)

True Solution

Commercial solution	Dilute solution
① specific gravity	① molarity
② density	② normality
③ weight percent	③ mole fraction
④ volume percent	④ ppm
⑤ weight ratio	

① specific gravity $= \dfrac{\text{mass of solute}}{\text{mass of equal volume of solvent}}$

② Density $= \dfrac{\text{mass of solute}}{\text{volume of solvent}}$

$\overset{\overset{\text{solvent}}{\uparrow}}{A}B \rightarrow$ solute

③ weight percent of B $= \dfrac{\text{mass of B}}{\text{mass of (A+B)}} \times 100$

④ volume percent of B $= \dfrac{\text{volume of B}}{\text{volume of (A+B)}} \times 100$

[for expressing solubility]

⑤ weight ratio of B $= \dfrac{\text{weight of B}}{\text{weight of A}}$ [for expressing gas liquid solution]

for liq/liq solⁿ

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Dilute solution

1 Molarity (C) $= \dfrac{\text{No. of moles solute}}{\text{volume of soln is L}}$

2. Normality (N) $= \dfrac{\text{No. of equivalents}}{\text{volume of sol}^{n}\text{ in L}}$

3. Molality (C_m) $= \dfrac{\text{No. of mole of solute}}{\text{Mass of solvent in kg}}$

$$\text{molarity} = \frac{\text{mass of solute}}{\text{molar mass of solute}} \times \frac{1000}{\text{volume of soln (mL)}}$$

$$= \frac{m}{M} \times \frac{100}{V}$$

$$\text{normality} = \frac{\text{mass of solute}}{\text{Equivalent weight of solute}} \times \frac{1000}{\text{volume of sol}^{n}\text{(mL)}}$$

$$= \frac{m}{E} \times \frac{1000}{V(\text{mL})}$$

$$C_m = \frac{m}{M} \times \frac{1000}{w(g)}$$

$$\frac{C}{N} = \frac{\frac{m}{M} \times \frac{1000}{V}}{\frac{m}{E} \times \frac{1000}{V}} = \frac{E}{M}$$

$$\frac{C}{C_m} = \frac{\frac{m}{M} \times \frac{1000}{V}}{\frac{m}{M} \times \frac{1000}{W}} = \frac{W}{V}$$

④ Mole fraction (X_B) = $\frac{\text{No. of moles of B}}{\text{No. of moles of (A+B)}}$

$$X_B = \left(\frac{n_B}{n_A + n_B}\right) = \frac{\frac{m_B}{M_B}}{\frac{m_B}{M_B} + \frac{m_A}{M_A}}$$

⑤ PPM = mg/L

$$= \frac{\text{mass of solute in mg}}{\text{volume of soln in L}} = \left(\frac{m_B \times 10^{-3} g}{M_B} \times \frac{1}{V_L}\right)$$

Problem

④ Normal saline contains 0.91% (w/v) NaCl calculate the Molarity of NaCl

$$C = \frac{1000\,w}{MV} = \frac{1000 \times .91}{58.5 \times 100}$$

$$\text{Normality} = \frac{m}{E} \times \frac{1000}{V(ml)}$$

m = 0.91g

$$= \frac{m}{E} \times \frac{1}{V_{(L)}}$$

$$= \frac{0.91\,g}{58.5\,g/mol} \times \frac{1000\,ml/L}{100\,ml}$$

$$= 0.15\,M/L$$

④ Describe the preparation of approx. 6M HCl solution in 100 ml The label on the bottle specifies that the commercial reagent is 37% and has specific gravity of 1.09

⇒ Generally the commercial solutions are expressed in weight ratio, i.e, 37g HCl is present 100g conc. ~~solutio~~ HCl soln/comm. soln

Specific gravity = 1.09, can be expressed as

$$\text{density} = \frac{1.09g\ \text{HCl(conc)}}{\text{ml of conc. soln}}$$

$$\frac{\text{Weight}}{\text{Volume}} = \frac{1.09\,g\ \text{HCl conc}}{\text{ml. of conc Soln}} \times \frac{37g\ \text{HCl}}{100g\ \text{conc/Soln}} \quad ①$$

$$= 0.403\ g\ \text{HCl/ml of conc. Soln}$$

The weight of HCl required to prep 6M soln in 100ml dil soln

$$= 100 \text{ ml } \cancel{\text{dil soln}} \times \frac{6 \text{ m mol } \cancel{\text{of HCl}}}{\text{ml of } \cancel{\text{dil}} \text{ soln}} \times \frac{\overset{1 \text{ m mol}}{0.0365 \text{ g HCl}}}{\text{m mol } \cancel{\text{of HCl}}}$$ ②

$= 21.9\text{g HCl}$

substituting equation ② in ①

$$\frac{21.9 \text{ g HCl}}{\text{Volume}} = 0.403\text{g HCl/ml of conc. soln}$$

$$\frac{21.9}{0.403} = \text{volume of conc soln}$$

$= 50.2 \text{ mL}$

$$C = \frac{1000(w)}{\underset{36.1}{M}(v)}$$

Colloid Chemistry.

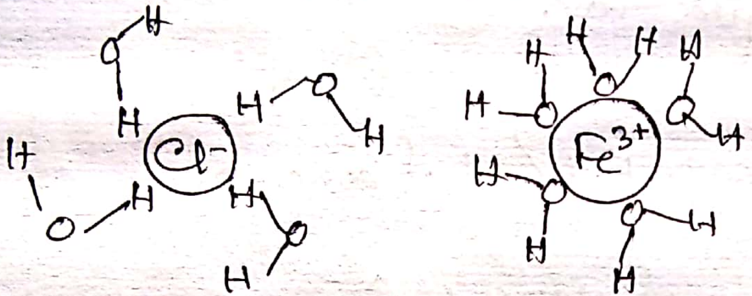
Disperse phase : refers to particles that form in the dispersion medium.

Dispersion medium : refers to the medium where dispersion takes place.

Yellow

$$FeCl_3 + H_2O \longrightarrow Fe^{3+} + 3Cl^- \xrightarrow{\Delta} Fe_2O_3 + H_2O$$ *

Brown

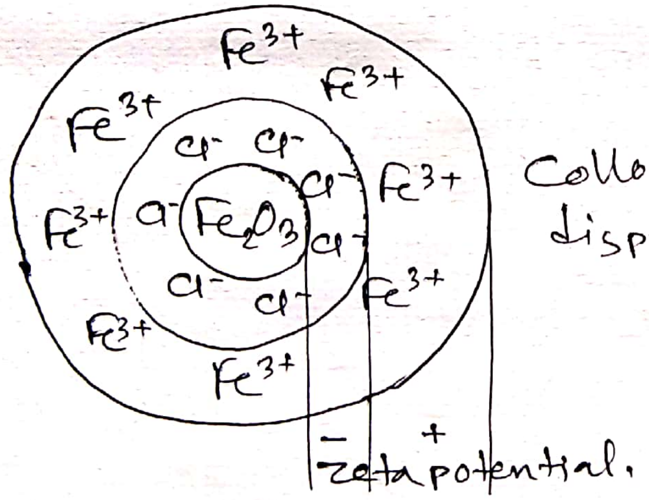


true solution থেকে colloidal solⁿ তৈরি হওয়ার সময় colour change হবে।

true solution : solute
- দুটো samephase হলে যেটা কম
- generally যেটা কঠিন থাকে। (solid – liquid)

যেটা গ্যাস (Gas – Liquid)

*



Colloidal dispersion.

Zeta potential nullify করতে পারলে dispersion থাকবে না। precipitation হবে।

Classification of colloidal system:

Dispersion medium	Disperse phase	Name of colloidal system	Example
Gas	gas	None exists.*	X
	liquid	liquid aerosol	Fog, mist, cloud
	solid	solid aerosol	Smoke, soot, dust.
Liquid	gas	Foam	shaving/ whipped cream
	liquid	Emulsion	milk/oil in water
	solid	Sol	S, Ag, Au, Pt, As, Si in water
Solid	gas	solid foam	Jelly, curd, ink
	liquid	Gel	foam rubber, styrene polymer
	solid	Solid Suspension	colored glass ruby glass

Classification of sol: (Hydrosol, when dispersion medium is water)

1. Lyophobic: ~~Force~~ The dispersed phase show little force of attraction with the dispersion medium

2 Lyophillic: They exhibit some extent of force of attraction.

Reasons (conflicted)

Lyophobic ions are charged. water ions. are also charged.
So these particles show repulsion. So
but instead of attracting, the overall force is lessened. unstable. Tindal effect আছে।

Lyophillic Stable. Might/might not be charged. higher force of attraction. Mostly organic in nature. starch, protein, DNA, RNA. Tindal effect (light scattering) নেই। Sol এর viscosity dispersion medium (H_2O) থেকে অনেক বেশি।

electrolyte যোগ করে সহজেই lyophobic কে destroy করা যায়

Preparation methods of lyophobic sols.

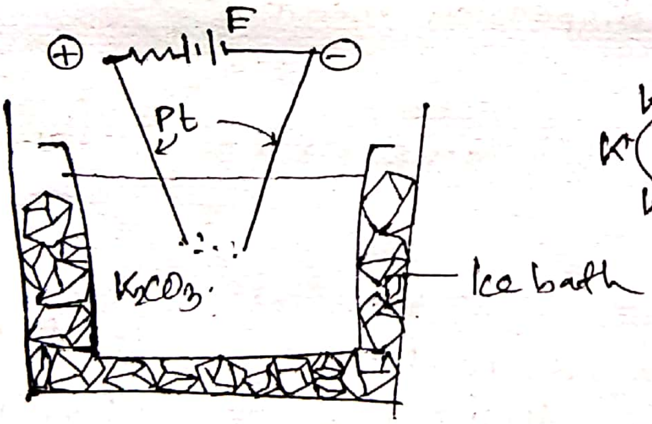
① Dispersion method :→ >200 mμ particle size coarse suspension or bulk material থেকে তৈরি

② Condensation method : →

① — electrical dispersion method / Bredig's arc method.
- mechanical method
- Chemical method / peptization method

coarse suspⁿ → colloidal sols

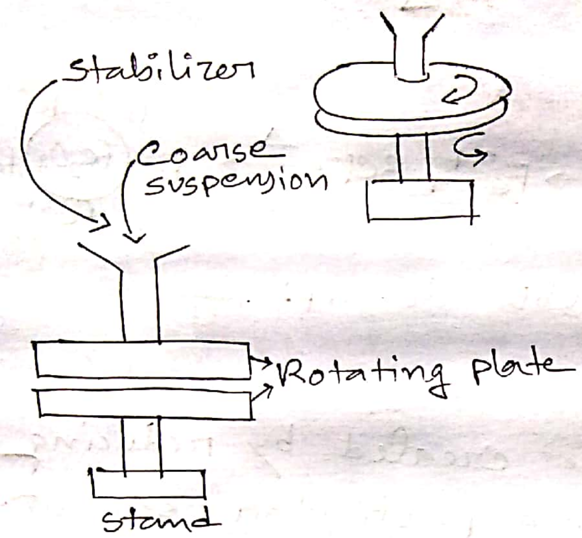
electrical dispersion method : noble metals.



⊛ here, the noble metal electrodes are short circuited and thus ~~art~~ arcs (sparks) formed [illegible] and the heat vaporises the electrodes. But the cold immediately condensates and turns into free particles the particles are prevented from precipicing by the ions.

2. Mechanical dispersion method

>2mu → grinding. 7000 rpm opposite rotating plates.



larger particle disintegrate করে Sol তৈরিতে Use করা হয় And stabilizer is used to avoid reunion and precipitation. The disintegrated particles then go to a container containing dispersion medium.

3. Chemical/peptization method:

IIIB

$$\left.\begin{matrix} Fe(III) \\ Cr(III) \\ Al(III) \end{matrix}\right\} \xrightarrow{NH_4OH} \underbrace{\left.\begin{matrix} Fe(OH)_3 \\ Cr(OH)_3 \\ Al(OH)_3 \end{matrix}\right\}}_{\text{ppt.}} \xrightarrow[\substack{\text{by adding material} \\ \text{(peptizing agent)}}]{\text{separation}} \text{two ppt} \rightarrow \text{Sol}^n$$

$FeCl_3$ add করলে,

$Fe(OH)_3$
$Cr(OH)_3$
$Al(OH)_3$

$Fe(OH)_3$ → primary layer (+)
Cl^- → secondary layer

in this method (precipitated material is converted) into colloidal by adding peptizing agent.

Reducing agents:

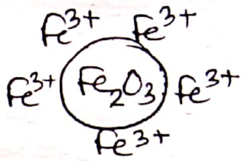
→ CO, H_2, NH_2-NH_2, NH_2OH, RHO, ~~NH~~ tanin

Condensation Method:

① Reduction : $\text{Noble salt} \xrightarrow{H_2O} \text{sol}^n \xrightarrow[\text{Electrolyte}]{\text{reducing agent}}$ Sol
Δ

② Oxydation :

③ Hydrolysis : $FeCl_3 + H_2O \rightarrow Fe^{3+} + 3Cl^- \xrightarrow{\Delta}$



④ Ionic equilibrium / Double decomp: Ag^+

① Sols of noble metals are created by reducing salt of noble metal in a particular solvent. the first solution will have color. After reduction color change will indicate prepped sol.

$$AuCl_3 + H_2O \rightarrow \overset{\text{yellow}}{0.1\%} \ \text{sol}^n \xrightarrow[\text{tanin}]{K_2CO_3} \Delta \rightarrow \text{cherry Red}$$

K_2CO_3 (electrolyte) → 0.1% sol^n

tanin → 0.1% sol^n

gently warm till cherry red.

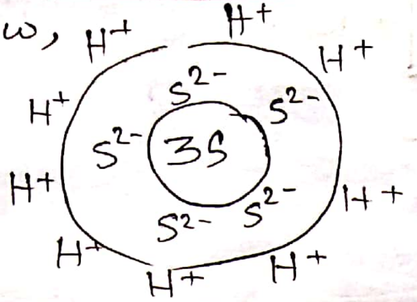
② Sols of sulphur (S) and Se can be prepared by oxydation of sulfide or selenide. using a solution of SO_2

$$2H_2S + SO_2 \longrightarrow 3S + H_2O$$

$$H_2Se + \quad \longrightarrow$$

if SO_2 gas is dispersed through H_2S gas, neutral solvent is found. (untill the odor of H_2S is gone)

Now,



③

④ $AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$

milky white colloid

Ag ion can be +/- depending on the relative amount added reagents.

$AgCl \longrightarrow +Ag$

④ Explain the origin of charge on the colloidal particles:

Ans: Origin of charge of colloidal particles

- due to selective absorption of ion from the reaction medium.

- due to association or dissociation of ion of the particles. [explains organic colloidal charge such as starch, DNA, RNA, enzyme etc]

organic molecules always have two parts. Dep. on PH

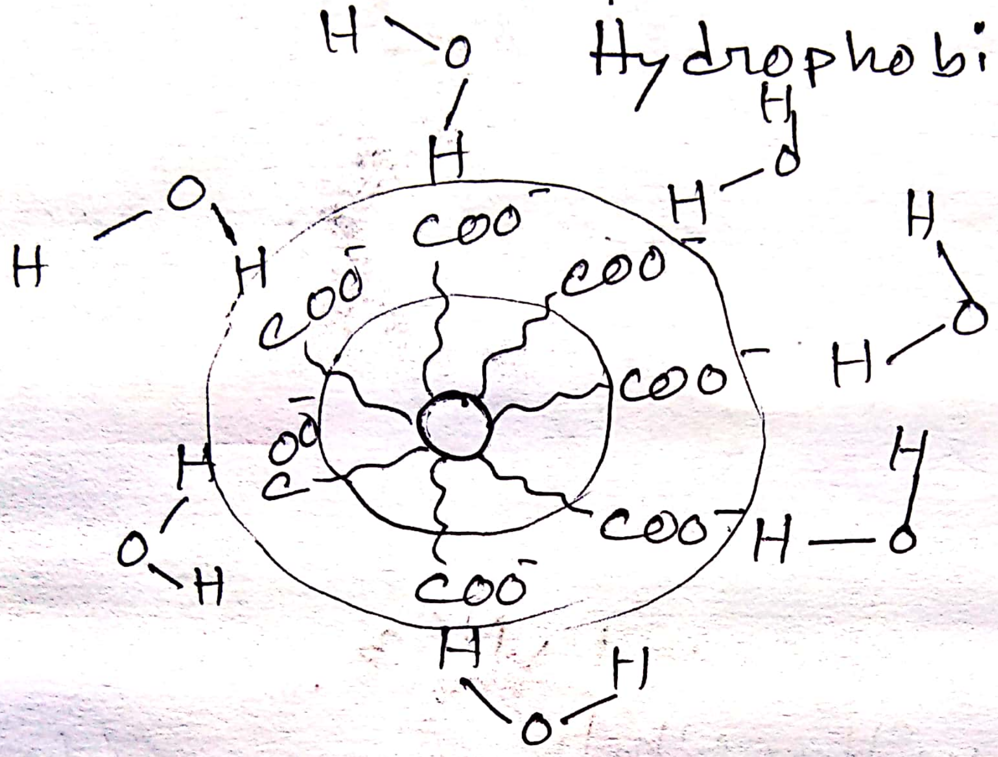
$NH_2 \sim\sim\sim COOH \xrightarrow{H^+} \overset{+}{NH_3} \sim\sim\sim COOH$

positive ion (Association)

$H_2N \sim\sim\sim COOH \xrightarrow{\bar{O}H} H_2N \sim\sim\sim COO^- + H_2O$

negative (Dissociation)

$$C_{17}H_{35}COONa \xrightarrow{+H_2O} \underbrace{\boxed{C_{17}H_{35}}}_{\text{Hydrophobic}}\overbrace{\boxed{COO^-}}^{\text{Hydrophillic}} + Na^+$$



Purification of Colloids.

Removing excess electrolytes.

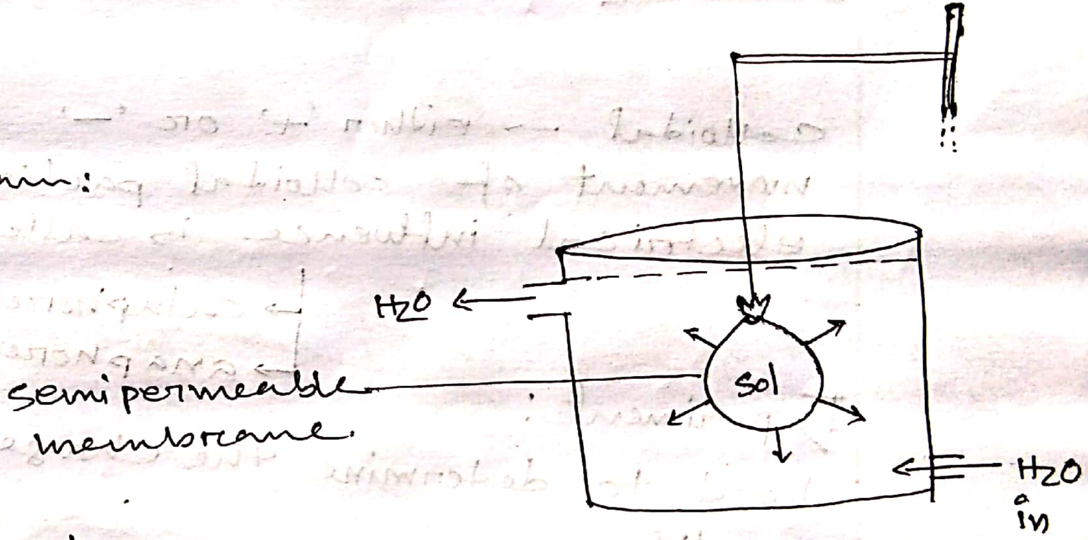
1. Ultrafiltration
2. Dialysis
3. Electrodialysis.

→ Only electrolytes, solvent passes through, not colloidal particle (large)

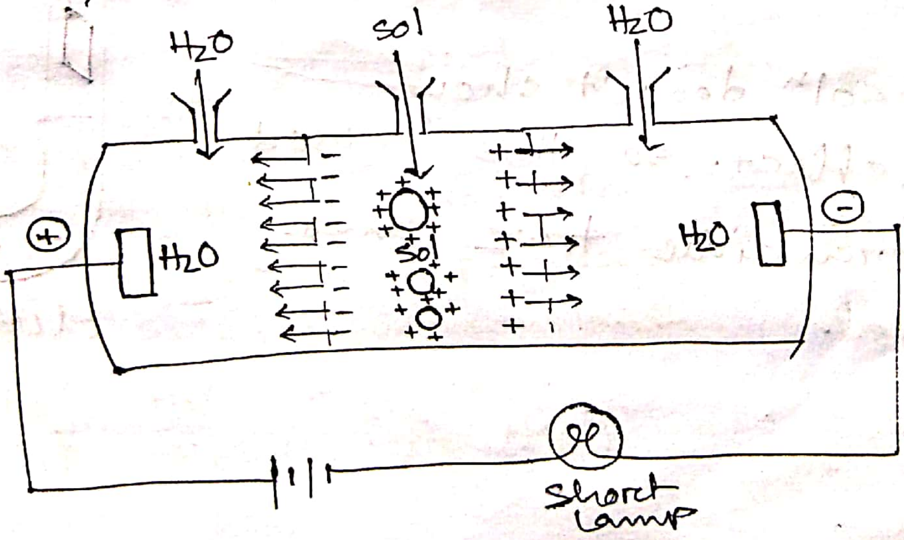
Collodion (semipermeable) = Partially evaporated solution of cellulose nitrate in alchohol or ether.

Cellophane =

Dialysis diagram:



Electrodyalysis diagram:



Properties of Colloid.

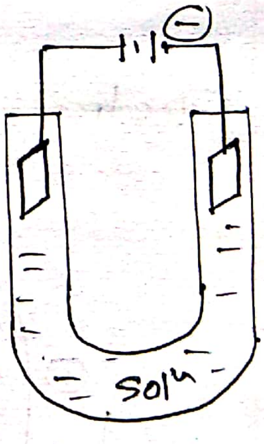
size
2 colore
3 shape > book

1. Electrical property → Electrophoresis
4. Optical property → Tyndal effect.
5. Kinetic property → Brownian movement.
(Robert brown, 1827)

① Na^+, H^+ → H^+ smaller, faster so it creates H_2 at cathode.
True sol^n

colloidal → either '+' or '−'
movement of colloidal particles under the electrical influence is called electrophoresis.
→ cataphoresis
→ anaphoresis

Experiment :
Used to determine the charge of colloidal particles.

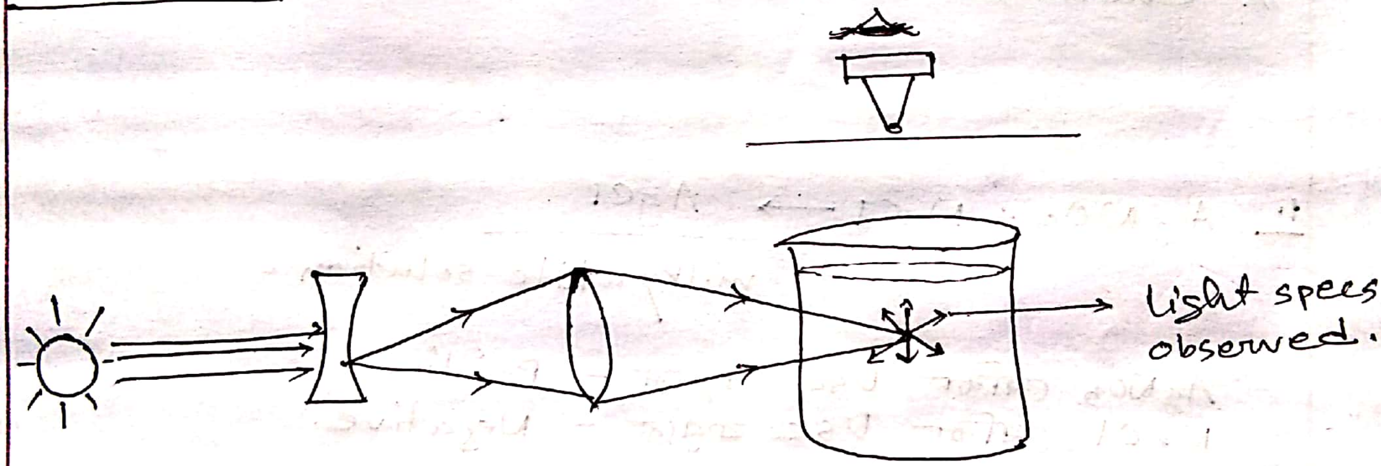


electrophoresis.

④ True sol^n doesn't show tindal effect. so this is used to differenciate true and colloidal.

[True sol^n : surrounded by cat and anions.]
(+) ions surrounded by '–' ve ions. polarization
ঘটে [5 mμ – 200 mμ determinies the light scattered]
incident wavelength, if matches with the colloidal
particle dimention then, tyndal effect
(light scattering is observed). Larger ~~co~~ particles
of colloidal sol^n create this effect. True
sol^n doesn't.

Diagram:



⑤ ceaseless movement of particles (random/zig zag motion) is solution.

hypothetial explanation:
colloidal particles < solvent molecules.

gas and liquids move constantly.
so, the collition between colloital particles and solvent molecules force the " " to move ceaselessly.

As long as this movement persists, solution stays colloidal.

17.06.2019

Precipitation of Colloids

Methods of precipitation

1. Physical method → Boiling, freezing, shaking
2. Chemical method

1. $AgNO_3 + NaCl \rightarrow \underset{\text{milky white solution}}{\underline{AgCl}}$

$AgNO_3$ বেশি Use করলে – Positive.
NaCl বেশি Use করলে – Negative.

Rules of precipitation: ~~of colloidal system should be of opposite charge~~

① The ion which is effective in causing precipitation of colloidal systems should be of opposite charge to that of colloidal particles.

② The higher the valency of precipitating ion, the higher the rate of precipitation of the electrolyte.

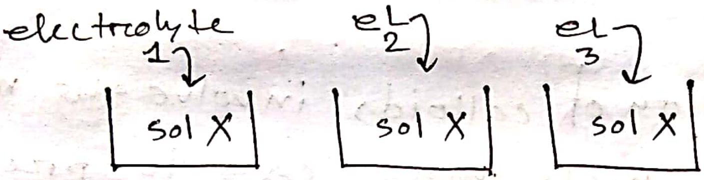
suitable
electrolytes

$\underbrace{Fe(OH)_3}$ colloidal particle positive.

$\underbrace{K_3[Fe(CN)_6]^{3-}}_{3^-}$, $\underbrace{BaSO_4}_{2^-}$, $\underbrace{KCl^-}_{1^-}$

↑ more charge, more precipitation power.

Flocculation value: measure of precipitation power.



different rates.

here, the ~~mil/m~~ mmol/L electrolyte needed to cause precipitation within two hours is the flocculation value.

Stabilization of colloids.

stabilized colloids do not precipitate.

electrolytis induce ~~electrolytic~~ electrostatic absorption that cause molecules to band / condense together and precipitate.

The stabilization of colloids involve the neutralization of those forces which may lead to precipitation of colloid. achieved by the addition of lyophillic colloids to lyophobic sols.

organic colloids
gilletin/
agar

The term used to denote the stabilization power of lyophobic sol is determined experimentally to be gold number.

The minimum amount of ~~stabilization~~ stabilizer in mg which may prevent the change in color when 1 cc of electrolyte is added to 10 cc of gold sol.

Protective colloid	gold number (mg)
Gelatin	0·005 − 0·01
Dextrin	6·0 − 20·0
Gum-Arabic	0·15 − 0·5
Albumin	0·2
Potato starch	25

Biological colloids → stabilization.

Applications of colloids.

CE
1. In purification of water
2. In air pollution control
3. Cleaning of raw hide. (leather industry)
4. In textile industry to fasten dye.
5. In warfare for the purpose of concealment.
6. As fireproofing agent.
7. The cleaning action of soap and detergent.
8. The formation of delta at the mouth of

$Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow Al(OH)_3 + 3CaSO_4$

(*) Write out an application of colloid as a civil engineer :

Air pollution control

Industrial smoke

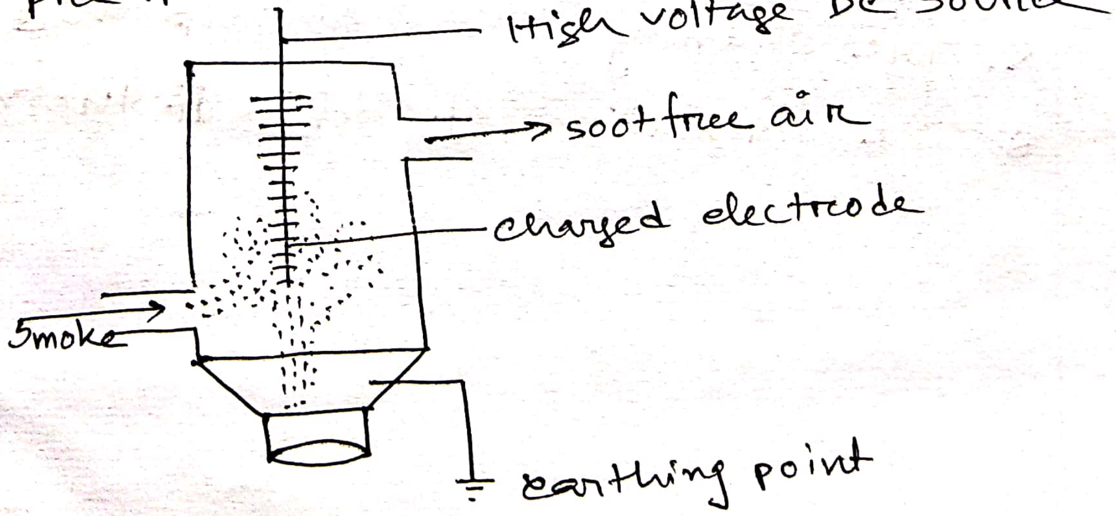
↓ soot particle

Pyrene, benzoalphapyrene ,anthracin + particulate metals $(\cdot 3-20\mu)$,

(metal oxides) → affects more harshly than primary pollutants (gases responsible for global warming)

- eye irritation
- skin irritation
- inhalation
- health hazard.

Cottrel precipitation. Cottrel precipitator.

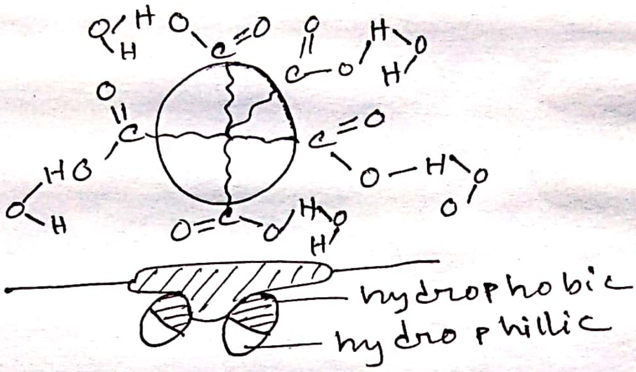


cement dust+ colloidal particles, metallic particles.

Cleaning action of soap and detergent.

emulsion $\overbrace{\text{water}}^{\text{polar}} + \overbrace{\text{oil(non water)}}^{\text{non polar}} + \underbrace{\text{emulsifying agent.}}_{\text{soap/detergent.}}$

mechanical process.



Cleaning of raw hide.

Warfare

Hydrasin → NH_2-NH_2 → fuel of fighter jets.

TiO_2 is mixed with the fuel that shrouds the aircraft in metallic smoke making it harder to detect.

Fire extinguisher

CO_2 foam + stabilizer colloids.