Fantaque Sir

17-11-2013

L-1 Topics:

- Assessment of Water Requirement
- Sources of Water
- Water Collection and Transportation
- Water Quality Investigation
- Water Treatment Technology
- Water Distribution and Storage.

- Safety
- Serviceability
- Cost.

Turbid water cannot be transported

Text:

1. Water Supply and Sewerage
   - T.J. Mc Ghee (5th/6th Edition)
2. Introduction to Environmental Engineering
   - M. Davis & D. Cornwell
3. Environmental Engineering
   - H. Peavy & D. Rowe.

Sources of Water

North Bengal - hardness
Mangane - effect memory cell

Q. Diff bet^{w} potable and palatable water

potable → physically, chemically, bac acceptable

palatable → physically acceptable

Classification of Impurities:

Algae - colloidal size

Membrane filtration

↓

water যাবে mineral যাবে না.

Ships use reverse osmosis.

Turbidity — by suspended material

Colour — by dissolved substance.

* NTU → Lower reading → Less turbidity

* Spectrophotometer or Color Determination

↓

Lower reading = More colour absorbed

∴ More colour

For turbidity —

For colour measure — Filter first (preferably with micron filter)

Colour

Unit - platinum cobalt unit —

chloroplatinate - 1 gm

Formazine Soln.

NTU - Neplometric turbidity Unit

L-2

20-11-2013

Carbon-dioxide (CO_2) & Natural Acidity :

→ In Bd groundwater, CO_2 present O_2 absent.
as land was under water, trees decayed.

→ CO_2 বাড়লে, pH ↓ কমে যায়ে না pH close to 4
Water এ ও pH = 6

⊢→ Relation bet^{n} CO_2 and acidity

Variation of Carbonic Acid Species with pH value

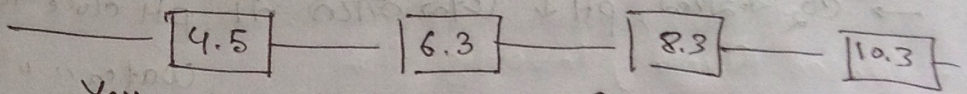
~~pH = 4.5~~ pH	Chemical Rear.	Major	Typ
< 4.5	H_2CO_3	Undissociated Carbonic Acid	No alkalinity
> 4.5	$H_2CO_3 \rightarrow HCO_3^- + H^+$	Dissociation of Carbonic acid Stant	M-Alkalinity st ant
6.3		$H_2CO_3 = HCO_3^-$	
< ~~8~~ 8.3		$H_2CO_3 \ll HCO_3^-$	
> 8.3	$HCO_3^- \rightarrow CO_3^{2-} + H^+$		

3 Alkalinity

Total Alkalinity = $\sum H$

→ যত টুকু acid লাগল, তত টুকু alkali ছিল

pH scale:



Yellow colour to Pink

Methyl Orange

Alternative: Bromcresol Green of Methyl Orange Powder

Pink Colour to colourless

Pheno

P - alkanity — 8.3

M - " — 4.5 to 8.3

4 ACIDITY

Total Acidity = $\sum 2(H_2CO_3) + (H^+)$

→ যত টুকু NaOH লাগল, তত টুকু acid আছে water এ।

Natural acidity

Phenolpthalein turns pink from colourless at pH = 8.3

Acidity - 30mg/L

↓ means

30mg/L $CaCO_3$ required to neutralize the acid present in water.

Hardness:

$$\text{Total Hardness} = \sum \frac{50}{20.04} Ca^{++} + \sum \frac{50}{12.15} Mg^{++} + \sum \frac{50}{27.92} Fe^{2+} + \sum \frac{50}{27.46} Mn^{++}$$

Hardness is expressed

Divalent Cations cause hardness, a quality that manifests itself in neutralization of soap.

Q. Distinguish between alkalinity and hardness. ← Question

alkalinity → anion

hardness → cation

Cation (+)	Anion (−)
Hardness	**Alkalinity**
Ca,	HCO_3 (pH > 4.5)
Mg,	HCO_3 (pH > 8.3)
Sr, Fe, Mn	OH (pH > 10.3
Non-hardness	**Non-Alkalinity**
Na	SO_4^{2-},
K	PO_4,
Li	NO_3, Cl, F

Interpretation of Water Quality Analysis Data:

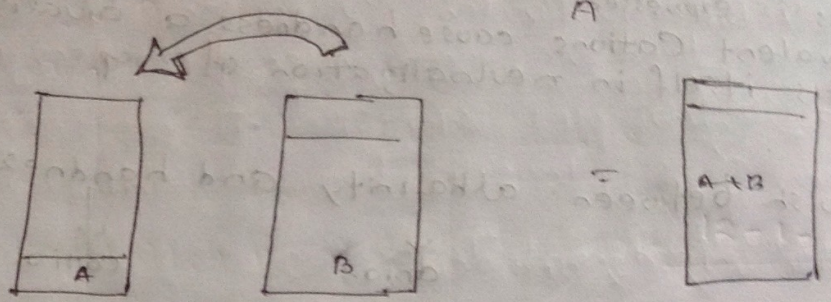
phenolphthalein (P)

L-3

24-11-2013

ODOR and Taste :

Threshold Odour No = TON = $\frac{A+B}{A}$



pH indicators

pH value	Indicator	Indicator Colour	Weaker Colour
< 8.3	Phenolphthalein	Colourless	Colourless
> 8.3	"		Pink
< 8.3	Methyl Orange	Yellow	Yellowish Orange
< 4.5	"		
< 8.3	Brom-Cresol Green	Green	Greenish Red
< 4.5	"		

Alkanidy = 50 $\therefore HCO_3 = \frac{\text{Alkalinity}}{50} \times 61$

Chemical Impurities.

- Fe: Red বালি → Iron কম.
  Greyish " → " বেশী
  → Iron oxidized হয়ে coating করেছে soil)
  → Fe oxidize oxidised হয়ে গেছে, dissolved আছে.

Manganese

Q. Chemicals:
- Source of origin
- Significance - থাকলে কি ক্ষতি হয়,
- Allowable limit - থাকলে কি ক্ষতি হয়।

Cl Problem - coastal belt এ

Sulphate:
- laxative effect → loose motion
- Corrosion → significance

Nitrate:
- Source: leachate → protein মাটি ভেদ করে হয়ে liquid হয়
- May cause infant death.
- Jatrabari, Mirpur যেখানে জমির চেয়ে নিচু হয়
  surrounding ground water.

Lead Poisoning

Mercury

Chromium and Cadmium

Arsenic

Dissolved Gases

- Hydrogen Sulfide
- Dissolved Oxygen
- Carbon Dioxide

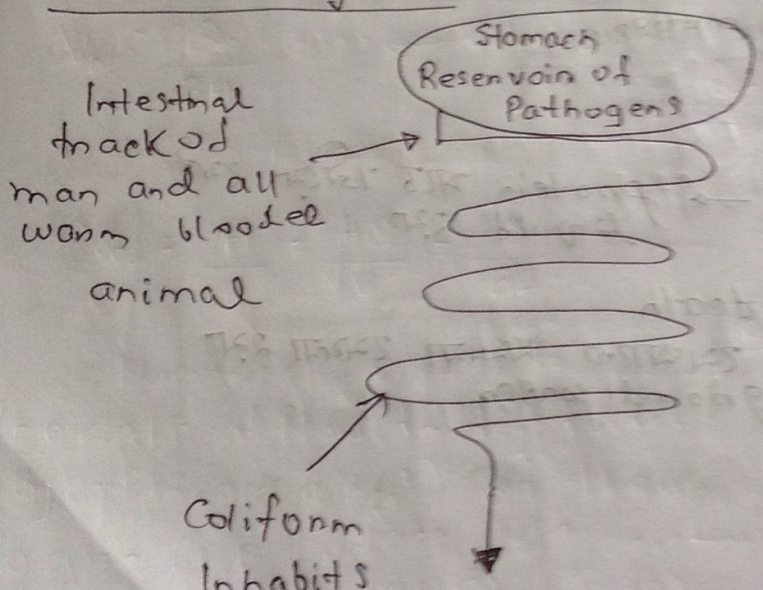
L-4 ✓

12-1-2014

Bacteria - Single cell
Protozoa - Multicellular

Discharge of Human Faecal Matter

Indicator Organism



Healthy Person's Excretion: Faecal Matter + Coliform Organisms (4×10^{10}/

Infected: " + " + Pathogen

① Coliform Group of Bacteria → 1 micron

Membrane → 0.45 micron (pore)

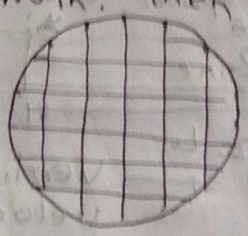
- Total Coliform
-

They ferment ~~and produce~~ lactose group and produce gas and acid.

② Lactose add করলে, bubble form করলে coliform present. Food চেক. Hiscalled media or broth. Then colony formed

Blue — Coliform — ?

Yellow - Bacteria — ?



① Test tube.

② Membrane used

Bentonite → tube well এ used. It reduces permeability preventing tube collapse.

Might be asked to draw flow chart.

Treatment.

- Source of origin
- Permissible limit (BS)
- What harms possible.
- Treatment?

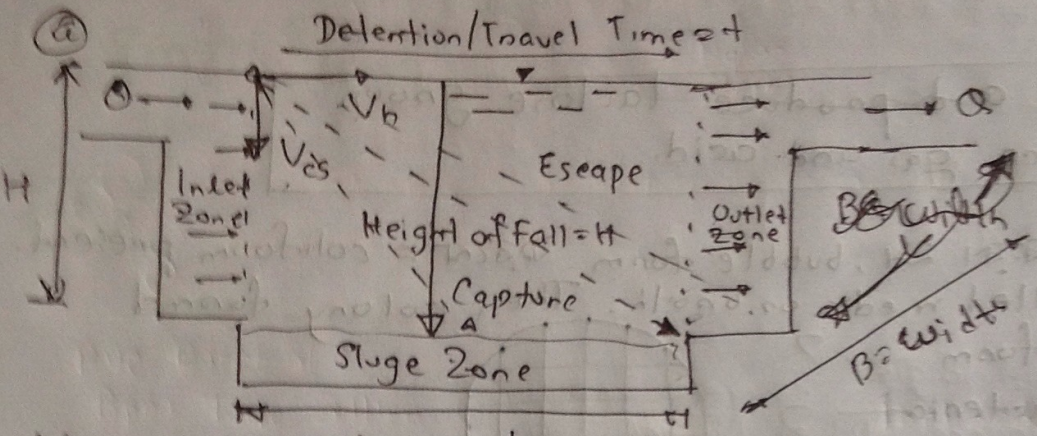
} Impurities study এর polarities

E-coli - মল stomach এ থাকে, confirmed faecal contamination of water if ৫ found in tube.

Cellulose + Acetole → membrane formed when Acetole evaporates. Rate ∝ Pore Size.

L-5

SEDIMENTATION THEORY:



$$V_s = \frac{g(\rho_p - \rho_w) d_p^2}{18\mu}$$ ← Vertical settling velocity of a particle in an aqueous system (Stoke's law) [mainly fun^c of diameter]

$$V_h = \frac{Q}{BH}$$ ← Horizontal velocity of flow [mainly fun^c of size (geometry) of sedimentation tank]

$$V_{cs} = \frac{H}{t} = \frac{HQ}{Vol^m} = \frac{Q}{BL}$$

$$t = \frac{V}{Q}$$

Numerically equal to the rate of flow (dm^3/day) divided by plan area (m^2) of the basin. i.e Surface over flow Rate ~~(SORR)~~ (SOR)

V_{cs} is f (Surface Area)

V_{cs} is independent of d

or

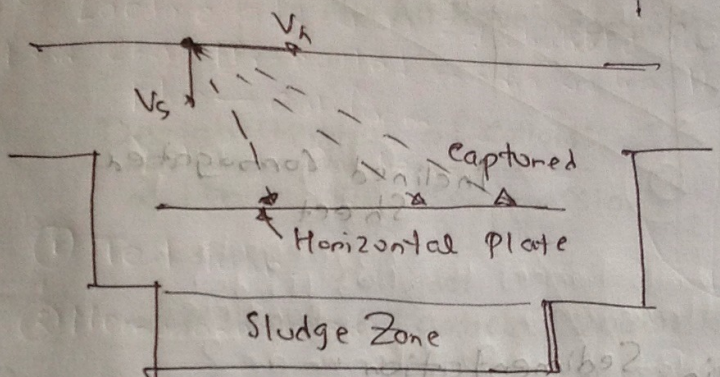
Effect/Adv of Surface flow Rate

We want low V_h, ∴ increase width

Suspended Size Range [Avg dia] dp in mm	Avg Settling Velocity of Suspended Particles (Vs in mm/sec)	Weight

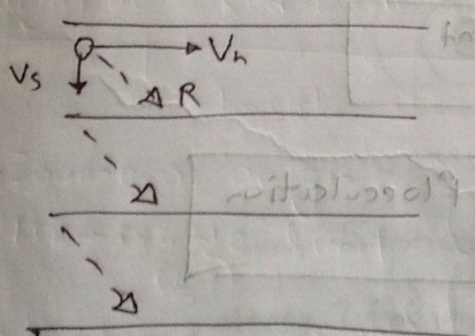
Area increase করলে, Vs কমবে ∴ বেশী particle captured.

(b)



Two Storied Sedimentation Tank

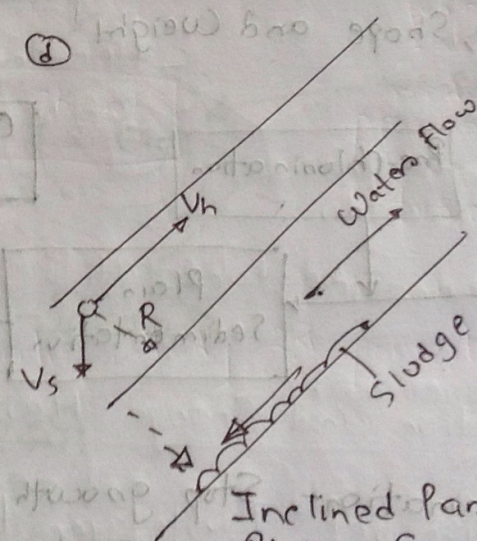
(c)



Horizontal Parallel Plates Separator

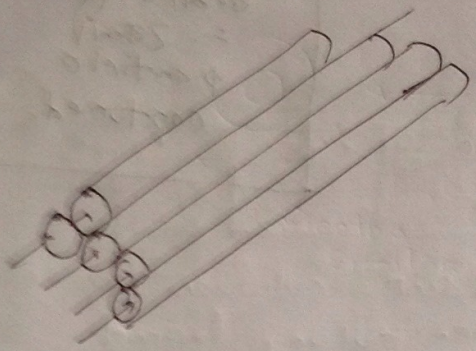
[4 plate reduces, t by 4 times t কমলে volume 3 কমে যাবে]

(d)

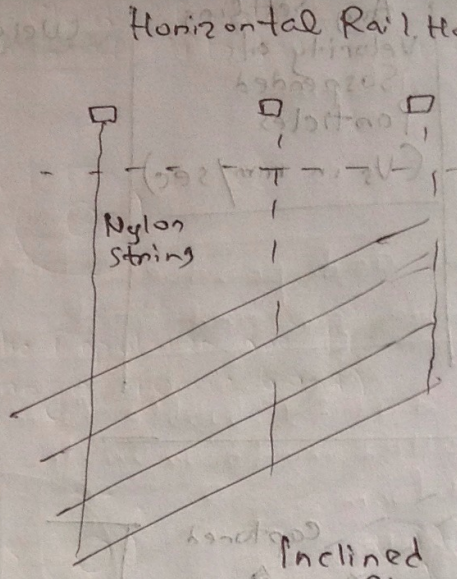


Inclined Parallel Plates Separator

Q. What are the advantages of parallel/inclined plate separators.



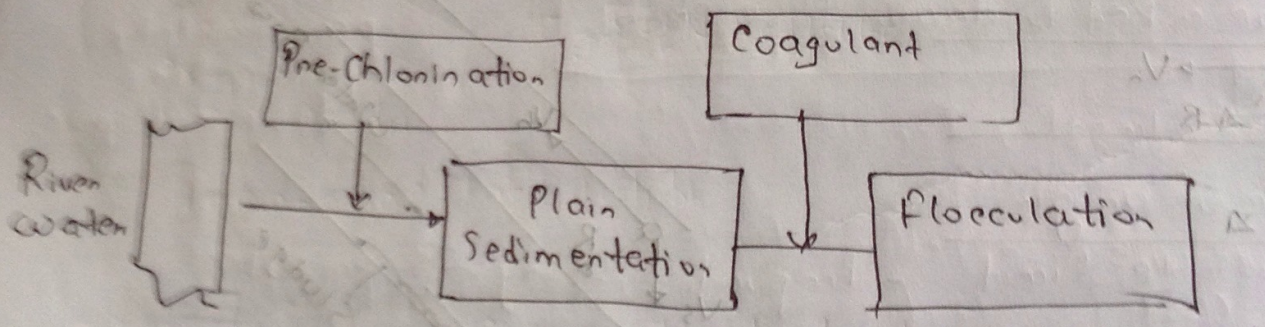
PVC Bunch of Pipes Tube Settler



Inclined Corrugated Sheet

Factors those Influence Plain Sedimentation:

- Size, Shape and Weight



Pre-Chlorination: Stop growth of algae, remove organic matter

L-6

19-1-2014

COAGULATION THEORY

- Stability of Colloids → Write briefly with diagram

i) Electrostatic Repulsion
ii) The Vander Waal's force of attraction.

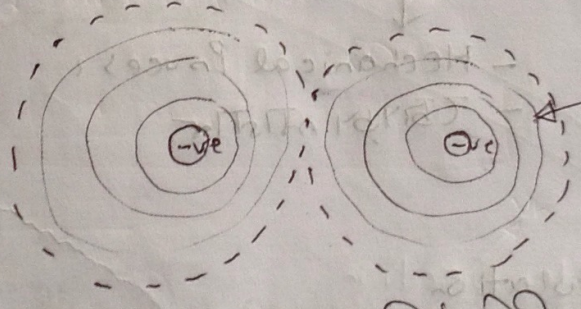
Colloid particle: ~~10^{-6}m~~.
→ 1×10^{-6} m
→ All have negative charge.

Padma – 64% colloidal particle

Destabilization of Colloids:

a) Ionic Layer compression.

-ve Charged Colloidal Particle – Double Layer Electrostatic Repulsion
[Distance between colloidal particles far apart]



+ve charge ion conc. (low)

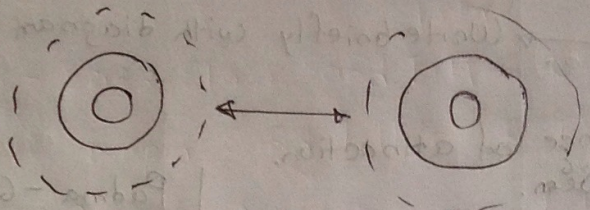
Aluminium Sulphate → ৭টি চার্জ কণা.
↓ Valency ২ বেশী,
ion এর strength ২ বেশী
↓
-ve Charged Colloidal Particles –

Vander Wall force of Attraction
reduced due to more electrolyte addition]

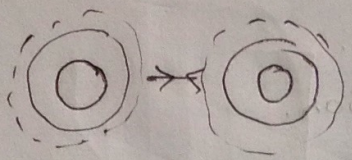
[Distance between colloidal particles further

+ve charge ion con (high)

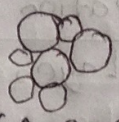
+ve Charged Ionic Cloud 'Double Layer' around -ve Charged Colloidal Particles



(Electro-Static Repulsion due to similar charge ionic bond)



(Vaan der Waals forces of Attraction)



(Aggregation of colloidal Particles)

Q. Clogulation and Floculation — Difference?

Clogulation
- Chemical Process
- Compress the ionic radii

Floculation
- Mechanical Process
- [illegible]

Pneumatic Floccculation

Adsonption and Change Neutralization:

Q. Distinguish bet^{w} Double layer theory and Adsonption and Change Neutralization

- [illegible]
- Ion cloud [illegible] (ionic shield), [illegible] adsorb [illegible].

Reaction Memorize লাগবে না.

FLOCCULATION THEORY:

Camp Number:

G – per sec [G কত হবে t কতক্ষণ থাকবে]

t – sec

1-7

2-2-2014

Biological Treatment and Basic Requirements of Life

1- Source of Carbon- Dead Organic Matter – CO_2

~~Carbon, O_2, Energy~~.

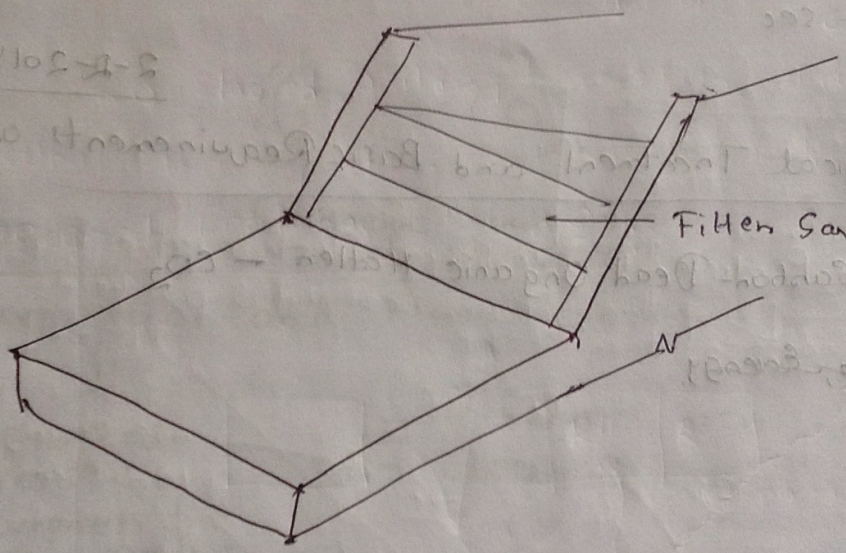
2.

Aerobic Biological Oxidation of Wastes:

BOD – Oxygen required to break down ~~bacteria~~

Filtration

- Slow Sand Filter (SSF)
- Rapid Sand Filter (RSF)
- Coarse Media Roughing Filter (Horizontal flow / up flow)



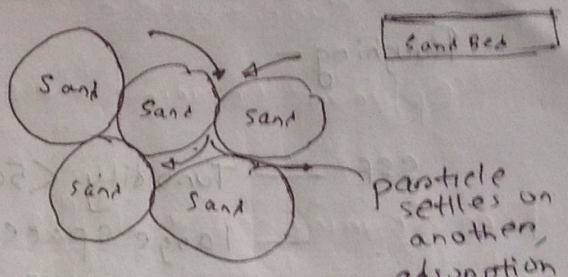
Rapid Sand Filter Section

Backwash

Direction filtration not recommended for highly turbid water.

Theory of Filtration

(1) Mechanical Straining 0.5mm → 500μ



Bacteria, Virus removed via filtration.

~~BMS~~ [BFID - Dual Multistage filter.]

Flocculation, Sedimentation, Adsorption, Biological Metabolism.

[Coating of sand is responsible for removing bacteria]

[READ:] Types of Filter and Characteristic Differences

Low turbid — SSF

— RSF = back wash সাপোর্ট

Characteristics | SSF | RSF | UF Rough Filter

L.8 9-2-2014

Types of Filter and Characteristic Differences

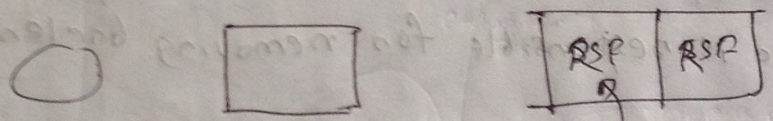
Roughing –

SSF — Turbidity < 50
— large space

Aeration if turbidity increases due to Fe, Mg

20 storied building - smell in water.

General Features of the SSF:



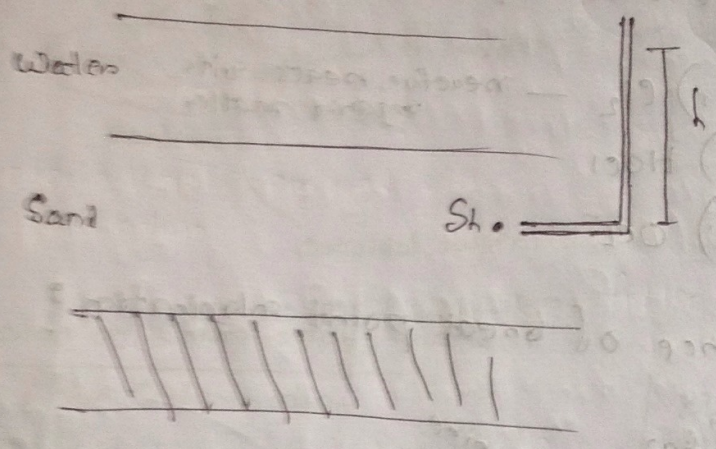
2 given so that bacteria removed even if sand is cleaned.

Under drainage System:

Washing Process:

Operation Difficulties:

Neg Head and Air Binding



DISINFECTION → Removal of pathogens

— Sterilization — All organisms removed.

—

→ Water এ stable হয়ে থাকলে 1 50% bacteria will die due to fluctuation of temp.

→ এগুলোকিন্তু থাকবে pH কমবে. Bacteria will die as they require pH=7 for survival

→ (Sweep floc) - Stir

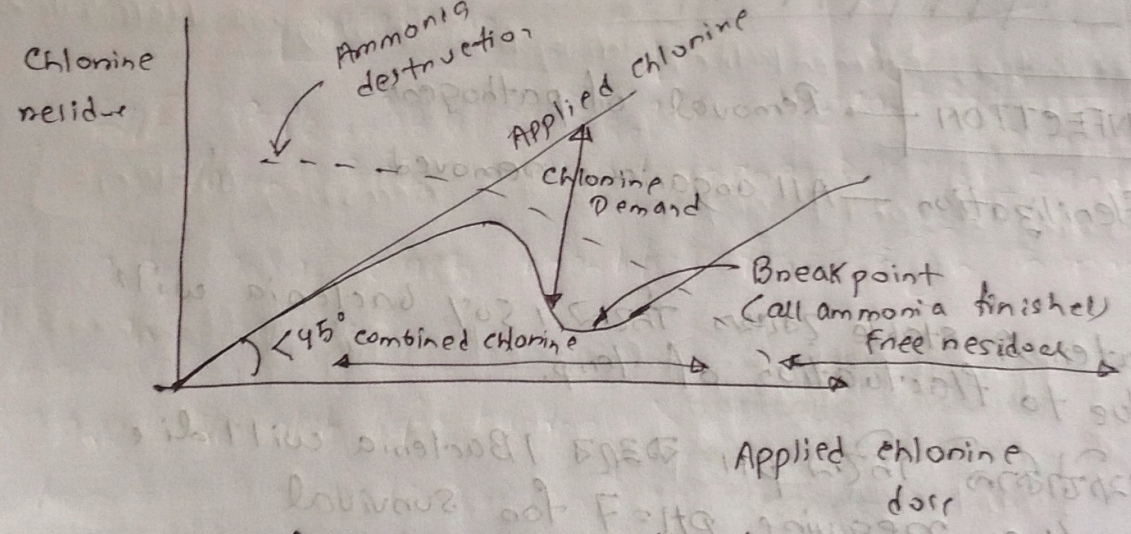
Chlorination:

- Banned in other countries
- Carcinogenic.

Optimum chlorine dose বের করা হয়

Free Chorine ⟶ i) Cl_2 — reactive, reacts with organic matter
ii) HOCl
iii) OCl^-

Q. What is the importance of break point chlorination?



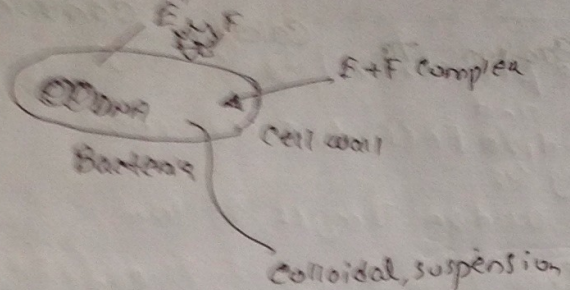
We want free Cl_2, as combined Cl_2 is less powerful. (10 times)

Advantages of break Point Chlorination:

Organic matter, reducing substance, ammonia নষ্ট.

Theory of Disinfection:

(a) Chlorine (free/combined) react with the cellular (wall) materials and rupture it.
(b) Destroy the enzymes (E) of bacteria cells, affect energy yielding process.
(c) Passes through cell wall, to attack intracellular systems.
Efficiency reduced by increased pH (8.5) and lower water temp.



L-9

23-2-2014

Forms of Chlorination:

(i) Pre Chlorination
(ii) Post "
(iii) Double "
(iv) Super "
(v) Break Point Chlorination

River এ algae হয় বা কারণে water turned up and down.

→ H_2S, Fe ইত্যাদি Cl_2 কিছু vanishes.

- Chloramines with ammonia.
- THMs - Tol

Water Softening:

Don't memorize Eq^n.

Theory:

Convert all Ca^{2+} ~~the Carbon~~ to Calcium Carbonate.

Optimum pH = 9.4

Precipitation Softening:

- Industry ~~20 50~~ 20 mg/l $CaCO_3$
- Rest has to be done with ion exchange chamber

- If $CaCl_2$, $CaSO_4$ are added Na_2CO_3 (soda ash / commercial ~~soda~~), it will form $CaCO_3$ without increasing ~~the~~ hardness.
- $CaCl_2$, $CaSO_4$ are identified from high hardness, low alkalinity
- Add soda ash if hardness > alkalinity

- How pH value/alkalinity affect softening process.

$CaCO_3$ — 40mg as $CaCO_3$ solubility.

$Mg(OH)_2$ — 10mg " " "

Re-carbonation (Addition of CO_2)

Done to reduce pH after raising pH ~~dec~~ to remove Magnesium.

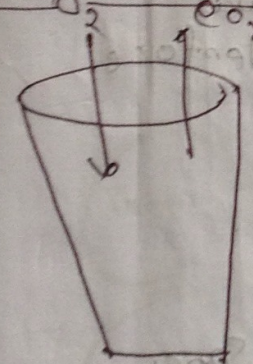
2-3-2014

L-10

Occurence of Iron and Manganese

- প্রাকৃতিক ভাবে 2য় Iron.
- Organic matter থেকে organic matter CO_2 produced.

Reaction and Natural Oxidation of Iron:



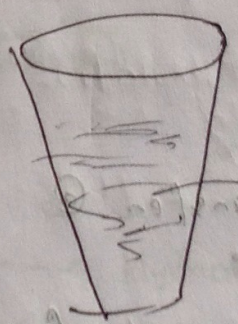
Fresh/clean water

Fennous (Fe^{++}) Soluble form

CO_2 > 100mg/L (acidic)

pH value < 6.3

DO < 1.0mg/L



Stored/Turbid Water.

Fennic (Fe^{+++}) insoluble form

CO_2 < 15 mg/L

pH value > 7.3

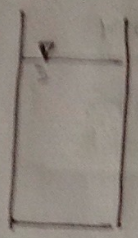
DO > 3 mg/L

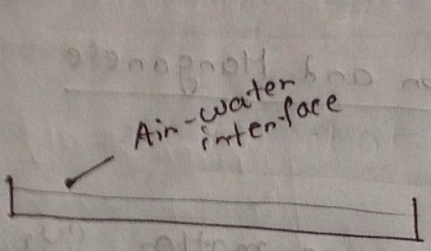
Iron precipitate করতে flocculation করা লাগে as size is small.

Objectives of Aeration

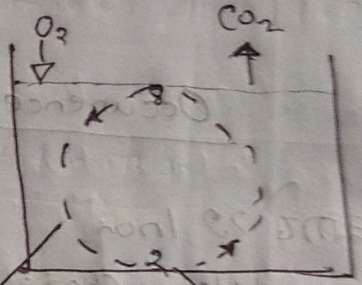
- Primarily increase pH value > 7.3, through stripping out CO_2 and
- Secondarily, oxidize Fe(II) to Fe(III) iron through adding O_2

1 mg/L O_2 oxidizes 7 mg/L of Iron

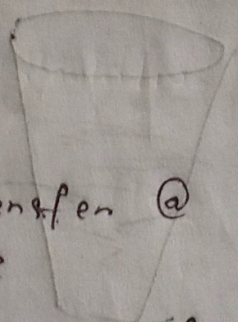




Increase of interfacial Area



Renewal of Interface



Agitation

\#

Increase rate of transfer @ air water inter-face

- Increase air water interface, Area — Spray.
- Increase exposure time, by increasing velocity of rise
- Renewal of interface

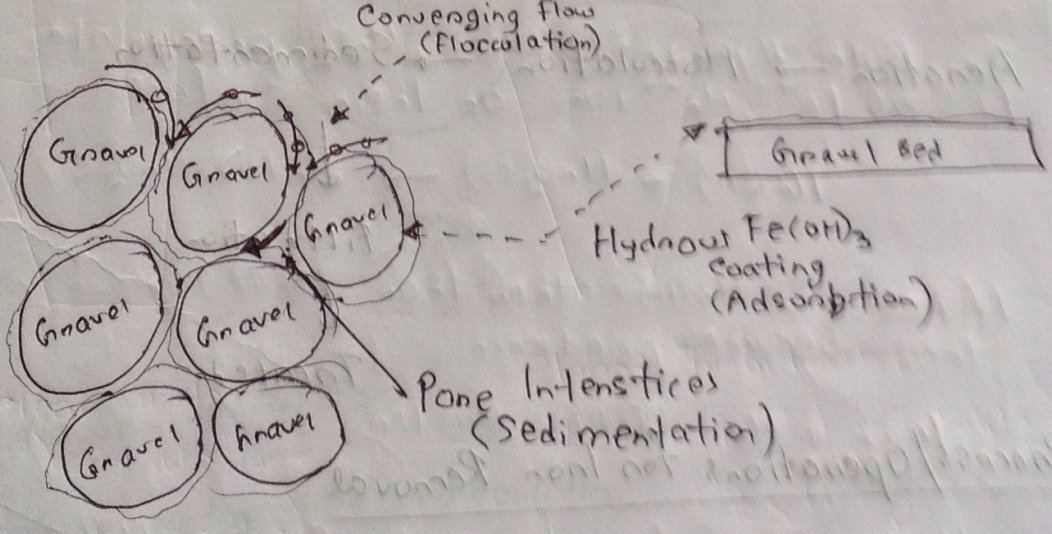
Kinetics of Iron Oxidation, Precipitation & Removal

- Initial Iron Concentration:
- pH value
- Alkalinity
- Precipitated Iron Flocs.

Chittagong, Noakhali, Sylhet – Fe removal difficult as soil is alkaline.

Criteria & Theory of Iron Removal

Catalytic Contact Oxidation of Metal Ions and Sorption [During Flow through Porous Media]

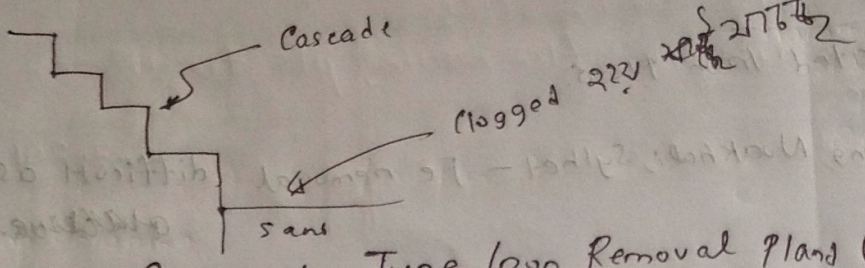


(I) $Fe(II) + Fe(OH)_3 \longrightarrow Fe(II).Fe(OH)_3$ (Adsorbed)

(II) $Fe(II) \longrightarrow Fe(III)$ (Oxidation)

Fe থাকলে Arsenic বা অন্য ধাতু থাকে, but Arsenic থাকলে Fe থাকতেই

একটা time এ বেশী iron জমে গেলে, excess পুরো wash করে ফেলে



Community Type Iron Removal Plant (IRP)

Effect of Direct Filtration

Pretreatment before Filtration

Aeration → Flocculation → Sedimentation

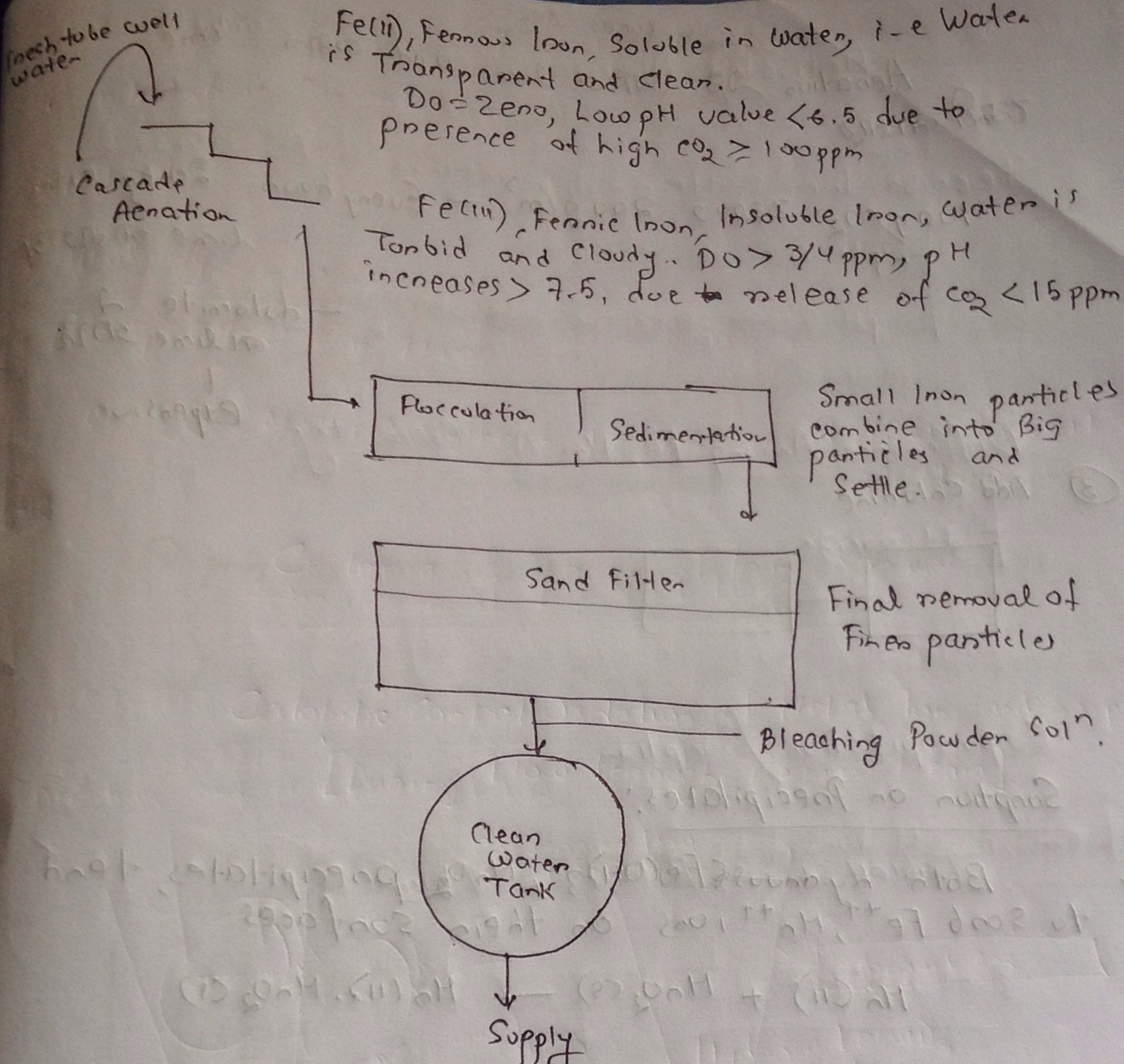
↓

Filtration

↓

Treated

Unit Process/Operations for Iron Removal



5-3-2014

L-11

Flow diagram আকারে হবে

1. Remove iron under diff env condition.
— কেন করতে হবে।

(1) Aeration

(2) Flocculation — increase size
— reduce load on sand filter

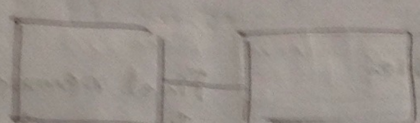
removes CO_2.

Aeration এর পরে lime add করলে lime বেশি লাগবে

100 g CO_2 এর জন্য 200 g/m³ — Every hour 20 kg extra lime লাগবে

— dolomite ও lime লাগে
|
expensive

③ Add Chlorine



Sorption on Precipitates:

— Both hydrous Fe(OH)$_3$, MnO_2 precipitates, tend to sorb Fe^{++}, Mn^{++} ions on their surfaces.

$$Mn(II) + MnO_2(s) \rightarrow Mn(II).MnO_2(s)$$

— If Fe(II) > Mn(II) rather than Mn(II) alone, removal than becomes predomin

Iron + Mn একসাথে faster হয়।

Multiple Tray Aeration with Coarse Media.

Oxide, hydroxide of Fe, Mn coating have low level surface charge which adsorb / on which other metal ion adsorb. Cation/Anion কে adsorb করে।

Criteria & Theory of Manganese Removal

Fe oxidize করতে pH has to be just above 7.
But → Mn ৭.০

Arsenic Removal

Mn^{4+}, Fe^{3+} → insoluble / Fe(II), Mn(II) - soluble

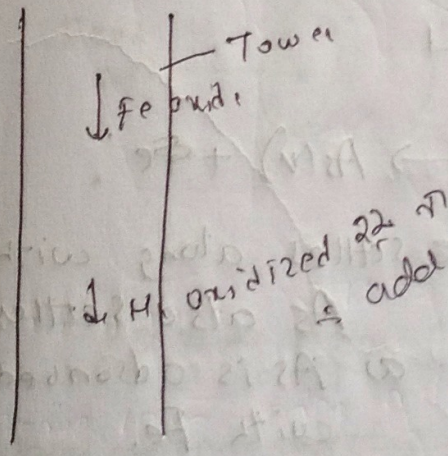
As (III) - soluble

As (V) — soluble — surface charge present (-ve)

Fe precipate করতে গেলে As co-precipitate with Iron chlorides.

As(III) অপসারণ - pH ↑ → As dissociates just as in case of oxidation.

Co-precipitation, Sedimentation, Filtration & Adsorption



Activated Alumina Based Arsenic Removal Unit

Describe the 3 alternative method of As removal.

- pH use করা cheapest.
- pH=9 — [illegible] কারণ? — taste

Difference Among Fe, Mn, As Chemistry

- Memorize

Coprecipitation / Sorption

Tablet — Potash + Alum

$As(III) \longrightarrow As(V) + Fe$

Fe settles along with it
As also settles.
@ As is adsorbed with Fe.

Next Week (পরীক্ষা হবে) — Exam

L-12

9-3-2014

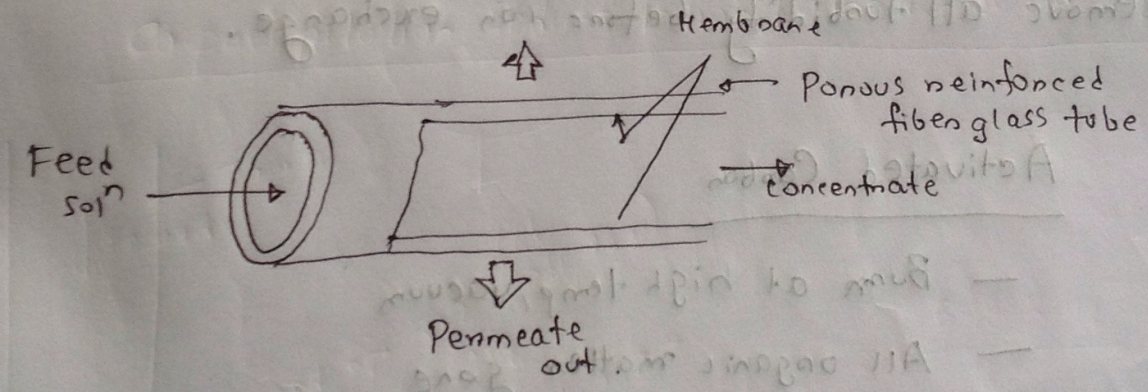
Desalination

i) Evaporation.
ii) Solar stills
iii) Freezing
iv) Ion exchange
v) Electrodialysis (ED)
vi) Reverse Osmosis. (RO)

Snow এলাকা Jap car engines will explode unless saline chemicals not added to water of car engine.

Q. What is the diff b/w ED and RO?

Membrane Filtration Tube



ED more expensive than RO

- Water molecule selective membrane in RO, ion selective membrane ED
- Driving force - mechanical in RO, Electric potential in ED.

Demineralization of water

(DEMI)

Q. How hardness cannot be brought down be 40 mg/L.?

Mg - 10 - 15

Ca - 25 mg/L solubility

40 mg/L soluble নয়

All cation will be replaced by H^+

" anion " " " " OH^-

Remove all turbidity before ion exchange.

Activated Carbon

— Burnt at high temp, vacuum

— All organic matter gone

To remove all organic matter — use activated carbon.

[Class on next week's Wednesday]