Molecular Mass of $CaCO_3$ = 100
" " of lime = 74
" " of Soda = 106

100 parts of Mass $CaCO_3$ are equivalent to 74 parts of Mass lime $Ca(OH)_2$ are equivalent to 106 parts of mass $Na_2CO_3$ are equivalent.

lime required for softening
$= \frac{74}{100}$ [temp. hardness of $Ca^{+2}$ + 2X temp. hardness of $Mg^{+2}$ + permanent hardness of $Mg^{+2}$] X volume of water (in L)

& Soda requirement for softening
$= \frac{106}{100}$ [Permanent hardness of $Ca^{+2}$ & $Mg^{2+}$] X volume of water (in L)

Q. Calculate the amount of lime & Soda required for softening 50,000 L of hard water containing $Mg(HCO_3)_2$ = 146 ppm, $MgCl_2$ = 95 ppm, $CaCl_2$ = 111 ppm, $Ca(HCO_3)_2$ = 81 ppm.

Soln:- lime required = $\frac{74}{100}$ [(81 + 2X146 + 95) X 50,000] (Also add every multiplying factor.)

$= \frac{74}{100}$ [(Multiplying factor for $Ca(HCO_3)_2$ X 81) + 2 X Multiplying factor for $Mg(HCO_3)_2$ X 146 + Multiplying factor for $MgCl_2$ X 95] X 50,000

$= \frac{74}{100}$ $\left[\frac{100/2}{162/2} \times 81 + 2 \times \frac{100/2}{146/2} \times 146 + \frac{100/2}{95/2} \times 95\right] \times 50,000$

= 16.25 kg.

r one day)

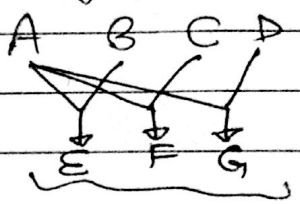
Soda required $\Rightarrow \frac{106}{100}\left[\frac{100}{111} \times 111 \text{ mg/L} + \frac{100}{55} \times 95 \text{ mg/L}\right] =$

$= 10.69 \text{ kg}.$

## Humic Substances / Humes :-

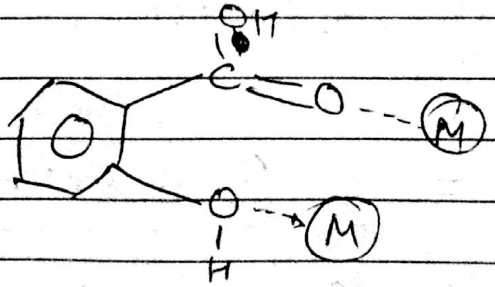
$(CH_2O) \longrightarrow CO_2 + H_2O.$

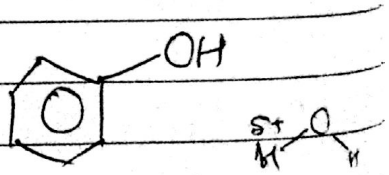
Animal and plant nutrients / Organic matter $\xrightarrow{\text{microorganism}}$ Biodegradeble Organic matter + Non-biodegradable Organic matter




humic substance.

$C_{20}H_{15}(COOH)_6(OH)_5(O)_2$




(1) Humins $\Rightarrow$ black
not soluble in water.

(2) Humic acids $\Rightarrow$ brown in colour
$\Rightarrow$ ph > 2 then soluble in water.

(3) Fulvic acids ⇒ Yellow
Soluble in acids.

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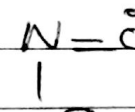
# Water Pollution

## Surface water :-

1) Municipal sewage effluent.
2) Industrial waste water →
   tanneries, chemical plant, paper mills, dye & pigment industry, pharmaceuticals, textile industry, food processing industries, etc.

dyer ⇒ Organic compound

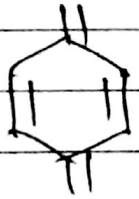
$-NO_2$ (nitro)



chromophores

$-N=O$ nitroso

$-N=N-$ (azo)



quinoid.

Pigments :- Paints, printing ink, plastic, rubber, etc.

White pigment ⇒ $ZnO$, $TiO_2$

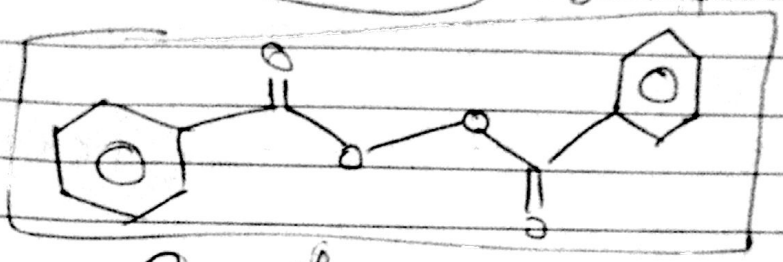
Blue pigment ⇒ $Co_3O_4$, $Al_2O_3$

Red Pigment :- ⇒ $Pb_3O_4$

Green Pigment ⇒ $Cr_2O_3$

Yellow Pigment ⇒ $Fe_2O_3$

SPF 25 Sun protecting



Benzoyl peroxide

3) Agricultural runoff :-

fertilizers, pesticides.

insecticides herbicides

Ground Water :-

1) The spillage from underground storage tank.
2) Efficient from pebbic-tanks.
3) Leachate, a product or solution formed by leaching from agricultural activities.
4) Mining activities.

Pollutants :-

1) Inorganic Pollutants,
2) Organic Pollutants.
3) Radioactive Pollutants.

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## Inorganic Pollutants :-

Metals, organically bound metals (coordination complexes)

$$C_6H_6 + O_2 \xrightarrow{\text{micro organism}} 6CO_2 + 3H_2O$$

$$C_6H_6 + \cancel{O_2} + NO_3^- + H^+ \xrightarrow{\text{''}} 6CO_2 + 3N_2 + 6H_2O$$

gud water.

## # Water Pollution :-

### Inorganic Pollutants :-

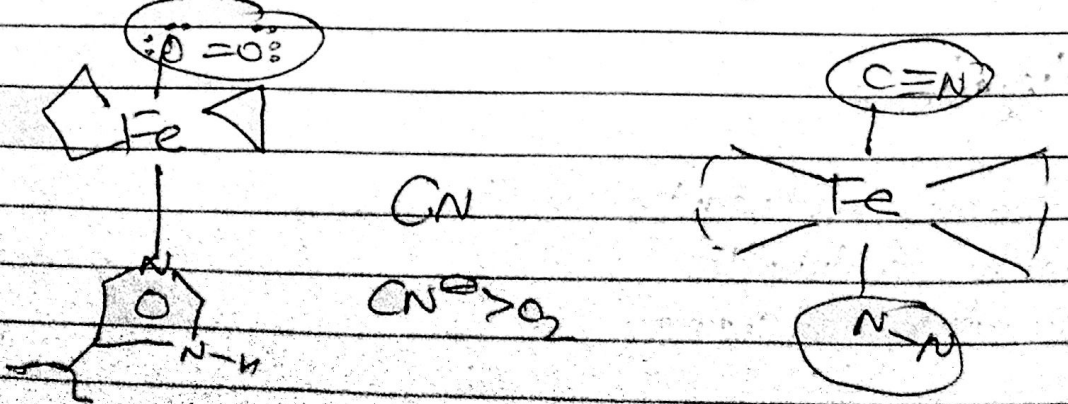
(A) Metals :-

(B) Inorganic species →

(i) $CN^-$ → metal cleaning, electroplating, extraction of gold.

$$NaCN + Au \rightarrow Na[\overset{I}{Ag}(CN)_2]$$ Sodium cyanide

$$Na[Au(CN)_2] + Zn \rightarrow Na_2[\overset{II}{Zn}(CN)_4] + Au\downarrow$$



# Ammonia ($NH_3$) :- $NH_4^{\oplus}$

(i) As a fertilizer $(NH_4)_2SO_4$, $NH_4NO_3$
(2) Refrigerant gas.
(3) An window or floor cleanup.
(4) Synthetic textile fibres-nylon, rayon & polyurethanes.

(i) $HNO_3$, $CN^{\ominus}$

Hatching & growth rate of fishes may be affected.

# Hydrogen Sulphide ($H_2S$) :-

(i) Used for the production of elements S & $H_2SO_4$
(ii) to precipated $Ni^{+2}$, $Cu^{+2}$ & Cobalt
(iii) $SO_4^{2-} + 2\{CH_2O\} + H^+ \xrightarrow{\text{microorganism}} CO_2 + H_2O + H_2S$

# $NO_2^{\ominus}$ (Nitrite)

Corrosion inhibitor

$SO_3^{2-}$ (Sulphate)

(ii) $O_2$ Scavanger.

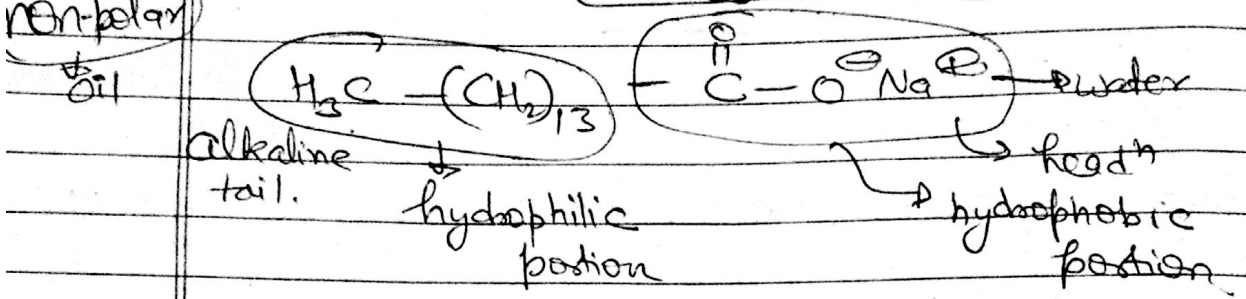
$$2SO_3^{2-} + O_2 \rightarrow 2SO_4^{2-}$$

## Organic Pollutants :-

**Biodegradable :-** (A) soap (B) Detergent.

**Na-Sterate**

$C_{17}H_{35}COO^{\ominus}Na^{\oplus}$



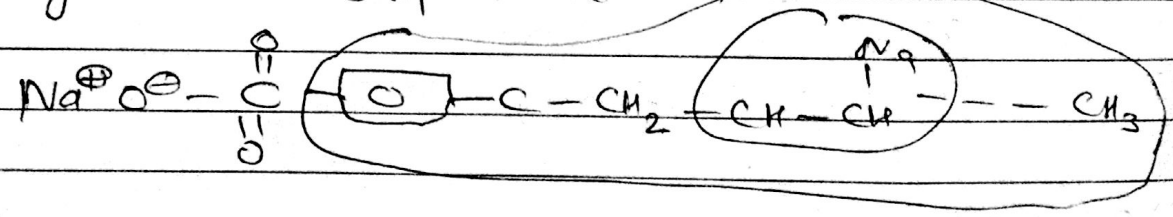

# **Detergent :-**

Surface Tension

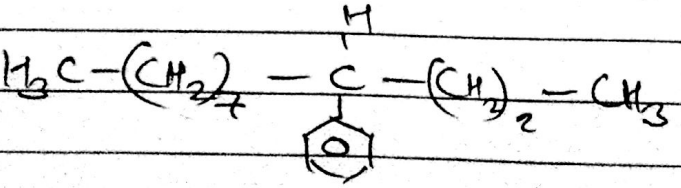
builder

**Water insoluble dust :-**

alkyl benzene sulfonate (ABS)




linear alkyl Sulfonate (LAS)




polyphosphate

Acrylic polymer.

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24th Aug

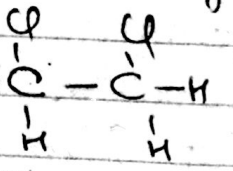
Page No.:
Date: / /

# Non-biodegradable Organic Compounds Pollutants.

(Bio- retracting Organism)

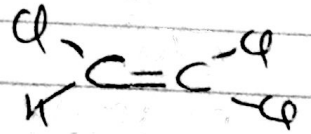
A) VOC {Volatile Organic Compounds)
B) POPs (Persistent Organic Comp. Pollutants)

**VOC's** → (i) Volatile in nature
(ii) low molecular weight.
(iii) vapour pressure high

e.g. $CHCl_3$, $CCl_4$, 

(1,2-dichloro ethane)

(Formyl chloride) 

(Trichloroethylene) 

**Note:-** (Remember names not structure)

**Sources:-** fossil fuels.

**Uses:-** Soluble in $CCl_4$, $CHCl_3$.

**Toxic effects** → Carcinogen.

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**POP's :-** Resistant Organic Pollutants.

↓

So stable they remain in environment for long period of time.

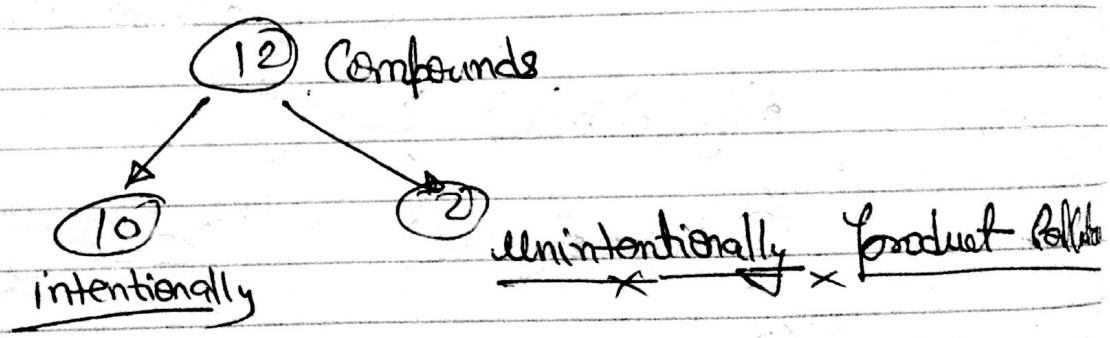
→ They are aromatic in nature, Halogens.

**Sources :-**

Industrial water, agricultural waters

**Reasons** → They are persistent.

1) Stable
2) Non-biodegradle
3) bio-accumulative in nature.
(Fat Soluble)




**10) Compounds (Remember 2 or 3) :-**
(intentionally developed)

1) Polynuclear aromatic hydrocarbons (PAHs)
2) PCB's (Polychlorinated Diphenyls)
3) DDT
4) Heptachlor 5) Chlordane 6) Aldrin 7) Dialdrin
8) Rirex 9) Tenaphene 10) Hexachlorobenzens

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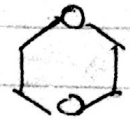
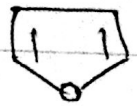
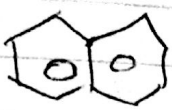
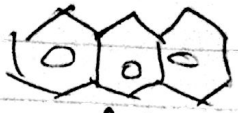
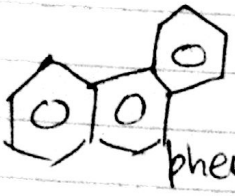
2 unintentional :-

a) Poly chlorinated dioxins 

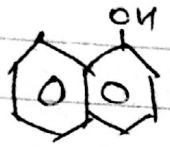
b) Poly chlorinated dibenzofuran 

1) PAHs

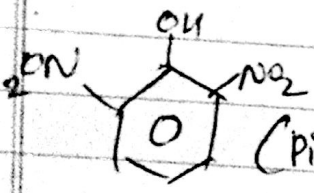
eg.  Benzene  naphthalene  Anthracene

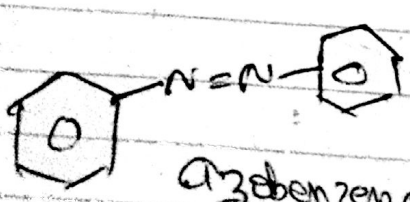
 phenanthrene

Sources → Incomplete combustion.

 (naphthol)

↳ ① Pink
② Light violet

 (Picric acid) ⇒ Yellow.

 ⇒ Orange

azobenzene.

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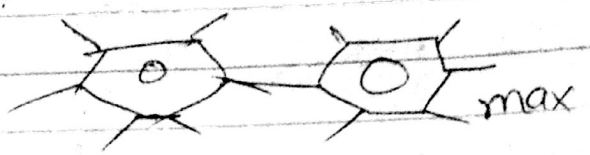
# Polychlorinated Biphenyls (PCBs)



max

$10H \rightarrow 10Cl$

$\rightarrow$ min $1Cl$

$C_{12}H_{10-n}Cl_n$

207 130

Uses :-

(1) Plasticizers
(2) Insulating materials.

Toxic effects :-

(1) Endocrine disscriptors
(2) maker eggshell thin.
(3) interfere with Ca-metabolism.

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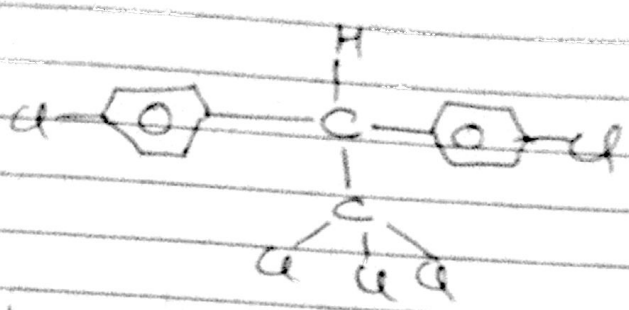
# DDT and other organochlorine insecticides :-

dichlorodiphenyl trichloro ethane

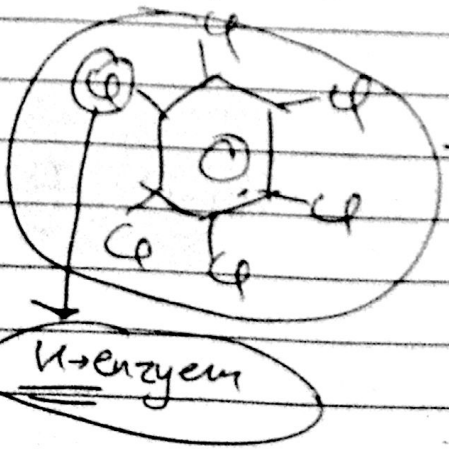


Pesticides :-

Pests :- → Insecticides → kill insects
→ herbicides
→ fungicides
→ bactericides

(1) Broad spectrum insecticides.
(2) Make the eggshell thin
(3) Interface with Ca-metabolism.

# Hexachlorobenzene :-

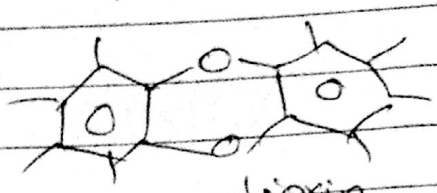


→ used for synthesis of many pesticides.

U → enzyem

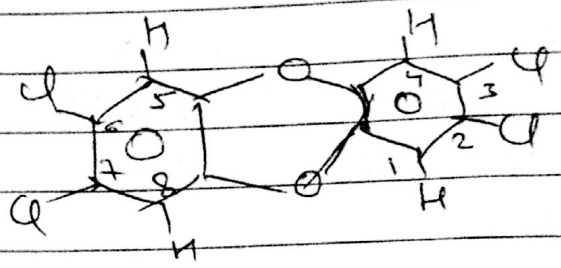
If unintentionally produced POP's :-

dioxins
furans



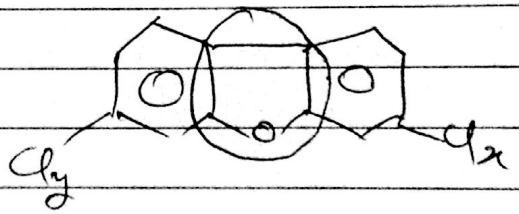
dioxin

1-8 H → 1-8-Cl

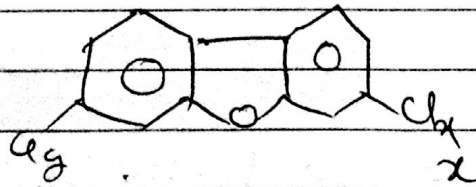


2,3,7,8 tetrachloro dibenzo-p-d
↓
Para

(TCDD)



Furans



$x = 1-4$

$y = 1-4$ Polychlorinated dibenzo furan (PCDF).

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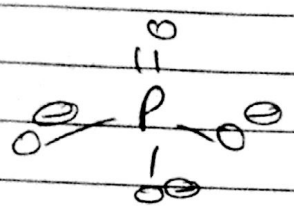
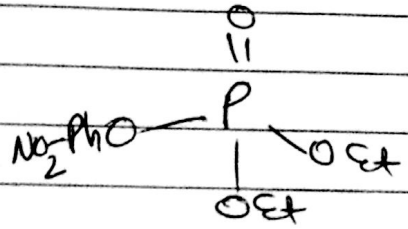
# Less persistant & More Biodegradible pesticides

## (1) Insecticides :-

**Organophosphate** — **Carbamates**



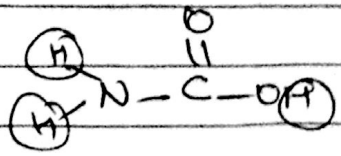
Paraxon



| Parathion | Melathion |
|---|---|
| → Highly Toxic ~120 mg → death hence melathion is made | Mamals human |

## Carbamates :-

- Carbaryl → lawn garden
- Carbofuran → plant systemic insecticides
- Primicarb



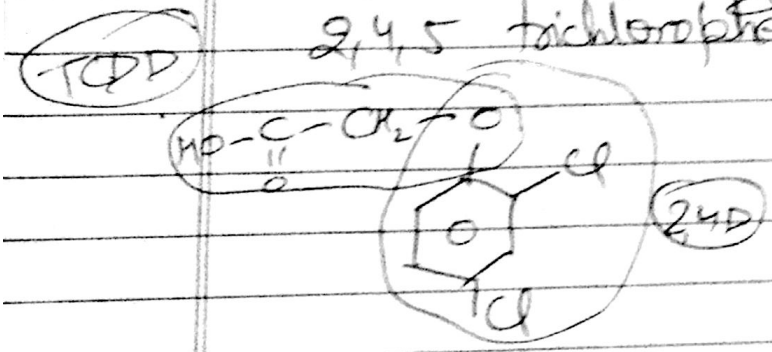
## Herbicides :-

### 1) Chlorophenoxy herbicides :-

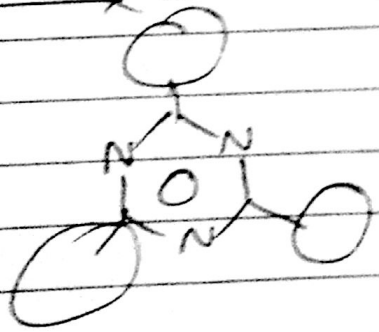
Systemic herbicides :-

(i) Growth hormone
(ii) Inhibit their Enzymic activity.

Ex:- 2,4 dichlorophenoxy acetic acid (2,4-D)
2,4,5 trichlorophenoxy acetic acid (2,4,5-T)



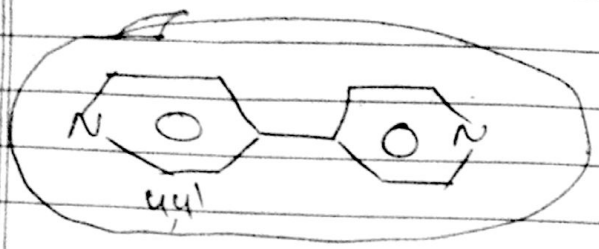

### 2) Triazine herbicide :-



Ex:- Atrazine, Cyanazine, metabuzin, Shnazine

photosynthesis

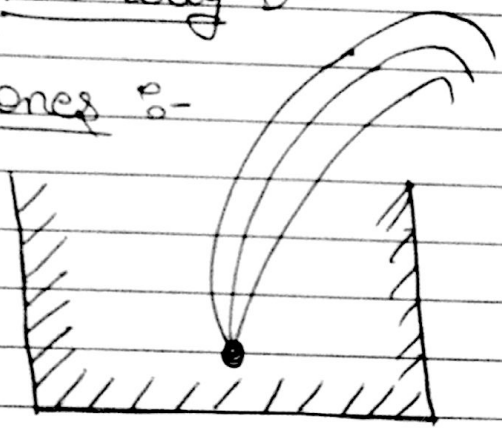
③ Bipyridilium herbicides :-




Dignet & paraquat.

# Alternative way :-

Pheromones :-



Radio active Isotopes / Radionuclides :-

Same no. of proton & Diff no. of neutron

Sources :-

(i) by weapons.
(ii) medical field industry.
(iii) nuclear powerplant waste product.
(iv) In nature → by cosmic ray interaction

→ ionization radiation

↙ α, β, ℓ particle.

(iii) Destroys bone marrow.

(i) Genetic damage (ii) Harmful some Chemical rxn in tissue.

fragrance

Isoamyl acetate — Banana
Octyl acetate → Orange
Linalool → Lavender.
Citronellol → Rose.

IOLC

BOLR

Aphid: A small bug which feeds by sucking sap from plants.

# Waste Water Treatment

#Cleaned water stream :-

Multistage process
time, money

Waste water → Preliminary treatment (Physical method only)
→ (Physical & Chemical method)
→ Primary treatment
→ Secondary treatment (Biological method)
→ Tertiary treatment

These three stages are common for every waste water treatment

Secondary treatment → remove biodegradable organic components.

Tertiary treatment
(i) Chemical
(ii) Physical
(iii) Biological

Advanced treatment (To remove Nitrogen content from waste water)

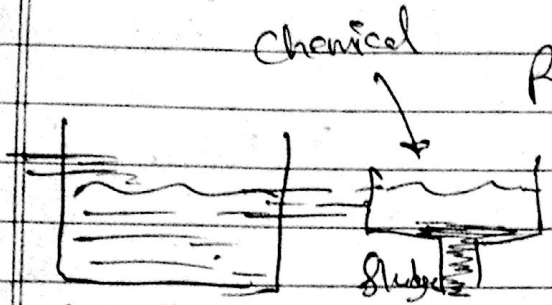
## Preliminary :-

(1) Screening :- Bar Screen → large Bulky floating object.

(ii) Comminution ⇒ Comminutor → large stones ⇒ Smaller pieces.

(ii) Comminution → Comminutor
→ large stones → small pieces

(iii) Grit Removal :- Equipment
→ Grit chamber to remove Grit.




Grit Chamber

Primary treatment
Primary Sedimentation Tank.

(1) Suspended Solids → 20-30% Biodegradable Solids we also removed

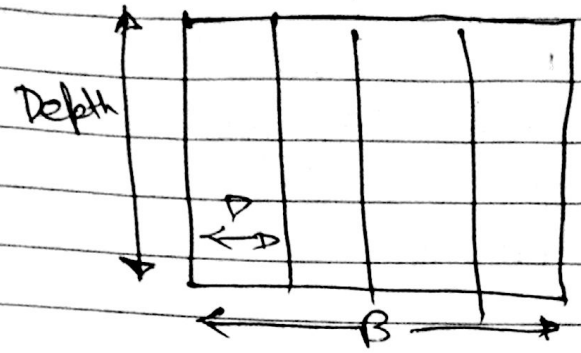
eg ⇒ $Al_2(SO_4)_3$ + $Ca(OH)_2$ → raise PH (alkaline)

gletenous ppt at high PH

$$Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2\underline{Al(OH)_3}\downarrow + 3CaSO_4.$$

ppt

Q Design a Screen chamber with max$^m$ flow of 0.15 $m^3/s$ of domestic ww with width to depth ratio of 1.5:1. Velocity of ww is 0.75 m/s. The chamber is with a clear opening of 25 mm & dia of each bar is 10 mm Cal the no of bars.




Channel dimension

$$A_x = \frac{\text{Rate of flow } (Q_{max})}{\text{Velocity of ww } (V_x)} = \frac{0.15 m^3/s}{0.75 m/s} = 0.2 m^2$$

width : depth = 1.5 : 1

$B = 1.5 D$

$A_x = 1.5 D \times D$

$0.2 m^2 = 1.5 D^2$

$D = 0.4 M$

$B = 1.5 \times 0.4 = 0.6 m$.

Let the No. of Bars be 'n'.

Opening $(n+1) + [\text{width of the Bars} \times n] = 0.6$

$0.025 (n+1) + 0.01 (n) = 0.6$

$0.035\, n = 0.575$

$n = 16$

Exact area from which water can pass

= total width $- (0.01 \times 16) m$

$= 0.6 m - (0.01 \times 16) m$

$= 0.44 m$

Effective cross sectional area of channel

$$A = 0.44 \times 0.4$$
$$= 0.176\ m^2$$

Velocity of flow through screen bars.

$$V = \frac{0.15\ m^3/s}{0.176\ ms^2}$$

$$V = 0.9\ m/s.$$

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21/9/15

Q. A wastewater treatment plant receives a flow of 35000 $m^3$/day. Cal the particular settle velocity ($V_s$), surface area, vol & retention time of a 3m deep horizontal flow. Int chamber which removes grit with a specific gravity of 2.09 & size of 0.2 mm. Temp → 22°C & viscosity of water is $1.002 \times 10^{-3}\ kg/(ms^{-1})$

density of water = 1000 kg/$m^3$.

Stokes's law :-

$$V_s = \frac{g(\rho_p - \rho_w) \times (\text{diameter of particle})^2}{18\mu}$$

$\rho_p$ = density of particle.
$\rho_w$ = density of water.
$\mu$ = viscosity of water.

$$V_s = \frac{9.81\ m/s^2 (\rho_p - 1000)\ kg/m^3\ (0.2\times10^{-3})^2\ m^2}{18\times1.002\times10^{-3}\ kg\,(ms)^{-1}}$$

$= 0.02\ m/s \rightarrow$ 8-day
$= 0.02\times3600\times24\ m/day.$

$$\boxed{V_s = 1728\ m/d}$$

$$A = \frac{Q}{V_s} = \frac{35000}{1728}\ \frac{m^3/d}{m/d}$$

$$A = 20.25\ m^2$$

$Vol = 60.75\ m^3\ (A\times H)$

Retention Time ($t$) = $\frac{\text{Volume of grit chamber}}{\text{Flow rate}}$

$$= \frac{60.75\ m^3}{35000\ m^3/d}$$
$= 0.0017d$
$= 2.5\ min.$

Q. Determine the quantity & volume of sludge produced in 10 days in the treatment of 10 MLD of domestic wastewater with following Condⁿ.

(i) SS in WW = 250 g/m³.
(ii) SS removal efficiency of primary Tank = 60%.
(iii) Concⁿ of solids in the sludge = 0.06
(iv) Density of water = 1000 kg/m³.
(v) Solid contribution per person = 75 g
(vi) Sp gravity of sludge = 1.03

Also cal. vol of tank & no. of people residing in that area.

Ans Quantity of sludge produced

$W_S$ = SS removal efficiency × SS in water × Vol. of water per day.

= 0.60 × 250 g/m³ × 10 × 10⁶ m³/d
= 1500 kg/d.

Vol. of primary sludge = Quantity of sludge produced/day / (Density of water × Sp. gr. of sludge × solids in sludge)

= 25 m³/d.

Retention Time = Vol. of primary sedimentation Tank / Qnt. of Sludge produced per day.

Vol. of tank = 25 $m^3/d$ X 10d
= 250 $m^3$.

Total Person = Total Sludge Produced / Per capita Sludge Contribution

= 1500 kg/d / 75 g/Capita

= 20,000 person.

## Secondary Waste Water Treatment :-

### (I) Trickling filter method