1) Air pollution control - B steen Vol-1, 2, 3

2) Pollution control in chemical & allied process Industries - S.P Mahajan

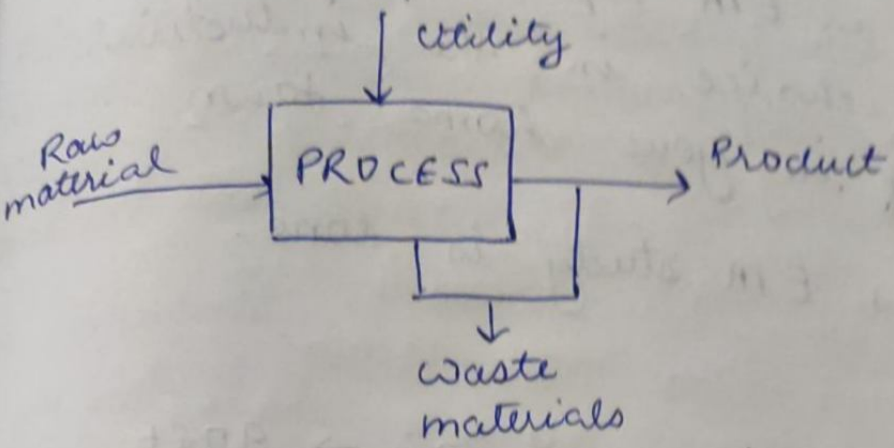
3) Environmental Engineering - C.S Rao

4) Waste Water Engineering treatment & Reuse - Metcalf & Eddy

5) Physico - chemical Processes for water quality - Webber W.J.

6) CPCB Guidelines for Air & water pollution Sampling & monitoring.

7) M.T by Graywal (CH-2, 3)



Utility → air, water, steam, electricity.

Self study

1. Nature of air pollutants & their effect on health & environment
2. Basic definition of air & water pollution
3. NAAQS for air pollutants.
   PM 10 & PM 2.5, SO_2, NO_x, CO, NH_3, Hydrocarbon
4. CPC → central pollution control Board.
5. Occupational Health Hazards.

EIA → environmental ~~income~~ impact assessment
EMP → "

6. Find industrial cluster in your state
- If you have to setup a industry in that cluster what will be your EIA.
- what is the nature of pollutants in existing industries. (Present scenario)

assignment

- Prepare an EIA report for the plant of your choice in the industrial cluster of in your home town.
- Learn how EIA study is done.

Min height of chimney → 30m → 90ft.

old ~~meter~~ plant → 70 - 80m

new plant → 200 - 275 m

Sulphur is present in the form of pyrites in coal.

NAAQS (2009 – present date)

Pollutant	Time weighted avg	conc^n in ambient air: Industrial, Residential, Rural	Ecological sensitive area
SO_2	annual	50	20
	24 hrs	80	80
NO_2	annual	40	30
	24 hrs	80	80
PM_{10}	annual	60	60
	24 hrs	100	100
$PM_{2.5}$	annual	40	20
	24 hrs	60	60
O_3	8 hrs	100	100
	1 hr	180	180
Pb	Annual	0.5	0.5
	24 hrs	1	1
CO	8 hrs	2	2
	1 hr	4	4
NH_3	Annual	100	100
	24 hrs	400	400

Benzene

Arsenic

Nickel

units

Annu 6 20

Benzene Anneal 20

Arsenic Anneal

Nickel Anneal

units → $\mu g/m^3$ except CO → mg/m^3

Benzene	Annual	5	5
Arsenic	Anneal	6	6
Nickel	Anneal	20	20

units → $\mu g/m^3$ except $CO \rightarrow mg/m^3$

Find different kind of equipment used in the plant (APCD)
- Gravity settling chamber
- cyclone separator
- Bag houses
- ESP
- scrubbers

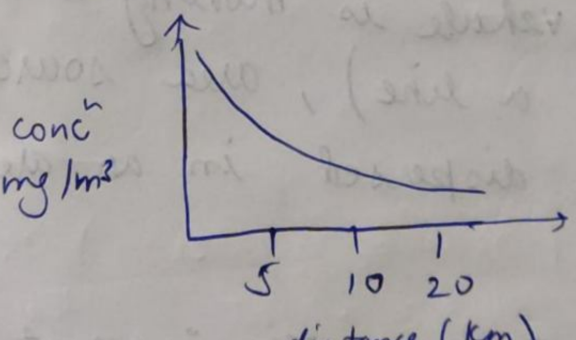
Find out whether APCD are adequate or not suggest modifications.

→ Find out the sources of air pollution from the industry.

→ What are the monitoring devices to check conc^n of pollutant at 1) stack → Gas analyzer
2) ambient air

installed at exhaust

→ Find the conc^n v/s distance



Find the sources of pollutions and identify what pollutants are coming / industrial cluster health affect (7 days) assignment on lab sheets.

EIA (first week of September)

16/08/22

on

Online monitoring devices → callibration is very important

if callibration is wrong → source of pollution

Dust will be accumulated at the roof top of residents which are in close visinity of any industry

Running any pollution control equipment requires money. Industrialist wants to reduce their investment. So after midnight emission load is huge (less pollution filter are used)

narrow exit of chimney → pollants emitting gets dispersed evenly

~~If~~ conc^n of pollutants near the residential area < Permissible limit

> Permissible limit

free to open the industry

Sources of pollution

Dissolved O_2 (DO) is reduced due to —

1) Rise in temperature
2) Microorganism used up the DO.

Levels of pollution

1) Detectable level - no illness
2) - mild discomfort or health issues
3) severe illness

Two types of pollutants

1) Primary pollutant → directly emitted from source. it may be point source (chimney) line source (vehicle is moving & ~~...~~ emitting pollutant in a line), area source (mining pollutants are dispersed in an area)

2) Secondary pollutants → It is created due to the reaction b/w 2 compounds. It is more deadly. ex - acid rain

$$SO_2 + O_2 \text{ (air)} \longrightarrow SO_3 \xrightarrow{H_2O} H_2SO_4$$

$$SO_2 \xrightarrow{H_2O} H_2SO_3$$

(Sulphurous acid)

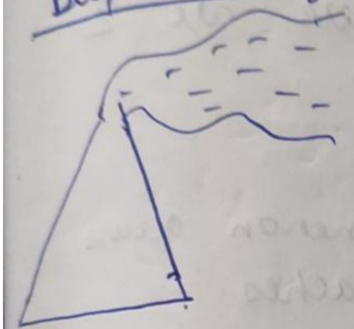
H/C in presence of sunlight (UV rays) photocatalytic rxn takes place.

$$H/C \xrightarrow{h\nu} C^-$$

↳ much more deadly.

H/C is emitted from exhaust of vehicles, industries.

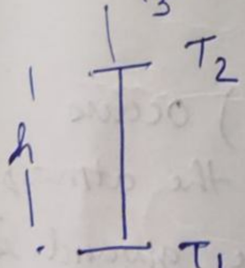
Dispersion of Air pollution



Wind speed — Humidity
Wind direction — Rain fall.
Temperature
Pressure

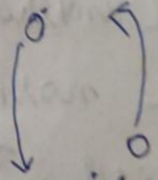
as altitude ↑ T ↓.

→ Dry adiabatic lapse rate → constant
→ Prevailing environmental lapse rate.



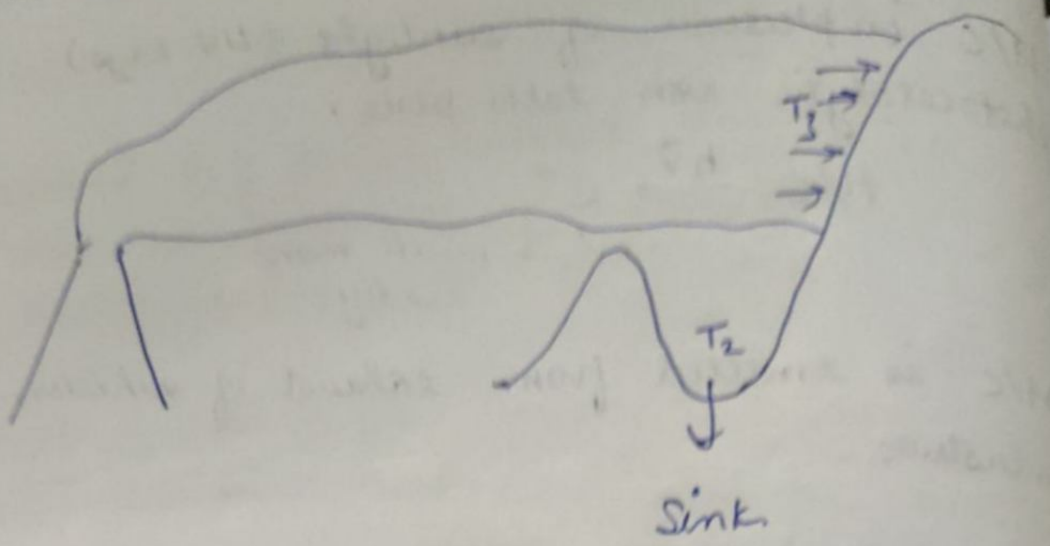
$T_2 < T_1$ $\quad \rho = \frac{PM}{RT}$

$\rho_2 < \rho_1$



Some gases will go up
Some gases will go down.
→ circulation of air.

$T_3 > T_2$ → it is possible.



$T_3 > T_2$ (because of pollutants)

Inversion is happening here. There are 2 types of inversion:

1) <u>Thermal inversion</u> → this phenomenon occurs near sea beaches
(Radiation inversion)

2) <u>Pressure inversion</u> → (cyclones, pressure drop)

Thermal inversion (weather inversion) occurs when the normal heat gradient of the atmosphere is reversed. Typically, air near the ground is relatively warm, and the atmosphere grows colder with elevation. During a temperature inversion, cold air is trapped beneath warm air, creating a pocket of stagnanted air close to the Earth's surface.

Equipments of pollution control:-

→ Scrubbers
→ Air filters
→ cyclones separators
→ Incinerators
→ catalytic reactors
→ Electrostatic precipitators
→ Gravity settling chamber

22/08/22

DRY ADIABATIC LAPSE RATE :

$$P = \rho g h \Rightarrow \rho = \frac{PM}{RT} \text{ for gases}$$

$$\frac{dT}{dh} = \frac{dT}{dP} \times \frac{dP}{dh}$$

$$\frac{dP}{dh} = -\rho g$$

$$PV = nRT$$

$$\frac{P}{RT} = \frac{n}{V}$$

$$\frac{dP}{dh} = -\frac{ngM}{V}$$

under adiabatic conditions.

$$PV^{\gamma} = \text{const} \qquad \gamma = \frac{C_P}{C_V}$$

$$\frac{T}{T_0} = \left(\frac{P}{P_0}\right)^{R/C_P}$$

$$T = T_0\left(\frac{P}{P_0}\right)^{R/C_P}$$

$$\frac{dT}{dP} = T_0\left(\frac{T}{T_0}\right) \times \frac{R}{PC_P} = \frac{RT}{PC_P}$$

$g = 9.8\ m/s^2$

$M = 28.9\ g/mol \rightarrow$ M.W of air

$\gamma = 1.4$

$C_p = 3.5\ \gamma \qquad c_p = 1\ kJ/kg$

$R = 8.314\ J/mol\ K$

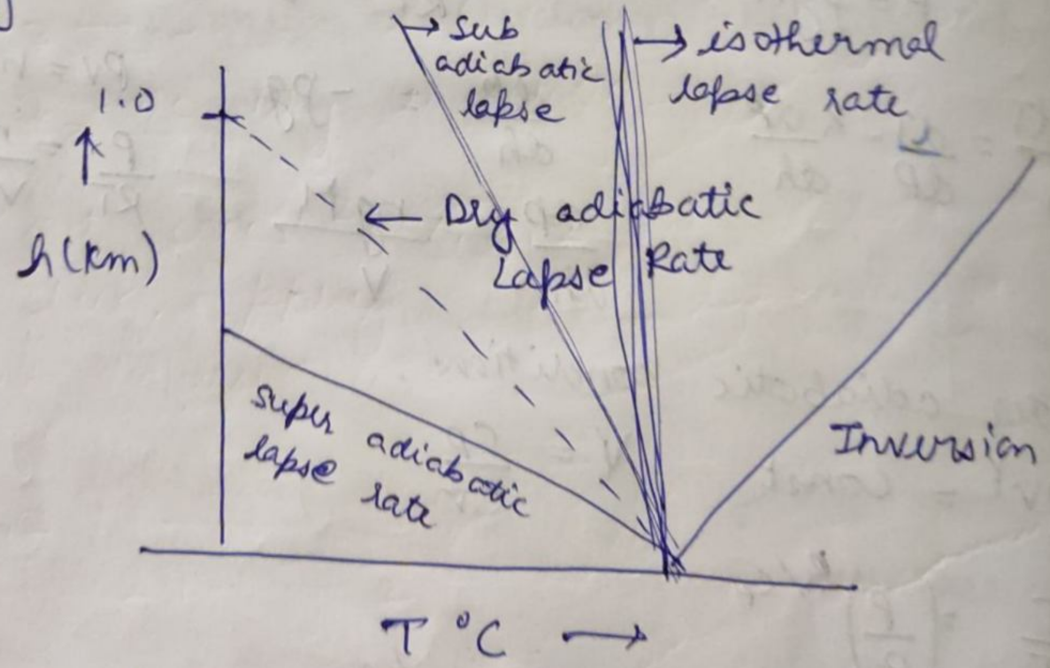
$$\frac{dT}{dh} = \frac{dT}{dP} \times \frac{dP}{dh}$$

$$= \frac{RT}{PC_p} \times -\frac{ngM}{V}.$$

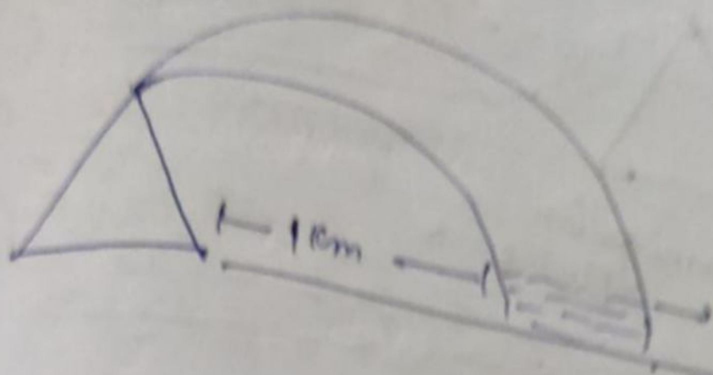
$$\boxed{\frac{dT}{dh} = -\frac{gM}{C_P}} = -\frac{9.8 \times 28.9}{3.5 \times 8.314} = -9.86\ °C/km$$

$$\frac{dT}{dh} = -9.86\ °C/km$$

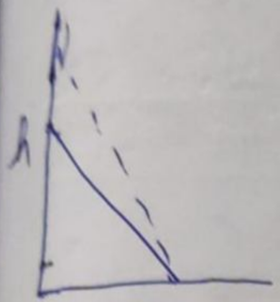
Dry ALR $= -6.5\ °C/Km$



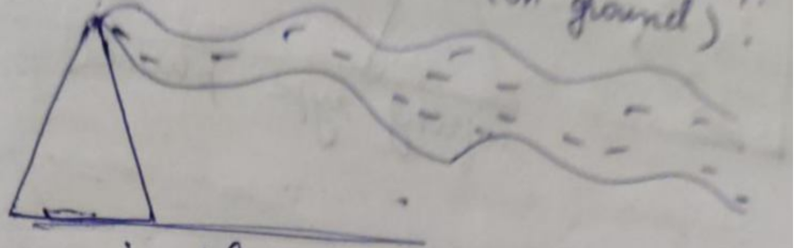
plume → fuel gas



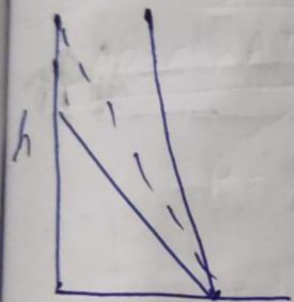
plume gets free and gets concentrated at the bottom. (on ground).



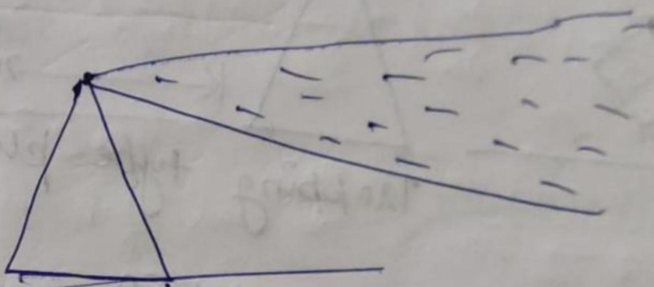
super



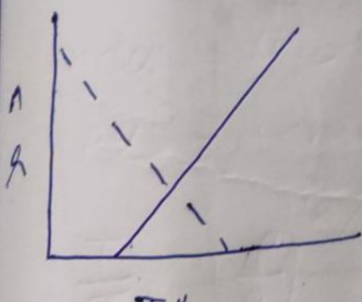
leoping plume



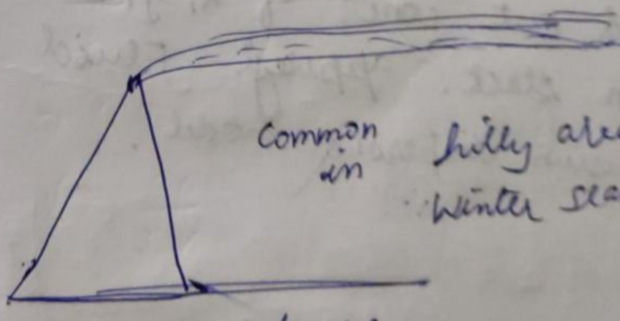
super adiabatic



Coning plume



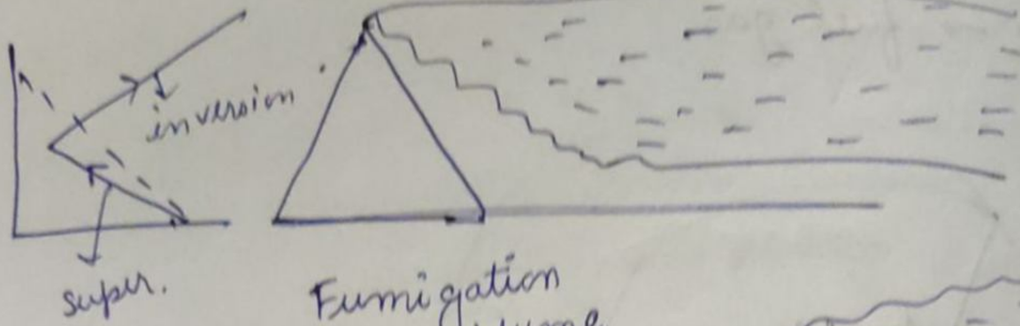
inversion



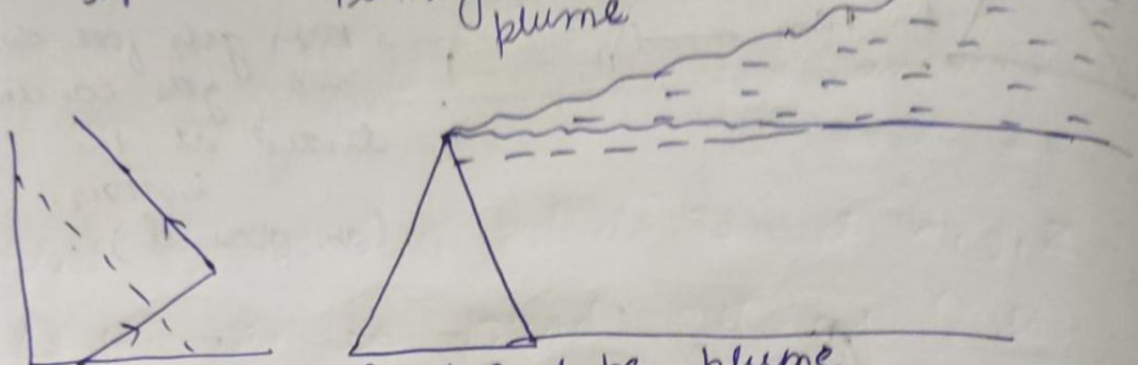
Common in hilly area
Winter season

Fanning plume.

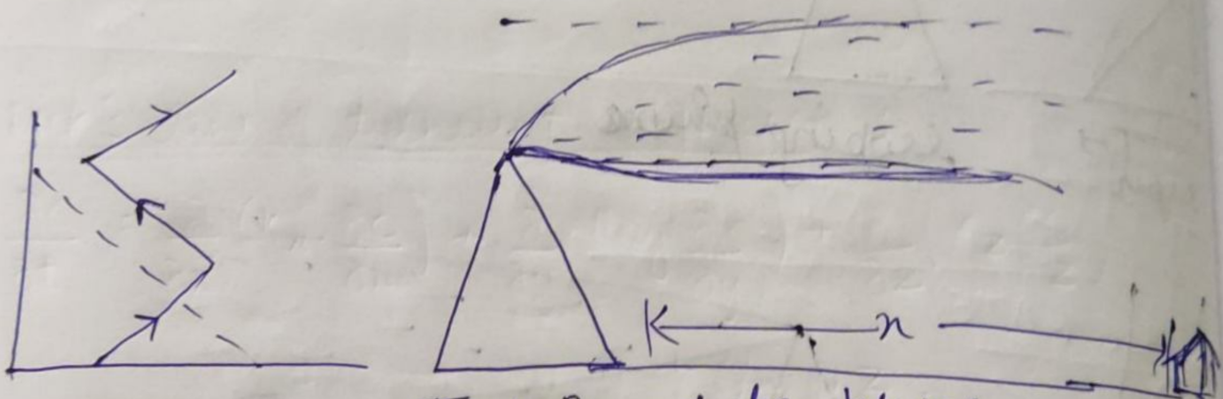
once inversion is disappeared 1st or second case appears.



Fumigation plume



lofting type plume



Trapping type plume.

Last 2 are very uncommon.

Find out conc^n of x, y, z at a distance from stack. applying Fluid dynamics, MT^n, Gausian dispersion model.

conditions for less pollution

i) tall chimney

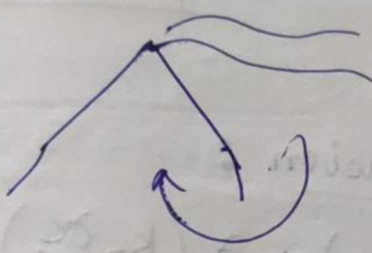
ii) Wind speed (ambient air → 2-3 m/s)

$\frac{40000}{3600}$ = 11.1 m/s

with height wind speed is more.

If height of stack is high then wind speed ↑ and it will take away more pollutants

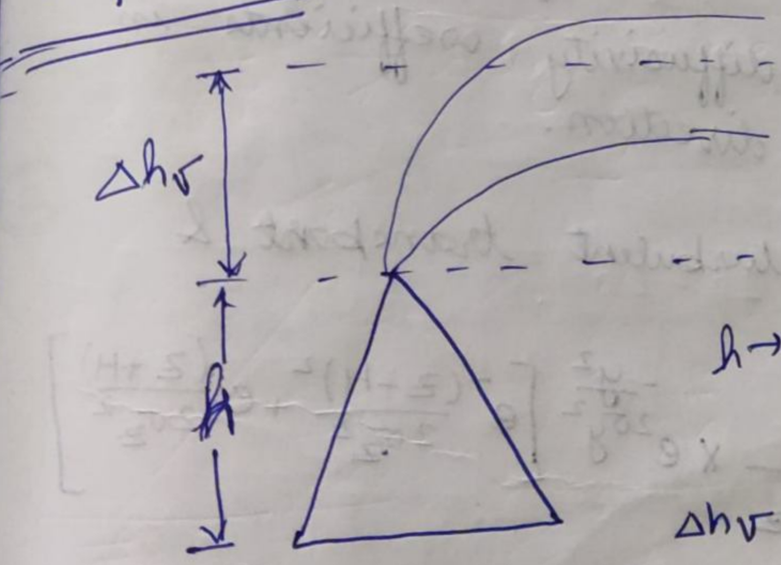
iii) Temperature is more → good for dispersion



more temp, draft ↑

iv) Horizontal distance is more.

23/08/22 DISPERSION OF AIR POLLUTANTS



$h \rightarrow$ physical stack height

$\Delta h_v \rightarrow$ change in height due to velocity head

Total height = $h + \Delta h_v$

$H \rightarrow$ effective stack height

$H = h + \Delta h_v$

$\Delta h_r \rightarrow$ calculate, based on ambiend temp, wind speed, fuel gas temp. etc.

x, y, $z \rightarrow$ height of plume from chimney head

$x \downarrow$ distance of chimney from main gate

$y \rightarrow$ transverse dist to x, z.

Find the conc^n of pollutants at x, y, z distance

↳ this can be found out by **Gaussian plume model**

- Fick's law of turbulent diffusion :

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial x}\left(k_x \cdot \frac{\partial c}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial c}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_z \frac{\partial c}{\partial z}\right) + Q_{x,y,z}.$$

$Q_{x,y,z} \rightarrow$ Source or sink for the pollutant.

$k_x, k_y, k_z \rightarrow$ Eddy diffusivity coefficients in x, y, z direction.

conc^n profile under turbulent transport & polluted air.

$$C_{x,y,z} = \frac{Q}{2\pi u \sigma_y \sigma_z} \times e^{\frac{-y^2}{2\sigma_y^2}} \left[e^{-\frac{(z-H)^2}{2\sigma_z^2}} + e^{-\frac{(z+H)}{2\sigma_z^2}} \right]$$

GCP $Q \rightarrow$ Pollutant Emission Rate gm/s

$u \rightarrow$ wind speed m/s (at a particular pt.)

$\sigma_y \rightarrow$ Plume standard deviation in cross wind direction m

$\sigma_z \rightarrow$ Plume standard deviation in vertical direction.

downwind dirⁿ → distance in x-dirⁿ at which concⁿ of pollutant needs to be detected / calculated.

CASES

① when $z = 0$

$$C_{x,y} = \frac{Q}{\cancel{2}\pi u \sigma_y \sigma_z} \times e^{-\frac{1}{2}\left(\frac{H^2}{\sigma_z^2} + \frac{y^2}{\sigma_y^2}\right)}$$

② when $y = 0, z = 0$

$$C_{x,0} = \frac{Q}{\cancel{2}\pi u \sigma_y \sigma_z} e^{-\frac{1}{2}\frac{H^2}{\sigma_z^2}}$$

concⁿ at ground level $z - H = 0$

$$C_{x,0} = \frac{Q}{\pi u \sigma_y \sigma_z}$$

Max ground level concⁿ

$\sigma_z = 0.707 H$ $\quad \frac{\partial z}{\partial x}$ = concⁿ

~~Coal → 1000TPD~~ = 1000

Wind speed ⇒

$$u_2 = u_1 \times \left(\frac{Z_2}{Z_1}\right)^{\bar{P}}$$

P → exponential term.

Value of exponential term

	A	B	C	D	E	F
Rural	0.07	0.08	0.10	0.15	0.35	0.55
Urban	0.15	0.17	0.20	0.25	0.3	0.35

$$\boxed{\Delta h_v = \frac{\overset{\text{stack gas velocity, (m/s)}}{V_s}\, D}{u}\left[1.5 + 2.68 \times 10^{-3}\, PD\left(\frac{T_s - T_a}{T_s}\right)\right]}$$

D → dia of stack exit (m)

u → wind speed (m/s) at H

P → Atm pressure, (mili bar)

T_s → Stack Gas temp (K)

T_a → Ambient temp (K)

For unstable condition

Δh_v increases 10 – 20%.

For stable condition

Δh_v decreases 10 – 20%.

Ques A 500 MW thermal power plant burns 18,000 tons of coal per day containing 0.58 % sulphur. The plant emits the fuel gases into the atmosphere through a stack of inside diameter of 1.5 m and height of 60 m. The velocity and the temperature of the plume at the exit are 5 m/s and 155°C resp. The ambient air temp is 28°C and the wind speed at the stack altitude is 7 m/s. The barometric pressure is 825 mbar at the top of the stack. Assume a moderately stable plume.

1) Calculate the effective height of the stack.

2) What is the downwind SO_2 conc^n in the plume centerline at a distance of 2 km in the day time?

3) Calculate maximum concentration of SO_2 along the central line of the plume and at what downwind distance it will occur.

4) Show a conc^n profile of SO_2 upto 10 km downwind (x) distance and 800 m along the cross wind (y) distance. Also state whether this plant would require any pollution control device if there exists a residential area at a distance of 3 km. Justify.

$$H_{eff} = h + (\Delta h)$$

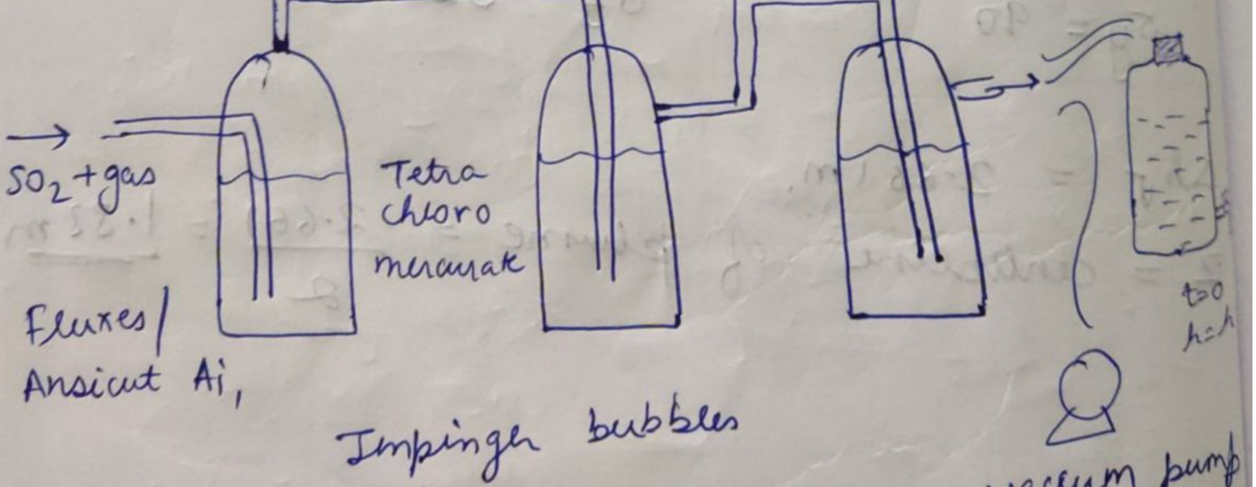
AIR POLLUTION SAMPLING & MONITORING

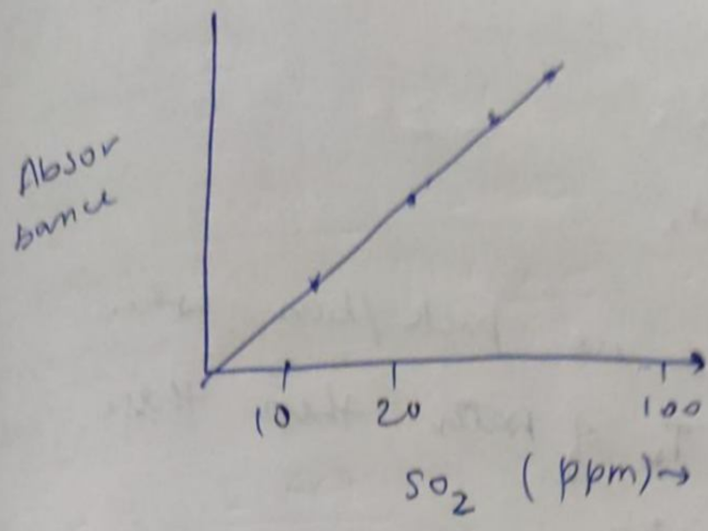
1. Ambient air quality
2. Stack sampling & monitoring

SPM, SO_x, NO_x, O_3, PM_{10}, $PM_{2.5}$, H/C

Sampling methods

→ freeze out sampling
→ Grab "
→ stack "
→ smoke "
→ tape "
→ High vol. "
→ dust fall "
→ inertia collector
→ precipitator collector





UV-vis → pink colour complex

GC → concⁿ measurement.

Glass fibre → used for measurement of P

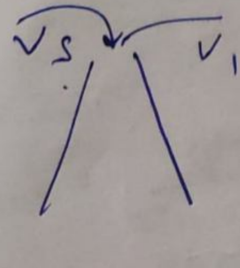
Initial wt. of filter paper $= W_1$

Final wt. of filter paper $= W_2$

$$\text{conc}^n = \frac{W_2 - W_1}{Q \times t} \quad \mu g/m^3$$

$Q \rightarrow$ vol. flow rate

isokinetic Sampling



$V_1 < V_s$

$V_1 > V_s$

thin ball

$U \xrightarrow{t=0} W_1$

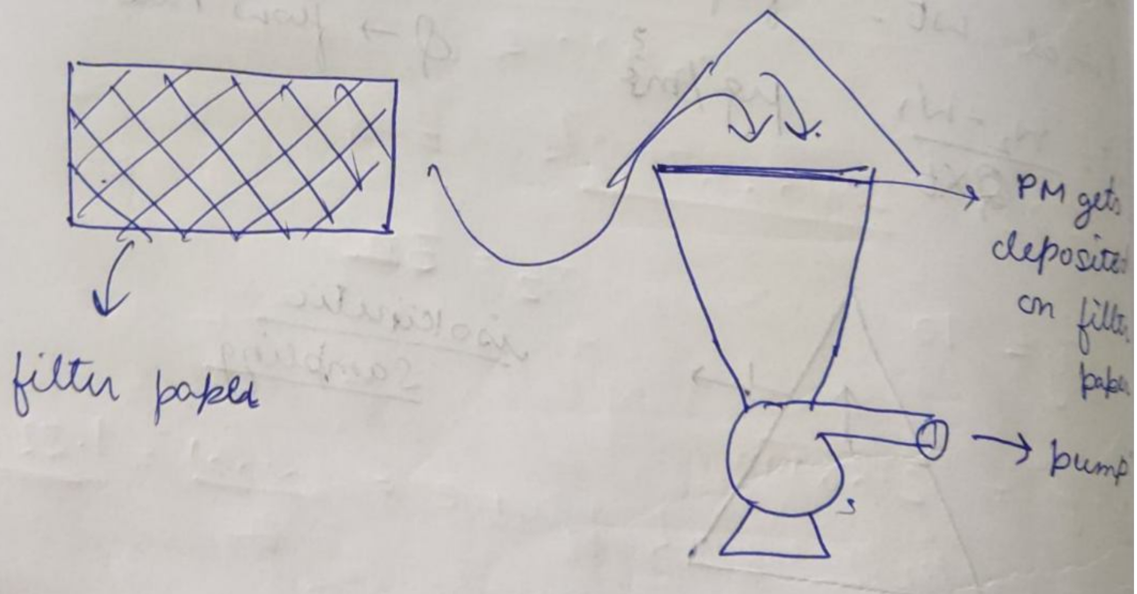
$U \xrightarrow{t=30\,min} W_2$

Sometimes we need ice pack / bar when chimney temp > T_b of water then there would be vapourization.

- High volume sampler → PM_{10}

Why concⁿ is measured for 24 hrs avg.

↳ Day time concⁿ + night time concⁿ



Q A stack in an urban area is emitting 80 g/s of NO_x. It has an effective stack height of 200 m the wind speed is 4 m/s at 10 m. It is a clear summer day with the sun nearly overhead. Estimate the ground level concⁿ at

a) 2 km downwind ~~on~~ the centreline

b) 2 km downwind, 100 m off the centreline.

Solⁿ

$Q = 80\ g/s$ $\qquad \sigma_y = 400\ m$

$H = 200\ m$ $\qquad \sigma_z = 2000\ m$

$u = 4\ m/s$

a) $x = 2\ km \quad y = 0 \quad z = 0$

$$C_{x,0,0} = \frac{Q}{\pi u \sigma_y \sigma_z} e^{-\frac{1}{2}\frac{H^2}{\sigma_z^2}}$$

$$= \frac{80}{3.14 \times 6.27 \times 400 \times 2000} \underbrace{\exp\left(-\frac{1}{2}\frac{(200)^2}{(2000)^2}\right)}_{0.995}$$

$= \cancel{7.9 \times 10^{?}\ g/gm^3}$

$= 5.07\ \mu g/m^3$

b) $x = 2\ km \quad y = 100 \quad z = 0$

$$C_{x,y,0} = \frac{Q}{\pi u \sigma_y \sigma_z} e\left(\frac{-y^2}{2\sigma_y^2}\right) e\left(\frac{-H^2}{2\sigma_z^2}\right)$$

$$= \frac{80}{3.14 \times 6.27 \times 400 \times 200} \underset{0.969}{\exp\left(\frac{-(100)^2}{2(400)^2}\right)} \underset{0.995}{e\left(\frac{-(200)^2}{2(2000)^2}\right)}$$

$= 4.91\ \mu g/m^3$

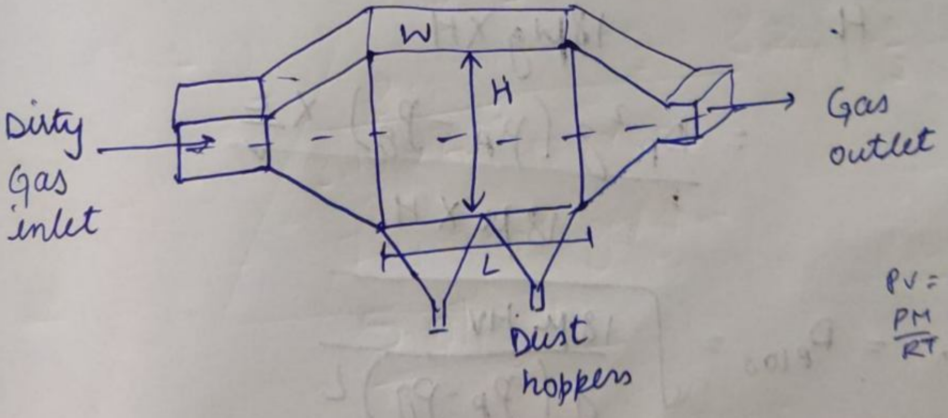
6/09/22

Air pollution control equipments

Particulate matters → 1) Gravity settling chamber — ~~low~~ efficiency; easy installation; large space required
2) ESP
3) Cyclone separator
4) Bag houses — low temp

Particulate + Gaseous air pollutant → 1) Venturi Scrubber
2) Packed towers
3) Spray towers
4) Bubble column scrubbers
5) Cyclonic Scrubbers.

Gravity settling Chamber



$PV = nRT$

$\frac{PM}{RT} = \rho$

Cross-sectional area × velocity = vol. flow Rate

terminal velocity → depends upon diameter & density.

$$\rho = \frac{PM}{RT} = \frac{101325 \times 28.9}{8.314 \times 298}$$

273
25

$$= 1.182 \text{ kg/m}^3$$

$$\eta = \frac{h}{H} \rightarrow \text{efficiency} \qquad t = \frac{h}{u_t}$$

$h \rightarrow$ height given

$H \rightarrow$ total height of chamber

$$u_t = \frac{D_p^2 (\rho_p - \rho_g) g}{18 \mu_g}$$

Strokes law

Intermediate region

turbulent region

$$\eta = \frac{u_t \times t}{H} = \frac{D_p^2 g (\rho_p - \rho_g)}{18 \mu_g \times H}$$

$$= \frac{D_p^2 g (\rho_p - \rho_g) \times \frac{L}{V}}{18 \mu \times H}$$

$$D_{p\,min} = D_{p100} = \sqrt{\frac{18 \mu H V}{g (\rho_p - \rho_g) L}}$$

$$= \left(\frac{18 \mu \, H \times Q}{(\rho_p - \rho_g) g L} \right)^{1/2}$$

$$\% \eta_t = \left(\frac{D_p}{D_{p_{min}}} \right)^2 \times 100$$

$\bar{D}_p$	1	2	- - - -	
η_i	η_1	η_2	- - - -	η_n

$$\eta_{overall} = \Sigma \eta_i w_i$$

WATER POLLUTION TREATMENT

→ Dr Siwambabu Varanasi

29/08/22

Assessment.

- Assignment → 30%
- continuous evaluation - 20%
- Tests - 50%

(*) Slides will be provided

BOOKS

Industrial Water pollution control by Wesley
→ Eckenfelder.

→ Wastewater Engineering (Treatment & Reuse)

→ Environmental pollution

Sources of Water Pollution

pt. sources → easy to calculate

farm runoff → depends upon weather conditions / dirⁿ of wind, rainfall.

Major Sources

major source is organic substances → oxygen demanding substance

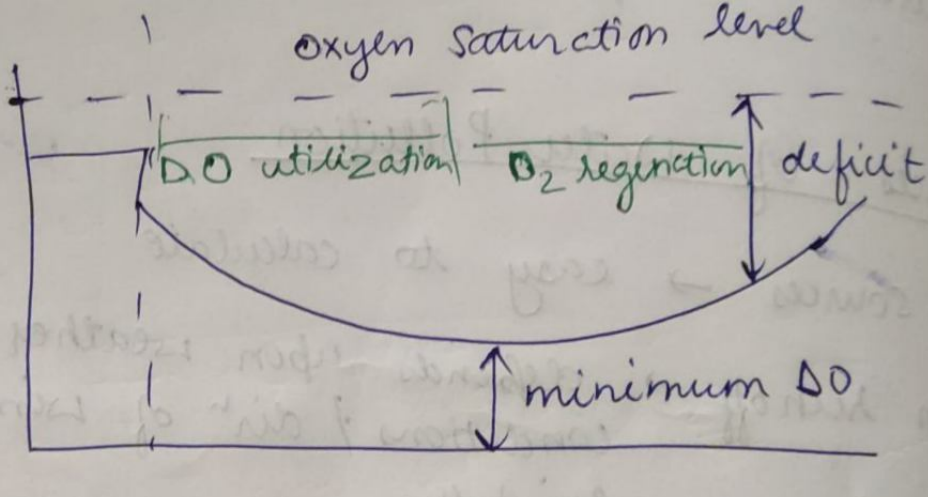
If required amount of oxygen is not present ~~than~~ for decomposition of organic substance then anaerobic conditions are created.

when sunlight doesn't penetrate into water eutrophication occurs.
water beings doesn't survive.

→ when hot water is dumped into water gas solubility decreases.

→ Decomposition of water contaminants also need oxygen. so oxygen supply decreases for water animals

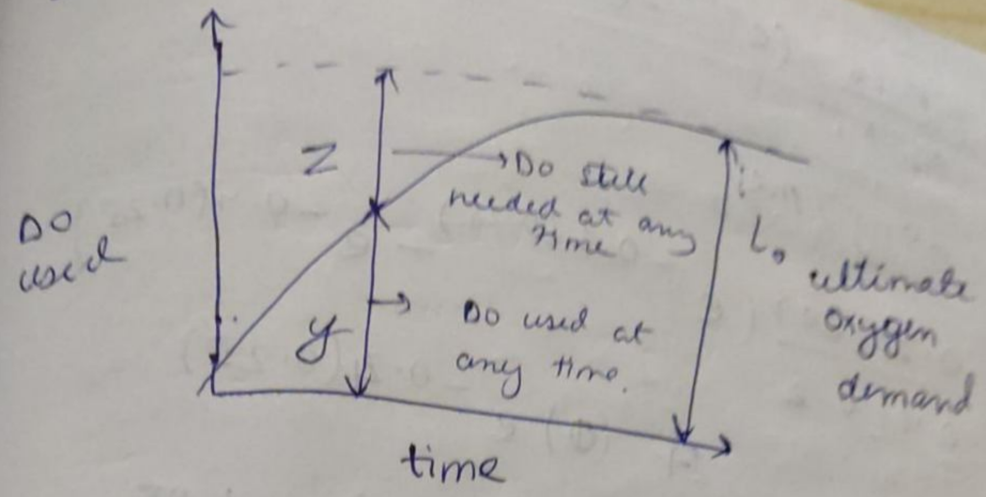
What happens when organic matter enters the stream?



D.O. ↓ because organic substances used up oxyen for its decomposition.

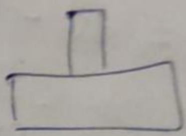
There is conc^n gradient ~~b/w~~ of oxyen b/w air & water. So oxyen moves towards water. Therefore, conc^n of D.O increases again.

Dissolved O_2 (DO)



huge BOD → huge contaminants
less BOD → less contaminants

Reoxygenation



Q what is the DO level 30 km down stream? If $K_1 = 0.2$/day & $K_2 = 0.4$/day.

stream velocity = 5km/h

time taken to travel 30km $= \frac{30}{5} = 6$ hr $= 0.25$ day

saturated at initial condition, $D_0 = 0$

Deficit (D) = 1mg/L = 1 mg/L ×

DO = saturation − deficit = $10 - 1 = 9$

Oxygen demand = 20mg/ml.

Saturated DO = 10mg/ml.

$$D = \frac{K_1 L_0}{K_2 - K_1}\left(e^{-K_1 t} - e^{-K_2 t}\right) + D_0 e^{-K_2 t}$$

$L_0 = 20$ mg / ml

$$D = \frac{0.2\,(20)}{0.4 - 0.2}\left(e^{-0.2(0.25)} - e^{-0.4(0.25)}\right)$$

$$+ (0)\, e^{-0.4(0.25)}$$

$$= 20\,(0.9512 - 0.9048) = \cancel{1.02}$$

$$= 0.928 \text{ mg}$$

$DO = 10 - 0.928 = 9.072$ mg / ml

Deficit = $\underset{\substack{\downarrow \\ \text{solubility}}}{\underline{\text{saturated}}}$, DO − actual DO

$\frac{dC}{dt} \propto C$ $\quad$ demand $\quad$ deficit

$$\frac{dC}{dt} = KC$$

30/08/22

microbes consumes organic matter for their growth

$$\underbrace{CHONS}_{\text{organic matter}} + \text{microbes} + O_2 \rightarrow CO_2 + H_2O$$

CHONS + microbes → new cells

respiration

~~CHONS~~ new cells + microbes → $CO_2 + H_2O$

Biological Waste water treatment

microbes is used to decompose Organic matter present in water.

primary treatment - material / substances that are toxic to microbes needs to be removed first.
excess organic matter shouldnot be present

secondary treatment - microbes decomposes Organic matter.

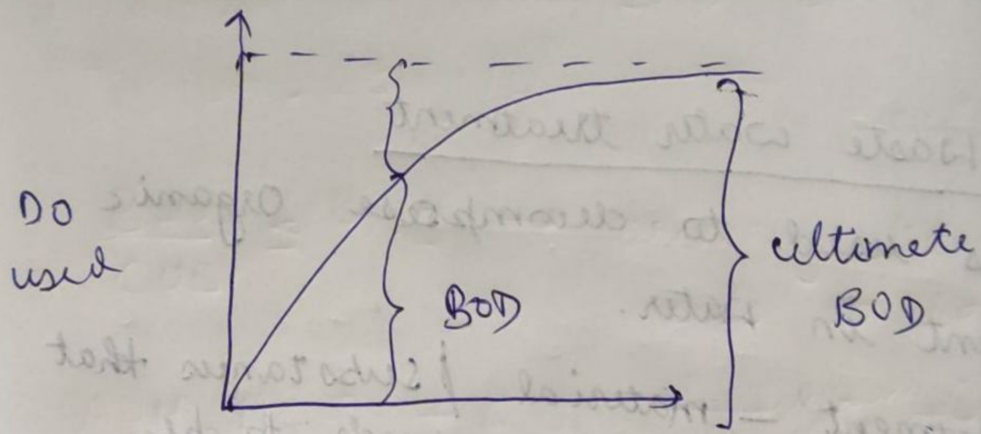
tertiary treatment - substance that microbes are unable to remove are removed in this step.

Waste water characteristics

→ Estimating the organic content.

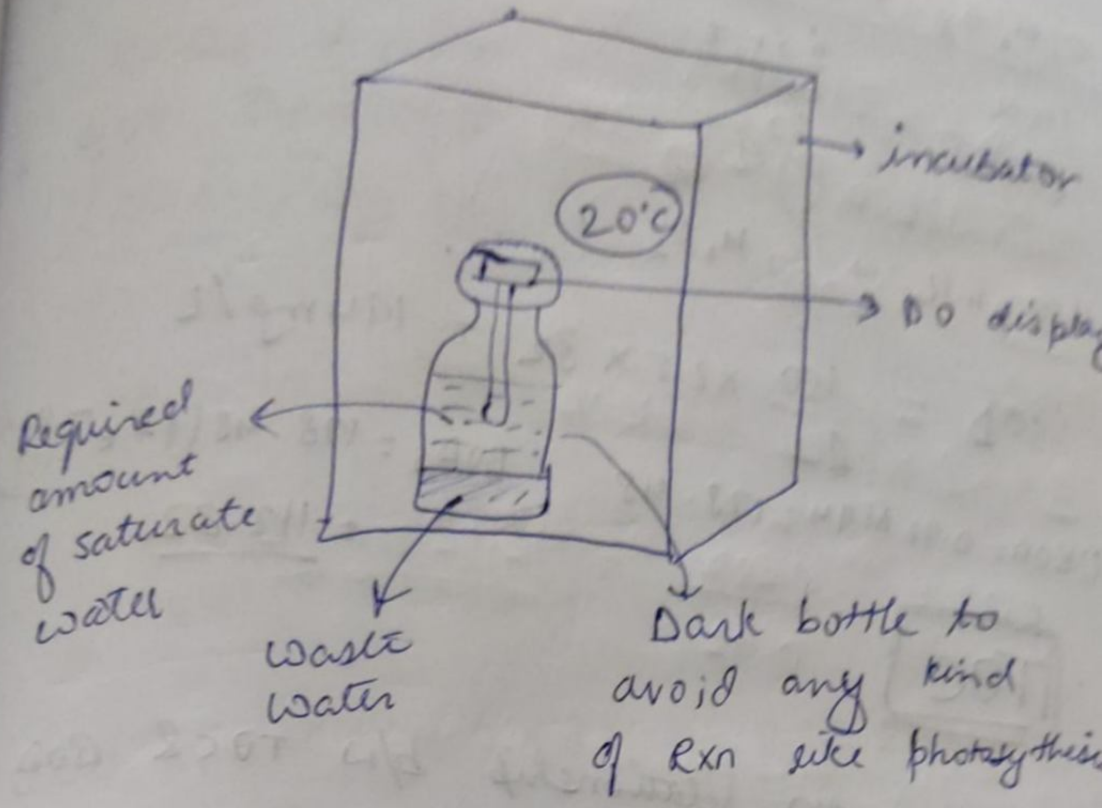
- BOD (biochemical oxygen demand)
- COD (chemical oxygen demand)
- TOC (total organic carbon)
- TOD (total oxygen demand.

$\boxed{\text{BOD}}$ → oxygen needed by microbes for their survival & decomposition of O.M.



- BOD_5 → BOD test is performed for 5 days.
- ultimate BOD → time taken for complete decomposition (60 days)

BOD $y = L_0 (1 - 10^{-kt})$



- If waste water doesn't contain microbes then we add microbes.
- For microbes growth we add nutrients.

NH_3 can get oxidised
so nitrification has to be suppressed.

COD

COD → organic + inorganic
if waste water contains only organic matter

$$COD = BOD$$

otherwise,
$UBOD = 0.92 \times COD$

$C_2H_6O_2 + 2.5O_2 \longrightarrow 2CO_2 + 3H_2O$

1 mol   2.5 mol

62g   32g

150 gm/L → $C_2H_6O_2$

$$COD = \frac{150}{62} \times 2.5 \times 32 = 194 \text{ mg/L}$$

$UBOD = 0.92 \times 194 = 178.48$, $BOD_5 = 178.48(1-e^{-1}$

$= \underline{112.82}$ (b)

$\boxed{TOC}$

there is no relationship b/w TOC & BOD, TOC & COD.

$\frac{BOD}{COD} \leq 0.3$ → primary treatment needs to be designed properly.

$\frac{BOD}{COD} = 0.6$

<u>Example problem</u>

- 150 mg/L of ethylene glycol ($C_2H_6O_2$) (MW-62)
- 100 mg/L of phenol (C_6H_6O) (MW-94)
- 40 mg/L of sulphide (S^{2-})
- 125 mg/L of ethylene diamine hydrate ($C_2H_{10}N_2O$) - non degradable component (MW - 94)

Est
- C
- E
- Af

(C

Estimate

- COD and TOC
- BOD_5 if K is 0.2/day
- After treatment, the BOD_5 is 25mg/L ($k = 0.1$/day). Estimate the COD.

$e^{-0.1}$

OD,

ed

(b) $C_6H_6O + 7O_2 \rightarrow 6CO_2 + 3H_2O$

1 mole   7 mole

94   32

$$COD = \frac{100}{94} \times 7 \times 32 = \underline{238.29\ mg/L}$$

(c) $S^{2-} + 2O_2 \rightarrow SO_4^{2-}$

1 mol   2 mol

32   32

$$COD = \frac{40}{32} \times 2 \times 32 = \underline{80\ mg/L}$$

Q2)

$0.92 \times 80 = 73.6$

$UBOD = 0.92 \times COD =$

$BOD_5 = 73.6(1 - e^{-0.2(5)})$

$= \underline{46.52\ mg/L}$

$= 0.92 \times 238.29 = 219.2268$

(b) $UBOD = 219.226(1 - e^{-0.2(5)})$

$BOD_5 =$ ~~1923 mg/L~~ 138.57 mg/L.

after treatment

$BOD_5 = 25 \text{ mg/L}$.

$25 = UBOD(1 - \cancel{e}^{-0.5})$

$\frac{25}{0.63} = UBOD$

$39.68 \text{ mg/L} = UBOD$

$COD = \frac{UBOD}{0.92} = \underline{43.13 \text{ mg/L}}$

~~(c) after treatment~~

~~$BOD_5 = 25 \text{ mg/L}$.~~

~~$25 = UB$~~

$C_2H_{10}N_2O + 6O_2 \longrightarrow 2CO_2 + 5H_2O + 2NH_2$

$78 \qquad 6 \times 32$

$COD = \frac{125}{78} \times 6 \times 32 = 307.69 \text{ mg/L}$

$UBOD = 0.92 \times 307.69 = 283.074 \text{ mg/L}$

$BOD_5 = 283.074(1 - e^{-0.2(5)})$

$= \underline{178.93}$

Total COD = 819.98 ≈ 820 mg/L

COD degradable = 512.29 mg/L

UBOD = 0.92(512.29) = 471.30 mg/L

$BOD_5 = 471.3(1-10^{-0.2\times5})$

$= 424.17$ mg/L

~~After~~ ~~BOD treatment~~,

BO

1 mol of $C_2H_6O_2$ → moles of C = 2

$\frac{150}{62}$ $\frac{150}{62}\times2$

mass of C = $\frac{150}{62}\times2\times12$ =

TOC = add all values = 173 mg/L.

After treatment.

$BOD_5 = 25$ mg/L

$K = 0.1$ /day

$25 = UBOD(1-10^{-0.1\times5})$

$= \underline{36.6}$ mg/L

06/09/22

most of the pollutants are carciogenic

primary pollutants → EPA

Water purification

primary
treatment

Biological process

any harmful
chemical

↑
waste
water

Necessary
conditions

excess
degrable
pollutants

primary
Secondary
tertiary treatment → expensive

primary & secondary
treatment can be done by tertiary treatment
but its maintainence & replacement is
expensive.

flow chart of RO

RO remove all the salts including
minerals. but we need minerals. So some
water is sent to ultrafilteration.

Primary treatment

→ Screening
→ Equalization
→ spill pond
→ Neutralization
→ Floatation

Secondary treatment

tertiary treatment

- membrane filtration
- adsorption

Water containing nontoxic organics.

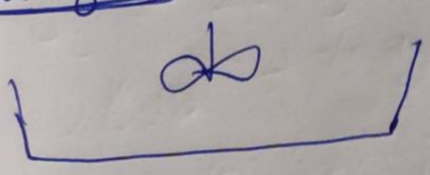
• Example
→ pulp & paper mill effluent
→ food industry effluent.

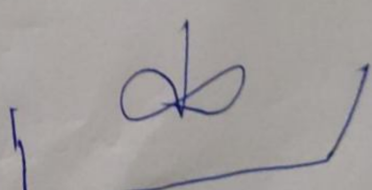
PRETREATMENT

Pb → ion exchange, precipitation

Waste water streams ⇉ equilization.

equalization





variable vol. equilization tank.