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Environment, Ecology & Biology

https://groups.google.com/forum/#!forum/evsbio2017-i/new

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Quiz, Assignment	5%
Attendance, Presentation	10+10
End Term	75

Topics

1. Fundamentals of aquatic chemistry
2. Water Pollution
3. Waste Water Treatment
4. Air Pollution
5. Solid waste Management
6. Population Growth
7. Ecology
8. Bio diversity
9. Sustainable Development

Global warming
Population
depletion of resources
sustainable development

There is more precipitation on land than oceans
- We have covered ground with concrete and due to this ground is unable to soak water and does not get recharged.
- other reason is deforestation

$R = 1.987$ cal deg^{-1} mol^{-1}
1 Cal = 4.2 J.

Thursday Topic → ecosystem
evaporation from soil & Transpiration by Plants
Evapotranspiration and Precipitation difference.....

- Thermal Stratification
Due to Temperature & density relationship Thermal Stratification takes place.

Top layer → more Temp, less density.
bottom layer → less Temp, more density
upper layer rich in oxidation so Fe will exist in Fe^{3+} here and in Fe^{2+} at bottom layer.

T↑ O_2 in water ↓

Clausius - Clapeyron equation describes transaction between 2 phases of matter-

$$\log \frac{C_2}{C_1} = \frac{\Delta H}{2.303 R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

Que $\log \frac{C_2}{8.32 \text{ mg/l}} = \frac{40.65 \text{ KJ/mol}}{2.303 R}\left[\frac{1}{298} - \frac{1}{283}\right]$

Ques2 $P = 17.5$ Torr
$T = 293$ K
$R = 8.31$

$$\log \frac{P_2}{P_1} = \frac{\Delta H}{2.703(8.31)} \left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Ans2 42.9 KJ/mol

$$P = \frac{\text{Force}}{A} = \frac{m \times \text{disp}}{A}$$

$$\text{con} = \frac{\text{mass}}{A \times L}$$

$$\frac{P}{\text{con}} = \text{disp} \times \text{Length}$$

Ques1

$$\log\left(\frac{C_2}{8.32\times10^{-3}\ g/L}\right) = \frac{\Delta H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\log C_2 = \log 8.32\times10^{-3}\ g/L + \frac{40.65\ KJ/mol}{1.987\times4.2}\left(\frac{1}{298} - \frac{1}{283}\right)$$

$$\log C_2 = \log 8.32 - 3 + \frac{40.65\times10^6}{1.987\times4.2}\left(\quad\right)$$

1 atm = 760 torr

$\log C_2 =$

3/8/17

L-2

2 main types of autotrophs.

- One type gets energy from the sun → by Photosynthesis
- Another type gets energy without light by Chemosynthesis

Aquatic life:

Decomposer : microorganism subclass of heterotrophic organism

Photosynthesis Reaction $CO_2 + H_2O \xrightarrow{h\nu} (C_6H_{12}O_6) + O_2$ (CH_2O)

Microbial decomposition Rxn

① $\{CH_2O\} + O_2 \longrightarrow CO_2 + H_2O + PO_4^{3-} + NO_3^- + SO_4^{2-}$ + new cells

② $\{CH_2O\} \longrightarrow CO_2 + H_2O + CH_4 + PH_3 + H_2S + NH_3 +$ new cells

getting both oxidized and reduced

Productivity: The ability of a body of water to produce living organisms is known as productivity.

Eutrophication is not desired (excess of nutrients not required to support aquatic life)

↓

"well nourished condition"

Eu ⇒ abundant
Hopki = nutrients
water is overloaded with nutrients
excessive growth of algae is known as "algal bloom".

Untreated municipal Sewage efficient

P N

Phosphorus is added in detergents as Polyphosphic → binders → Mg^{2+}, Ca^{2+} → to avoid white precipitate formation

② Agricultural runoff

N, P fertilizers

Soap + Ca^{2+}/Mg^{2+} → white ppt
(hard water)

At particular temperature concentration of O_2 is fixed

Eutrophication reduces quality of water

Henry's law:

PH of pure water is 7.00 due to dissolved CO_2

$CO_2 + H_2O \rightleftharpoons H_2CO_3$

$H_2CO_3 \rightleftharpoons H + HCO_3^-$ $\quad Ka_1 = 4.95 \times 10^{-7}$

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$ $\quad Ka_2 = 4.69 \times 10^{-11}$

Pure water is slightly acidic in nature

among CO_2, HCO_3^- & CO_3^{2-} which will be present in water in excess ?

FORMATION OF LIMESTONE CAVE

$CaCO_3 + H_2O + CO_2 \rightarrow Ca^{2+} + 2HCO_3^-$

above PH > 10.3 → CO_3^{2-} will dominate

PH < 5.3 → CO_2

Henry's Law

$[X_{(aq)}] = KPx$

$= K[P^\circ - P_{H_2O}]$ × mole fraction of that gas in the atm

(↓ 1 atm)

O → ≈ 21%

≈ 0.95%

Sum: Cal conc of O_2 in water at 25°C. K = 1.38×10^{-3} mol/lit/atm

$[O_2(aq)] = 1.38 \times 10^{-3}$ mol/lit/atm $(1\text{ atm} - P_{H_2O}) \times 0.21$

$= 1.38 \times 10^{-3} \frac{mol}{lit} \left(1 - \frac{23.95}{760}\right) \times 0.21$

$= \frac{0.2898}{760} \times (736.55) \frac{mol}{lit}$

$= 2.60 \times 10^{-4} \frac{mol}{lit}$

Calculate in ppm ?

$2.60 \times 10^{-4} \frac{mol}{lit} \times 32 \frac{g}{mol}$

$\Delta x \to 0$

Group1

Ecosystem

- Bering Sea Ecosystem
- Chemosynthesis

$$CO_2 + H_2O + 4H_2S \longrightarrow CH_2O + 3H_2SO_4$$ (no O_2 Produced)

- difference b/w Photosynthesis & Chemosynthesis
- Decomposers are detritivores.

Types → Bacteria (any environment)
Fungi (mostly moist environment)

- what is Function of decomposers
- There are differences between decomposers and detritivores.
- Water cycle

Group2

- Types of ecosystems
- Biomes
- Tundra & Taiga
- Temperate coniferous forest
- The desert biome
- Tropical rain forest
- The Carbon Cycle
- The Oxygen Cycle
- Role of Nitrogen gas
- Bacteria involved in different steps
- Nitrogen Fixation
- Biological Fixation

EEB L-3

Hard water → Structure of soap molecules

$2\,C_{17}H_{35}COONa + Ca(HCO_3)_2 \longrightarrow (C_{17}H_{35}COO)_2Ca + 2\,NaCl$

$2\,C_{17}H_{35}COONa + Mg(HCO_3)_2 \longrightarrow (C_{17}H_{35}COO)_2Mg\downarrow + 2\,NaCl$

→ Temporary, Permanent

Softening of hard water

- Soda lime
- Zeolite

$CaCO_3$ equivalent hardness

Calcium Carbonate equivalent = $\frac{\text{Equivalent weight of } CaCO_3}{\text{Equivalent weight of hardness producing substances}} \times$ Mass of hardness producing substance

Multiplication factor = $\frac{\text{Equivalent weight of } CaCO_3}{\text{Equivalent weight of hardness producing substances}}$

Ques 204 mg of $CaSO_4$ per litre

$CaCO_3 = 100$

$CaSO_4 = 136$

$\frac{100/2}{136/2} \times 204\ mg/L = 150\ ppm$

~~MF = $\frac{100}{2}\left(\frac{136}{2}\right) + \frac{100}{2}$~~

1 ppm = 0.07° Cl

1° Cl = 1 grain of $CaCO_3$ eq

1 ppm = 1 mg/L = 0.07° Cl = 0.1 Fr

1° Cl = 1.43° Fr = 14.3 ppm = 14.3 mg/L

Ques 2 Calculate the temporary, permanent & total hardness of a sample of water containing

$Mg(HCO_3)_2 = 7.3$ mg/L ; $Ca(HCO_3)_2 = 16.2$ mg/L

$MgCl_2 = 9.5$ mg/L ; $CaSO_4 = 13.6$ mg/L

and express hardness in °F

① $\frac{100/2}{146/2}(7.3\ mg/L) + \frac{100/2}{162/2}(16.2\ mg/L) + \frac{100/2}{95/2} \times 9.5 + \frac{100/2}{136/2}(13.6\ mg/L)$

$= \frac{50}{73}(7.3) + \frac{50}{81}(16.2) + \frac{20}{19}(9.5) + 10$

$= \underbrace{5+10}_{\text{Temporary}} + \underbrace{10+10}_{\text{Permanent}}$

$= 15$ ppm

Permanent Hardness $= 20$ ppm

Total $= (15+20)$ ppm $= 35$ ppm

$\equiv 20 \times 0.1$ °F

$= 2$ °F

Calculation of lime & soda required for the softening of hard water by the lime soda process

For Calcium we need to add Soda (S)

for Mg " " " Soda (S) + Lime (L)

to remove hardness

Date
Page

Lime Requirement for Softening

$$= \frac{74}{100}\left[\text{T.H of } Ca^{2+} + 2 \times \text{T.H. of } Mg^{2+} + \text{P.H of } Mg^{2+}\right] \times \text{Vol of water in litre}$$

T.H = temporary hardness
P.H = Permanent hardness

Soda Requirement for Softening

$$\frac{106}{100}\left(CaCl_2 + MgCl_2 \text{ in terms of } CaCO_3 \text{eq}\right) \times \text{vol of water}$$

Ques TH of $Ca^{2+} = \frac{100/2}{162/2} \times 81 \text{ ppm} = 50 \text{ppm}$

T.H of $Mg^{2+} = \frac{100/2}{146/2} \times 146 \text{ ppm} = 100 \text{ppm}$

PH of $Mg^{2+} = \frac{100/2}{95/2} \times 95 \text{ ppm} = 100 \text{ppm}$

$$= \frac{74}{100}\left(50 + 2(100) + 100\right) \times 50{,}000 \text{ l}$$

$$= 74\,(350)\,500 \text{ mg}$$

$$= 12515000 \text{ mg}$$

$$= 12.5 \text{ Kg}.$$

Soda $\frac{106}{100}\left[\frac{100}{111} \times 111 + \frac{100}{95} \times 95\right) \text{mg/l} \times 50000 \text{l}$

$$= \frac{106}{100}(200) \text{mg} \times 50{,}000$$

$$= 10{,}600{,}000 \text{ mg}$$

$$= 10.6 \text{ Kg}$$

Group 3

GU

Biodiversity

Water Conservation

L4

10/8/17

Quality of Surface Water

BOD (Biochemical Oxygen demand) → Amount of oxygen required to degrade organic matter biologically in a given volume of water

to estimate the presence of biodegradable organic matter

COD

$BOD_5 \rightarrow \{CH_2O\} + O_2 \xrightarrow{\text{micro organism}} CO_2 + H_2O$

↓ oxidising agent

BOD bottle in dark to avoid the oxidation caused by algae during photosynthesis

$DO_i - DO_f$

$BOD_5 = DO_i - DO_f$

DO_f should never be zero

At 25°C DO = 8.32 ppm

$n' = O_2$

$n' = O.W$

$DO_f = 0$

Dilution method when DO = 0

Dissolved oxygen

Organic waste (ow)

$DO_f = 0$ → A: n mole DO = n; no of moles O.W = (n+3)

B: 1 n' mole of OW ⇒ Bio decomposition

3 mol OW will be left out

$$BOD_5 = \frac{DO_i - DO_f}{P}$$; P = the dilution fraction = $\frac{\text{Volume of waste water}}{\text{Volume of wastewater + dilution water}}$

Ques 10 ml of sample of sewage mixed with enough water to fill 300 ml bottle which has $DO_i = 5.0$ mg/L. Calculate BOD_5 in each case: 1) 2.0 mg/L drop (consumed in DO during five day run

1) $\frac{2.}{10/300} = 60$ mg/L

2) $BOD_5 = \frac{9.0 - 2.0}{10/300}$ mg/L

2) It desirable to have final DO atleast 2.0 g/L.

Ques If BOD_5 is measured to be 3 mg/L, then we need to find out it's corresponds to how many number of moles of oxygen

32 gm of O_2 → 1 mol of O_2

1 gm of O_2 = 1/32 mol of O_2

Ques A wastewater contains 250 mg/L benzoic acid ($PhCOOH$). What is the BOD of this water. Molecular weight of benzoic acid is 122 g/mol

$$n = \frac{250 \text{ mg/L}}{122 \text{ g/mol}} = 2.05 \times 10^{-3} \text{ in one liter}$$

$$C_6H_3COOH + \left(\frac{15}{2}\right)O_2 \rightarrow 7CO_2 + 3H_2O$$

∴ no of moles of oxygen required to bio decompose the organic matter is 7.2

1 mol of benzoid acid = 7.5 mol of oxygen required

∴ for 2.05×10^{-3} mol = $7.5 \times 2.05 \times 10^{-3}$

= 15.4 mol of oxygen

The BOD (in mg/L) can be calculated as

= $(15.4 \times 10^{-3} \times 32)$ g

= 493 mg

Ques A certain sewage treatment plant located on a river typically removes 4.54×10^7 g.

$$\{CH_2O\} + O_2 \xrightarrow{\text{microorg}} CO_2 + H_2O$$

30 g/mol 0.W

at 25°C (O_2) = 8.32 mg/L

$$n = \frac{4.54 \times 10^7}{30} = 15.13 \times 10^5 = \text{no of moles of oxygen}$$

1 mol O_2 → 32 g (consume)

15.13×10^5 → 4.8×10^8 mg

at 25°C $[O_2] = 8.32$ mg/L

no of litres of river water will lose oxygen $= (48 \times 10^9 \text{ mg}) \div 8.32 \text{ mg/L}$

$= 5.76 \times 10^9$ L

8/17

L-5

Why do we carry out BOD experiment?

How do u measure amount of biodegradable matter? → COD

COD → to measure both biodegradable & non biodegradable matter

↳ provides in general amount of organic matter in water but does not specify the amount of biodegradable & non biodegradable

for specific biodeg — we use BOD

COD → measures conc^n of organic substances that can be oxidised by acidified dichromate at 100°C

$$3CH_2O + 16H_3O^+ + 2Cr_2O_7^{2-} \longrightarrow 4Cr^{3+} + 3CO_2 + 27H_2O$$

dichromate is acting as an oxidising agent

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

BOD	COD
1 Decomposition is taking place BIOLOGICALLY	Decomposition is taking place CHEMICALLY
2. only biodegradable organic matter can be decomposed	2] Hence both biodegradable as well as non-bio organic matter that can be oxidised by acidified dichromate can be decomposed
3] Specific in nature	3] less specific
4] BOD test is slower than COD test	4] much faster
5] BOD value is less than COD value as COD value includes both bio & non bio organic matter	5] COD > BOD for a sample by a factor of 2 or more

Date
Page

CH-2

Desired By

$A + B \xrightarrow{\text{Solvent}} \text{Product} + \text{Product}$

$CHCl_3$
CCl_4
C_6H_6

Water

→ Purposes
→ Water disposal
→ Water pollution

• Sources of Liquid Waste

1. Municipal Sewage effluents
2. Agricultural runoff
3. Industrial wastewater

COAL Washing

Acid Mine drainage

$$FeS_2 + \frac{15}{4}O_2 + \frac{7}{2}H_2O \rightleftharpoons Fe(OH)_2 + 2H^+ + 2HSO_4^-$$

one mole of pyrite produces 2 moles of sulphuric acid and one mole of ferric hydroxide, which is removed from solution as brown Precipitate

→ Pulp & paper industry
→ Tanneries (waste water from Tanneri Plant)
→ Textile & dyestuff industry
→ Sugarcane Based Industry
→ Pharmaceutical industries
→ Food Processing Plants
→ Cosmetic industry

Name of Pigment	Composition	Colour
Zinc oxide Titanium oxide	(1) ZnO (100%) (2) TiO_2 (100%)	white
Cobalt blues	(1) Co_3O_4 - 30-35% & Al_2O_3 - 65-70%	Blue
Red Lead Synthetic iron	(1) $Pb_3O_4 + PbO$ (2) Fe_3O_4	Red

Co_2O_3 — Green

Naturally occurring Fe_2O_3 (30-35%) — Yellow

Sources of H_2O Pollution

1) Point Sources
2) Non Point Sources or diffused Sources

Water Pollution may be divided into following Categories

1 Ground water Pollution
2 Surface H_2O "

How underground water is formed

- Recharge Process

Because of cool, dark & anaerobic atmosphere it is difficult to recover ground water once it is polluted

Why is it difficult to regenerate ground water

$$C_6H_6 + \frac{15}{2}O_2 \longrightarrow 6CO_2 + H_2O$$

decomposition of benzene by nitrates under anaerobic condition

Inorganic Species as Pollutants

(1) Cyanide

is used to make paper, textiles & plastics

$$2\,Na[Au(CN)_2] + Zn \longrightarrow Na_2[Zn(CN)_4] + 2\,Au\downarrow$$

Volatile HCN is very toxic and has been used in gas chamber executions in the US.

→ Structure of Haemoglobin

2) Ammonia

→ It is normal constituent of groundwaters.
→ Produced during the ~~anear~~ anarobic decay of nitrogenous organic wastes.

(L7)

③ Hydrogen Sulphide (H_2S)

22/3/17

Persistent Organic Pollutants (POPs)

→ These compounds are very stable
→ microorganisms no able to decompose into smaller fragment.

Why do industries continue to produce such type of products?

1. → Mostly these are chlorinated aromatic compounds
2. These compounds are very stable, do not break into simpler less toxic form very easily
   Poorly biodegradable
3. Soluble in fat hence, bioaccumulative

group person
Valuing Nature
" Culture
Social Justice

Volatile organic Compounds

memorize intensionally produced POP & un intensionally produced POP

↓

1. PAHs
2. PCBs
3. DDT
4. heptachlor
5. chlordane
6. aldrin
7. dieldrin / endrin

↓

1. Polychlorinated dioxins
2. Poly Chlorinated dibenzo furans (PCDF)

PAHs (Polynuclear Aromatic Hydrocarbons)
PCBs (poly Chlorinated Biphenyls)

→ Toxic effects of POPs:

① Polynuclear aromatic hydrocarbons

Eg. Naphthalene, anthracene, phenatherene

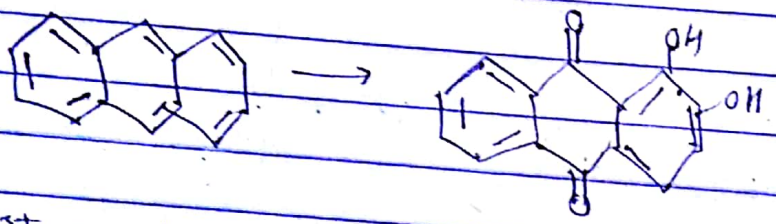
→ How do PAHs get in the environment

• Produced from incomplete combustion of organic compounds

→ Uses

• In making of dyes, plastics, pesticides, pharmaceuticals

• A mixture of phenanthrene and anthracene is used to coat water storage tanks to prevent rust



Al^{3+} → red

Sn^{2+} → pink

Fe^{3+} → brown

② Polychlorinated Biphenyls

Chemical formula $C_{12}H_{10-x}Cl_x$

1 to 10 Chlorine atoms are attached

→ Sources

• by-product of coal tar

→ Uses : as insulating materials, coolants & lubricants in electrical equipment such as transformers

Where does it go?

→ Deposition in river / lake

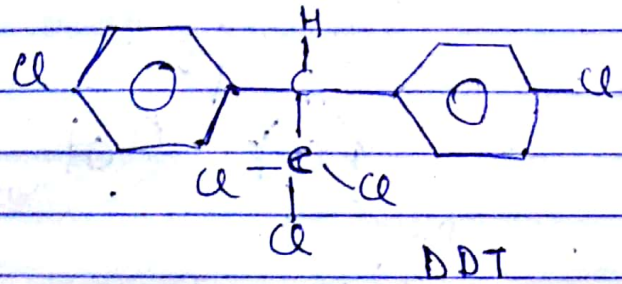
Toxic effects: Disrupt reproduction & fetal development

• These chemicals can be transferred from mother to fetus through Placenta.

3 DDTE

Pesticides : These are chemicals or biological agents used to control pets etc.

Naturally occurring insecticides
1) nicotine sulfate
2) Pyrethrins
3) rotenone
4) Azadirachtin



DDT

DDT interferes with the calcium metabolism in birds.

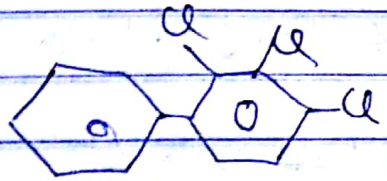
Octanol-water partition coefficient (Kow)

$K = \frac{C_{octanol}}{C_{water}}$ → organic medium

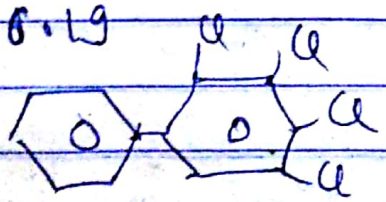
Kow indicates the tendency of fat solubility of a contaminant i.e it proves us information about how much a pesticide is bioaccumulative

$(\log K_{ow})_2 = (\log K_{ow})_1 + \text{"Pi-value"}$ (It is also called preference index)

↓ unknown ↓ known ↓ describes lipophilic nature of substance.

Ques log Kow of  then what will be

6.19

log Kow of  ?

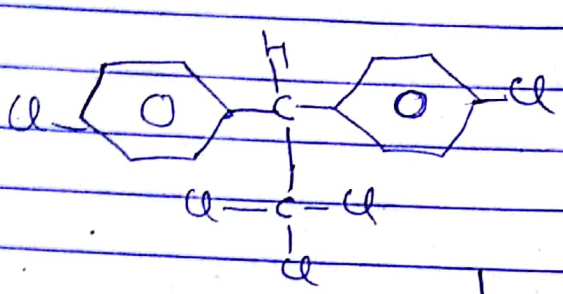
Pi of Cl = 0.71

$(\log K_{ow})_2$ = 6.19 + 0.71 = 6.90

K_{ow} = 1.54×10^6

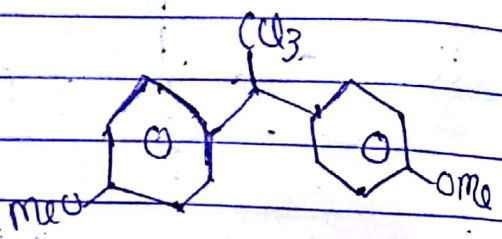
Compound having more Kow value is more bioaccumulative i.e more fat soluble

Q2



DDT

$\log K_{ow}$ = 5.87



$\log K_{ow}$ = ?

$(\log K_{ow}) = (\log K_{ow})_{DDT} - 2\,Pi(Cl) + 2\,Pi(OMe)$

= 5.87 − 2(0.71) + 2(−0.02)

= 4.41

$(K_{ow})_{methoxychlor} = 2.57 \times 10^4$

$(K_{ow})_{DDT} = 7.41 \times 10^5 = 10^{5.87}$

$\frac{(K_{ow})_{DDT}}{(K_{ow})_{methoxychlor}} = \frac{7.41 \times 10^5}{2.57 \times 10^4} = 29$

24/8/17 L8

Alternative approach to Control the pests : Environmentally attractive approach to control the pests

→ Environmental methods are costly and are not easy to use.

* Organic compounds released by pests (Pheromones)

One pesticide can't be used for long as pests get used to its resistance

(A) Natural Chemical Defenses : Application of PHEROMONES

→ only target pest will be killed

Ch12

Wastewater Treatment

↓ used water

→ To remove contamination

→ Sewage treatment is a multistage process.

- Preliminary (large float bulky floating oth.)] Physical Process
- Primary (Physical & chemical method)
- Secondary biological process as we are employing microorganism
- Tertiary Could be physical, chemical or biological.

↓

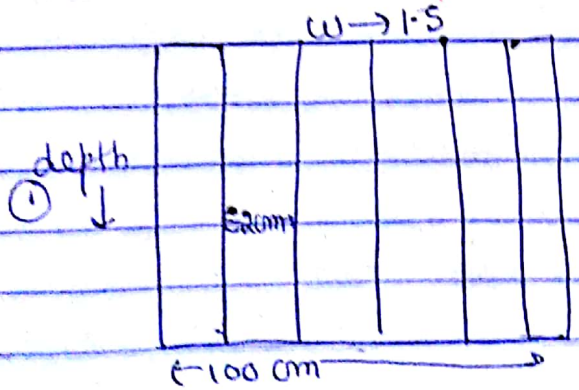
Disposal in water bodies

Screening, Comminutor, grit chamber → Preliminary Treatment

Primary Treatment

Ques Design a Screen Chamber with max. flow (Q) of $0.15 m^3/s$ of domestic wastewater.

Width to depth ratio 1.5 : 1, Velocity of waste water $V_h = 0.75 m/s$



$5 \times 20mm = 10 cm$

$(100 - 10) cm = 90 cm$

$A_n = 1.5D \times D = 1.5D^2$

$1.5D^2 = 0.2$

$D = \sqrt{\frac{2}{15}}$

$= 0.4 m$

$W = 1.5D$

$= .6 m$

Ans If no of bars = 4, then no of opening = 5

(a) Channel dimensions: $A_n = \frac{\text{Rate of flow}}{\text{Velocity of waste water}}$

i.e. Cross Sectional Area

$= \frac{0.15}{0.75} = \frac{1}{5} = 0.2 m^2$

Let the no of bars = n

[opening (n+1)] + [n × width of each bar] = 0.6

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

$0.035n = 0.575$

$n = 16$

Effective width of Channel = total width − width of 16 bars

= 0.6 −

=

Ques A w.w treatment plant receives a flow of 35,000 m^3/d (d → day). Calculate the particle setting velocity, surface area, vol & retentn time of a 3 m deep horizontal flow grit Chamber

?

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

μ is viscosity of water

Specific gravity = $\frac{\text{density of Particle}}{\text{density of water}}$

$\rho_p = 1.9 \times 1000\ kg/m^3$

$$V_s = \frac{9.81\,(900)\,(0.2 \times 10^{-3})^2}{18 \times 1.002 \times 10^{-3}} = 0.02\ m/s$$

$= 0.02 \times 60 \times 60 \times 24\ m/d$

$= 1728\ m/d$

Date
Page

Setting Velocity $V_s = \frac{Q}{A}$

$A = \frac{35000}{1728} \frac{m^3/d}{m/d} = 20.25\ m^2$

Retent^n Time(t) = $\frac{\text{Vol of grit Chamber}}{\text{flow rate}}$

L-g

29/8/17

Primary Treatment : Alum will be added

$Al_2(SO)_4, Ca(OH)_2 \longrightarrow Al(OH)_3 + CaSO_4$

Suspended Solids are removed

Ques. Determine quantity & ~~quality~~ volume of sludge produced in 10 days in treatment of 10 MLD of domestic wastewater with following Condition (10 million liters of water per day)

1 Suspended Solid in wastewater = $250\ g/m^3$
2 SS removal efficiency of primary tank = 60%.
3 Concentration of Solids in Sludge = 6%.
4 Density of water = $1000\ kg/m^3$
5 Solid Contribution per capita = 75g
6 Specific gravity of Sludge = 1.03

$1 ML = 10^6 L$

$10 MLD = 10 \times 10^3\ m^3/d$

$10 \times 10^{10}\ L/d \times 10^3$

Quantity of Sludge = SS remot efficiency × SS in water × Volume of ww per day produced

Volume of Sludge = Quantity of Sludge Produced / Density of water x specific gravity x % of solids in sludge

= 1500 kg/d / 1000 kg/m³ x 1.03 x 0.06

= 25 m³/d

Retention time = Volume of Primary Tank / Volume of Sludge Produced per Day

Vol of Primary tank = 25 m³/d X 10 d.

= 250 m³

Total person = total Slude produced per capita solids cat

Secondary Treatment

- Trickling Filter Method

Ques A wastewater treatment plant receives a flow of 35,000 m³/d containing BOD of 250 mg/L. Primary Treat. removes 25% of organic matter. Calculate the number of trickling filters with diameter of 60 m which would accomodate an organic load of 250 g/m²/d

Sol Total amount of org. matter

= 250 mg/L x 0.75 x 35000 m³/d

= 6562500 g/d

Total area required = Total avg mater in ww / Org load = milkers = 6 212 500 g/d / 260 g/m²/d

Total area = 262500 m^2

area of one filter = $\pi(r^2)$ = 2831 m^2

No of filters = $\frac{262500}{2831}$ = 10

$K_T = K_{20}\theta^{(T-20)}$

K_T → temp (°C)

K_{20} → Rate constant at standard of 20°C

θ → has a value of 1.135 for temp. b/w 4 → 20°C & 1.047 for temp b/w 20-30°C

Ques $F/M = \frac{\text{Rate of flow} \times \text{Conc of organic mater in ww}}{\text{Volume of acc tank} \times \text{Concn of biological mass}}$

31/8/17

1-10

Digestion :

Digester: An Air-tight container where the substrates are heated and the fermentation process takes place.

Secondary Treatment & anaerobic digestion are different

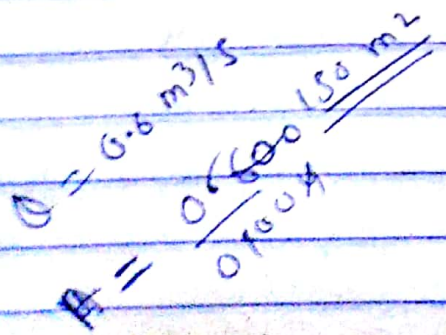
- no heat
- ample amount of oxygen needed

- apply heat
- no oxygen

Mesophillic : organisms - -

Thermo Phillic : — —

- Two end products of anaerobic digestion
  (a) Biogas
  (b) Fertilizer Pellets from Sludge Treatment



Tertiary Treatment

Final cleanup of the water effluent

Removal of Phosphorus

Removal of Ammonia

(a) Nitrification followed by denitrification

$NH_3 \rightarrow NH_4 \rightarrow NO_2 \rightarrow NO_3 \rightarrow N_2$ (reducing agent)

Nitrobacter

Nitrosomonas

(c) Chemical Process

→ Chlorination for Removing Ammonia

$Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl$

$NH_4^+ + HOCl \longrightarrow NH_2Cl + H_2O + H^+$

$NH_2Cl + HOCl \longrightarrow NHCl_2 + H_2O$

$NHCl_2 + HOCl \rightarrow NCl_3 + H_2O$

Ques A flow of 850,000 gpd requires a dose of 25 mg/L Chlorine. If Sodium Hypochlorite is 15% available Chlorine, how many pounds per day are needed.

$$\text{Lbs/day} = \text{Conc}\left(\frac{mg}{L}\right) \times \text{flow (MGD)} \times 8.34 \frac{\text{lbs}}{\text{gal}}$$

$$= 25 \times 0.85 \times 8.34 / 0.15$$

$$= 1.181 \text{ lb/d}$$

Water disinfection

(HOCl and OCl^-) are known as free available Chlorine

$2NH_3 + 3Cl_2 \rightarrow N_2(g) + 6H^+ + 6Cl^-$

$m_{Cl_2} = \frac{3}{2} m_{NH_3}$

$\frac{mass\ Cl_2}{71} = \frac{3}{2} \frac{Mass\ NH_3}{17}$

$M_{Cl_2} = \frac{105}{17} M_{NH_3}$

3 mols Cl_2 = 213 g

2 mols N = 2 × 14 = 28

Ratio = $\frac{213}{28}$ = 7.6 g Cl_2 Per gram of N

Ques A waste treatment plant handles 1500,000 L/day of sewage that contains an average of 50 mg/L of NH_3-N. How many grams of Cl_2 (eq) must be present daily in the wastewater to remove all of the ammonia?

Amount of NH_3 = 50 mg/L

for 28 g N → 213 g of Cl_2 required

1 mol NH_3 contains 14 g N and 3 g of H

50 mg/L NH_3 contains $\frac{14}{17}$ × 50 mg/L = 41.2 mg/L of N

Total N in 1500,000 L is 41.2 mg × 1500,000

= 61800 g N/day

Cl_2 = 7.62 × 61800

= 762 × 618

= 470 kg Cl_2/day or about 1036 lb/day

5/9/17

L-11

The Atmosphere & Air Pollution

CO_2 is not a pollutant but it has become cause of concern because of its increase quantity and as it is a green house gas.

Physical Characteristic of the Atmosphere

There are the 5 most abundant gases in the earth's atmosphere

Major Constituents:
Nitrogen, 78.08% (by volume)
Oxygen
CO_2
Water molecule
Argon

Why N_2 is more in % than O_2
→ N_2 is inert and O_2 is more reactive

Whatar vapor, a gas is invisible But Clouds are visible, why?
because they are made up of small drops of liquid or solid ice crystals, scatters light.

Major Regions of the Atmosphere
In Troposphere as height ↑, Temp ↓ (ground absorbs sunrays better than air molecules and then radiate heat through convection
" Stratosphere as Altitude ↑, Temp ↑

in given Table memorise data for Tropos. & Stratosphere.
(-ve)
Tropopause is heighest region of Troposphere.

Ozone layer is found in Stratosphere
↓
absorbs UV radiation
↳ highly energetic so breaks large organic matter.
↓
ozone molecules
this generates
radiation
↳ so Temp ↑ along with Altitude
Exothermic in nature

Calculation of mean molecular weight of air

- air mainly contains Argon, N_2 & O_2

$$M_a = \sum C_i M_i = \sum (78\%)(28) + (21\%)(32) + (0.934\%)38$$

$$= 28 \times 0.78 + 0.21 \times 32 + 0.00934 \times 38$$

$$= 28.91 \text{ g/mol}$$

$$= 28.91 \times 10^{-3} \text{ kg/mol}$$

Air Pollution

- Primary Vs Secondary Pollutant

CO CO_2

SO_2 NO NO_2

NAAQS National Ambient

What is toxic effect of CN^- and CO?

have great affinity towards iron

Ques Atmospheric CO_2 concentrations have increased from 280 ppm in pre industrial times to 365 ppm today. What is the concentration ↑ in the masses of atmospheric carbon? Assume CO_2 to be well mixed in the atmosphere

mass of atmosphere $m_a = 5.2 \times 10^{18}$ kg

Mean molecular weight of air $M_a = 29 \times 10^{-3}$ kg/mol

$$C_{CO_2} = \frac{n_{CO_2}}{n_a} = \frac{M_a}{M_C} \cdot \frac{m_c}{m_a}$$

C_{CO_2} → Conⁿ of CO_2 in atmosp

→ Total atmospheric masses.

$$C_{CO_2} = \frac{M_a}{M_C} \cdot \frac{m_c}{m_a}$$

M_C → 12 kg/mol

$$\Delta m_c = \frac{m_a M_c \cdot \Delta C_{CO_2}}{M_a}$$

g/mL

$$= 5.2 \times 10^{18} \times \frac{12 \times 10^{-3}}{29 \times 10^{-3}} \times 85 \text{ ppm} \times \text{g} \times 10^{-6}$$

365
280

$$= 1.8 \times 10^{14} \text{ kg} = 180 \text{ billion tons}$$

Air Quality Index

It is the ratio of measured to accepted concentrations multiplied by 100%.

Ques Avg CO conc^n in Jaipur air yesterday was 3 ppm. Is this high or unhealthy value or was the air quality OK

$$AQI = \frac{3 \times 100}{9} = \frac{100}{3} = 33\%$$

0-50 good

7/9/15 L-12

Calculate the concentration of CO_2 in the room after the fire extinguisher is emptied.
Amount of CO_2 is measured to be 10 lb. The dimension of the room is 10 ft x 10 ft x 10 ft. Temperature in the room is increased to 30°C (room temp was 20°C before fire) and that the ambient Pressure is 1 atm.

X_{CO_2} = (g mol CO_2) / (gmol gas) = C_{CO_2} = no of moles of CO_2 / no of moles of air in the atmosphere.

= (103 g mol CO_2) / 4131 gm

n_{CO_2} = (10 lb CO_2)(454 g/lb)(44 g/g mol CO_2)
= 103 gmol of CO_2

Volume = 1000 ft^3 = 28,300 L

Calculation of gmol of gas

$$n = \frac{PV}{RT} = \frac{(1\ atm)(28{,}300\ L)}{\left(0.08206\ \frac{atm \cdot L}{gmol \cdot K}\right)(303\ K)}$$

=

X_{CO_2} = (g mol of CO_2) / (g mol gas)
= (103 g mol CO_2) / (1138 g mol gas)
= 0.0905
= 9.05%

Greenhouse gases & its effect
- Captures & holds some of radiated heat

Average earth's surface Temp = 15°C

It could have been -18°C in absence of green house gases. on Mars Conc^n of green house gas is very less.

At night Temp of surface does not decrease drastically

Ques N_2 & O_2 do not have heat holding capacty? but CO_2 H_2O CH_4 do have. As N_2 & O_2 are composed of same atom.

N≡N O=O are not IR active elements/compounds

Very Stable Stable

Ques Given that the flow of oxygen into and out of the Earth's atmosphere is 3×10^{14} kg/year, what is the residence time of oxygen in the earth's atmosphere.

- At 15°C and 1 atmospheric pressure, volume of atmosphere is 4.3×10^{21} L
- At NTP (at 0°C and 1 atmospheric pressure), 1 mol of gas occupy 22.4 lit.

Vatm × 21%

$4.3 \times 10^{21}\ L \times 0.21 \times \frac{273}{288} =$

1 mol = 22.4 L

$x = \frac{4.3 \times 0.21 \times 273 \times 10^{21}\ L}{288}$

$= \frac{4.3 \times 0.21 \times 273 \times 10^{21}}{22.4}\ mol \left(\frac{32\ g}{mol}\right)\left(\frac{kg}{10^3\ g}\right)$

Mass of O_2 = 1.2×10^{18} kg

time = $\frac{mass}{frequency} = \frac{1.2 \times 10^{18}}{3 \times 10^4} = 4000$ year

Ozone & Nitrogen Oxides in Troposphere

- Photochemical smog is a type of smog produced when UV light from the sun reacts with different types of pollutants in a series of reactions.
- It is visible as a brown haze

* $N_2 + O_2 +$ high temp $\rightarrow 2NO$ (reaction in engines)

Round 3 pm – 4 pm formation of ozone

12/9/17

L-13

Major Air Pollutants

- Nitrogen oxides and nitric acid
- Health effect of Nitrogen oxide

$S + O_2 \rightarrow SO_2$

↓

may lead to classical smog (London smog), 1952

↓

Role of SO_2 in London smog

1) early in the morning during winter after longer NIGHTS before sun rises.
2) winds are calm
3) Clear sky
4) since there is no up and down motion of air. Hence SO_2 get stuck in the in the layer near surface.

Photochemical smog requires sunlight, afternoon
~~Classical~~ smog in dark, early morning

- Sulphur and Acid Rain

$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

Ques The total amount of Sulphur released into atmosphere per year by the burning of coal is about 75 million tonnes. Assuming this were all solid Sulphur, how big a cube would this occupy? Density of Sulphur is 2 g/cm³

$$\text{Volume} = \frac{75 \text{ million tonnes}}{2 \text{ g/cm}^3} = (7.5 \times 10^7 \text{ t})\left(\frac{\text{cm}^3}{2 \text{ g}}\right)\left(\frac{10^6 \text{ g}}{\text{t}}\right)$$

$$= 3.8 \times 10^{13} \text{ cm}^3$$

$$\text{Side} = (3.8 \times 10^{13} \text{ cm}^3)^{1/3}$$

$$= 3.35 \times 10^4 \text{ cm}\left(\frac{\text{m}}{10^2 \text{ cm}}\right)$$

$$= 335 \text{ m}$$

Ques for every 10,000 KW it generates, it must burn app 2000g of a coal. The coal used at this particular facility is in form of bituminous coal with the approx. Chemical formula $C_{100}H_{85}S_{2.1}N_{1.5}O_{9.5}$. Calculate the amount of CO_2 & SO_2 discharged into the atmosphere. 1 tons = 2000 lb

$$MW = (100)(12) + 85(1) + (2.1)(32.06) + (1.5)(14) + (9.5)(16) = 1525 \text{ g/mol}$$

$$C_{100}H_{85}S_{2.1}N_{1.5}O_{9.5} + 120.1\,O_2 \rightarrow 100\,CO_2 + 42.5\,H_2O + 2.1\,SO_2 + 1.5\,NO_2$$

1525 g of coal produces → 100 × 44 g of CO_2

1 g " " " → (100 × 44)/1525

2000 g of coal produces = (100 × 44)/1525 × 2000

= 5770 g of CO_2

3 × 10⁴

Date
Page

Suspended Particulate Matter

- Small and light enough to remain suspended air
- 62% from smoke, dust, pollen

diameter of Human Hair = 50 μm
" " Sand on beach = 90 μm

Ques - A power plant generates