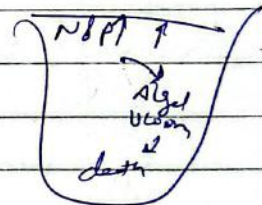


Water pollution - Water pollution can be defined as the contamination of water bodies. Water pollution is caused when water bodies such as rivers, lakes, oceans, ground water get contaminated with industrial and agricultural effluents.

Sources - (i) Physical - flow, temperature, Electrical conductivity, etc  
(ii) chemical - Bio-degradable organics, dissolved oxygen, and Sediment demand (SOD), nutrients (N and Phosphorus), toxic pollutants, salinity (dissolved solids), pH,  $\text{BOD}$ ,  $\text{CO}_2$ , etc.  
(iii) Biological - coliform bacteria, indicator parameters like chlorophyll a etc.

Eutrophication - It is a process in which water receives excess nutrients like Nitrogen & Phosphorus that stimulate excessive plant growth (algal bloom). It causes hypoxia (oxygen shortage condition).

Causes - # chemical fertilizers  
# Detergents.  
# Poor sewage treatment



\* Trophic state - (i) oligotrophic  
(ii) mesotrophic  
(iii) Eutrophic  
(iv) Hyper-Eutrophic

Water hyacinth

(i) oligotrophic - (i) lowest Productivity / limited growth  
(ii) highly well oxygenated  
(iii) found in the cold area  
(iv) quality drinking water is highly available

(ii) mesotrophic - (i) intermediate state b/w oligotrophic & Eutrophic  
(ii) Clear water with some macro plants

(iii) Eutrophic - (i) Biological productivity increases

(iv) Hyper-Eutrophic - (i) dense algal growth  
(ii) b/w the water there is dead zone  
 $>100 \mu\text{g/L}$  (Phosphorus),  $>40 \mu\text{g/L}$  (Chlorophyll)



BOD  $\rightarrow$  Bio-chemical oxygen demand  
COD  $\rightarrow$  chemical oxygen demand  
DO  $\rightarrow$  Dissolve oxygen.

### Organic waste $\rightarrow$

BOD  $\rightarrow$  Amount of free oxygen in water required for the biological oxidation of organic matter, under Aerobic conditions at  $20^{\circ}\text{C}$  & for period of 5 days.

\* large amt. of decomposable matter creates is BOD & more pollution of water.

COD  $\rightarrow$  Amount of oxygen required for chemical oxidation of organic matter in sewage (i.e. measure of oxidisable impurities present in sewage).

- \* gets completed in comparatively less time (3 hrs) than BOD (5 days)
- \* On basis of COD value, approx, BOD value can be estimated
- \* helps in designing water treatment plant.
- \* It is a quickly measured parameter for stream, sewage & industrial waste sample to determine their pollution strength.
- \* COD is higher than BOD.

$$\text{COD of Sample water} = \frac{(V_b - V_s)N \times 8000}{X}$$

FAS  $\rightarrow$  Potassium  
Ammonium  
sulphate

$V_b$  = Volume of FAS sol. run down in blank Titration

$V_s$  = " " " in Sample test titration

$N$  = Normality of FAS

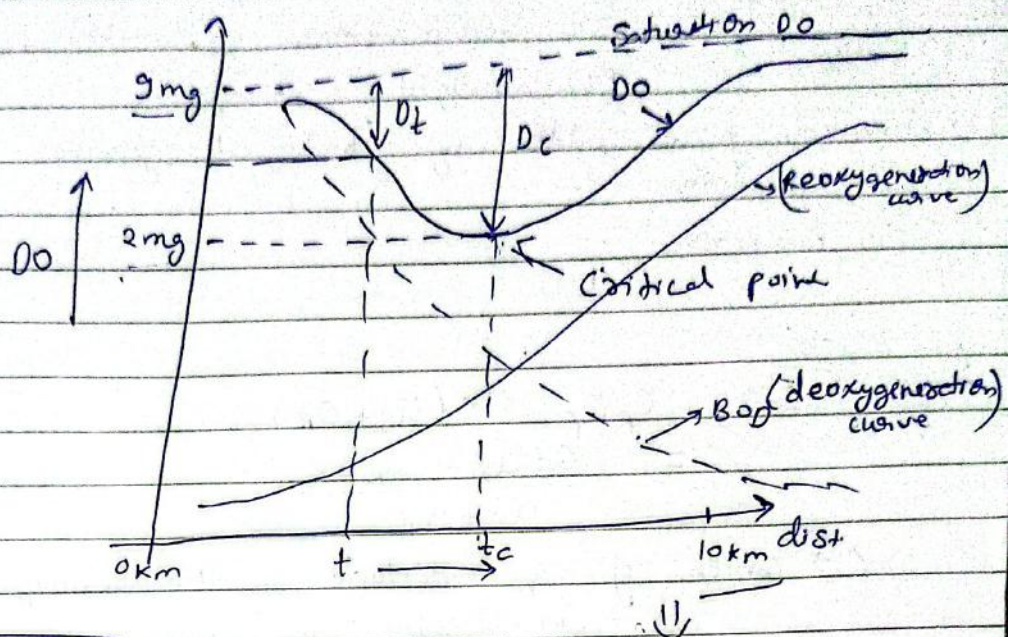
$X$  = Volume of test sample

$$\begin{aligned}\text{BOD of Sample water} &= (DO_b - DO_a) \times \text{Dilution Factor} \\ &= (DO_b - DO_a) \times \frac{\text{ml. of sample after dilution}}{\text{ml. of sample before dilution}}\end{aligned}$$

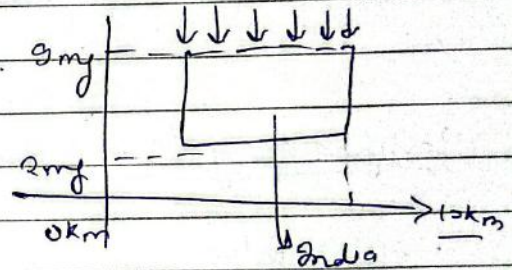
$DO_b$  = Dissolved oxygen present in Sample before incubation.



## Longitudinal profile of Dissolve Oxygen:-



$$L = L_0 e^{-x/t}$$



## Self purification capacity of stream:-

When sewage is discharged into a natural stream, the organic matter present in the sewage gets oxidized by bacteria and converted to simple, inoffensive, stable substance. In this process of oxidation the dissolved oxygen content of the river or stream water is utilized. Due to this deficiency of dissolved oxygen is created in river.

The deficiency of dissolved oxygen thus created in river is filled up by the absorption of atmospheric oxygen. Thus dissolved oxygen of river is consumed by sewage discharged into it and at the same time it is replenished by the atmosphere.



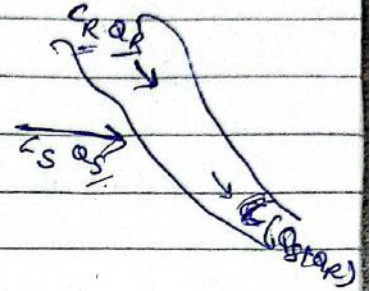
DO & clean water

BOD & clean water

Let sandy & heavy particles settle

### Natural Process

- (i) Physical forces → (i) Dilution & dispersion  
 (ii) Sedimentation settleable solids  
 (iii) Sunlight ↑ oxygen
- (2) chemical forces added by biological forces  
 (i) Oxidation  
 (ii) Reduction.



for dilution

$$C_S Q_S + C_R Q_R = C(Q_S + Q_R)$$

$$C = \frac{C_S Q_S + C_R Q_R}{Q_S + Q_R}$$

$C \rightarrow$  Concn. of any constituent in the resulting mixture of sewage and water flowing in river.

$Q \rightarrow$  rate of flow.

### Classification of (SWR) Based on Designated Best & Use

Water Bodies in 5 classes

DBU	Class	Criteria
(1) Drinking water w/o conventional source	A	DO $\geq 6$ and BOD $\leq 6$ MPN $\leq 50$ , 6.5 $\leq$ PH $\leq$ 8.5
(2) Organised outdoor (bathing)	B	DO $\geq 5$ , BOD $\leq 3$ MPN/100ml $\leq 500$ , PH "
(3) Drinking water with conventional source	C	DO $\geq 4$ , BOD $\leq 5.5$ MPN $\leq 5000$ , 6 $\leq$ PH $\leq 9$
(4) Wildlife Propagation	D	PH: 6.5 to 8.5, DO $\geq 4$ BOD $\leq 2$ , Ammonia, N $\leq 0.2$
(5) Irrigation, Industry & Controlled disposal of water	E	PH: 6 to 8.5, EC = 2.25 <small>micro mhos/cm</small> SAR $\leq 25$ , BOD $\leq 2$ <small>sodium absorption Ratio.</small>