CHEMICAL LIMNOLOGY

OXYGEN

Oxygen is important in the tropics due to relatively high temperature which allow low dissolved oxygen. At high temperature, metabolic activity rate increase at each 10°C hence more oxygen is required whereas low dissolved oxygen is available.

SOURCES

1. From atmosphere: air by simple diffusion into surface water. Since air has high concentration of oxygen compared to that in water hence as a result of concentration gradient, it diffuses into water. It is enhance by water movement/current.
2. Photosynthesis - oxygen produce as a waste product of photosynthesis of green plants, all bacteria, phytoplankton and higher plants e.g. *Cerabphylum vialisenaria* (90% aquatic dissolved oxygen).
3. oxidation processes which is a chemical process e.g. $Fe^{2+} \longrightarrow Fe^{3+}$,

   $NH_3 \xrightarrow{O_2} NO_2 \longrightarrow NO_3$; $C \longrightarrow CO_2/CO_3$; $P \longrightarrow PO^{4-}$

   All favoured by warmth 5-35°C which increase oxygen consumption under alkali/neutral pH.

USES: animal, plants and bacteria use it in respiration. Also it is use in aerobic decomposition of organic material and remains of animals.

FACTORS AFFECTING DISSOLVED OXYGEN CONCENTRATION IN WATER

i. Temperature- it has inverse relationship on dissolved oxygen. High temperature result into low dissolved oxygen. Cold water contain more DO

ii. Diurnal variation- during the daytime water is warm and hence low DO; during the night time, water is cold which implies high DO

iii. Atmospheric pressure - have direct relationship. Low pressure gives low DO related to altitude. At higher up the mountain, temperature is low and DO is high.

iv. Water movement- any form of water movement help to increase DO concentration e.g. using aerators/agitators. Aerate the water to increase the DO

v. Photosynthetic activities produce O_2, thus increase in DO in water during the day time and low DO at night when no photosynthesis. In addition, during the daytime, there is high light which give rise to high photosynthesis and high DO. At night, there is low light, low photosynthesis and high respiration therefore low DO. Dissolved oxygen at the surface increase than at the bottom because green plants and photosynthesis concentrated at the surface (just before the surface since high light intensity) more.

vi. Organic concentration- the greater the organic matter which requires oxygen for decaying processes, the lower the remaining dissolved oxygen.

vii. Presence of suspended materials intercept with light penetration, reduce light penetration, casing low photosynthesis and thereby leading to level of DO

viii. Water chemistry- chemical reaction due to oxidation of Fe^{2+}, NH_3, C and P lower DO in water

ix. High salinity also results in low dissolved oxygen e.g. 20mg salt decreases oxygen by 0.008mg/threshold.

VARIATION

- Diurnal: in day time there is high light in water, high nutrient and high dissolved oxygen in water.
- Seasonal - in dry season, water transparency increase as more light penetrate and photosynthesis increases as well as the level of dissolved oxygen. During rains, rain wash debris into water, water become turbid and there is low penetration of light, low photosynthesis and low dissolved oxygen.
- In running water (rivers and stream, due to water movement, mixing occur, hence high DO
- Spatial variation- dissolved oxygen increases at water surface, lower at the bottom. In shallow streams, uniform DO, water being light.
- In deeper water bodies, occasionally mixing increases DO at onset of thermal stratification; hypolim has high dissolved oxygen and latter falls.

DISSOLVED OXYGEN AS REGARD FISH CULTURE

In good water quality $NH_3 \longrightarrow NO_3$, $C \longrightarrow CO_2/CO_3$, $P \longrightarrow PO_4$

Thus, help to sanitize the water, converting some toxic substances into useful ones. High DO present, fish feed well as rate of metabolism increases resulting in growth. In low DO, there is low metabolic rate, fish feed poorly and result in low growth as it waste energy gasping for oxygen, hence low growth, low flesh is added.

In low DO, pathogenic bacteria, fungi, and leeches thrive well. Low dissolved oxygen, hence encourage disease outbreak leaving damage on fish skin. High dissolved oxygen encourages high stocking density of fish, fish eggs, larva and adults. Super saturation of DO in water will lead to high fish mortality which is as a result of gas bubble disease in young fish. As a result of excess oxygen in their blood, some oxygen release as bubbles block blood vessels and other organs and when it get to heart, disturb blood pumping by the heart hence death.

AERATING THE WATER TO INCREASE DO

a) Using aerators to pump air into water through airy stones/diffusers
b) Water agitators act like propellers with burning or rotating blade mixing the water
c) Some paddle like
d) Allow water to drop from a shower-like tap into the water body. As the water drops it picks more oxygen to increase water DO

DETERMINATION OF OXYGEN LEVEL

1) Using oxygen meter, pen sized with its electrode in water read DO in mg/litre or percentage oxygen saturation.
2) WINKLER'S TITRIMETRIC method, using Winkler's solution A and B i.e. KOH, KI and MnCl.
    i. Fix oxygen immediately collected from water
    ii. Pipette 2ml of each solution to about 200ml of water sample using different pipette all the time. 2ml of solution A pipette into 200-250ml of water (bottom of bottle). 2ml of solution B pipette into 200-250ml of same

water (near mouth of bottle). Cover this mixture with stopper allowing no air bubbles in, shake this mixture until a brown precipitate (MnO_2) is formed may be kept for weeks or months for further analysis.

3) TITRATION - add 2ml of conc. H_2SO_4 to dissolve precipitates which gives a yellow coloured solution and introduce acidic medium. Titrate this yellow solution against normal/80 of sodiumthiosulphate using fresh boiled starch solution as indicator. This gives blue-black colour on starch because of iodine. Titrate until blue-black disappears (no more iodine). Volume of Nathiosulphate used against 100ml of sample gives concentration f oxygen in mg/l in the water e.g. 8ml of Nahiosulphate against 100ml of Winkler's gives 8mg of oxygen per litre.
4) If one spit on water and the spit remain intact onmix, it implies low oxygen concentration. If water body is stirred and it foams, it implies pollution and low oxygen concentration