in numbers by 15 days exposure ...

OXYGEN-DEMANDING WASTES

Dissolved oxygen (DO) is a fundamental requirement for the maintenance of life of all living organisms in water. A water body is said to be polluted when the DO level falls below a certain minimal concentration necessary for sustaining a normal biota for that water. Oxygen demanding substances can remove large amounts of DO from water, causing changes in their flora and fauna. Organic pollution originates from incompletely digested sewage which has some **biochemical oxygen demand (BOD)** when it is released.

Oxygen demand increases as the organic matter decomposes due to the death and decay of the explosive growth of bloom forming algae and related species. Generally the organic materials are oxidised by bacteria to CO_2 and water. These deleterious substances create oxygen depletion, produce anaesthetic odour, endanger water supplies, give rise to scum and solids which make water unfit for recreational use. Consequently deeper waters in lakes may become oxygen deficient, destroying fish habitats and leading to elimination of many desirable aquatic species.

Dissolved oxygen is required maximum by fish, then by vertebrates and least by bacteria. Warm-water biota, including game fish, require 5 ppm. and cold water biota, not less than 6 ppm. O_2 level below saturation arises from the decay of oxygen demanding wastes. Most of them are organic, and may be represented as carbon which on oxidation converts to CO_2.

$$\underset{12\,g}{C} + \underset{32\,g}{O_2} \rightarrow \underset{44\,g}{CO_2}$$

It indicates that a 9 ppm. level of DO would be totally exhausted by $12 \times 9/32$ or about 3 ppm. of carbon-waste.

Biological oxygen demand (BOD) – The Royal Commission on Sewage Disposal (1912) first adopted the well known BOD test as a measure of the polluting organic matter present in a given sample of water. BOD can be defined as the amount of oxygen used up during oxidation of oxygen demanding waste when a sample of water is incubated for 5 days at 20°C with DO measured before and after.

The quantity of dissolved oxygen in water alongwith BOD is indicated by the kind of organisms present in water. Fish become rare at DO level of 4 to 5 ppm. of water. Further decrease in DO leads to death or migration of plant and aquatic fauna. The number of microbes as Escherichia coli (bacterium) increases tremendously which consume most of the O_2. When DO level decreases, bacterial decomposition shifts from aerobic (O_2 - requiring) to anaerobic (not O_2 -requiring).Under anaerobic conditions, the decomposition products tend to be more odoriferous and are likely to be more toxic. However, BOD values are useful in evaluation of self-purification capacity of a water body and for possible control measures of pollution.

One of the most serious effects of human and industrial wastes is to increase the **biochemical oxygen demand (BOD)** of natural water supplies. Aerobic bacteria uses oxygen to degrade the complex organic compounds in sewage to simpler and generally unobjectionable species such as CO_2, NO_3^- ions and SO_4^{2-} ions. This process reduces the amount of dissolved oxygen in water sometimes to the point where animal life is difficult to survive. If the oxygen content drops too low, anaerobic bacteria take over the decomposition process, forming rather noxious pollutants such as CH_4, NH_3 and H_2S.

The BOD of polluted water can be determined by measuring the amount of oxygen consumed by a sample of known volume. The water sample is first diluted with air saturated distilled water to ensure an excess of oxygen. The concentration of dissolved oxygen in the dilute sample is immediately determined and again after a period of 5 days. From the decrease in concentration BOD can be calculated.

$$\textbf{BOD} = \frac{\text{Number or mg of } O_2 \text{ required}}{\text{Number of litres of samples}} = \text{parts } O_2 \text{ / million parts of sample}$$

***Example 1** : Calculate the BOD of a water sample which contains one gm of urea for ...*

$$+ 4O_2 \rightarrow CO_2 + 2NO_3^- + 2H^+ + H_2O$$

Solution : From the balanced equation it is clear that 4 moles of O_2 are required to react with one mole of urea. One mole of O_2 weighs 32.0 g. and one mole of urea weighs 60 g. We have

$4(32.0 \text{ g. } O_2) \equiv 1 \text{ (60.0 g. urea) or } 4 \times 32 \text{ g. } \equiv 128 \text{ g. } O_2 = 60.0 \text{ g. urea}$

To react with 1.0 g. urea, we need

$$\frac{1.0 \text{ g. urea} \times 128.0 \text{ g. } O_2}{60 \text{ g. urea}} = 2.13 \text{ g. } O_2 = 2.13 \times 10^3 \text{ mg } O_2$$

$$\text{Thus BOD} = \frac{2.13 \times 10^3 \text{ mg } O_2}{100 \text{ litres}} = 21.3 \text{ mg } O_2/\text{litre}$$

A pure or nearly pure water contains a BOD of 0 to 3. BOD values higher than 5 indicate water of doubtful purity. Untreated city sewage has a BOD of 100 - 400. Some industrial waste have values as high as 10000. You can imagine the problems created if these materials ar dumped directly into water supplies.

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