CAI 334 IRRIGATION WATER QUALITY AND WASTE WATER MANAGEMENT

UNIT III NOTES

BOD

The biochemical oxygen demand (BOD) is a measure of the oxygen required to oxidize the organic matter present in a sample. through the action of micro-organisms contained in a sample of wastewater. It is the most widely used parameter of organic pollution applied to both wastewater as well as surface water. The BOD may be defined as the oxygen required for the micro-organisms to carry out biological decomposition of dissolved solids or organic matter in the waterwater under aerobic conditions at standard temperature. The BOD test results are used for the following purposes:

(1) Determination of approximate quantity of oxygen required for the biological stabilization of organic matter present in the was tewater

(ii) Determination of size of wastewater treatment facilitics.

Measurement of efficiency of some treatment processes.

(Determination of strength of sewage

(v) Determination of amount of clear water required for the efficient disprical of wastewater by dilation

The organic matter present in wastewater may belong to two groups (1) Carbonaceous matter and (#) Nitrogenous matter.

The ultimate carbonaceour BOD of a liquid waste is the amount of oryzen necessary for the micro-organisms in the sample to decompose the carbonacenus materials that are subject of microbial decomposition This is the first stage of cridation and the corresponding BOD is also inmetimes called the first stage demand. In the second stage, the nitrogenous matter is ridised, and the corresponding BOD is ksowns as second stage BOD of nitrification demand in fact, pollution waters will continue to absorb oxygen for a long time. Biochemical oxidation is a slow process and theoretically takes an infinite time to go to completion, though the oltimate first stage BOD of a given wastewater is equal to the initial oxygen equivalent of the organic matter present Generally, a 5 day period is chosen for standard BOD test, during which onidation is about 60 to 70 percent complete, while withos 20 days period, the oxidation is about 95 to 9 percent complete A constant temporation of 20°C is maintained during the inculation. The BOD value of 5 day incubation period is commonly wities Bol of 5-day BOD

1. Test for ROD BOD test can be performed by two methods: (i) Direct meriod and (i) Dilation method.

(i) Direct method: The test consists of keeping the sample of wastewater in contact with a definite sit it creygen, in a specially prepared vessel. The BOD then measured menometrically.

(W) Dilution method: This is the commonly used method. In this merkod the sample is sintably diluted with a specially prepared dilotion water. The dilution water is carefully manufactured so as tov include a mixture of saits providing all trace nutrients necessary for biological activity, along with phosphate buffer to maintain a neutral pH The water is aerated to saturate it with oxygen before mixing it with the sewage sample. The initial DO of this diluted sample is measured. The dilated sample is then incubated for 5 drys at 2010 in an ait tight glass vessel. The DO of the sample then again measured. The loss of oxygen or the orrygen consumed doring incobation is then found out by calculating the difference between the initial content of DO and the final content of DO BOD & thee computed from the relation

BOD = (Oxygen consumed)* dilution ratio

Dilution ratio = volume of diluted sample /volume of undiluted sewage sample.

Sources of BOD

Sources that increase the Biological Oxygen Demand of water are both natural and man-made. Pollution is a major contributor to increasing the BOD of water bodies. A good lifestyle is associated with an ample usage of water on a regular basis which results in a lot of wastewater with organic content in it. With increasing industrialization, pollution is increasing manifold. Factories have enormous wastewater being generated. Few industries that have huge quantities of wastewater are paper mills, food processing plants, jute mills, etc. The environmental factors contributing to increasing BOD include surface runoff, floating debris, dead animals and plants, soil erosion, etc. There are few chemicals that affect the BOD of drinking water. One of these is phosphate, which when present in high amounts increases the BOD of water.

Usage of BOD in Sewage Treatment Plants

Biochemical Oxygen Demand is used in secondary sewage treatment or biological sewage treatment. After the primary treatment in which the floating debris is removed by sequential filtration and sedimentation, the primary effluent is passed to aeration tanks where it is constantly agitated and the air is pumped into it. In aeration tanks, there are vigorous growth heterotrophic microbes into flocs. Flocs are masses of bacteria associated with fungal filaments.

Dissolved Oxygen

Dissolved Oxygen (DO) is a water quality parameter that is very important in secondary treatment processes. DO levels represent the amount of oxygen that is dissolved and dispersed throughout a water sample. Bacteria and microorganisms use dissolved oxygen to break down organic material, therefore reducing concentrations of DO. In wastewater treatment, microorganisms are added in flocs to aerobically digest and remove organic matter.1 As a result, efficient treatment relies on microorganism health and dissolved oxygen concentration.

Sources:

In nature, DO levels are higher in streams with choppy, turbulent water, at colder temperatures, and during the day when aquatic plants release oxygen. Common sinks for DO in the environment include microbiological degradation of organic compounds and algae blooms.

In wastewater treatment, DO levels decrease as Biological Oxygen Demand (BOD) and microorganism activity increase. If DO concentrations are too low, microorganisms will die off and treatment efficiency will therefore decrease. Aeration and bubbler systems are needed to keep DO levels around 2 mg/L and to evenly distribute DO throughout the flocs that contain microorganisms.

aquatic life relies heavily on enough oxygen to survive just like you and me. If dissolved oxygen levels drop too low there can be a large loss of fish and plant population. Therefore, dissolved oxygen measurements can provide a great insight into water quality, especially when paired with pH, temperature, and other probe measurements.

As a rule of thumb, according to the Environmental Protection Agency (EPA), dissolved oxygen levels approaching 3 mg/L are in the danger zone for supporting common aquatic life, and then levels below 1 mg/L cannot support any aquatic life.

Dissolved oxygen levels vary for each organism, but levels around 8-9 mg/L will support all life (fish or plants) and approach the oxygen saturation level of water. This high level of dissolved oxygen should be closely monitored in hydroponic setups, as large changes can have detrimental effects on the plants.

Generally, dissolved oxygen will naturally balance itself in moving waterways full of fish and plant life. Since natural aeration, agitation (wind, animal movement) increase dissolved oxygen levels, one should pay closer attention if these elements do not exist like in a basement hydroponic tank. Other factors that affect dissolved oxygen include temperature, pressure, and salt concentration (salinity).

1. Temperature – as temperature rises, DO levels decrease
2. Pressure – as pressure decreases, DO levels decrease
3. Salinity – as the salt content increases, DO levels decrease

These 3 factors define the oxygen saturation level of a particular water system. In most cases, the dissolved oxygen level will not increase, naturally, beyond 13-14 mg/L but as stated above 8-9 mg/L is a high-quality water condition.

Relation between BOD and OD

When BOD ***levels are high, dissolved oxygen (DO) levels decreases***, because the oxygen that is available in the water is being consumed by the bacteria. flag.

Effect of High BOD on the Aquatic Ecosystem

Increasing BOD has the same effect as the effects of dissolved depleting oxygen. When the BOD of a water body increases significantly, aquatic life is adversely affected. The oxygen used by aquatic organisms for respiration and metabolism is significantly reduced by the microbes for breaking down of organic waste. This results in the death of fishes and aquatic plants and complete disruption in the aquatic ecosystem. Oxygen concentration below 5ppm (parts per million) risks even low oxygen organisms like catfish and carps. The freshwater fishes like Catla and rohu do not survive at these concentrations. The overall aesthetic and beauty of the water body are damaged.

Pollution and Its Effects on Biochemical Oxygen Demand

With increasing pollution and urbanization, the water quality of the water bodies is significantly reducing. Water quality management is essential for the correct ecological functions. Urbanization leads to the production of much larger quantities of sewage. The number of sewage treatment plants was not enough for treating these large quantities of sewage. Untreated sewage was often discharged directly into water bodies which caused massive pollution and an increase in BOD of the water bodies. This also led to an increase in water-borne diseases like cholera, dysentery, jaundice, etc.

This increasing amount of BOD and pollution led to extreme pollution of the two main river bodies in India, Ganga, and Yamuna. The Ministry of Environment and Forests initiated the Ganga Action Plan in 1985 and the Yamuna Action Plan in 1993, to save these major rivers of the country. These plans initiated the building of a large number of sewage treatment plants to facilitate the discharge of only treated sewage in rivers.

Methods to Reduce BOD in Water

The biological oxygen demand of the water can be reduced by the following methods

- Advanced Oxidation Processes (AOP) by using H_2O_2/ UV, O_3/UV, Fenton's reagent (H_2O_2+$FeSO_4$), etc.
- Coagulation using alum or cationic polymers
- Flocculation (e.g. chitosan, isinglass, polyelectrolyte) and sedimentation.
- Adsorption using activated charcoal.
- Electro flocculation.
- Using the up-flow anaerobic sludge blanket reactor(UASB).
- Reverse osmosis.
- Dissolved air floatation technique.

Water is a basic need for all life forms to exist on earth. Therefore it is extremely important for us to conserve water and not pollute it. Polluting water directly harms every living creature be it mankind or the other forms of life. Rising biochemical oxygen demand levels in water are harming the ecosystem of the water bodies which indirectly is harming the whole ecology of the whole biosphere as a whole. It is our duty to keep these ecosystems alive. The other forms of life have the same amount of rights on environmental resources as human beings. We must keep our greed away and strive towards conservation of water bodies and reduction of BOD levels in them.

The measurement of the amount of dissolved oxygen consumed by aerobic microorganisms while decomposing organic matter in stream water is known as Biochemical Oxygen Demand.

Affecting Factors

Mentioned below are the affecting factors of biological chemical demand:-

- Biological oxygen demand affects the amount of dissolved oxygen in streams and rivers. The rate of oxygen consumption is affected by: pH, temperature, various kinds of microorganisms, and organic and inorganic materials.
- Less oxygen is consumed by higher forms of aquatic life. The consequences of the high BOD are the same as those for low dissolved oxygen.

Uses

Various uses of biological oxygen demand have been mentioned as follows :

- Biological oxygen demand is used in studies for measuring self purification capacity of the streams.
- It is an important method in sanitary analysis in determining industrial waste, the strength of sewage, and polluted water.

- It also serves as a source through which the quality of effluents discharged into the stream water can be checked.
- **Non point sources**
- **Nonpoint source** (**NPS**) **pollution** refers to diffuse contamination (or pollution) of water or air that does not originate from a single discrete source. This type of pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. It is in contrast to point source pollution which results from a single source. Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrological modification (rainfall and snowmelt) where tracing pollution back to a single source is difficult.[1] Nonpoint source water pollution affects a water body from sources such as polluted runoff from agricultural areas draining into a river, or wind-borne debris blowing out to sea. Nonpoint source air pollution affects air quality, from sources such as smokestacks or car tailpipes. Although these pollutants have originated from a point source, the long-range transport ability and multiple sources of the pollutant make it a nonpoint source of pollution; if the discharges were to occur to a body of water or into the atmosphere at a single location, the pollution would be single-point.
- Nonpoint source water pollution may derive from many different sources with no specific solutions or changes to rectify the problem, making it difficult to regulate. Nonpoint source water pollution is difficult to control because it comes from the everyday activities of many different people, such as lawn fertilization, applying pesticides, road construction or building construction. Controlling nonpoint source pollution requires improving the management of urban and suburban areas, agricultural operations, forestry operations and marinas.
- Types of nonpoint source water pollution include sediment, nutrients, toxic contaminants and chemicals and pathogens. Principal sources of nonpoint source water pollution include: urban and suburban areas, agricultural operations, atmospheric inputs, highway runoff, forestry and mining operations, marinas and boating activities. In urban areas, contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is usually included under the category of non-point sources (it can become a point source if it is channeled into storm drain systems and discharged through pipes to local surface waters). In agriculture, the leaching out of nitrogen compounds from fertilized agricultural lands is a nonpoint

source water pollution.[3] Nutrient runoff in storm water from "sheet flow" over an agricultural field or a forest are also examples of non-point source pollution.