CHAPTER-III
CHEMICAL PARAMETERS-Part-II
DISSOLVED OXYGEN [DO]

Introduction

Dissolved Oxygen [DO] is one of the most important parameters of the water quality directly affecting survival and distribution of flora and fauna in an ecosystem. All living organisms require constant supply of energy. Energy is necessary for different metabolic activities. All living organisms through respiration get constant supply of energy. The amount of oxygen in water is called DO concentration, which is influenced, by water temperature. The colder the water, the more oxygen it can hold, because gases like oxygen are more easily dissolved in cold water.

The two main sources of dissolved oxygen are diffusion (from air) and photosynthesis, while major factors responsible for its depletion are biochemical oxidation and respiration by flora and fauna. Algae and aquatic plants produce oxygen as a by-product of photosynthesis this is the transformation of heat energy from sunlight in to chemical energy that can be used by plants, and oxygen is also used by algae and aquatic plants for respiration. Respiration occurs all the the time but photosynthesis occurs only in the presence of sunlight dissolved oxygen levels depend on the physical, chemical and biological activities of the water body.

Dissolved oxygen is quite necessary to maintain healthy biological life in water. Low concentration of oxygen due to higher concentration of organic matter, low oxygen in water kills fish and other organisms present in water. The solubility of atmospheric oxygen in fresh water range from 14.6 ppm at 0 C to about 7.0 ppm at 35 C under 1 atmospheric pressure. Since, it is poorly soluble gas, its solubility directly varies with atmospheric pressure at given temperature. Further the rates biological oxidation increase
with temperature, and the oxygen demand increases accordingly. The low solubility of dissolved oxygen is a major factor that limits the purification capacity of natural waters and necessitates treatment of waste to remove polluting matter before discharge to the receiving water bodies. Dissolved oxygen levels in natural and wastewaters depend on the physical, chemical and biochemical activities in the water body.

The importance of dissolved oxygen in aquatic ecosystem brings various biochemical changes and its effect on metabolic activities of organisms was discussed by many ecologists. [Roy, 1955; Laxminarayan, 1965; David and Roy, 1966; Pahwa and Mehrotra, 1966; Saxena et al., 1966; Venkateshwaralu and Jayanti, 1967; Smet and Evans, 1972; Hancock, 1973; Mishra and Yadav, 1978; Verma et al., 1979 Adebisi, 1981; and Mitra, 1982]. They have discussed seasonal averages and fluctuations in dissolved oxygen. They reported maximum dissolved oxygen in winter and minimum in summer.

The dissolved oxygen of water sample was estimated in the field as well as laboratory with the help of water analysis kit and wrinkler's method.

**Observations**

In the present investigation the dissolved oxygen of water sample was maximum in the month of December 7.6 ppm and 7.4 ppm at station ‘A’ and ‘B’ respectively and minimum dissolved oxygen was found in the month of May 3.6 ppm and 3.3 ppm respectively in the year 1999-2000. The maximum dissolved oxygen was noted in the month of December 7.6 ppm and 7.5 ppm, minimum in the month of May 3.6 ppm and 3.4 ppm at station ‘A’ and ‘B’ respectively in the year 2000-2001. The values of dissolved oxygen are given in the table (14) and Fig. (14).
Discussion

Dissolved oxygen is one of the most important abiotic parameters influencing the life in an aquatic environment. During present investigation dissolved oxygen ranged between 3.6 ppm to 7.6 ppm at station ‘A’ and 3.3 to 7.4 ppm at station ‘B’ in the year 1999 – 2000. In the year 2000 – 2001 dissolved oxygen ranged between 3.6 to 7.6 ppm at station ‘A’ and 3.4 to 7.5 ppm at station ‘B’ respectively. There are two main sources of dissolved oxygen in water.

(i) Diffusion from air, which depends on factors like wind action, temp., and salinity.

(ii) Photosynthesis, which depends on transparency, Turbidity, CO₂ and algal biomass.

At a given point of time factors like temp., transparency, nutrient load and biomass of autotrophs, determine the dissolved oxygen. Normally high dissolved oxygen is encountered in unpolluted while lower levels of the dissolved oxygen in polluted areas of an aquatic ecosystem. Further depletion of dissolved oxygen to the level of anaerobia is the most critical manifestation of pollution. Lester (1975) has suggested the usefulness of dissolved oxygen as an indicator parameter for organic pollution. The winter maxima can be attributed to the higher solubility of oxygen gas due to low temperature. The minimum quantities of the dissolved oxygen required in water depend upon the individual organisms. Generally fishes required at least 5 ppm dissolved oxygen for 16 hours / day. Most natural waters for 8 hours contain 8 to 10 ppm oxygen (Agarwal et al. 1976, Prasad and Manjula, 1980). Dissolved oxygen was generally maximum in the winter season, this may be due to low temperature of water. The minimum dissolved oxygen was recorded in summer. This may be due to the higher temperature and
decrease in water level on evaporation. Similar observations were also recorded by Hazalwood and Parkar (1961) Patil and Sen (1983).

High winter values of dissolved oxygen could be attributed to relatively stable abiotic conditions and higher algal biomass stimulating rate of photosynthesis. Intermediate values in Monsoon could be attributed to dilution factor that adversely affects algal biomass and photosynthetic replenishment of oxygen. Dissolved oxygen in water firstly affects oxidation-reduction reaction involving iron, manganese, copper and compounds containing nitrogen and sulphur. Studies of oxygen concentration in water may give valuable indications concerning the cause of various problems during distribution. To achieve this, the concentration of biologically oxidisable materials, including ammonia, should be as low as possible. This does not preclude the use of ammonia for chloromination purposes. These are guidelines of WHO for drinking water quality. The maximum and minimum values were also recorded by workers Hannan (1979), Rheinheimer (1988) Parvateesam et al. (1991), Joshi et al. (1995). During the present study the amount of dissolved oxygen recorded was low in summer. Jain and Thakur (1991) in Pathari lake observed that depletion of dissolved oxygen results in death of fishes.

Ganapati (1962) reported increased photosynthetic activity is the main source for enhancing the oxygen contents. Kajihara (1968) noticed that the contents of Dissolved Oxygen in shallow water were affected by the rise in number of phytoplankton and also by the exchange of oxygen between air and water. Schindler (1971) also observed an increase in photosynthetic activity causing greater production of oxygen during winter months in Canadian lakes. Similar observations with respect to dissolved oxygen and
phytoplankton were also recorded by Lehn (1975) Singhai et al. (1990), Subbamma et al. (1992), Kaushik and Sharma (1994) and Jayachandran et al (1995). Leukowicz (1974) noticed a decrease in oxygen content that led to poor growth of phytoplankton.

The dissolved oxygen in the surface water is more than that of bottom water. This is due to more photosynthetic activity occurring in surface water and dissolution of high wind action. This is also supported by Devaraj et al. (1988). Dissolved oxygen is normally an important quality parameter to be considered for extensive fish farming. Similar trends were also noted by Smart (1981).

The distribution of oxygen in water column is also considered to be a reliable parameter in assessing the trophic status and the magnitude of eutrophication in an aquatic ecosystem. (Edmondson 1960; Bazin and Saunders, 1971).
Table [14]: Monthly mean value of dissolved oxygen in ppm.

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Figure: Variation in dissolved oxygen with month.
X axis: month, Y axis: dissolved oxygen (ppm)
BIOCHEMICAL OXYGEN DEMAND (BOD)

Introduction

Biochemical oxygen demand is defined as the amount of oxygen required by the microorganism in stabilizing the biologically degradable or decomposable organic matter under aerobic conditions. The term decomposable may be interpreted as the organic matter, which can serve as food for the bacteria and energy is derived from its oxidation.

BOD mainly depends on the pH, presence of toxin, reduced organic matter and different types of microorganisms. The BOD test is widely used to determine the polluting strength of domestic and industrial waste in terms of oxygen that will require its discharge into natural water bodies in which aerobic condition exists. Biological degradation of organic matter under natural condition is brought about by a diverse group of organisms that carry on oxidation essentially to completion that is almost entirely to carbon dioxide and water.

The biochemical oxygen demand [BOD] is defined as a quantitative measure of the amount of oxygen used by a sample of polluted water during a five day incubation period at 20 °C. It is the amount of oxygen consumed by microorganisms in stabilizing the organic matter. BOD is an important parameter that indicates the magnitude of water pollution by the oxidisable organic matter and the oxygen used to oxidise inorganic material such as sulphides and ferrous ions (APHA, 1972). BOD is an important parameter that indicates the magnitude of water pollution by oxidizable organic matter.

The values of BOD in the water sample were estimated in the laboratory by Wrinkle's method.
Observations

In the present investigations the values of biochemical oxygen demand were observed maximum in the monsoon i.e. 9.6 to 10.5 ppm and minimum in winter i.e. 3.6 to 3.3 ppm at station ‘A’ and ‘B’ respectively in the year 1999 – 2000.

In the year 2000 –2001 the maximum values were 10.4 to 10.7 ppm and minimum 2.7 to 3.1 ppm at station ‘A’ and ‘B’ respectively in the winter season. The BOD values were found high in the monsoon and low in the winter, similar observations were made by Qumerunnisa (1985). Number of workers have reported BOD test for various water samples (Kudesia et al. 1986, Jerald 1994, Loganathan et al. 1985, Sengar et. al. 1986 and Lahiri et al. 1993). The values of BOD are given in the table [15] and fig. [5].

Discussion

BOD can be defined as the quantity of DO in mg /l required under test condition for complete oxidation [by aerobic bacteria] of the organic matter in the representative sample. In unpolluted water BOD is lower while it is higher in the case of polluted water. (Hynes, 1960, Willoughby 1976) BOD affects benthic diversity (Bilgrami and Siddiqui 1983).

BOD does not work independently but depends upon many factors. In winter season the BOD values are recorded low, this may due to lesser quantity of solids, dissolved solids and microbial population. The same findings were reported by Wisniewski and Bledzki (1989). The higher values of BOD were recorded at monsoon in both the year. This may be due to presence of high amount of organic matter in contact with surface runoff water during heavy rains. The same opinion was recorded by Singhai et al. (1990) in National lake. After monsoon the turbulence and wind action cause the suspended solids settle on the bottom and water becomes clear, the phytoplankton population present in the winter temperature retards the rate of reproduction of organisms. Consequently the winter season shows the lowest BOD.
Table [15]: Monthly mean value of BOD in ppm

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Figure 1: Variation in BOD with month.
X axis: month, Y axis: BOD (ppm)
CHEMICAL OXYGEN DEMAND [COD]

Introduction

Chemical oxygen demand [COD] is the oxygen required by the organic substances in water system to oxidise them by a strong oxidising agent. The COD test allows measurement of waste in terms of the total quantity of oxygen required for oxidation to carbondioxide and water. It is based on the fact that all the organic compounds, with a few exceptions, can be oxidised by the action of strong oxidizing agents organic under acidic conditions. During the determination of COD, organic matter is converted to carbondioxide and water, regardless of the biological assimilability of the substances. COD values are greater than BOD values and may be much greater when significant amounts of biological resistant organic matter are present. The COD test is useful to find out toxic condition and presence of biological resistant substances.

COD is the measure of oxygen required in oxidizing organic compounds by involving a chemical oxidant such as potassium chromate or potassium permanganate. It has an advantage over biological oxygen demand determination in that the result can be obtained in about 5 hours as compared to 5 days required for BOD test. Further, the test is relatively easy, gives reproducible results and is not by interference of the BOD test. Number of the workers have reported the values of COD (Joseph, 1994), Khatavkar et. al. (1992), Srivastava (1993), have reported that the values of COD are more than tolerance limits. Singh et al. (1988) reported that COD values were found within the acceptable range for biological productivity through the river water rendered unsuitable for domestic uses during later summer and monsoon seasons. Sinha et. al. (1989) reported that COD is more than tolerance limit. The temperature and the concentration of Ca, Mg, Cl, and hardness were less than tolerance limits indicating that the river water at remote and quiet places like Kalkanakair are not safe for either drinking or bathing.
The values of chemical oxygen demands were estimated by dichromate digestion method.

**Observations**

In the present investigation the values of chemical oxygen demand were recorded. The maximum values of COD were recorded in monsoon i.e. 75.7 ppm and 42.6 ppm at station ‘A’ and ‘B’ respectively in the month August and minimum values were 52.3 ppm and 10.1 ppm in the winter at station ‘A’ and ‘B’ respectively in the month of November in the year 1999–2000.

In the year 2000–2001, the maximum COD values were recorded in monsoon i.e. 73.4 ppm and 39.1 ppm and minimum in the winter i.e. 51.6 ppm and 10.4 ppm at station ‘A’ and ‘B’ respectively. The values of COD are given in the Table [16] and Fig. [16].

**Discussion**

COD test is useful in pinpointing toxic condition and presence of biological resistant substances. Chemically polluted samples in which microbacterial degradation is not possible due to presence of toxicants/chemicals, BOD can not be determined accurately. In such waters, degree of organic pollution can be assessed by chemical oxygen demand [COD]. It is measure of oxygen required by oxidising organic compounds by involving a chemical oxidant such as potassium chromate or permanganate. In the present study COD ranged between 52.3 to 75.7 ppm at station ‘A’ and 10.1 to 42.6 ppm at station ‘B’ respectively in the year 1999 - 2000.

In the year 2000 – 2001, the values of COD ranged from 51.6 to 73.4 and 10.4 to 39.1 ppm at station ‘A’ and ‘B’ respectively. Slightly fluctuations were noticed in these two years. The COD values were slightly increasing from pre – monsoon and they were highest in monsoon during investigation. The low level of COD was recorded in the winter. It seems that temperature influence on COD not only temperature but some of the fatty acids, chlorides nitrates and iron are the main interfering radicals which influence
the COD value, similar trends were reported by Kudesia et. al. (1986), Qumerunnisa (1985). The BOD and COD were more during monsoon than winter and summer. The similar trends were observed by Kothari et. al. (1981), Suresh et. al.(1989) stated the highest value at down stream Varanasi and lower at down stream Ballia. Deepak et. al. (1993) also reported COD value by industrial effluents in New Bombay water pollution. Higher values of COD indicate that higher microbial activities and presence of oxidizable organic matter. Khulbe and Durgapal (1993) have also reported similar findings. The recommended COD values of water for drinking and domestic purposes should not exceed more than 10 ppm as per guidelines of [WHO] world health organization. During the present investigation low values of COD for drinking purposes were recorded from October to April at station ‘B’ in both the years, but station ‘A’ the values of COD were recorded beyond the permissible level in both the years. It may be concluded that due to excess amount of rain, organic matter might be dumped in the natural waters. High COD shows the presence of a huge amount of accumulated organic matter and its incomplete oxidation as observed by Klein (1973).
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Figure 14: Variation in COD with month.
X axis: month, Y axis: COD (ppm)