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Effectiveness of Aeration Units in Improving Water Quality of Lower Lake, Bhopal, India

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Abstract : To study the effectiveness of aeration units, we have selected the Lower Lake, which is situated in Bhopal, the capital city of Madhya Pradesh, India. The Lower lake (Lat 23^0 16' 00" N and Long 77^0 25' 00" E) is an artificial lake. It is situated towards the east end of the Upper lake and is an integral part of the latter. It has a small catchment area 9.60 Sq.Km. and water spread of 1.29 Sq.Km. The extent of water pollution has been found to minimize by aeration units. The physico- chemical parameters like pH, dissolved oxygen, Biochemical Oxygen Demand (BOD) Chemical Oxygen Demand (COD) nitrate, phosphate and bacteriological status have studied to ascertain the effectiveness of aeration unit. The floating fountain cum ozonizer installed at Neelam park station is more effective unit as it increases Dissolved Oxygen Concentration, reduces Biochemical Oxygen Demand (BOD) and Chemical oxygen demand and the ozonizer installed at Khatlapura is also effective to increase Dissolved Oxygen concentration in the hypolimnion and control total coliform (MPN). Therefore, the present study indicates the aeration units especially dual systems are very effective in improving the water quality of a degraded water body.

Keywords : Aeration, lake, Ozonizer, physico-chemical characteristics.

Introduction

Water supports life on earth and around which the entire fabric of life is woven. The requirement of water in all lives, from micro-organism to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization (Singh *et al.,* 2002).

Generally speaking, water pollution is a state of deviation from pure condition, whereby its normal functioning and properties are affected. Aggravated environmental problems often reflect the misuse or misunderstanding of technology (Petak, 1980). To study the effectiveness of aeration units, we have selected the Lower Lake, which is situated in Bhopal, the capital city of Madhya Pradesh, India. The Lower lake (Lat 23^0 16' 00" N and Long 77^0 25' 00" E) is an artificial lake. It is situated towards the east end of the Upper lake and is an integral part of the latter. It has a small catchment area 9.60 Sq.Km. and water spread of 1.29 Sq.Km.

The pollution of this lake is a matter of great concern, since it has reached an alarming level due to inflow of large volume

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sewage and solid wastes. The quality of water in Lower Lake has far more deteriorated than that in the Upper Lake (Pani and Mishra, 2000). The Lower Lake receives a large amount of raw sewage from its densely populated habitation. The water body is an urban eutrophic lake where the amount of nutrient is very high and O_2 depletion is very prominent (Varughese *et al.*, 2004). The untreated wastewater contains effluent rich in phosphate, caustic soda and detergent, etc. Organic enrichment of the lake through floral offerings, idol immersion and decomposition of aquatic weeds are also the significant causes of its eutrophication.

Two stations of Lower lake had been chosen as sampling stations, *i.e.*, Neelam Park station possesses a floating fountain cum ozonizer and Khatlapura station possesses ozonizer type of aeration unit. The artificial aeration cum ozonizer unit is a dual system of ozone mixed air pumping and founting of the lake and the ozonizer is a simple device to convert the atmospheric oxygen into ozone and pumps to the deeper layer of the lake water. The aeration units had been installed under Bhoj Wetland Project. Artificial aeration unit is an effective supporting device for supplement of oxygen (Rusan, 1971). These devices apart from beautification are effective in improvement of water quality of the lake.

Materials and Methods :

Lower lake is subjected to enormous anthropogenic stress receive heavy inputs of domestic waste and sewage. The lake water is used for fisheries and various recreational activities.

Sampling :

Two different sampling stations were selected having different types of aeration units *i.e.* station 1 is Neelam park (L_1) possess floating fountain cum ozonizer and station 2 is Khatlapura (L_2) possess ozonizer. The water samples were collected from both the site of the aeration units at different intervals and sampling was done six hourly i.e. pre, during and post functioning of the unit. The water samples were collected from the surface and bottom layers by holding the stopper, sterile bottle near to its base in the hand and plugging it (necked downward below the surface) and transporting to the laboratory in an ice box to avoid unpredictable changes in physico-chemical and bacteriological characteristics.

Physico-chemical and bacteriological characteristics :

The samples were subjected to physico-chemical and bacteriological analysis following the procedure prescribed by Apha (1995) and NEERI (1991). The parameter namely pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nitrate, phosphate and total coliform (MPN) were analyzed at regular intervals.

- The pH of water body was determined using digital pH meter.
- The Dissolved Oxygen of water sample was fixed instantly on the spot and analyzed immediately as per the Wrinkler's method with Azide modification.
- BOD was determined as per standard method (NEERI, 1991).
- COD was determined by potassium dichromate open reflex method (NEERI, 1991).

- Nitrate and Phosphate content was determined as per standard method (APHA, 1995).
- Total coliform (M.P.N.) was determined as per standard method (APHA, 1995).

Results and Discussion :

pH: A range of 8.5-9.2 , 7.6-7.8 and 7.8-8.2, 7.1-7.6 pH were obtained in surface and bottom layers of the station L_1 and station L_2 as shown in Figure 1.The value of pH 8.5,7.8 (surface) and 7.6, 7.1 (bottom) was observed during the functioning period of the aeration unit, which is within potable water limits. The USPH (United States Public Health Standards) limits of pH for drinking water is 6.0-8.5 (De, 2002). The pH controls the chemical state of many nutrients including dissolved oxygen, phosphate, nitrate, etc. (Goldmann and Horne, 1983) It regulates most of the biological processes and Biochemical reactions.

Dissolved Oxygen (DO): The DO in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity-taking place in a water body and determines the biological changes, which are brought about by the aerobic or anaerobic organisms. The DO concentration of water body in the range of 11.6-16.0, 3.6-10.4 and 9.6-12.6, 2.6-5.6 mg/l were obtained in surface and bottom layers of the station L_1 and station

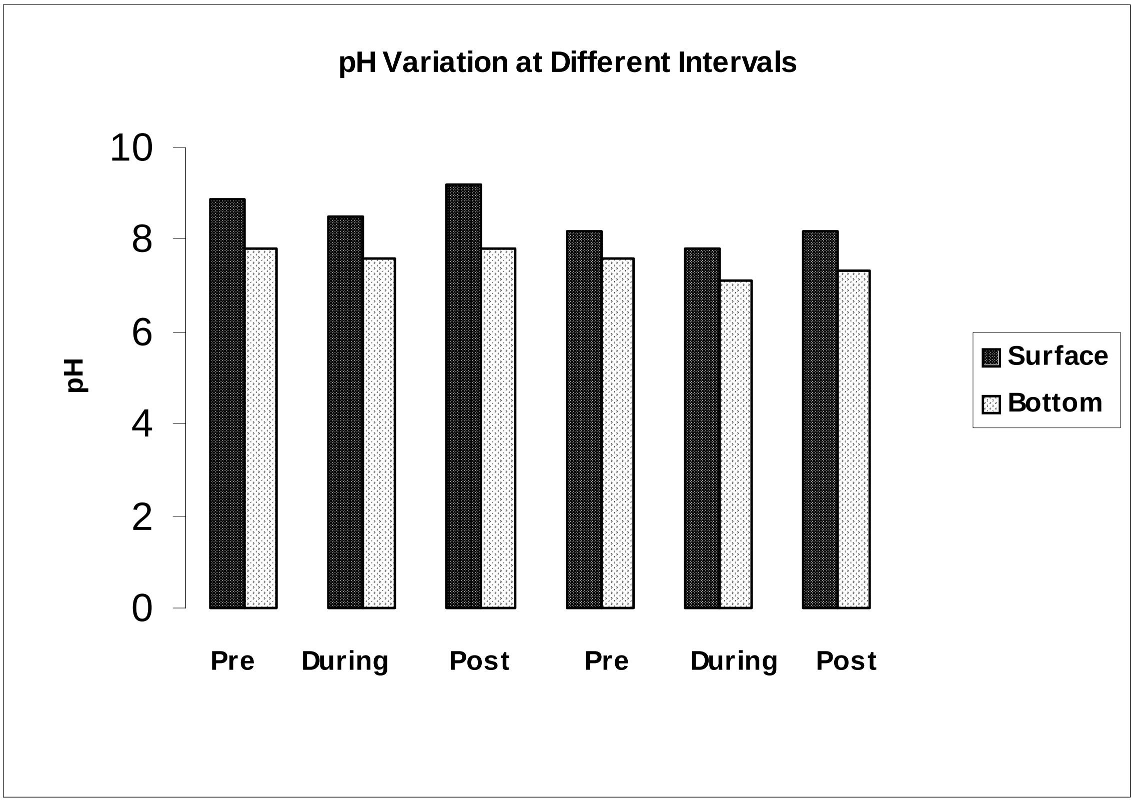

Fig. 1 : Graph showing Variation in pH of two stations at different functioning interval of aeration unit.

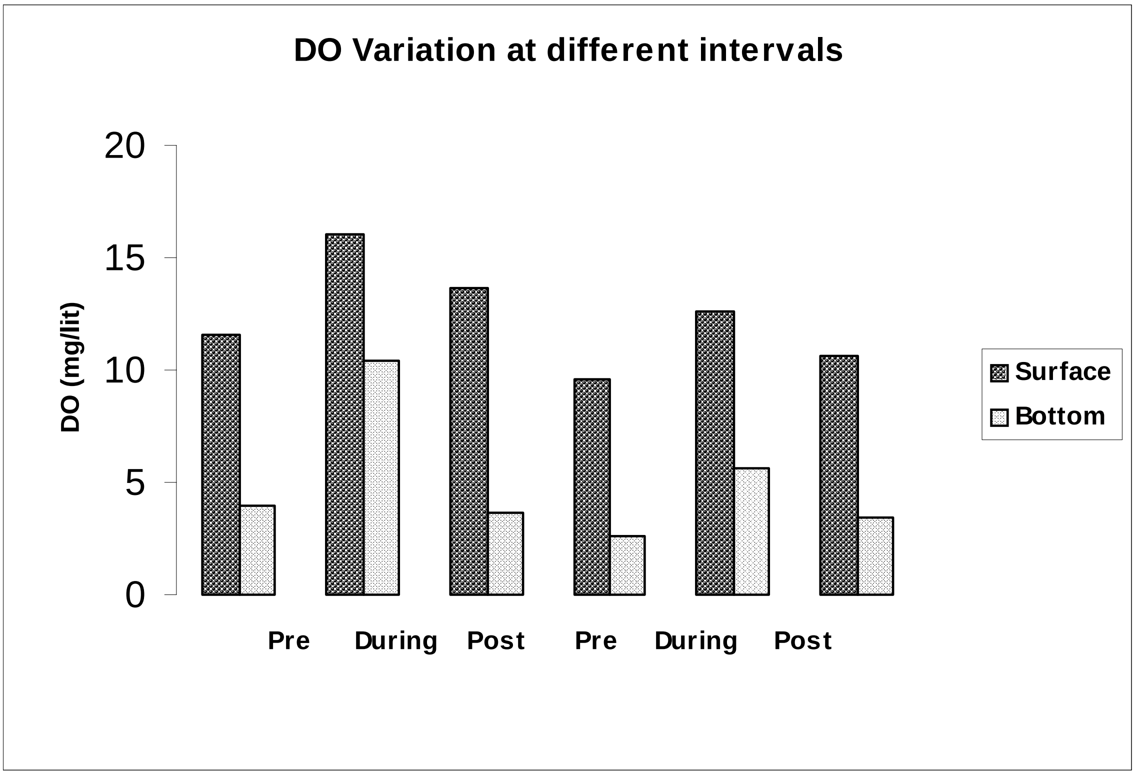

Fig. 2 : Graph showing Variation in DO concentration of two stations at different functioning interval of aeration unit.

L_2**.** The maximum increase in the DO was recorded at the surface and bottom layers while the aeration units was operational as shown in Figure 2. The value of DO was found low, mostly at the bottom layer on account of lower production of oxygen and higher consumption of DO by microbial activities (Tamot and Batnagar, 1988).

Biochemical Oxygen Demand (BOD): A range of 10-12, 16-28 and 4.4-7.2, 10.4-14.4 mg/l were obtained in surface and bottom layers of the station L_1 and station L_2. The minimum value of BOD was recorded at the surface and bottom layer during the functioning period of the aeration units as shown in Figure 3. The BOD indicates the presence of microbial activities and dead organic matter on which microbes can feed. The BOD is directly linked with decomposition of dead organic matter present in the lake and hence the higher values of BOD can be directly co-related with pollution status of the lake (WQM, 1999). An inverse relation was found between the dissolved oxygen concentration and biological oxygen demand values (Coscun and Gurol, 1987).

Chemical Oxygen Demand (COD): The COD is more realistic parameter, which indicates the pollution status of water body as it is related with the allocthonous matter present in the lake (WQM, 1999). The COD concentration of water body in the range of 60-80, 64-104 and 86-92,80-138 mg/l were

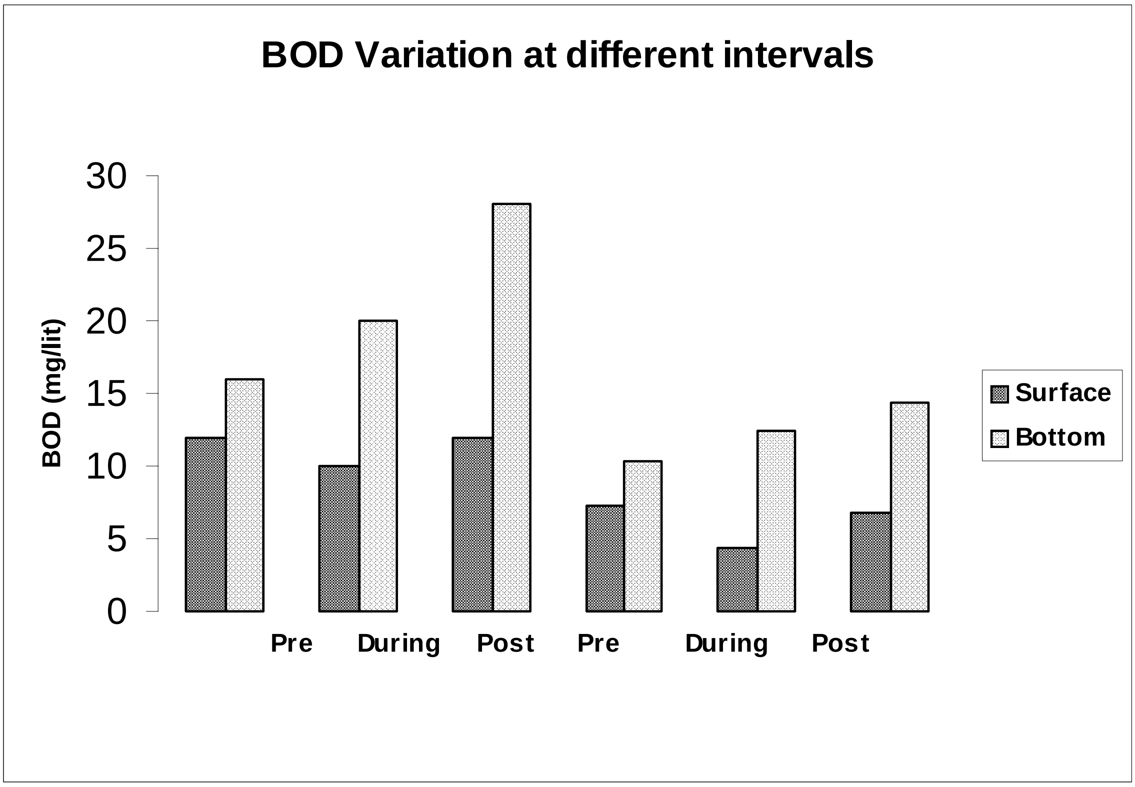

Fig. 3 : Graph showing Variation in BOD concentration of two stations at different functioning interval of aeration unit.

obtained in surface and bottom layers of station L_1 and station L_2, respectively. A significant fall in the COD was observed during the operation of the aeration systems as shown in figure 4. The increase COD concentration was found in bottom water where organic matter has been ingreater concentration. (Prasad and Qayyum, 1976).

Nitrate: The nitrate content of the water was found in the range of 0.455 - 1.197, 0.928 - 1.612 and 0.92-1.14, 1.18-1.61 mg/l at the surface and bottom layers of the station L_1 and station L_2. It was within the standard limit. The APHA standard drinking water quality guideline for nitrate is 40 mg/l The lowest concentration of nitrate in water was recorded during functioning intervals of aeration unit as shown in Figure 5. Lesser value in the surface water is due the fact that nitrate is readily soluble in water.

Phosphate: The Phosphate content of the water was found in the range of 5.198-5.515, 5.295-6.183 and 0.73-0.84, 0.84-0.94 mg/l at the surface and bottom layers of the station L_1 and station L_2, respectively. For phosphate, USEPA (United States Environment Protection Agency), 1985), suggested 0.08 ppm for lakes as critical level for eutrophication of water bodies to occur. The amount of phosphate in both the stations of Lower lake water comes out to be much higher than the acceptable limits. While, comparing the three intervals of time

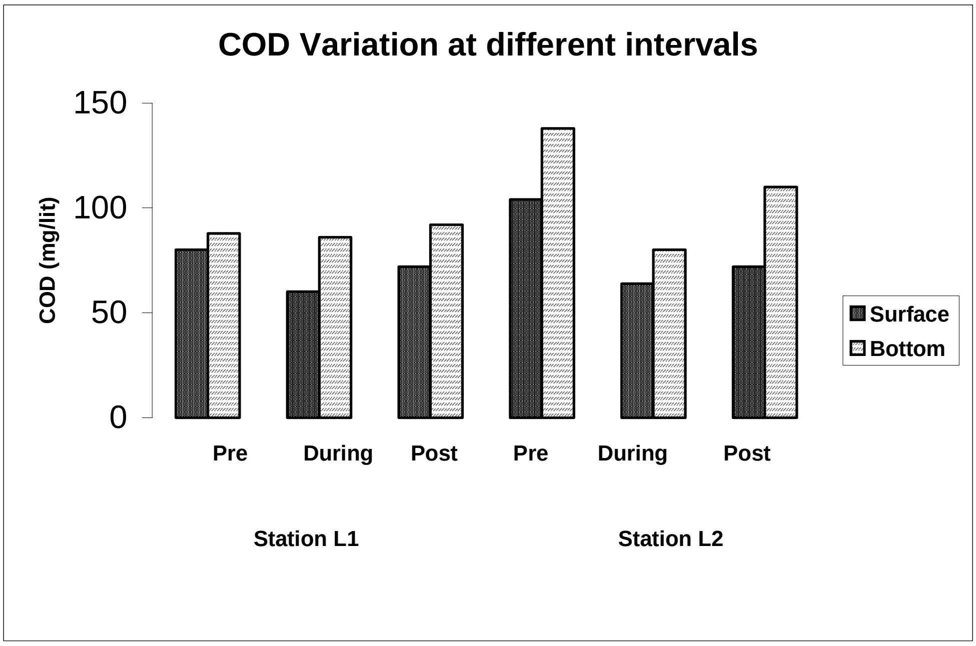

Fig. 4 : Graph showing Variation in COD concentration of two stations at different functioning interval of aeration unit.

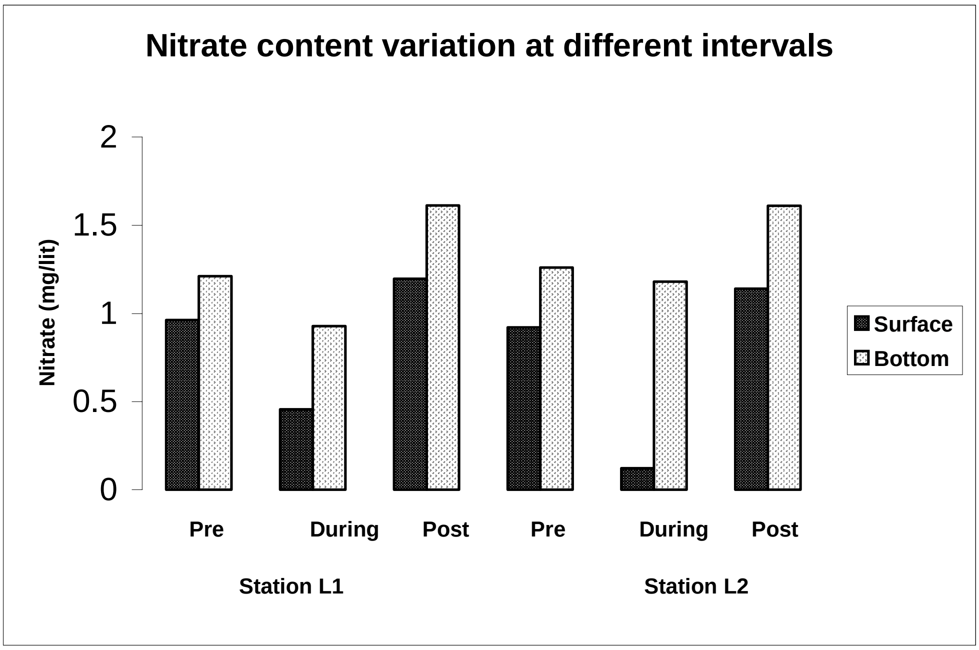

Fig. 5 : Graph showing Variation in Nitrate content of two stations at different functioning interval of aeration unit.

a reduction was found in the phosphate concentration during functioning intervals as shown in Figure 6. The total phosphate level gradually increases with the increasing depth (Mehrotra, 1988). The total phosphate values were always high at the bottom as compared to the surface water in the present study. This was due to decomposition at bottom of the lake; there is a high release of phosphorus at the bottom.

Total Coliform: The total coliform (MPN) of the water was found in the range of 1800- 3000 per 100 ml at the surface and 1800-3500 per 100 ml at the bottom layer at station L_1 and a range of 1300-1700 per 100 ml at the surface and 1400 to 2400 per 100 ml at the bottom layer at station L_2. While comparing the three intervals of time the maximum decrease in the count of the total coliform was observed when the aeration systems were operational as shown in Figure 7. The minimum value of MPN per 100 ml was recorded at station L_2 because of ozonization of hypolimnion and control of microbes.

Conclusion :

The artificial aeration unit contributes to the improvement of water quality. The floating fountain cum ozonizer installed at Neelam park station is more effective unit as it increases Dissolved Oxygen Concentration, reduces Biochemical Oxygen Demand (BOD) and Chemical oxygen demand and the ozonizer installed at

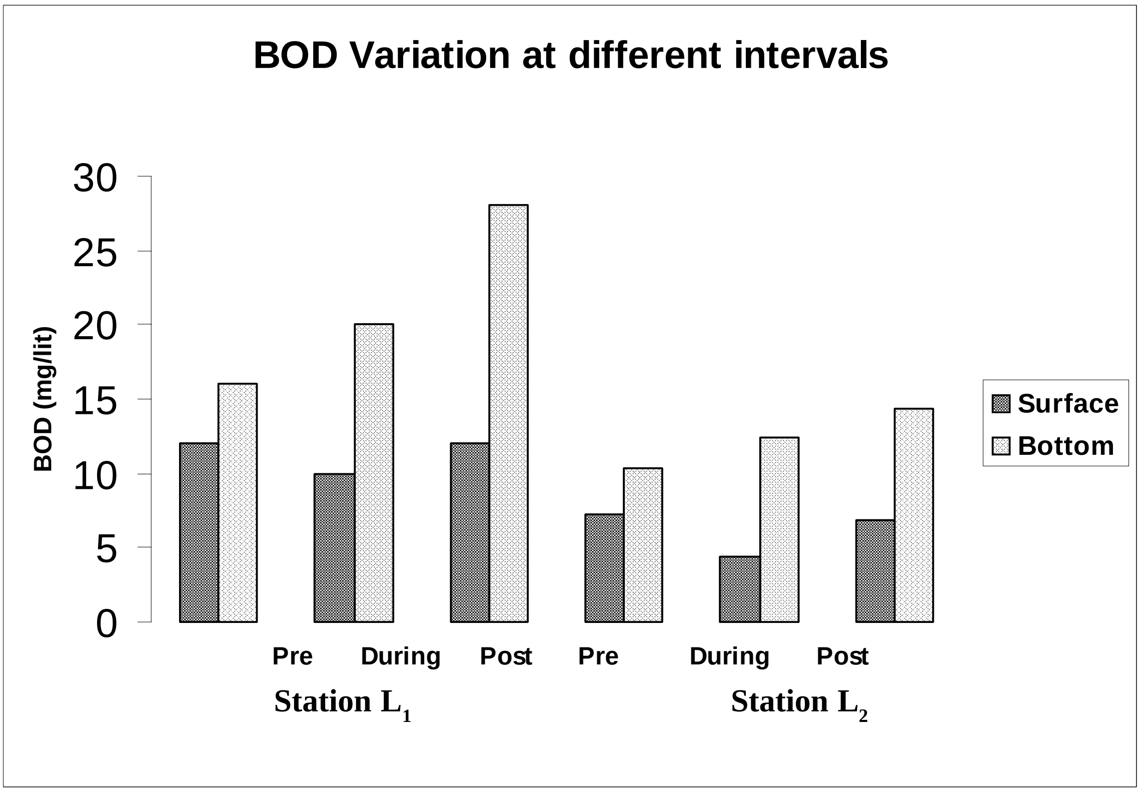

Fig. 6 : Graph showing Variation in Phosphate content of two stations at different functioning interval of aeration unit.

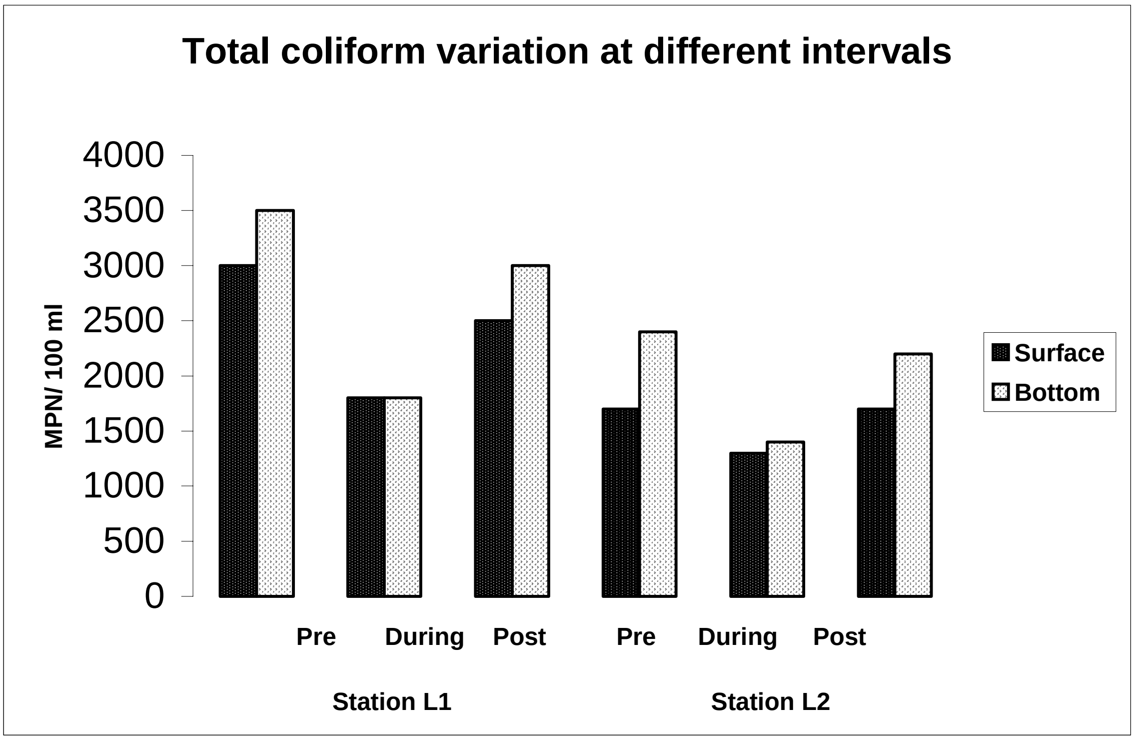

Fig. 7 : Graph showing Variation in Total coliform count of two stations at different functioning interval of aeration unit.

Khatlapura is also effective to increase Dissolved Oxygen concentration in the hypolimnion and control total coliform (MPN). Therefore, the present study indicates the aeration units especially dual systems are very effective in improving the water quality of a degraded water body.

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