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The Effects of Aeration Units on Water Quality in Upper Lake, Bhopal, India

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The freshwater bodies around the world are becoming polluted due to sewage, agricultural effluent, domestic and industrial waste. The water body selected for this study is Upper Lake of Bhopal, the state capital of Madhya Pradesh, India. The upper lake is one of the important sources of potable water supply for the Bhopal city. The lake receives a large amount of domestic wastes, sewage, agricultural and industrial effluents, hence it is grossly polluted. It has a floating fountain type of aeration unit, which is very useful in improving the lake's water quality by aerating the water at varying depths. The authors examined physicochemical parameters like pH, dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand to ascertain the effectiveness of the aeration unit.

Introduction

Water resources in India have reached a point of crisis due to unplanned urbanization and industrialization (Singh, Pathak, & Singh, 2002). Urban water bodies receiving external pressure from human settlements adversely affect nearby aquatic ecosystems. Urbanization has direct negative impacts on water bodies (Khan, Bhatnagar, & Saxena, 1988). To study the effectiveness of artificial aeration units, the water body selected for the study is Upper Lake of Bhopal city. Upper Lake that possesses floating fountains has been chosen as sampling stations. The Upper Lake of Bhopal is a small man-made reservoir as per the definition and classification by Welch (1948). The quality of water in Lower Lake has deteriorated to a greater extent than that in the Upper Lake (Pani & Mishra, 2000). Organic enrichment of the lake through floral offerings, idol immersion, and decomposition of aquatic weeds are also the significant causes of its eutrophication.

The aeration units had been installed under Bhoj Wetland Project. An artificial

aeration unit is an effective supporting device for supplement of oxygen (Rusan, 1971). Floating fountains are mechanical devices to facilitate pumping of the lower level anoxic/low oxygenated water to expose them to the atmosphere. These devices, apart from beautification, are effective in improvement of water quality of the lake by oxygenating it through aeration.

Experimental Work

The study area selected was Upper Lake located in the Bhopal city, the state capital of Madhya Pradesh, India (latitude 23 0 12'-23 0 16'N and longitude 77 0 18'–77 0 23'E).

The Upper Lake has an area of 31 km 2 and a catchment area of 361 km 2. The Upper Lake has a partial urban component in its catchment on the eastern end while the remainder is rural. The topography of the lake indicates that the basin is natural, as northern and southern sides of the lake are hilly while the western end has flat contours and forms the agricultural land.

Sampling

Two different sampling stations with floating fountain aeration units were selected. Water samples were collected from both stations at different distances (i.e. 0m, 10m, 20m) and time intervals. Sampling was done six hours prior to the functioning of the units, then during the functioning, and finally six hours after the functioning of the units. The water samples were collected in sterile glass bottles such that their necks were below the water surface so as to avoid the inclusion of atmospheric oxygen. Sampling and physicochemical investigation was carried out according to standard methods (American Public Health Association, 1985).

> pH: T he pH of the samples was determined using digital pH meter.

> Dissolved oxygen: Dissolved oxygen was fixed instantly on the spot and analyzed immediately as per the Wrinkler's method with Azide modification (De, 2002).

> Biochemical oxygen demand (BOD) : BOD was determined as per standard method (De,2002).

> Chemical oxygen demand (COD): COD was determined by potassium dichromate open reflux method.

Results and Discussion

pH: pH ranged from 7.2-7.9 and 7.8-8.0 in the surface layer at stations 1 and 2 respectively (Table1). The USPH (United States Public Health Standards) limits of pH for drinking water are 6.0-8.5 (De, 2002, pp245-252). The values obtained were on the higher side of normal. Higher pH values of surface water were explained on the basis of increased photosynthetic activity of the algal bloom, the carbonates of calcium and magnesium are precipitated from bicarbonates and water becomes more alkaline. pH controls the chemical state of many nutrients including dissolved oxygen, phosphate, nitrate, etc. (Goldmann & Horne, 1983). It regulates most biological processes and biochemical reactions.

Dissolved Oxygen (DO): DO concentration of water body in the range of 6.0-12.8 and 6.0-9.6 ppm were obtained in surface layer of the station 1 and station 2. The maximum increase in the DO was recorded while the aeration units was operational as shown in Table 1.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 & Bhatnagar, 1988). DO is one of the most important parameters to study the quality of water. It is required for the metabolism of all aquatic organisms. It acts as an indicator of the magnitude of eutrophication. In natural water resources the concentration of dissolved oxygen depends upon the physical, chemical and biological activities prevailing in the water body.

Table 1. Variation in pH and DO concentration at two stations at different functioning intervals (Pre Aeration, During Aeration and Post Aeration).

Sampling Station	pH			DO(ppm)		
Station No.1	Pre	During	Post	Pre	During	Post
0 m Distance	7.9	7.8	7.9	6.4	8.0	8.2
10 m Distance	7.8	7.6	7.2	6.0	12.8	10.0
20 m Distance	7.8	7.9	8.0	6.8	12.4	9.8
Station No. 2	Pre	During	Post	Pre	During	Post
0 m Distance	7.8	8.0	8.0	6.4	8.4	6.4
10 m Distance	7.8	8.0	8.0	6.4	8.0	6.0
20 m Distance	8.0	7.9	7.9	6.4	9.6	6.4

Biochemical Oxygen Demand (BOD): A range of 2.8-16.0 and 7.2-28.2 ppm were obtained at stations 1 and 2 respectively (Table 2). The minimum value of BOD was recorded at the surface layer during the functioning period of the aeration units. BOD indicates the presence of microbial activities and dead organic matter on which microbes can feed. BOD is directly linked with decomposition of dead organic matter present in the lake and hence the

higher values of BOD can be directly related with pollution status of the lake (WQM, 1999). An inverse relationship was found between the dissolved oxygen concentration and biological oxygen demand values (Coscun, Yurteri, Mirat, & Gurolet, 1987).

Chemical Oxygen Demand (COD): COD indicates the pollution level of a water body as it is related to the organic matter present in the lake (WQM, 1999). COD concentrations in the range of 16-64 and 28-44 ppm were obtained in the surface layer of stations 1 and 2 respectively (Table 2). The increase in COD concentration was found in the bottom water where organic matter is more (Prasad & Qayyum, 1976).

Table 2. Variation in BOD and COD concentration at the two stations at different functioning intervals (Pre Aeration, During Aeration and Post Aeration).

Sampling Station	BOD (ppm)			COD (ppm)		
Station No. 1	Pre	During	Post	Pre	During	Post
0 m Distance	14.0	2.8	12.0	44.0	20.0	28.0
10 m Distance	12.0	11.2	4.0	56.0	16.0	20.0
20 m Distance	16.0	8.0	14.0	64.0	28.0	44.0
Station No.2	Pre	During	Post	Pre	During	Post
0 m Distance	16.0	7.6	16.0	38.0	26.0	32.0
10 m Distance	12.0	7.4	12.0	40.0	32.0	36.0
20 m Distance	12.0	7.2	28.2	44.0	28.0	36.0

Conclusion

The results indicate that after the aeration of lake water using floating fountains, the studied parameters showed marked differences. There was a noticeable increase in the DO content of lake water whereas the BOD and COD content decreased significantly. Thus the study clearly reveals that floating fountains installed at both stations of Upper Lake have been helpful in enriching the lake water with oxygen and thus are effective in improving the water quality significantly.

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