WATER QUALITY ASSESSMENT OF UPPER LAKE BHOPAL (M.P.) WITH SPECIAL REFERENCES TO AERATION SYSTEM

KalpanaKumari Thakur[1], Avinash Bajpai[2] and Shailbala Singh Baghel[1]
[1]Department of Chemistry, Sarojini Naidu Govt. P.G. College, Bhopal, (M. P.), INDIA
[2]Makhanlal Chaturvedi University, Bhopal, (M.P.), INDIA
E-mail: ktthakurkalpana99@gmail.com

Abstract: Fresh water is emerging as one of the most critical natural resource issues facing humanity. One of the greatest problems facing the planet is the management, conservation and equitable distribution of fresh water resources. These resources are continuously losing their glory due to over exploitation and mismanagement. The water body under study is Upper Lake of Bhopal, the state capital of Madhya Pradesh, which is the main source of potable water supply. The water quality of lake under stress due to rapidly changing environmental conditions and modern urbanization. The lake has a floating fountain type of aeration system which helps in improving water quality. The physico-chemical& microbiological parameters like DO, BOD, COD, nitrate & MPN were analysed quarterly from December 2012 to May 2013 using standard methods to assess the extent of degradation in water quality as well as effectiveness of aeration system in upgrading quality of water.
Keywords: Aeration, exploitation, conservation, floating fountain, degradation.

Introduction

Water is a key component in determining the quality of our lives. Today, people are concerned about the quality of the water they drink. Although water covers more than 70% of the Earth but only 1% of the Earth's water is available as a source of drinking. Yet, our society continues to contaminate this precious resource. Availability of clean drinking water is still a dream in most part of developing countries. The requirement of water in all forms of lives, from micro-organisms to man, is a serious problem today because many water resources have been reached to a point of crisis due to unplanned urbanization and industrialization (Singh et. al.,2002; Dixit and Tiwari, 2008) [1,2]. This shows that degraded water quality leads to water scarcity as it limits its availability for human consumption as well as for the ecosystem. Availability of clean drinking water is still need to address in most parts of developing countries (Biswas, 2000) [3]. Bhopal is also known as "Lake City" as it has eighteen water bodies. Out of eighteen water bodies only few are safe for drinking purpose after preliminary treatment. Bhopal's water supply depends on two water bodies i.e. Upper Lake and Kolar reservoir. Upper Lake is the main source of potable water supply and

has a floating fountain type of aeration system which is installed under Bhoj Wetland Project and sponsored by JBIC. It is geographical situated at Latitude $23^0 12'$- 23^0 $16'$N and Longitude 77^0 $18'$- 77^0 $23'$E. The upper Lake has a catchment area of 361 sq. km and water spread area of 31 sq. km. It is an urban water body and its water quality deteriorated due to pollution caused by human intervention. This resulted in tremendous pressure on these water bodies due to inflow of untreated sewage and other anthropogenic activities (Misra et. al., 2001) [4].

Aeration is the most important and indispensable operation system for the treatment of wastewater (Chen et. al., 2003; Boyle, 2002)[5,6]. Aeration systems transfer oxygen into a liquid media by either diffusing gas through a gas – liquid interface, or dissolving gas into solution using a semi- permeable membrane (Rosso and Stenstrom, 2006)[7]. An aeration system is effective in streams or reservoirs consists of one or more rotating discks provided with perforations at the periphery and supplied axially with air (Zieminski et. al., 1958)[8]. Floating fountains are mechanical devices to facilitate pumping of the lower level anoxic/lowoxygenated water of the lake to expose them to the atmosphere. These devices apart from beautification are effective in improvement of water quality of the lake (Verma et. al., 2006) [9]. Ponds without water circulation and without a supplementary aeration mechanism, show higher concentration of organic nitrogen, ammonia & nitrate (Avinimelech et. al., 1992; Tavares et. al., 1999) [10, 11]. The aeration systems improve the dissolved oxygen content by removing volatile gases present in water and wastewater (Rao and Kumar, 2007) [12].
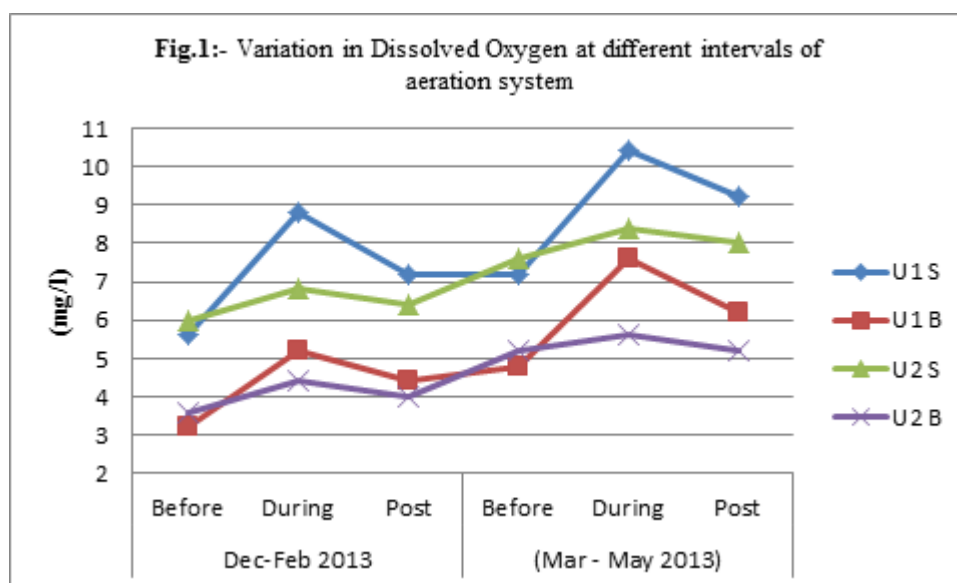
Materials & Methods

In order to assess the extent of degradation in water quality as well as effectiveness of aeration system in upgrading quality of water, the water samples were collected from two different sampling stations namely U1 (Boat Club) having floating fountain type of aeration system & U2 (Near Takia island) taken as reference having no aeration system. The sampling was done three hourly i.e. before, during and post operation of aeration system and water samples were collected quarterly from the surface and bottom layer of the lake. The physico-chemical & microbiological parameter namely DO, BOD, COD, nitrate& total coliform (MPN) were analysed at regular intervals according to the methods prescribed by APHA (1995) [13] and NEERI (1991) [14].
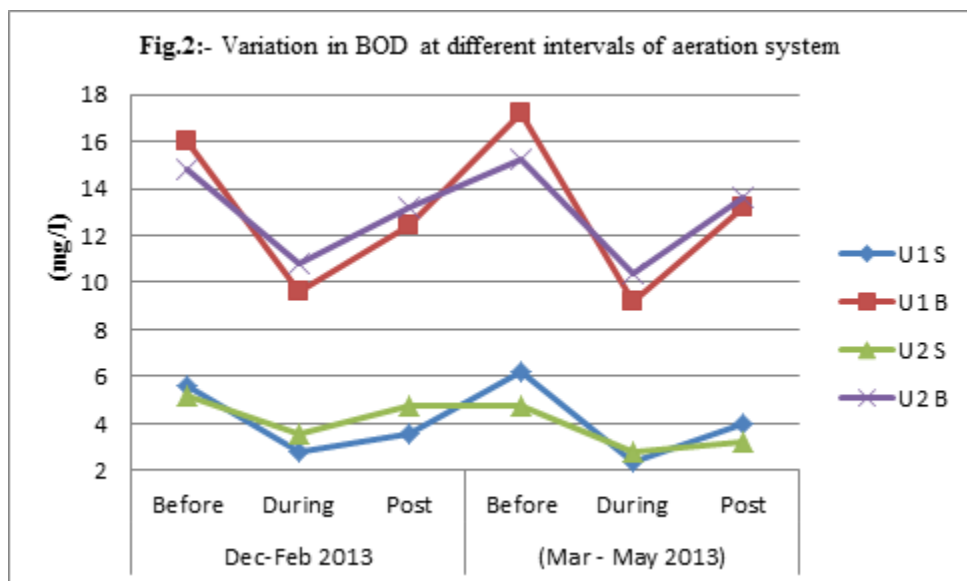
Results & Discussion

Dissolved Oxygen (DO)

DO concentration varied from 5.6-10.4 mg/l, 3.2-7.6 mg/l (U1) & 6.0-8.4 mg/l, 3.6-5.6 mg/l (U2) in surface & bottom layer at station 1 & station 2 of Upper Lake as shown in fig.1. The maximum value of DO was recorded in summer & the significant increase in DO value was observed during the functioning period of aeration system. After the installation of aeration systems the water quality of Upper Lake improves as DO increases whereas BOD, COD were decreased (Bajpai and Mishra,2006) [15]. (Choubey et. al.,2008) [16] also reported higher DO value in Upper Lake during summer.
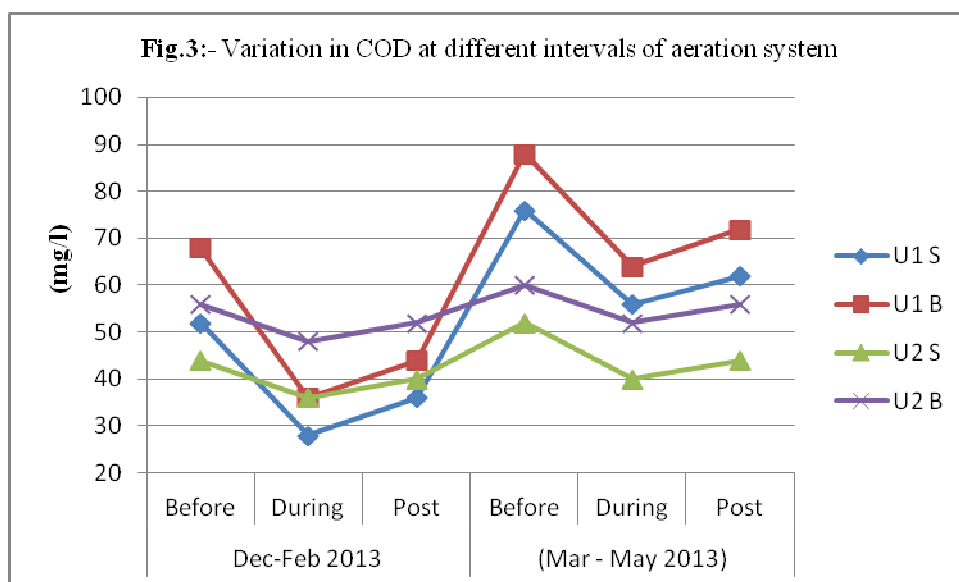

Fig.1:- Variation in Dissolved Oxygen at different intervals of aeration system

Biochemical Oxygen Demand (BOD)

BOD value ranges from 2.4-5.6 mg/l, 9.2-17.2 mg/l (U1) & 2.8-5.2 mg/l, 10.4-15.2 mg/l (U2) in surface & bottom layer at station 1 & station 2 of Upper Lake as shown in fig. 2. The maximum value was found in bottom layer as compared to surface layer. A significant fall in BOD value was observed during operational period of aeration system. Similar types of findings were observed by [Thakur et. al., (2014a); Thakur et. al., (2014d)] [17, 18].

Fig.2:- Variation in BOD at different intervals of aeration system
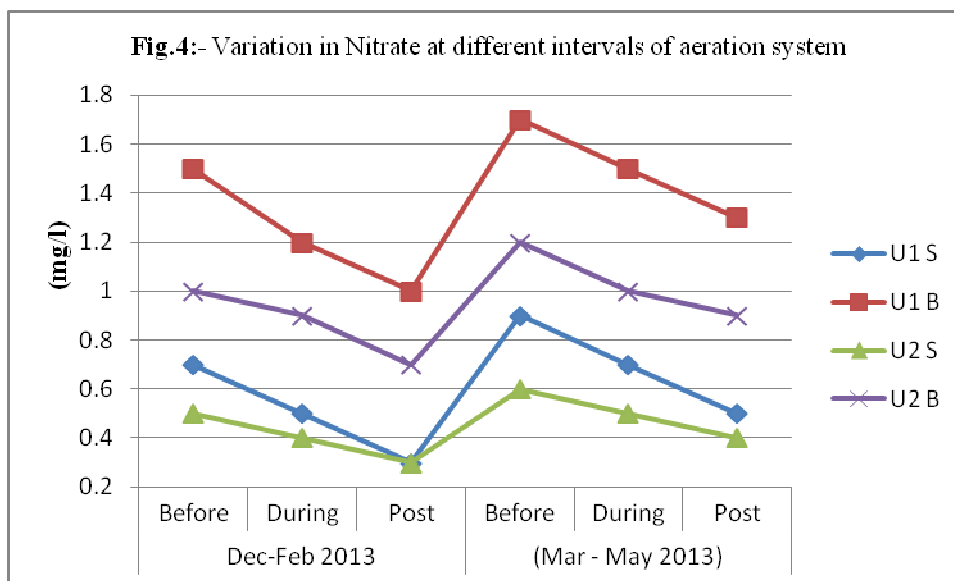
Chemical Oxygen Demand (COD)

COD value ranges from 28.0-76.0 mg/l, 36.0-88.0 mg/l (U1) & 36.0-52.0 mg/l, 48.0-60.0 mg/l (U2) in surface & bottom layer at station 1 & station 2 of Upper Lake as shown in fig. 3. The minimum value of COD was recorded in surface layer during operational period of aeration system. Verma et. al.,(2006)[9] in Upper Lake and Dixit et. al.,(2007)[19] were also reported significant fall in COD value during operational period of aeration system.

Fig.3:- Variation in COD at different intervals of aeration system
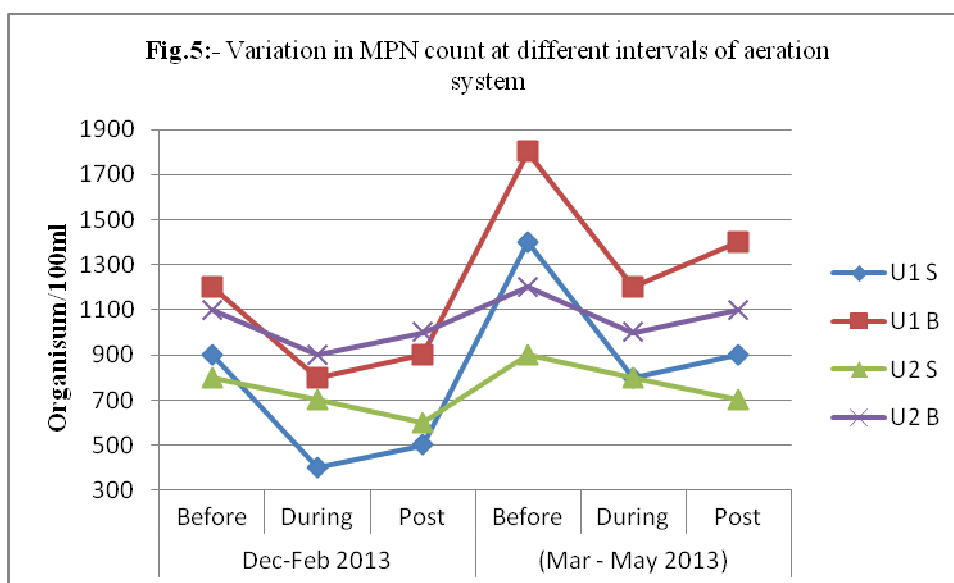
Nitrate

Nitrate concentration varied from 0.3-0.9 mg/l, 1.0-1.7 mg/l (U1) & 0.3-0.6 mg/l, 0.7-1.2 mg/l (U2) in surface & bottom layer at station 1 & station 2 of Upper Lake as shown in fig.4.

Decrease in nitrate concentration was observed through aeration. Above findings were confirmed by [Verma et. al.,(2009); Thakur et. al.,(2014d)][20,18].

Fig.4:- Variation in Nitrate at different intervals of aeration system

Total Coliform (MPN)

MPN count ranges from 400-1400/100 ml, 800-1800/100 ml (U1) &600-900/100 ml, 900-1200/100 ml (U2) in surface & bottom layer at station 1 & station 2 of Upper lake as shown in fig.5. The bacterial density has been found to decrease during the operational period of aeration system. Verma et. al., (2008) [21] and Verma et. al., (2009) [20] also reported the reduction in MPN count due to aeration.

Fig.5:- Variation in MPN count at different intervals of aeration system

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