



Study on Some Physico-Chemical Characteristics and Heavy Metal Contamination of Powai Lake, Mumbai (India)

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An objective of the present study to generate data from regular scientific study which will help to implement compatible policies and programme so as to gauge the extent of pollution of Powai lake ($19^{\circ} 8' N$ and $72^{\circ} 54' E$). The study was performed to understand the physico-chemical properties and heavy metal content in water of Powai lake, during month of March-April and August-September 2014. The three sampling stations were selected on the basis of their importance. The samples collected from three different sites were analysed for physico-chemical parameters included pH, temperature, electrical conductivity, total dissolved solid, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand. The study was also extended further to estimate level of toxic heavy metal viz., aluminium, arsenic, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead and zinc. The concentration of selected heavy metals were found by highly sensitive AAS-ICP- AES (atomic absorption spectroscopy, inductively coupled plasma, emission spectroscopy). The results indicate that there are some diverse contamination and pollution in Powai lake. Therefore, it is unsafe for domestic use hence needs a more attention for its sustainability factor.

Keywords: Powai lake, Physico-chemical parameters, Heavy metals.

INTRODUCTION

Lakes are very important part of urban ecosystem. Though relatively small in size, lakes perform significant environmental, social and economic functions. Lake water are sources of potable water, recharging ground water, acting as sponges to control flood and supporting bio-diversity¹. Lakes whether man made, natural, fresh water, or brackish play a very vital role in maintaining environmental sustainability particularly in urban environments. Despite knowing their environmental social and economic significance, city planner have wilfully neglected and destroyed these water bodies. In Mumbai lakes are varying degree of environmental degradation. The degradation is due to encroachment eutrophication (from domestic and industrial effluents) and silt. There has been quantum jump in population during the last century without corresponding expansion of civic facilities resulting in lakes and reservoir, especially the urban ones, becoming sink for contaminants. The main causes for the impaired conditions of the lake could be due to fixed point and non-point sources. The human settlement and public affluent sources are the chief factors for the degradation of the lakes, particularly urban lakes². In case of Powai lake front property has societal prestige, which cause

intense shoreline development in Powai area and thus adversely impact on the lake water quality. The water quality of urban lakes has deteriorated so much as to cause serious disturbance to the biodiversity of the lake. Bio-remedial measures alone as the case of Powai lake has unable to achieve lake equilibrium full. The health of lake and their biological diversity are directly related to health of almost every component of the ecosystem. Lakes are also subjected to various natural process taking place in the environment like the hydrological cycle with unprecedented development activities. Human being are responsible for choking several lakes to death³ of all the water quality issues facing lake everywhere, eutrophication is of great concern.

Study area: Powai lake (named after Farmaji Kavasji Powai Estate) is Mumbai's first artificial lake. It was created in 1891 by constructing dam between two hillocks across tributary of Mithi river.

Location: Plush hotels are located in the Powai valley, where a Powai village once existed. Indian Institute of Technology, Bombay (Mumbai) and The National Institute of Industrial Engineering (NITIE), some of the prime educational institutions in India are on the periphery of this lake⁴. Plush and expensive housing complexes are developed all around the lake.

Dimensions: When it was built, the lake had a water spread of about 2.1 Km² (520 acres) depth varied from about 3 meters (9.8 ft) (at the periphery) to 12 meters (39 ft) at its deepest.

EXPERIMENTAL

In present study three sampling stations were selected on the basis of their importance. The samples collected in month of March-April & August-September 2014 from three different sites were analyzed for physico-chemical parameters including pH, temperature, electrical conductivity, total dissolved solid, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand, selected heavy metals *viz.*, Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn also were analyzed⁵.

Methods of water sampling: Water samples for physico-chemical parameters were collected from a depth of 1 meter of water⁶. Before sampling 3 L polythene bottle were rinsed with 0.1 N chromic acid then washed twice with distilled water. The samples are collected up to the brim, without leaving any space so as to prevent the premature release of dissolved gases during the transit period⁷. The physico-chemical analysis was done according to APHA standard method for examination of water and waste water. For heavy metal analysis water samples were acidified with conc. HNO₃ to pH < 2. AAS-ICP-AES (atomic absorption spectroscopy-inductively coupled plasma-emission spectroscopy) were used for analysis of selected heavy metals⁸ (Table-1).

TABLE-1
TECHNIQUES FOR THE ANALYSIS OF
REQUIRED PARAMETERS

Parameters of water analysis	Methods
Temperature	Reverse thermometer
pH	pH-meter
Conductivity	Conductometric method
Dissolved oxygen	Winkler method
Chemical oxygen demand	Dichromate reflux
Biochemical oxygen demand	Azide modification
TDS	Argentometric
Selected heavy metals	AAS-ICP-AES

RESULTS AND DISCUSSION

The results of physico-chemical characteristics of Powai lake in the month of March-April and August-September are given in Tables 2 and 4, respectively.

Temperature: Temperature is important for its affects on chemical and biological activities in the organism attributing in aquatic media⁹. A rise in temperature of water leads to the speeding up of the chemical reaction in aquatic organism. It reduces the solubility of gases. It was found maximum temperature of water at S₃ in the month of August-September and minimum temperature at S₁ in the month of March-April.

pH: pH is an important factor that determines the suitability of water for various purposes including toxicity to animal and plant. In present study pH ranged from 6.90-8.50.

Electrical conductivity: Electrical conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions¹⁰, on their total concentration, mobility and on the temperature of measurement. In present study electrical conductivity varied from

TABLE-2
PHYSICO-CHEMICAL CHARACTERISTICS OF
POWAI LAKE IN THE MONTH OF MARCH-APRIL 2014

Parameters	S ₁	S ₂	S ₃
Temperature (°C)	28.0	29.5	28.5
pH	6.97	6.90	7.10
Electrical conductivity at 25 °C (µs/cm)	380	420	385
Total dissolved solid (mg/L)	287	293	260
Chemical oxygen demand (mg/L)	180.99	200.45	210.90
Dissolved oxygen (mg/L)	6.85	6.33	6.05
Biochemical oxygen demand (mg/L)	9.38	9.00	11.00

TABLE-3
HEAVY METAL CONCENTRATION OF
POWAI LAKE, MARCH-APRIL 2014

Sr. no	Metal (mg/L)	S ₁	S ₂	S ₃	Detection limit (mg/L)
1	Al	ND	ND	ND	0.010
2	As	ND	ND	ND	0.005
3	Cd	ND	ND	ND	0.003
4	Co	ND	ND	ND	0.010
5	Cr	ND	ND	ND	0.010
6	Cu	ND	ND	ND	0.010
7	Fe	1.32	1.25	1.40	-
8	Hg	ND	ND	ND	0.001
9	Mn	ND	ND	ND	0.010
10	Ni	ND	ND	ND	0.010
11	Pb	ND	ND	ND	0.005
12	Zn	ND	ND	ND	0.010

*ND = below detection limit

TABLE-4
PHYSICO-CHEMICAL CHARACTERISTICS OF POWAI
LAKE IN THE MONTH OF AUGUST-SEPTEMBER 2014

Parameters	S ₁	S ₂	S ₃
Temperature (°C)	30.0	31.0	31.0
PH	7.80	8.50	8.20
Electrical conductivity at 25 °C (µs/cm)	453	490	505
Total dissolved solid (mg/L)	320	343	310
Chemical oxygen demand (mg/L)	375	348.3	320.53
Dissolved oxygen (mg/L)	3.33	4.22	2.80
Biochemical oxygen demand (mg/L)	15.00	13.23	14.33

380-420 µs/cm in the month of March-April and 453-505 µs/cm in the month of August-September. High electrical conductivity indicates a large quantity of dissolved minerals, salts their by making it sour and unsuitable for drinking.

Total dissolved solid: Total dissolved solid is the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water. In present study total dissolved solid ranged from 260-343 mg/L¹¹. The concentration of total dissolved solid that is too high or too low may limit growth and lead to the death of aquatic organism.

Chemical oxygen demand: Chemical oxygen demand determines the organic load of a water body. This is widely used as a means of measuring pollution strength of domestic and industrial effluent. It allows measurement of total amount of oxygen required for oxidation to CO₂. In present study, chemical oxygen demand values ranges from 180.99-343 mg/L¹². It gives an idea of toxic conditions and the presence of biologically resistant organic compounds in lake water.

Dissolved oxygen: Dissolved oxygen is an important parameter in water quality assessment. It reflects the physical and biological processes prevailing in the water. Non-polluted surface water is normally saturated with dissolved oxygen. It deficiency directly affects the ecosystem of lake due to bioaccumulation and biomagnifications. The concentration of dissolved oxygen was found maximum 6.85 at S₁ in the month of March-April and minimum 2.80 at S₃ in the month of August-September.

Biochemical oxygen demand: Biochemical oxygen demand test is a bioassay method which involves measurement of quantities of oxygen consumed during biological oxidation of organic waste matter under controlled conditions. The chemical oxygen demand observations for the two season varied from 9.00-15.00 mg/L.

The results of selected heavy metals Al, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn given in Table-3 (March-April) and Table-5 (August-September) 2014.

TABLE-5
HEAVY METAL CONCENTRATION OF
POWAI LAKE, AUGUST-SEPTEMBER 2014

Sr. no	Metal (mg/L)	S ₁	S ₂	S ₃	Detection limit (mg/L)
1	Al	0.25	0.40	0.37	0.010
2	As	ND	ND	ND	0.005
3	Cd	ND	ND	ND	0.003
4	Co	ND	ND	ND	0.010
5	Cr	ND	ND	ND	0.010
6	Cu	ND	ND	ND	0.010
7	Fe	1.67	0.60	1.11	-
8	Hg	ND	ND	ND	0.001
9	Mn	0.21	0.26	0.33	0.010
10	Ni	ND	ND	ND	0.010
11	Pb	ND	ND	ND	0.005
12	Zn	ND	ND	ND	0.010

*ND = below detection limit

A heavy metal is any metal or metalloid of environmental concern. The term originated with reference to harmful effect of cadmium and lead all of which are denser than iron. It has since been applied to any other similar toxic metal or metalloid such as arsenic regardless of density. Occurrence of heavy metals in lake water indicates presence of natural or anthropogenic sources.

Aluminium use in industry such as food and beverages industries. It is use for the processing, packaging and preservation of the product. It is also use in the manufacturing of

kitchen utensils, which result in a more extensive contact between public and Al metal. In present investigation, Al level varied from 0.25-0.40 mg/L in the month of August-September. Concentration of Fe and Mn detected in these studies have close relation to residential area wastewater and corrosion of metal component originated from domestic activities. The maximum amount of Fe found at S₁ in the month of August-September. The concentration of Mn varied from 0.21-0.33 mg/L. There is no evidence of As, Cd, Co, Cr, Cu, Hg, Ni, Pb and Zn at all sampling stations in the month of March-April as well as August-September.

Conclusion

Water quality of Powai lake from three sampling stations was analyzed and studied. Analyses reveal that although the situation is not too worst, but it is alarming. It is possible that the metal salts introduced during the Ganapati immersion diluted during the rains and the amount were well below the detection limits of the instrument used (AAS-ICP-AES). The sewage contamination appears to be the main problem of the Powai lake¹³. Proper conservation, management plans and strategies have to be formulated and implemented for the restoration, conservation and management of Powai lake at government and public level¹⁴.

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