

Environmental impact assessment of industrial effluents on water quality of Betwa river discharged from Mandideep industrial area in Madhya Pradesh

VANDANA MAGARDE¹, S.A. IQBAL², SUBRATA PANI³ and NEELOFAR IQBAL²

¹Department of Chemistry, Rajeev Gandhi College, Bhopal - 462 039 (India).

²Department of Chemistry, Saifia College of Science & Education, Bhopal - 462 001(India).

³Lake Conservation Authority of Madhya Pradesh, Bhopal - 462 016 (India).

(Received: October 20, 2009; Accepted: December 17, 2009)

ABSTRACT

Present study was conducted at Betwa River, near Mandideep industrial area during 2007 to evaluate the impact of industrial effluents and domestic sewage on water quality of the river. Observation recorded during the year long study depicted that the river is polluted in certain areas as comparatively higher values of BOD and COD were recorded.

Key words: Industrial effluent, river water quality, pollution.

INTRODUCTION

Water is the basic and primary need of all vital life processes and it is now well established that the life first arose in aquatic environment. Ever since the pre-historic times man has been intimately associated with water and the evidences of past civilization that all historic human settlements were developed around inland freshwater resources have conclusively proved it. Even today it is the major consideration for all socio-economic cultural, industrial and technological developments. Besides drinking, water is also used for fish and aquaculture, irrigation hydropower generation etc. but these days water the elixir of life is becoming more and more unfit and dearer to mankind due to unwise use, neglect and mismanagement.

Today water resources have been the most exploited natural systems. Pollution of water bodies is increasing steadily due to rapid population growth, industrial proliferation, urbanization, increasing living standard and wide sphere human activities. The rapid urbanization has caused population explosion in urban centers and the generation of wastes both

liquid and solid has grown to commendable proportions. The pace of development of waste disposal schemes could not match the rapid rate of urbanization in these urban centers during the last few decades. As a result the waste not properly disposed reaches the water sources and therefore our water sources like river, lakes and reservoirs that are in close proximity of these urban centers are highly polluted.

Most of our cities developed without proper development plan. Consequently sewage systems of these cities are not well planned. Therefore wastes of homes and industries mixed with the catchment areas of water by the fault sewage system. The most significant example is river Betwa, which is considered to be lifeline of Madhya-Pradesh along with river Narmada, but unfortunately the river is highly polluted these days.

Due to increase in generation of wastewater in the urban centers in M.P. only few class-1 cities have partial sewage collection and proper disposal facilities. Consequently, more than 90% of domestic wastewater is discharged through

natural drainage, which pollutes the water bodies. It is estimated that more than 2/3rd of run-off available through rainfall is polluted by wastewater, rendering water unfit for various uses. Most of lakes, tanks, ponds etc. are in the state of eutrophication. Thus availability of the utilizable water has declined sharply. In spite of this major problem water treated for drinking purpose is being used for several non-drinking purposes such as flushing toilets, washing, watering of garden, vehicle cleaning. This is a waste of scarce resources and money required in treating large quantity of water up to the drinking water quality standards. The treatment cost of the conventional treatment systems is the major constrains in a poor country like that of ours.

Water quality of river Betwa was assessed to evaluate the degree of pollution caused due to input of industrial as well as domestic wastewater.

Study area

Betwa an important river in central part of state of Madhya Pradesh originates from village Jhiri of Raisen District and travels through the industrial belt of Mandideep and Bhojpur. After flowing through several cities of Madhya Pradesh it enters the neighboring state Uttar Pradesh at Hamirpur and finally joins in Yamuna River. However the quality of river water deteriorates at several places due to inflow of sewage, industrial effluents, agricultural residues etc. The present study deals with the assessment of the impact of pollution on the Betwa River water quality along the stretch of Mandideep Industrial Areas.

The major problem of Betwa River is the pollution of aquatic resources due to inflow of sewage from the Mandideep Town. The accrual of nutrients in the water body increases the luxuriant growth of the macrophytic vegetation. Most of the water-spread area of the riverbed is shallow so the rooted vegetation has almost covered the three forth part of the bed and rest of the area covered with algal blooms. Although water quality of the catchment is good enough for the fish culture but it is not suitable for the drinking purpose without proper treatment. The water depth at the shore is about half feet even in the deeper part of the river. The small portion of the river is only having 10 to 15 feet dept and rest of the water-spread area is

having only 1 to 2 feet depth. It is obvious that the water retaining capacity of the catchment has substantially reduced due to accumulation of silt.

The environmental problems of the River Betwa near Mandideep of the Raisen district are as follows:

1. Industrial effluents

The major problem of river Betwa is the pollution from the nearby industries. Innumerable industries are located on the bank of the river and some of the industries do not have well-established sewage treatment facilities therefore effluents from these industries are directly discharged in the river. This resulted in frequent depletion of oxygen concentration in the river. As a consequence the Biological Oxygen Demand and Chemical Oxygen Demand is usually very high.

2. Inflow of sewage

Another problem of the Betwa river is the inflow of sewage from the adjoining areas where number of new colonies are being developed without proper infrastructure like sewage network etc. As a result the sewage generated from these newly developed colonies are directly discharged in the river without proper treatment..

3. Siltation

Inflow of silt from the catchment due to intensive agricultural activities is another reason for reduction in the river bed level and deformation of the river bank.

MATERIAL AND METHODS

For present investigation a meticulous survey was conducted to identify the pollution prone zones of the river. Based on the survey, four sampling stations were chosen for the study. Monitoring of the river was carried out as per guidelines of Central Pollution Control Board, New Delhi.

Water samples were collected in different season i.e. Summer, Monsoon and winter during the year 2007 from different sampling sites at monthly interval from a varying depth of 30-45 cm. Sampling and analytical procedures were followed as per Standard Methods (APHA, 1995)

Parameters Analyzed

Following parameters were analysed during the course of study

1. pH

The hydrogen ion concentration is the indicator of acidity and alkalinity of any aqueous system. During present investigation pH was measured with the help of a pH meter.

2. Turbidity

Turbidity was determined with the help of Nephalo Metric Turbidity Tube. The results are expressed as Nephelometric Turbidity Unit (NTU).

3. Dissolved Oxygen

Dissolved oxygen was analyzed by Winkler's method with azide modification following the description given in APHA..

4. Free CO₂

Free CO₂ was determined by titrimetric method using standard alkali (0.02 N NaOH) solution as titrant.

5. Total Dissolved Solids

TDS was measured using the electronic TDS meter (ELE) and was reported as mg/l or parts per million (ppm).

6. Total Suspended Solids

TSS was measured by filtering a known amount of water through pre weighed filter paper and then weighing the filter paper after drying at 1050 C (APHA, 19th Ed. 1998). The difference in the weight of the filter paper after drying and initial weight of the filter paper represents the weight of the suspended solids present in the water sample.

7. Nitrate

Nitrate was determined spectrophotometrically using the phenol disulphonic acid method on UV-Vis spectrophotometer.

8. Nitrite

Nitrite was analyzed using sulfanilamide method on UV-VIS Spectrophotometer.

9. Orthophosphate

Orthophosphate was determined spectrophotometrically using the stannous chloride

method on UV-Vis spectrophotometer.

10. Total Phosphorus

Total phosphorus was determined after digestion of the sample by UV Vis-Spectrophotometer.

11. Biochemical Oxygen Demand

BOD was analyzed by subtracting the value of final concentration of DO (after 5 days of incubation at 20oC) from the initial concentration of DO. Dissolved oxygen was analyzed using Wrinklers method with azide modification.

12. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand was measured by Dichromate reflux method because it has advantages over other oxidants owing to its oxidizing power, its applicability to a wide variety of samples.

RESULTS

Variations in various parameters during the study period are depicted in Table 1.

Hydrogen ion concentrations in different months during 2007 ranged from 7.2 to 8.1 in station 1, 7.0-8.9 in station - 2 , 7.4 to 8.4 in station 3 and 7.3 to 8.2 in station-4. In general pH values indicate the alkaline nature of the river water. Agrawal¹, Kushwah⁵, Shastri¹⁰, Philipose⁷ related high pH with photosynthetic activity. The high rate of photosynthesis can be related to the higher concentration of the plant nutrients, which is an indicator of pollution in the aquatic systems (Bajpai *et al.*, 2001).

The value of turbidity ranged from 17.02 to 73.0 NTU at station -1 , 30.0 to 182 NTU at station -2, 28.0 to 162 at station-3 and 20.0 to 89.0 NTU at station-4. In general maximum values of turbidity were recorded during rainy season. The surface runoff along with silt and organic debris resulted in increasing the turbidity value during monsoon period.

Conductivity varied from 180 to 644 μ mhos /cm at station-1 , 341 to 1004 μ mhos /cm at station-2, 320 to 990 μ mhos /cm at station-3 and 300 to 760 μ mhos /cm at station -4 .

The TDS fluctuated from 132 to 522 mg/L in station-1, 280 to 840 at station-2, 260 to 690 mg/L in station-3 and 258 to 650 mg/L in station-4.

The BOD value during winter ranged from 1.2 to 4.8 mg/L station-1, 2.0 to 7.6 mg/L in station-2, 2.2 to 4.8 mg/L in station-3 and 2.0 to 4.6 mg/L in station-4.

Similarly the COD values fluctuated between 18.4 to 48.8 mg/L in station-1, 30 to 77.8 mg/L in station-2, 24.2 to 50.4 in station -3, 21.2 to 52 mg/L in station-4. Both the parameters viz. BOD and COD depict the pollution of the water source due to pollutants of organic origin. The water level of the river recedes during the summer season thereby decreasing the volume of water and increasing the concentration of organic matter and thus the concentrations of BOD and COD.

DISCUSSION

The major sources of water pollution can be classified as municipal, industrial, and agricultural. Municipal water pollution consists of wastewater from homes and commercial establishments. For many years, the main goal of treating municipal wastewater was simply to reduce its content of suspended solids, oxygen-demanding materials, dissolved inorganic compounds, and harmful bacteria. In recent years, however, more stress has been placed on improving means of disposal of the solid residues from the municipal treatment processes. The basic methods of treating municipal wastewater fall into three stages: primary treatment, including grit removal, screening, grinding, and sedimentation; secondary treatment, which entails oxidation of dissolved organic matter by means of using biologically active sludge, which is then filtered off; and tertiary treatment, in which advanced biological methods of nitrogen removal and chemical and physical methods such as granular filtration and activated carbon absorption are employed. The handling and disposal of solid residues can account for 25 to 50 percent of the capital and operational costs of a treatment plant. The characteristics of industrial wastewaters can differ considerably both within and among industries.

The impact of industrial discharges

depends not only on their collective characteristics, such as biochemical oxygen demand and the amount of suspended solids, but also on their content of specific inorganic and organic substances. Three options are available in controlling industrial wastewater. Control can take place at the point of generation in the plant; wastewater can be pretreated for discharge to municipal treatment sources; or wastewater can be treated completely at the plant and either reused or discharged directly into receiving waters.

Sewage is defined as water supply of the used water of community. It contains dilute water-borne wastes from residence, business houses, and industries. In other words Sewage is domestic wastewater.

It consists of

1. Domestic water-borne wastes including human excrement and wash-water everything that goes down the drains of a home and city and into its sewerage system.
2. Industrial water-borne wastes such as acids, oil, grease, and animal and vegetable matter discharged by factories.
3. Ground, surface, and atmospheric waters that enter the sewerage system.

The chemical composition of sewage varies from day-to-day or even from hour. It also varies considerably between different cities, because they produce the wastes of different characters. Sewage water contains inorganic waste, which creates a problem of disposal, but apart from inorganic waste, undesirable organic matters, which are offensive and dangerous, are also present. Inorganic compounds of sewage water support the growth of harmful bacteria and other microorganisms, which sometimes lead to the epidemics among the human beings. Health standards are dependent upon efficient waste disposal. It has been observed that numbers of the serious diseases are transmitted through sewage e.g. gastrointestinal, typhoid fever, paratyphoid fever, cholera, and dysentery certain nematode infection, etc.

The sewage of a city is collected through a sewerage system, which carries the used water to its ultimate point of treatment and disposal. As

civilization progressed, the privy and such bathroom facilities as ingenuity could manage made living conditions tolerable. The methods used to treat sewage before it is discharged into rivers, lakes or the ocean or other water bodies are not so expensive. The procedures are considered to be effective for the purpose of rendering the waste moderately safe in far as its bacterial content is concerned. The virus load and toxic chemical content of sewage discharges have not been as thoroughly evaluated. There are various methods, which are used to treat sewage water. The suitability of the method is mainly dependent on the area to be served and by the density of population. Chemical or biological processes to remove organic matter may treat the sewage water. The four sewage treatment plants are based on facultative and anaerobic oxidation of wastewater using natural process. These sewage treatment plants have been designed keeping in view the less investment and minimum energy requirement for treatment process. The sewer pipes carry domestic sewage to the Sewage pump houses using gravity where from it is being pumped to respective sewage treatment plant. The non-energy intensive process is based on natural oxidation under anaerobic and aerobic conditions. The studies show that aerobic decompositions 10 times faster than anaerobic decomposition but maintaining aerobic condition in raw sewage is a costly affair. It involves the use of large mechanical devices for providing oxygen. Natural oxidation on the other hand involves the use of algal cells to release oxygen in photosynthetic process and provided it for decomposition. Although slower and less efficient this process is less capital cost and involves very little operation cost.

Inference

Betwa being is an important river of the central part of Madhya Pradesh supplies water to a large command area of the state. The present investigation was aimed at assessment of water quality and thereby an estimation of pollution loads on the river just close to its origin. The study reveals that the water quality is poor and pollutants of both organic and inorganic origin are entering into the river, thereby deteriorating its water quality. The high concentration of BOD and COD are due to high concentration of decomposable organic matter that enters with the inflow of sewage and industrial effluent. The increased concentration of TDS depicts high concentration of dissolved inorganic solids. It is evident from the study that the human settlements near the river Betwa are polluting it by discharge of wastewater. The severely polluted state of water of River Betwa has rendered its water unfit for human consumption like almost all the water resources in the country and has become a matter of great concern for the people depending on its water. Treatment of wastewater from these settlements and the industries before discharge in the river is the only means by which the problem of water pollution could be mitigated. During the present investigation, the water quality of River Betwa in the upstream was observed quite good in comparison to downstream of the river, which was found to be highly polluted due to discharge of municipal sewage through surface drains & industrial effluent of Mandideep industrial area.

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