

# STUDY ON PHYSICO-CHEMICAL CHARACTERISTICS OF FLOWING WATER OF GANGA RIVER AT MOKAMAH

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Key words : Physico-chemical characteristics, water, Ganga, Mokamah.

Investigation into the physico-chemical characteristics of water of the Ganga river at Mokamah (Bihar) was carried out from January to December, 2006. The sampling sites were at Mokamah where sewage and industrial effluents from several industries located in the nearby areas are discharged into this river. The chain of polluting industries principally include Bata India Ltd., McDowell Distillery, Barauni Thermal Power Station, Hindustan Fertilizer Corporation and Indian Oil Refinery. Bathing and cremation are also offending practices leading to increased pollutants in the Ganga water at Mokamah. The parameters of analysis included temperature, colour, odour, pH, D.O., B.O.D., C.O.D., chloride, nitrate, sulphate, phosphate, T.D.S., Calcium and Magnesium. The results obtained in the present investigation revealed that the discharge of untreated effluents and sewage have resulted in considerable pollution of the river Ganga at Mokamah making it unsafe for human consumption which needs serious attention for remediation and control.

## INTRODUCTION

Originating from the lofty Himalayan heights, the Ganga enters Bihar at Buxar and flows through a stretch of about 560 Kms in Bihar. For Mokamah town (and nearby Barauni township) Ganga river is the main source of ground water which, in turn, provides drinking water to these twin townships. But observations reveal that it has become polluted due to discharge of industrial effluents and remains of cremated dead bodies, ash, detergents and soaps and a variety of wastes thrown into the river at this point. This pollution also creates unhygienic and unaesthetic conditions at the bathing ghats. The present study has been carried out in order to evaluate and assess the physico-chemical characteristics of Ganga river water at Mokamah.

## MATERIALS AND METHODS

A water quality monitoring programme comprises mainly two steps : firstly collection of water samples and secondly physico-chemical analysis of these samples. Sample collection sites were chosen with respect to the actual and desired use of river and its various sources of pollution. The water samples were collected from four different sampling sites selected on the basis of the well-defined objectives of the investigation. The samples were collected during the months of January to December, 2006. A sample is only an infinitesimally small part of the total volume of a particular river system. Therefore, for analytical work, samples were collected in sterilized bottles in accordance with the standard methods of American Public Health Association (APHA-2000). Instruments were used in the limit of precise accuracy and the chemicals used were of analytical grade.

The parameters and methods used and applied for the said investigation and the results obtained are presented in Table-1 and 2.

## RESULTS AND DISCUSSION

In order to ascertain the physico-chemical quality of Ganga water at Mokamah and the extent of pollution caused by major

industries located in the surrounding area, a total of fourteen parameters have been analysed during the period from Jan,06 to Dec. 06, from four different sampling sites symbolized as S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, and S<sub>4</sub>.

The overall variation in surface water temperature exhibited an expected seasonal pattern. The temperature of water and the surroundings were found to be nearly constant at all the sampling sites. The mean values of water and air temperatures were calculated to be 28°C, and 26°C respectively at S<sub>1</sub>. Almost similar temperature trends were observed at other sampling sites S<sub>2</sub>, S<sub>3</sub>, and S<sub>4</sub>.

A considerable variation in pH values of water samples was observed at different sampling sites. Average pH values at all the four sampling sites S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, and S<sub>4</sub> have been observed to 7.50, 6.86, 7.62 and 7.71 respectively. The sharp decrease in pH value at site S<sub>2</sub> is attributed to the discharge of industrial effluents from major industries like Bata India Ltd. and McDowell Distillery. Effluent discharge of these industries is acidic (pH=5.5) in nature.

The overall data on D.O. has given a clear indication of fairly constant D.O. value at all sites except at S<sub>2</sub>. Dissolved Oxygen is one of the most important parameters in assessing water quality and reflects the physical and biological processes prevailing in the water. A good water should have the solubility of oxygen, 7.0mg/l at 30<sup>o</sup>-35<sup>o</sup>C (Kudesia, 1989). Oxygen saturated water has a pleasant taste. Lowest D.O. value range (5.3-6.7 mg/l) at S<sub>2</sub> appears to be caused due to discharge of industrial wastes and effluents.

Besides this, it is a known fact that industrial effluent rich in chemical pollutants when discharged into inland surface water, will lead to decrease in D.O. value and increase in C.O.D. value of water sample. The maximum C.O.D. value (permissible) is 10 mg/l for drinking water (De, 1985). Higher C.O.D. values at site S<sub>4</sub> (20.00-48.0) mg/l seems to be caused due to presence of organized cremation by burning dead bodies at Simaria ghat. Besides overflow of industrial wastes with fly ash, discharge of untreated or partially treated

industrial effluents discharge by Bata India Ltd. and McDowell's Distillery caused high C.O.D. value at site S<sub>2</sub> (61.4-80.0 mg/l).

The high values of TDS at site S<sub>2</sub> can be attributed to the presence of untreated & partially treated industrial effluents from Bata India Ltd. and McDowell's Distillery. TDS imparts a peculiar taste to water and reduces its potability. Permissible limit of TDS for drinking water is 5000 mg/l (WHO). TDS in water less than 1000 mg/l is classed as non-saline.

In general, the total alkalinity values have been found to be positively correlated to the pH values of Ganga water.

There was no significant variation in calcium (Ca) content at sites S<sub>1</sub>, S<sub>3</sub> and S<sub>4</sub> except at site S<sub>2</sub> where maximum concentration of Ca has been observed.

The overall variation trend of Mg has been found to be similar to that of calcium. In other words, magnesium is positively correlated to calcium at all the sampling sites from S<sub>1</sub> to S<sub>4</sub> and was found to be well within the permissible limit (30 mg/l) prescribed by WHO (1971) and Ministry of Works & Housing (1975).

At site S<sub>2</sub>, high values of chloride (74.0 mg/l) and sulphate (33.2 mg/l) may be attributed to the industrial effluents discharged from Bata India Ltd. and McDowell's Distillery. The observation is further confirmed by the fact that the chloride content in industrial wastes discharged by Bata India Ltd., Mokamah was analyzed and recorded to be 2400 mg/l (Red *et.al.*, 1990).

## CONCLUSION

In view of the high levels of contaminants, it may be suggested that the investigated stretch of river Ganga at

Mokamah should not be used as drinking water sources without any pretreatment and disinfection.

The Gangetic region is well known for its high number of cases of aerobic dysentery, gastroenteritis, tape worm infections, typhoid, cholera and viral hepatitis- one person dies every minute of diarrhoea. Native plants and animals do suffer as well. Fresh water animals gharials, crocodiles, smooth Indian otter and Asian small clawed otter are on the way of decline. Hopefully, the people of India will soon realise the imminent danger and take care to restore and preserve the purity of Ganga river. Concerted efforts are needed at the level of the Govt., the NGO's and the public at large.

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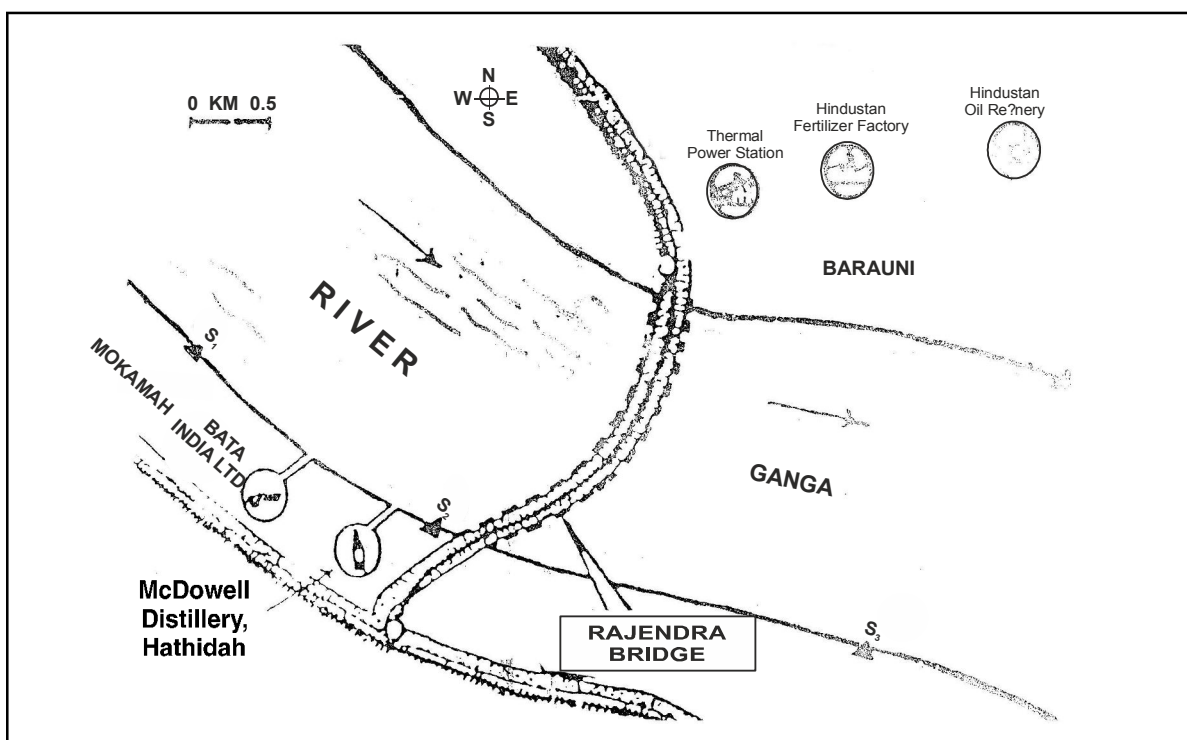
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**TABLE-1**  
**Parameters and Methods employed in the Chemical Examination Samples.**

Sl. No.	Parameters	Methods
1.	Odour	Smelling
2.	Temperature	Thermometric
3.	pH	pH-meter
4.	D.O.	Winkler's Method
5.	C.O.D.	Dichromate reflux
6.	TDS	Argentometric
7.	Chloride	Gravimetric
8.	Sulphate	Spectrophotometer
9.	Calcium	Titration
10.	Magnesium	Titration

**TABLE-2**  
**Physico-Chemical Characteristics of Ganga Water at Mokamah**

Sl. No.	Parameters	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
1.	Temperature	29°C	26°C	28°C	29°C
2.	pH	7.50	6.86	7.62	7.71
3.	TSS	177.0	176.0	76.0	88.0
4.	TDS	90.0	319.0	224.0	265.0
5.	TS	266.0	495.0	300.0	354.0
6.	Hardness	116.0	210.0	133.0	132.0
7.	Ca	22.9	42.9	29.0	31.4
8.	Mg	11.3	25.2	11.3	12.9
9.	Alkalinity	154.0	107.0	119.0	160.0
10.	Chloride	15.0	74.8	70.5	22.0
11.	DO	8.0	6.7	1.0	7.75
12.	COD	61.4	80.2	45.5	48.0
13.	Sulphate	16.0	33.2	12.0	16.3
14.	Conductivity	283.0	442.0	276.0	304.0
15.	Turbidity	21.7	82.0	22.0	28.0



**Fig-1: Diagrammatic representation of Mokamah-Barauni Industrial Complex & Sampling Stations (S<sub>1</sub>-S<sub>4</sub>)**

**S<sub>1</sub> :** 150 m. u/s of the River w.r.t. effluents discharge point (Western Side)

**S<sub>2</sub> :** 30 m. d/s of the River (Western Side)

**S<sub>3</sub> :** 250 m. d/s of the River (Eastern Side of the Bridge)

**S<sub>4</sub> :** 300 m. d/s of the River (Eastern Side of the Bridge)