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Research Article

Physiochemical qualities of Damoder river water and turbidity control studies in monsoon season

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Abstract: A study of the surface water of Damodar River has been made during the monsoon season (rainy). A remarkable change in physical – chemical qualities has been noticed. A large surface wash out and run off which enhance the value of chemical oxygen demand in Damoder river water in mansoon season. The predominating suspended particulates matters which enhanced the turbidity and it was removed some extent by sedimentation process within 1 hour. The amounts of clay types of particles are less than the amount of silks and sands. Some fraction of resident turbidity, mostly due to ultra clay and colloidal type of particles which cannot be removed easily by simple sedimentation process.
Keywords: Damodar River, Turbidity, Pollutants, Chemical Oxygen Demand, Sedimentation.

INTRODUCTION

Surface water pollution with chemical, physical and biological contaminants by anthropogenic activities is of great environmental attention all over the world [1, 2, 3]. Surface water systems mainly mean the waters naturally open to atmosphere, for example rivers, lakes and reservoirs water [2]. Rivers play an important role in a watershed for carrying off municipal and industrial wastewater and run-off from farm land, and are one of the most susceptible water bodies to pollutants [4, 5, 6]. The constant discharges of domestic and industrial wastewater and seasonal surface run-off due to the climate all have a strong effect on the river discharge and water quality. However, rivers are the main water sources for domestic, industrial and agricultural irrigation purposes in a region [7], river water quality is one of important factors directly concerning with health of human and living beings [8]. Therefore, it is imperative and important to have reliable information on characteristics of water quality for effective pollution control and water resource management. There is a great need to evaluate the river water quality and it is useful in identification of possible factors caused by natural and anthropogenic activities that influence water systems [15]. Damoder river data (DRD), one of the most developed regions in Dhanbad, Jharkhand is an intensity region of population and industrial, the mass of sewage discharge increase year by year in this region, especially the discharge of domestic sewage almost increase sharply with population growth. Due to the value and importance of freshwater resources, surface water pollution in DRD has become a serious problem, and policy-makers and researchers are trying to look for a balance between economic development and environmental protection. Water resource management has targeted water quality improvement resulting from the understanding of deleterious impact of various pollutants on water. The object of the present study is to analyze physico-chemical parameters of river water quality from Damodar using PCA and CA multivariate technique, and to assess information about the similarity and dissimilarities among the different monitoring stations, to identify water quality variables for spatial differences, and further to make sure the impact of the pollution sources on the water quality parameters.

The industrialists prefer surface water more commonly because of its easily availability and acceptability for industrial use. The quality of the surface water depends on its contact with sand and pollutant. Any modern industry using ultra pure water for proper functioning of the industries. Turbidity is the main obstacle for use of the surface water in industrial application. Most commonly it is removed to a great extent in well – designed settling tank. The efficiency in the reduction of turbidity by plain sedimentation is a function of the particles size distribution of the suspended matter present in turbid surface water.

In this paper on attempt has been made to study some important aspects of turbidity and pollution in Damodar River from where water is used by many industries situated on its bank. Attention has been paid to studying the variation in the physical and chemical qualities of the turbid surface water during monsoon when the surface water shows maximum variation in quality and turbidity due to a large wash-out area and maximum run-off. The degree of pollution has been determined indirectly in terms of chemical oxygen demand. The nature of turbidity has been determined by the particular size distribution of the suspended matter and by carrying out plain setting experiments. It is hoped that this model of study may be extended to any

surface water for judging the acceptability of the water for industrial uses and for design of the settling tank for removed of turbidity etc.

EXPERIMENTAL

Seven sample of Damodar river water were collected during monsoon season in the month of July to August of the year 2011for the study of the turbidity and physical, chemical and biological contaminants in surface water of Damoder river.

1. Determination of physical and chemical properties of the surface water

Turbidity, pH, temperature, conductivity, hardness, alkalinity etc. Properties of surface water were determined by using the standard method in the laboratory.

2. Determination of particle size in Surface water

The particle size distribution was determined by the pipette method, using Andreasen apparatus. In this experiment, an appropriate amount of raw water was centrifuged and the sediment was washed with distilled water to remove the soluble matters present in the system. The properly washed sediment was then slurries with distilled water. The volume of the slurry was made up to 500ml in the Andreasen tube. The distribution of the particle size in the prepared of the suspended slurry after a predetermined interred of time from a depth of 10cm. For determination of the percentage of the seventh fraction (table-2) of the suspended matter the sample was taken from a depth of 1cm in order to minimize the length of time. These entire samples were dried at 103 ± 2^0c in the air oven and the percentage composition of the different fraction was calculated after weighing the dried samples.

3. Settling Experiment:

A sample setting experiment was conducted. For this 2.5 litre of raw water sample of predetermined, turbidity was allowed to settle in a bottle of 3 litre capacity raising the water column height to 18cm. An appropriate amount of turbidity water sample was taken after a predetermined interval of time for measurement of residual turbidity & residual suspended matters.

RESULT AND DISCUSSION

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The result of the physical-chemical quality of the seven collected water samples in themonsoon season of year 2011 from Damoder river shown in Table-1. The table reveals that the total alkalinity & hardness due to heavy rain or dilution due to the pure rain water in sample B. Again when there was no rain, in the sample B, the total hardness had gone up to 86 ppm as calcium carbonate against the total hardness equivalent to 28 ppm. & the total alkalinity in sample I has gone up to 68 ppm as calcium carbonate against the total alkalinity of 27 ppm in sample B, similarly a marked change in the conductivity of the turbid water was observed during the heavy rain & flood. It was also noticed that turbidity was maximum during heavy rain in the catchment area of the river. The maximum value of chemical oxygen demand was obtained in sample F & B, when there was maximum turbidity. The COD was maximum probably due to large surface run off during heavy rain. The result of the second part of the experiment is given in table 2. The maximum & minimum values of the seven fraction of the suspended matter have been underlined. The percentage compositions of the entire fraction have been given in the same table. It is apparent from the table that the percentage compositions of different fraction of the suspended matter in the entire sample in the study are not constant. It is probably due to rapid run off & varying erosions accompanying the flow in the Damodar River.

The large fraction viz course & fine sand of diameter > 0.05 mm, varies from 50.92 to 5.09 percent. The maximum value was obtained when there were few showers in the attachment area. The original turbidity was 625 JTU. The minimum value was obtained when there was practically no rain in the attachment area & the was grayish in appearance (Table 1). This was probably due to the maximum amount of grey clay (Sample D). The average value obtained was 45.02%.

The second fraction of the suspended matter causing turbidity has been termed very fine sand in this study. The diameter of particles of this fraction is 0.05 to 0.02 mm. the fraction of suspended matter varied from 12.3 to 0.94 %. The maximum value was found in sample F during the heavy rain & in the middle of the monsoon. The minimum value of this fraction was obtained in sample C. when there were only a few showers in the catchment area of the river. The average percentage of this fraction is 11.40%.

The third fraction of the suspended particular has been termed coarse silts it covers particles of altimeter ranging from 0.02 to 0.01 mm. in sample D the percentage of this fraction was 19.7 of the total suspended matter present. It was the highest value observed during the study. This sample was collected when practically there was no rain in the catchment area. The minimum percentage of this fraction was found in the water sample C. The minimum value is 3.02%. The average value of this fraction is 16.6%.

The fourth fraction of the suspension in the turbid water has been termed fine silts having particles of diameter ranging from 0.01 to 0.005 mm. The maximum of this fraction was obtained in sample G and minimum in sample A. The maximum value was 17.75 % and the minimum value was 3.8 % of the total suspended matters.

The fifth fraction is termed very fine silt (table 2). This fraction is due to particles of diameter

0.005 to 0.002 mm. in this study the variation was 23.7 % maximum in sample B to 8.6 % minimum in sample F of the total suspended matter present in each sample. The sixth fraction of the suspended matter in the turbid water is termed clay. The diameter of the particles of this fraction range from 0.002 to 0.001 mm. The amount of the clay in the study varied from 35.6 % maximum in sample D to 14.4 % in sample B.

The seventh fraction of the suspended matter is termed ultra clay in this study. In this fraction the particles are of the diameter 0.001 to 0.0001 mm. The Percentage of the ultra clay particles was very small in comparison with the other fraction of suspended matter present in the turbid water samples. The maximum percentage of this fraction w 01.1% of sample F. It is also seen from the table that as the amount of clay in increasing the ultra clay percentage is also increasing.

The results of the third part of the experimental work have been graphically illustrated. The first graph (fig. 1) has been plotted to mark the change in turbidity against time. The second graph (fig. 2) has been plotted by computing the results and it illustrates the relationship between turbidity and the size of the suspended particles contributing to the fractional turbidity.

Table-1: The result of the physical-chemical quality of the seven collected water samples in themonsoon season of year 2011 from Damoder river.

Sl. no.	particular of sample	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F	Sample G
1	Date of collection	16.06.11	19.7.11	28.7.11	07.8.11	18.8.11	20.8.11	27.9.11
2	Condition	After a few days rain in the encatchment area	Heavy rain during the preceding three daysin the encatchment area	Few showers in some of the encatchment area	No rain for last 7 days. Water were grayish in colour	Heavy rain for last two days in the encatchment area	Heavy rain for last 4 days.	Light rain for few days
3	Temperature (^{o} C)	28.5	28.5	31	31	30	30	30
4	P ^{H}	7.45	7.1	7.5	8.3	8.1	7.5	7.5
5	Turbidity (JTU)	550	1250	625	375	400	1000	650
6	Alkalinity P, (ppm) $CaCo_3$	0	0	0	0	0	0	0
7	Alkalinity M, (ppm) $CaCo_3$	52	27	44	68	53	39	---
8	Total hardness, (ppm) $CaCo_3$	60	28	58	86	62	40	--
9	Chloride, ppm	12	07	9.5	09	07	6.5	--
10	Sulphate	35	15	24	32	26	---	--
11	Silica	10.7	07	10.7	12.5	10	--	---
12	COD	26.9	52.2	34	33.4	30.4	60.5	
13	Conductivity	$145*10^{-6}$	$70*10^{-6}$	$165*10^{-6}$	$170*10^{-6}$	$125*10^{-6}$	$85*10^{-6}$	--

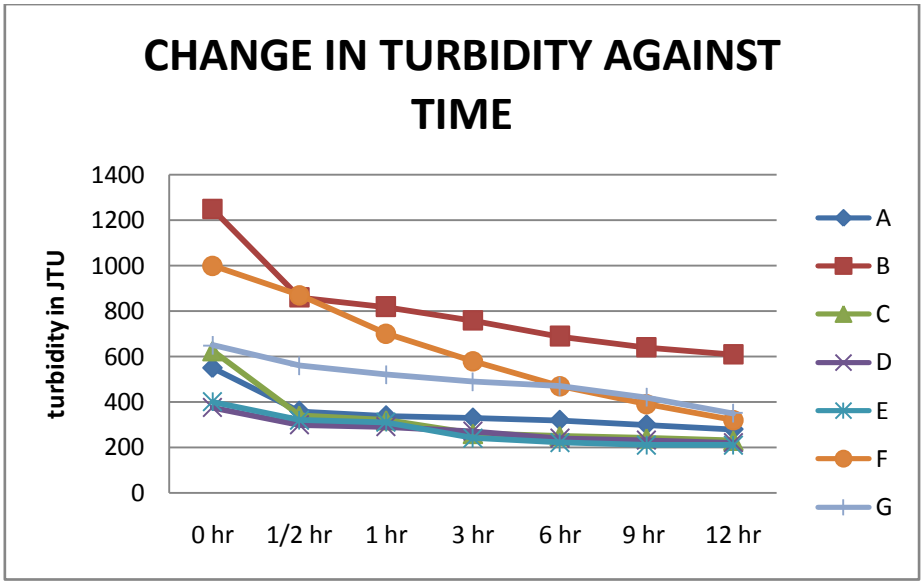

Figure 1: The change in turbidity against time.

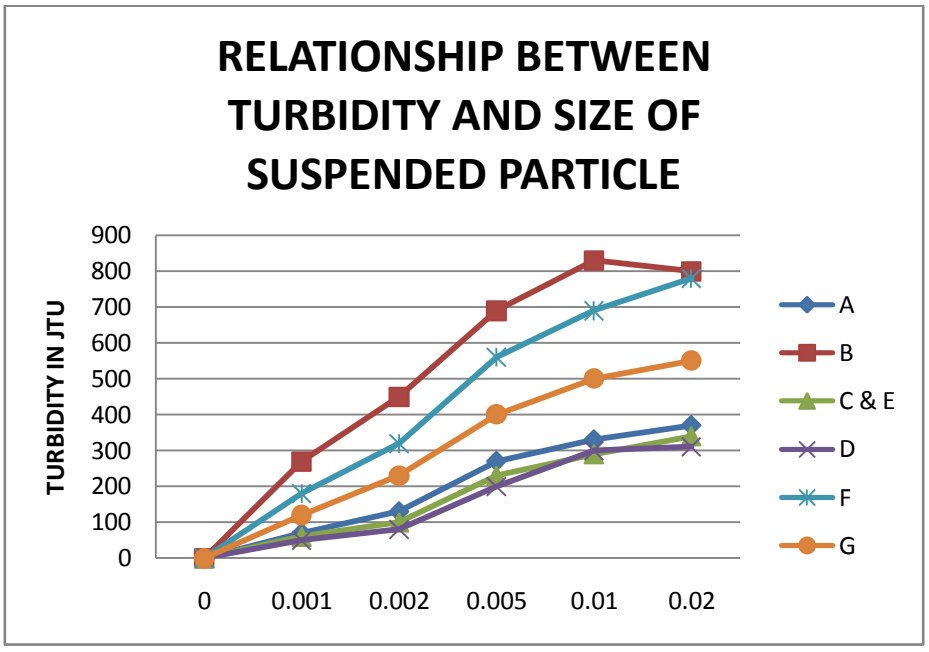

Figure 2: Relationship between turbidity and size of suspended particles

Fig. 1 illustrates the results of the plain settling experiments there is a sharp fall in the turbidity in half an hour approximately. The slope decreases as the time increases. In the sample A, C & D the turbidity reaches 290 to 340 after 1 hour and 220 to 280 in 12 hours, in the water sample B, F & G the slope is more up to six hours of time setting is depended matter (Table2) & the original turbidity of the raw water sample (Table 1).

It is apparent from fig. 2 that even a very fine fraction of the suspended matter of diameter less than 0.001 mm results in turbidity equivalent to 50 to 270 JTU. The residual turbidity is depended on the original turbidity of the river water (Table1). In case where the original turbidity is high, the resident turbidity remains high. It is also observed that the nature of the reduction of turbidity is similar in all the six samples. Again, there is a substantial reduction in turbidity when particles of diameters above 0.005 mm are removed from the system.

CONCLUSION

During heavy rain and flood, the water is diluted and the mineral contents are reduced due to large surface runoff and wash-out, and consequently the chemical oxygen demand is very high. The rapid run off & erosion during flood cause high turbidity is the river water. The major part of the turbidity is due to the course fraction of the suspended matter & it may be removed within one hrs.

The turbidity due to the finer fraction of the suspended matter may be removed by prolonged storage to some extent. Some part of the total turbidity

cannot be removed by plain sedimentation. Hence for chemical classification the setting for at least one hour would save a considerable amount of energy and chemical for this type of turbid water.

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