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Formulation Of Innovative Water Quality Index For Assessing Sugar Mill Effluent.

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ABSTRACT

The objective of water quality index calculation is to change complex water quality data into information that is understandable and useable by the public. In other word, water quality index is a tool used to summarize large amounts of complex, highly technical water quality data into a simple, easy-to-understand message. There are various water quality index calculation method developed in the world. The new index was applied to the sugar mill effluent and the results gave a quantitative picture for the water quality situation. Heber water quality index method has been successfully applied to measure water quality of effluent from sugar mill. The parameters analyzed were Temperature, pH, Total Solids, Turbidity, Dissolved Oxygen, Biochemical Oxygen Demand and Total Phosphate. The total HWQI values are in the range of 0.45-11.97. These values suggest that almost all the water samples collected during different months are bad in quality and must be treated before discharge.

Keywords: Heber water quality index-1, total solids, turbidity, dissolved oxygen, biochemical oxygen demand, total phosphate.

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INTRODUCTION

Environmental pollution has become appreciable recently as it adversely affects human and the biosphere (Sabitha et al, 2009). Industrial wastes make the ground water polluted and unfit for human consumption (Nyroos, 1994). Chemical industries discharge tons of untreated effluents with heavy metals and toxic organic and inorganic pollutants into the ground water, making it poisonous for plants and living organisms (Gupta et al*.,* 1997).In India, there are 369 sugar factories (Manohar Rao, 1987). Indian economy mainly depends on these industries which provide employment to large sectors. Tons of waste materials both organic and inorganic loads are released from sugar industries (Rajukkannu and Manickam, 1997).

The effluents generated from Nizam Deccan Sugar factory at Bodhan, Nizamabad, District of Andhra Pradesh, India showed electrical conductivity between 1557-13050 µmhos/cm and higher BOD values (Dasarath et al., 2005). The studies proved that the water cannot be used for irrigation or human consumption. Studies of Nomulwar et al (2005) on the sugar factory effluents revealed that most of the parameters such as colour, odour, total dissolved solids, chemical oxygen demand, total alkalinity, pH, temperature, phosphate and sulphate have exceeded ISI limits. The effluent contain high amount of total hardness, total dissolved solids, biological oxygen demand (BOD) and chemical oxygen demand (COD).

The water quality standards and maximum pollution load for water body are framed by Total Maximum Daily Load (TMDL) regulations (Copeland 2002). Water quality index (WQI) is developed by regulatory agencies to indicate the quality of water in terms of water quality variables, such as dissolved oxygen (DO), conductivity, turbidity, total phosphorus, and fecal coliform, each of which has specific impacts to beneficial uses.

The general WQI was developed by Brown et al., (1970) and improved by Deininger for the Scottish Development Department (1975). Overall index has been framed by Horton (1965). Water quality index provides sufficient information about the quality of water and proved to be effective tool. WQI is defined as a rating reflecting the composite influence of different water quality parameters (Atulegwu and Njoku, 2004).

The following are the major objectives of this investigation:

(a) To visit the sugar mill to collect important information regarding the nature of the effluent discharged.
(b) To check whether the effluent discharged by the mill is properly treated or not.
(c) To assess the quality of the collected water samples during different months using Heber Water Quality index (HWQI).

The quality of water can be assessed using more than 35 parameters. As it is difficult to analyze all the parameters, important seven parameters related to climatic conditions are taken into consideration for framing new, effective and successful water quality index. Heber Water Quality index (HWQI) is a novel method to determine the quality of water (Rajendran et al., 1999). The parameters considered for calculating Heber Water Quality index (HWQI) are temperature, pH, total solids, turbidity, Dissolved Oxygen, Biochemical Oxygen Demand and total phosphate.

MATERIALS AND METHODS

Ground water forms the source for drinking and domestic usage in India. It becomes important to formulate a method which is reliable and cost effective to analyze water and predict the usability (Rajendran et al., 1999). The important parameters which determine the water quality as prescribed by National Sanitation Foundation (NSF) of USA, are temperature, pH, total solids, turbidity, Dissolved Oxygen, Biochemical Oxygen Demand and total phosphate. Analysis of these parameters provide weighing curve values (Q-values) and weightage factor from which the water quality index is determined.

Ground water quality can be assessed using new water quality index. Temperature is an important parameter from which other data such as density, viscosity can be calculated. It also affects the chemical and biological reactions of organisms in water. Temperature variation causes depletion of oxygen dissolved in water, changes in taste and odour and also affects the rate of photosynthesis.

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Temperature change and phosphate are not usually considered as pollutants as they change according to the climatic conditions (Rajendran et al., 1999). Since India is a tropical country, the variation in temperature of aquatic system is high. The contribution of thermal power plants to temperature change is also minimal. Hence the parameter gains less importance in calculating the index (Rajendran et al., 2000). Heber Water Quality Index (HWQI) makes use of the seven parameters namely temperature, pH, total solids, turbidity, Dissolved Oxygen, Biochemical Oxygen Demand and total phosphate (Kumar et al., 1993). The Heber Water Quality Index (HWQI) is formulated by arranging the seven parameters in decreasing order of importance with scores of 0-9 from low (0) to high value (9) and weighing curve value is assigned to each parameter.

Sampling station

Water samples were collected from sugar mill. Seven Water quality parameters for calculating HWQI were analyzed.

From the effluent discharge stream of sugar mill, the effluent samples were collected in 2 litre polythene can (Rainwater et al., 1960). The bottles for sample preservation were thoroughly cleaned by rinsing with 8M Nitric acid solution, distilled water, double distilled water and effluent samples. It was stored in a refrigerator at temperature approximately 4ºC, after adding the necessary preservatives, (APHA, 1985). Preservatives are added to retard biological action. These samples were used for analysis of water quality parameters such as turbidity (AOAC, 1998), pH, temperature, total solids, (APHA, 1985; Jeffery et al., 1996), BOD and DO (USEPA, 1986; Young et al., 1981) and total phosphate (APHA, 1998).

The percent saturation chart was used to determine the dissolved oxygen present in water at a given temperature. A straight line joining the water temperature of the sample site and the dissolved oxygen in mg/l is drawn. The percent saturation at the intercept on the sloping scale was recorded.

Procedure for determining Q-value

The test value line intersects the weighing curve and a horizontal line was drawn to the "Y "axis which is the point of intersection Q-value. It was recorded in the table. The weighing curve value (i.e., Q- value) for each test was multiplied by the weighing factor listed in the table for a particular test. Similarly, the weighing factors for different parameters such as pH, turbidity, BOD and total phosphate (according to HWQI) were determined. The overall water quality index (WQI) for the sampling station during different months was determined by adding the total of the seven test results.

The weighing factor for the parameters was given in table 2. The overall HWQI values were calculated to be 39.37 (Table 3) during October, 38.69 (Table 4) during November, 24.79 (Table 5) during December, 23.48 (Table 6) during January, 23.73 (Table 7) during February and 23.83 (Table 8) during March respectively which indicates that the effluent are bad during October and November whereas it is very bad during December, January, February and March as given by the quality rating table 1.

Table 1: Quality Rating

Range	Quality
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very Bad

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Table 2: Weighing Factor for parameters

S.NO.	Parameter	Weighing Factor
1	pH	0.117
2	Turbidity	0.09
3	BOD	0.126
4	DO	0.133
5	Temperature	-
6	Total solids	0.09
7	Total Phosphate	0.1

Table 3: Heber Water Quality Index (HWQI) during October

S.NO.	Parameter	Test Result	Q-Value	HWQI Weighing Factor	Total
1	pH	7.3	93	0.117	10.88
2	Turbidity (NTU)	2.8	91	0.09	8.19
3	BOD (mg/l)	59	5	0.126	0.63
4	DO (mg/l)	84%	90	0.133	11.97
5	Temperature $^{\circ}$C	25	16	-	-
6	Total solids (mg/l)	1908	20	0.09	1.80
7	Total Phosphate (mg/l)	0.522	59	0.1	5.9
HWQI = 39.37					

Table 4: Heber Water Quality Index (HWQI) during November

S.NO.	Parameter	Test Result	Q-Value	HWQI Weighing Factor	Total
1	pH	7.2	92	0.117	10.76
2	Turbidity (NTU)	2.6	91	0.09	8.19
3	BOD (mg/l)	51	5	0.126	0.63
4	DO (mg/l)	71%	76	0.133	10.11
5	Temperature $^{\circ}$C	24.8	16	-	-
6	Total solids (mg/l)	1687	20	0.09	1.80
7	Total Phosphate (mg/l)	0.391	72	0.1	7.2
HWQI = 38.69					

Table 5: Heber Water Quality Index (HWQI) during December

S.NO.	Parameter	Test Result	Q-Value	HWQI Weighing Factor	Total
1	pH	7.6	92	0.117	10.76
2	Turbidity (NTU)	100	17	0.09	1.53
3	BOD (mg/l)	153	5	0.126	0.63
4	DO (mg/l)	Nil	2	0.133	0.27
5	Temperature $^{\circ}$C	24.5	16	-	-
6	Total solids (mg/l)	839	20	0.09	1.80
7	Total Phosphate (mg/l)	0.055	98	0.1	9.8
HWQI = 24.79					

Table 6: Heber Water Quality Index (HWQI) during January

S.NO.	Parameter	Test Result	Q-Value	HWQI Weighing Factor	Total
1	pH	7.8	90	0.117	10.53
2	Turbidity (NTU)	118	5	0.09	0.45
3	BOD (mg/l)	159	5	0.126	0.63
4	DO (mg/l)	Nil	2	0.133	0.27
5	Temperature °C	26.7	14	-	-
6	Total solids (mg/l)	873	20	0.09	1.80
7	Total Phosphate (mg/l)	0.062	98	0.1	9.8
HWQI = 23.48					

Table 7: Heber Water Quality Index (HWQI) during February

S.NO.	Parameter	Test Result	Q-Value	HWQI Weighing Factor	Total
1	pH	7.4	93	0.117	10.88
2	Turbidity (NTU)	126	5	0.09	0.45
3	BOD (mg/l)	167	5	0.126	0.63
4	DO (mg/l)	Nil	2	0.133	0.27
5	Temperature °C	26.5	14	-	-
6	Total solids (mg/l)	966	20	0.09	1.80
7	Total Phosphate (mg/l)	0.065	97	0.1	9.7
HWQI = 23.73					

Table 8: Heber Water Quality Index (HWQI) during March

S.NO.	Parameter	Test Result	Q-Value	HWQI Weighing Factor	Total
1	pH	7.5	93	0.117	10.88
2	Turbidity (NTU)	115	5	0.09	0.45
3	BOD (mg/l)	147	5	0.126	0.63
4	DO (mg/l)	Nil	2	0.133	0.27
5	Temperature °C	26.9	13	-	-
6	Total solids (mg/l)	897	20	0.09	1.80
7	Total Phosphate (mg/l)	0.052	98	0.1	9.8
HWQI = 23.83					

RESULTS AND DISCUSSION

Dissolved oxygen is one of the most important parameters in water quality assessment and reflects the physical and biological processes taking place in it. The dissolved oxygen means oxygen is in dissolved state obtained by absorption from the atmosphere. It keeps water fresh and its depletion is a signal severe pollution. Most aquatic plants and animals need a certain level of oxygen dissolved in the water for survival. Dissolved Oxygen was mostly affected by chemical effluents as seen in the present study. The percent saturation level of DO was 84% and 71% during October and November whereas it became 0% during December to March (working season).

The much of dissolved oxygen is consumed in waters of high BOD as Biochemical Oxygen Demand and Dissolved Oxygen are inversely related. Low BOD values (59 and 51 mg/l) were recorded during October and November where the DO was 84% and 71%. When the BOD reached high values of 153 mg/l, 159 mg/l, 167 mg/l and 147 mg/l during December to March, the corresponding DO values were zero.

pH is the measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. Depending upon the nature of the dissolved salts and minerals in water, it may be alkaline or acidic. For potable water, pH value should be between 6.5 and 8.5 and for public water supplies, the pH value cause tuberculation and corrosion. The higher values cause incrustation, sediment deposition, difficulty in chlorination and other ill-effects on the human using the water. The pH value is very important in industries since many chemical and Biochemical reactions take place at low pH value or high range of pH value. The control of pH value is particularly much important in the chemical flocculation or trade wastes, treatment by digestion of sewage sludges and of trade wastes. As for as the pH parameter is concerned the effluent is slightly alkaline which will not harm the aquatic system.

The high total solids and turbidity might be due to the fact that the effluent was rich of some sulphates and chlorides. The total phosphorus of the effluent was very high during all the seasons which exceeded the standard limit of 0.0326 mg/l. It will stimulate the growth of algae and other aquatic plant forms, leading to a condition called “Eutrophication”. “Eutrophication” is a condition where a water body becomes loaded with nutrients and dissolved solids with a decrease in the transparency of the water column which in turn reduces the DO in water and light penetration.

CONCLUSION

The overall water HWQI values for samples collected during different months were 28.98. This indicates that the quality ranking of the effluent was very bad. It poses serious threat to the environment. This method was found to be more suitable, reliable, less time consuming and less consumption of chemicals. From the data obtained by the analysis of the effluent taken from the sugar mill during different seasons, it was found that total HWQI value was 28.98 which suggest that the quality of the effluent was very bad. Based on the above findings and reasons, it was concluded that effective measures are to be taken before discharging the effluent into ground water system. In a developing country like India people especially living in semi urban area depend mostly on ground water for their drinking and other domestic uses.

REFERENCES

[1] Sabitha MA, Sarala Thambavani D and Selvasundari R. The Asian Journal of Experimental Chemistry 2009; 4(1&2): 126-132.
[2] Nyroos H. Publication of the water and environment research institute 1994; 14: 1-85.
[3] Gupta AK and Sexena GC. Indian J. Environ. Protection 1997; 17(6): 434-441.
[4] Manohar Rao AJ. Development of Indian sugar industry, Historical Bharathya Sugar Directory, (2nd edn), ISMA, New Delhi, 1987.
[5] Rajukkannu K and Manickam TS. In: Proc.Sixth National Symposium on Environment, Tamil Nadu Agricultural University, Coimbatore, India 1997; pp 286-290.
[6] Dasarath D Reddy E and Narasimha. Chemistry 2005; 21(2): 283-286.
[7] Nomulwar, Poonam and Patil PM. Journal of Aquatic Biology 2005; 20(1): 45-48.
[8] Copeland C. Water quality: Implementing the Clean Water Act 2002; available at: http://www.policyalmanac.org/environment/archive/crs_water_quality.shtml.
[9] Brown RM, McClelland NI, Deininger RA and Tozer RG. Water & Sewage Works 1970; 117: 339–343.
[10] Scottish Development Department. Report of a River Pollution Survey of Scotland 1975.
[11] Horton RK. Journal–Water Pollution Control Federation 1965; 37: 300–305.
[12] Atulegwu PU and Njoku JD. Int. Res. J. Eng. Sci. Technol. 2004; 1: 47-52.
[13] Rajendran A, Sharon AA, Jeyakar Chellaraj DA and Princy Merlin J. Indian J Environ. Protection 1999; 19(1): 842-845.
[14] Rajendran A, Gugan S, Ramesh Kumar C, Princy Merlin J and Jeyakar Chellaraj DA. Poll Res. 2000; 19 (3): 485-489.
[15] Kumar S and Singh KP. Indian J. Environ. Protection 1993; 13(5): 349-345.
[16] Rainwater FH and Thatcher LL. U.S. Government print office, Washington. D.C., U.S.A. 1960.
[17] American Public Health Association (APHA). Standard methods of the examination of water/wastewater, 16th Edition. APHA, AWWA, and WPCF, New York 1985.
[18] AOAC. Official methods of analysis of the Association of Official Analytical Chemists. Alexandria, VA: Association of Official Analytical Chemists 1998; 432-444.

[19] Jeffery GH. Vogel's textbook of quantitative chemical analysis (5th edn), Addison Wesley Longman Limited, Harlow, England 1996.
[20] USEPA. Environmental Monitoring and Support Lab., Cincinnati, Ohio 1986.
[21] Young JC, McDermott GN and Jenkins D. Journal of Water Pollution Control Federation 1981; 53: 1253-1253.
[22] American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater, 20th edn. Washington, D.C 1998.