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STUDIES ON PHYSICO-CHEMICAL PARAMETERS AND CONCENTRATION OF HEAVY METALS IN SUGAR MILL EFFLUENT

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ABSTRACT

The physico-chemical characteristics and heavy metal contents in the effluents discharged from Neoly sugar mill have been explored. The physico-chemical parameters such as colour, odour, temperature, pH, electrical conductivity, total dissolved solids, dissolved oxygen, COD, BOD, alkalinity, total hardness, Ca^{+2}, Mg^{+2}, sulphate, chloride, fluoride and concentration of heavy metals (like Cr, Mn, Ni, Zn, Cd, Fe, Cu, Pb and Hg) of the effluent collected from the various sites between the exit point at the mill and discharge point in a natural drain in different months have been determined.

Key words: Sugar mill effluents, Physico-chemical parameters, Heavy metals.

INTRODUCTION

The recent studies have indicated that the water bodies becoming increasingly contaminated due to the domestic and industrial wastes[1,2]. The effluent discharge from sugar mill consists of a number of chemical pollutants that can bring about changes in temperature, humidity and oxygen supplies amounting to a partial or complete alteration in the physical, chemical and physiological sphere of the biota[3]. Such changes disrupt the ecological cycle of living organisms[4]. Further, the letting of effluents sugar mill run into the natural water is responsible for bad quality water which affects aquatic life severely[5]. It is, therefore, very essential to study the physico-chemical parameters and heavy metal contents of the effluents to ensure their proper treatment prior to their disposal into open land or natural water resources.

The present paper deals with the estimation of the heavy metals and physico-chemical parameters of sugar mill effluents collected from Neoly Sugar Mill, district Kanshiram Nagar UP (India). This study was conducted during the winter season (Dec- Feb)

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when sugar mill remained in its full crushing capacity.

EXPERIMENTAL

Samples of sugar mill effluents were collected from the different points on the drain viz. point-1 (the exit in the premises) point-2 (1/2 km. from point-1) and point-3 (1/2 km. from point-2) in the months of Dec., 2008, Jan. and Feb., 2009. The physico-chemical analysis of sugar mill effluents was carried out as per the standard methods for analysis of water, waste water and industrial effluents[6]. Flouride contents have been determined by ion selectivity meter (Thermo-Orion Model 720), dissolved oxygen has been measured by Winkler's method, sulphate was determined by gravimetric method, pH was measured by digital pH meter (Bio-craft NDC-736) and electrical conductivity was determined by electrical digital conductivity meter. The effluent samples were analyzed for heavy metal contents by the atomic absorption spectrometer (Perkin Elmer-Analyst-100).

RESULTS AND DISCUSSION

Physico-chemical parameters

The results related to the physico-chemical parameters of the sugar mill effluents collected at different time intervals from the various sites have been listed in the given table.

Colour: The colour of the effluent was found variable at different points. The effluents are yellow in colour and intensity decrease from Point-1 to Point-3.

Odour: The odour of effluents of the mill was found sweet to alcoholic from Point-1 to Point-3.

Temperature: The temperature is the highest at Point-1 and decreases appreciably up to Point -3.

pH: The pH value of the effluent sample varies from 5.14 to 6.24. pH values are increased with increase in the distance travelled by the effluent. The ISI permits a range of pH from 5.5 to 9 for the effluents that could be released into any natural water source (ISI 1974)[7].

Electrical conductivity

Electrical conductance goes on decreasing along the stream from 4.86 to 3.40 mho/cm most likely due to the absorption and seepage of some ions of the effluent stream into the soil with its propagation.

Table 1: Physico-chemical analysis and concentrations of heavy metals of Neoly sugar mill effluents at different time intervals (All concentration are reported in ppm (mg/L) except pH,temperature in (°C) and electrical conductivity in (mho/cm)

Parameters	December-2008			January-2009			February-2009		
	Point-1	Point-2	Point-3	Point-1	Point-2	Point-3	Point-1	Point-2	Point-3
Colour	Yellow	Light yellow	Very light yellow	Yellow	Light yellow	Very light yellow	Yellow	Light yellow	Very light yellow
Odour	Sweet	Light sweet	Light alcoholic	Sweet	Light sweet	Light alcoholic	Sweet	Light sweet	Light alcoholic
Temperature	42.00	30.00	24.00	44.00	29.00	25.00	41.00	27.00	23.00
pH	5.41	5.48	5.92	5.62	5.87	5.95	5.14	5.40	6.24
EC	4.80	4.10	3.40	4.86	4.58	4.32	4.76	4.48	4.14
TDS	8000.00	7600.00	7200.00	7600.00	7200.00	6400.00	7600.00	7800.00	6400.00
DO	5.94	6.41	7.77	4.05	5.40	6.85	4.86	6.41	8.10
COD	300.00	180.00	168.00	250.00	190.00	158.00	300.00	235.00	220.00
BOD	98.60	89.20	70.40	64.80	60.80	52.00	78.40	67.40	43.20
TH	322.00	304.00	300.00	350.00	324.00	306.00	388.00	330.00	292.00
Ca^{2+}	136.50	130.20	115.50	151.20	134.40	117.60	178.50	163.80	130.20
Mg^{2+}	45.26	42.40	45.01	48.50	46.26	45.96	51.11	40.55	39.47

Cont…

Parameters	December-2008			January-2009			February-2009		
	Point-1	**Point-2**	**Point-3**	**Point-1**	**Point-2**	**Point-3**	**Point-1**	**Point-2**	**Point-3**
Alkalinity	190.00	164.00	150.00	180.00	166.00	130.00	150.00	144.00	128.00
Cl^-	134.73	127.64	99.27	141.82	120.55	85.09	191.46	170.19	113.46
F^-	0.95	0.95	0.66	0.47	0.66	0.28	0.19	0.28	0.38
SO_4^{2-}	5.14	4.03	2.67	8.72	6.50	4.32	6.91	5.60	4.64
Cr^{3+}	0.25	0.23	0.22	0.25	0.31	0.23	0.26	0.24	0.25
Mn^{2+}	0.49	1.00	0.28	0.44	0.16	0.14	1.10	0.14	0.30
Fe^{2+}	7.08	6.59	4.83	6.21	3.21	4.51	6.03	4.15	7.14
Ni^{2+}	0.10	0.06	0.06	0.07	0.08	0.04	0.07	0.08	0.13
Cu^{2+}	0.03	0.09	0.17	0.08	0.07	0.01	0.02	0.00	0.01
Zn^{2+}	0.53	0.60	1.47	0.55	0.40	0.09	0.05	0.07	0.17
Cd^{2+}	0.01	0.02	0.28	0.03	0.05	0.05	0.06	0.03	0.05
Pb^{2+}	0.10	0.10	0.01	0.06	0.06	0.02	0.11	0.05	0.03
Hg^{2+}	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND: Amount below the detectable limit

TDS (Total dissolved solids)

The TDS value in the sugar mill effluent ranges between 8000 to 6400 mg/L. This indicates the large amount of salts dissolved in the sugar mill effluents. As per the ISI standard for the discharge of industrial effluent into the inland surface water the permissible total solid limit is only 100 mg/L.

DO (Dissolved oxygen)

Dissolved oxygen was found varying over the range 8.10 to 4.05 mg/L. The ISI permits 6.0 mg/L of dissolved oxygen.

BOD (Bio-chemical oxygen demand)

The Table 1 shows the values of BOD for the sugar mill effluent which vary from 98.60 to 43.20 mg/L at different distances. The ISI maximum permissible value for BOD is 30 mg/L.

COD (Chemical oxygen demand)

The observed COD during winter season ranges from 300 to 158 mg/L. The ISI permitted limit for COD is 250 mg/L.

TH (Total hardness)

The term 'Total hardness' indicates the concentration of Ca^{2+} and Mg^{2+} ions only. It is expressed in terms of calcium carbonate. Total hardness varied from 388 to 292 mg/L.

Calcium (Ca^{2+}): Calcium values range from 178.50 to 115.50 mg/L.

Magnesium (Mg^{2+}): Magnesium values range from 51.11 to 39.47 mg/L, which are higher than the ISI limits.

Alkalinity: Alkalinity found at varying distance during winter season is of the order 190 to 128 mg/L. It is evident that the alkalinity at all the sampling sites was much greater than the recommended value, 50 mg/L.

Chloride (Cl^-): The concentration values of chloride in the effluent samples ranged over 191.46 to 85.09 mg/L.

Flouride (F^-): The flouride content of sugar mill effluent varied from 0.95 to 0.19 mg/L. The maximum permissible limit by ISI is 0.2 mg/L.

Sulphate (SO_4^{2-}): The concentration of sulphate ions found varing from 8.72 to 2.67 mg/L. These values are well below the permissible limit (ISI 1974).

Heavy metals

The various heavy metals present in the sugar mill effluent and their concentration values are given in the Table 1.

Chromium: The concentration of Cr varies from 0.31 to 0.22 mg/L. The acceptable limit of concentration of chromium is 0.05 mg/L as recommended by the BIS 1991[8].

Manganese: Manganese (Mn) content of effluent from sugar mill has variation from 1.10 to 0.14 mg/L. The recommended maximum concentration of Mn is 0.20 mg/L[9].

Iron: The content of iron (Fe) in sugar mill effluent shows a variation from 7.14 to 3.21 mg/L. The BIS has recommended 0.30 mg/L as the desirable limit for it.

Nickel: The present study indicates that the concentration of nickel (Ni) is less than 0.20 mg/L at all the sampling sites.

Copper: The concentration of copper (Cu) in sugar mill discharge varies from 0.17 to 0.00 mg/L.

Zinc: Zinc concentration in the sugar mill effluents exhibits a variation from 1.47 to 0.05 mg/L. These values are well below the ISI suggested limits.

Cadmium: Cadmium concentration varies from 0.28 to 0.01 mg/L.

Lead: For the concentration of lead, values vary from 0.11 to 0.01 mg/L.

Mercury: Mercury could not be measured in the sugar mill effluent samples as it may be present in too low amounts to be detected.

CONCLUSION

It is explicit from the data that the pH of the effluents increases and EC decreases with the distance travelled. The value for TDS and BOD were higher than the prescribed ISI limits. The values for alkalinity and the concentration of the magnesium as well as fluoride ions are higher than the recommended value for the industrials effluents. The sulphate ions are well below the standard ISI limits. The heavy metal concentration are far below the

permissible limits. However, the manganese and iron are slightly higher than the standard values. The present study exhibits that the treatment of the effluent is being done regularly before its disposal into the natural water sourse. However, the maintenance of the treatment plant as well as the periodic training of the workforce are required.

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