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ASSESSMENT OF PHYSICO-CHEMICAL CHARACTERISTICS OF SUGAR INDUSTRY EFFLUENTS

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ABSTRACT

Sugar mills play a major role in polluting the water bodies and land by discharging a large amount of wastewater as effluent. The sugar mill effluents are having high amount of suspended solids, dissolved solids, BOD, COD, chloride, sulphate, nitrates, calcium and magnesium. The continuous use of these effluents harmfully affects the crops when used for irrigation. The sugar industry wastewater is characterized by its brown color, low pH, high temperature, high BOD, high COD, odor problem, total solids, and high percentage of dissolved organic and inorganic matter. So this untreated wastewater will create problem to the environment. The analyzed parameters like pH, EC, TDS, Chloride, Chemical Oxygen Demand and Biochemical Oxygen Demand fluctuated from 4.0-8.78, 130-953 μs/cm.147-2400, 19.36-347.9, 14.4-977.6 and1, 5-43.2ppm respectively.

KEYWORDS: Effluents, COD, BOD, Physico-chemical properties etc.

INTRODUCTION

Wastewater from sugar industries is one that has complex characteristics and is considered a challenge for environmental engineers in terms of treatment as well as utilization. Before treatment and recycling, determination of physicochemical parameter is an important mechanism. Many different types of techniques are introduced and modified for the purpose, but depend upon the water quality parameters. The main aim of this study is to determine the physicochemical characteristics of sugar industry waste water by the standard method and minimize the fresh water consumption in sugar industry by water pinch methodology. Industrial revolution has generated unprecedented disturbances in the environment due to the introduction of anthropogenic pollutants such as organic, inorganic and xenobiotic chemicals in the form of untreated industrial waste water. With increasing population and industrial expansion, the need for the treatment and disposal of the waste has grown.[1] Sugar industry is the largest agro processing industry in India with 2.5% weight in the annual industrial production. products, such as bagasse (the fibre residue of sugar cane), press mud (filter cake), molasses and distillery spent wash. Press mud contains about 70% organic matter and 29% minerals. The discharge of effluents will create pollution to the environment. Sugar industry offers employment potential and contributes substantially to economic development. Apart from sugar and alcohol, these factories generate many by-products and waste materials. For example, large amount of organic and inorganic chemicals are being generated.[2] Sugar industry plays a major role in producing a higher amount of water pollution because they contain large quantities of chemical elements. They contain higher amounts of total hardness, total dissolved solids, biologica oxygen demand and chemical oxygen.[3] Various compounds of organic matter containing materials can be measured in two simple parameters, such as biochemical oxygen demand (BOD) and chemical oxygen demand (COD). It is well known that BOD is a standard test for assaying the oxygen-demanding concentration of microbes to degrade organic matter over a given time period, usually 5 days but can be extended to 30 days. COD is a standard test for water to consume oxygen in the form of potassium dichromate during the degradation of organic matter and inorganic chemicals such as ammonia and nitrite for few hours. The potassium dichromate is not specific to oxygen-consuming chemicals either organic or inorganic and therefore, both chemicals are included in COD.[4] Effluents from sugar industries induce environmental pollution. India, being one of the major producers of sugar in the world, is prone to large volume of wastes from sugar industries. The byproducts namely bagasse, molasses, distillery wastes and press mud are some of the major objectionable wastes generated by the sugar industries contributing to high BOD and COD.[5] Many researchers have been done to identify a low cost substitute for activated carbon for the treatment of industrial effluents to reduce BOD and COD. The low-cost adsorbents can be viable alternatives to activated carbon for the treatment of wastewater. It is important to note that the adsorption capacities may vary, depending on the characteristics of the individual adsorbent, surface modification and the initial concentration of the adsorbate. India is the second largest country manufacturing sugar from cane in the world. There are 488 in operation sugar mills in the country with a production of 145.39 lakh tones of sugar.[6] Sugar industry plays an important role in India’s economy. It is the largest processing industry next to textiles. Located in rural areas, sugar mills have an intrinsic symbiotic relationship with the rural masses and serve as a nerve center for rural development. It is one of the major commercial crops grown here in Karnataka and is one of the major sources of revenue for majority of the farmers. The production of sugar involves enormous amounts of water and energy. The main energy source is the combustion, usually bagasse and other low quality fossil fuels with high sulphur content are used. In sugar production, the water used for processes such as cane washing, clarification of juice, cleaning of evaporators, heaters and purging boilers, cooling systems and sanitary services are discarded. Sugar cane industry generates 0.2-1.8 m3 /tone waste water with COD 1800 to 3200 mg/L, BOD 720 – 1500 mg/L . Sugar wastewaters if disposed off into the water bodies untreated, can contaminate surface and subsurface waters. The BOD/COD causes rapid depletion of oxygen content of the waters, creates foul smell, renders the stream unfit for propagating aquatic life, drinking and for other purposes.

MATERIAL AND METHODS

STUDY AREA

North Karnataka, locally known as Uttara Karnataka, is a geographical region consisting of mostly semi-arid plateau from 300 to 730 meters (980 to 2,400 ft) elevation that constitutes the northern part of the South Indian state of Karnataka. It is drained by the Krishna River and its tributaries the Bhima, Ghataprabha, Malaprabha, and Tungabhadra. North Karnataka lies within the Deccan thorn scrub forests ecoregion, which extends north into eastern Maharashtra. It includes the districts of Belgaum, Bijapur, Bagalkot, Bidar, Bellary, Gulbarga, Yadagiri, Raichur, Gadag, Dharwad, Haveri, Koppal and Uttara Kannada District. Major cities in the region are Belgaum, Hubli, Dharwad, Bellary, Bijapur, Gulbarga, Bidar, Karwar , Sirsi, Chikodi, Hospet and Gokak. Though the region is semi-arid, parts of Uttara Kannada and Belgaum district receive enough rainfall to make them lush and green throughout the year. Uttara Kannada district is coastal and hence boasts of some of the best beach towns of Karnataka like Karwar, Gokarna and Bhatkal. Belgaum district is quite big and though the north parts of the district are arid and receive less rainfall, the southern parts which are adjacent to Uttara Kannada district, like Londa, have an almost highland tropical climate. The stretch from Londa to Alnavar has some of the most dense and beautiful jungles on the Western coastal belt of India. They are part of the Western Ghats and their foothills which are now protected under National Wildlife laws. Certain parts of the region are well irrigated by many largest multipurpose projects like Upper Krishna Irrigation Project that includes Basava Sagara and Almatti Dams, Tungabhadra Dam, Supa, Kadra, Kodasalli dams, and many major and minor lift irrigation projects. Notably different from the regions of Old Mysore, Coastal Karnataka and Central Karnataka in terms of language, cuisine and culture, the region is well known for it's contributions to the literature, arts, architecture, economy and politics of Karnataka.

For the present study the samples of untreated effluent from a sugar industry located at North Karnataka India were collected. A comprehensive study was carried out primarily, data collection for the related work and secondary literature survey took place. Then to obtain basic ideas of the quality, characteristics and chemical composition of the effluent of sugar factory samples of effluents was collected in1 liter polythene-carboys bottle and mixed well in equal proportion to get homogeneous samples.[7] Random selection procedure was adopted for the selection of both sampling unit and the sampling point in given site (APHA1985). Tape water and 8 M HNO_3 were used to wash the bottles, which were used for the sample preservation followed by washing them with distilled water and finally with double distilled water. Then the bottles were rinsed thrice with effluent samples stored in refrigerator. pH, electrical Conductivity (EC) were measured at the sample collection site. Physicochemical properties such as total dissolved solids (TDS) chemical Oxygen Demand (COD), chloride and APHA standard method,[8] For physical and chemical analysis of the samples a number of sophisticated instruments were used and standard methods were followed.

Water quality data is essential for the implementation of responsible water quality regulations for characterizing and remediating contamination and for the protection of the health of humans and the ecosystem. Regular monitoring of river water resources thus play a key role in sustainable management of water resources. This study conducted seeks to serve as a preliminary study to assess the river water quality in terms of drinking and agricultural uses for a rapidly developing community located in Jamakhandi taluka.

RESULTS AND DISCUSSION

pH

In the present investigation the pH value of effluent water were recorded as 5 and 6.8 respectively. According BIS standards the pH of the effluents should be in range 6.5 to 8.0.Relativelylow pH values of both treated and untreated samples are due to use of phosphoric acid and Sulfur dioxide during cleaning of sugar cane juice. pH is one of the important biotic factor that serves as index for pollution. If such water is used for irrigation for a longer period the soil becomes acidic resulting in poor crops growth and yield. The factors like photosynthetic exposure to air, disposal of industrial effluent and domestic sewage also affect the pH of the soil. pH is affected not only by the reaction of carbon dioxide but also by organic solutes present in water. Any alteration in water pH is accompanied by the change in other physicochemical parameters.[9] PH maintenance (buffering capacity) is one of the most important attributes of any aquatic system since all the biochemical activities depend on pH of the surrounding water. It was concluded that the pH of water were slightly acidic. The pH was relatively low due to the use of phosphoric acid and sulfur dioxide during clarification of sugar cane juice.[10]

EC

The conductivity measurement is an indicator of ionic concentration of water. It depends upon temperature and concentration and types of ions present.[11] The electric conductivity value (130-953 (µs/cm) was found much high in effluents released from the sugar industries.

According to the DoE standard the EC of the effluent should be 1200 µs/cm. Higher EC values suggest existence of highly mineralized groundwater. Mineralization is possibly due to higher residence time, sluggish movement of groundwater and intensive water – rock interactions in the alluvial aquifers.

Table.1 Analysis of Sugar industry effluents of North Karnataka
TOTAL DISSOLVED SOLIDS

S.NO	Name of sugar factory	pH	EC (µs/cm)	TDS in mg/l	Chloride Mg/l	COD ppm	BOD ppm
1	Nagaralli sugar factory Yadagiri	6.15	206	916	29.1	152	20.7
2	Saidapur sugar factory Mudhol	4.0	502	254	26.6	136	9.0
3	Monali Sugars Malaghan, Sindagi	6.7	296	147	36.2	161.6	1.8
4	KPR sugars Kadani Sindagi	6.45	296	148	33.7	163.2	15.0
5	Nirani Sugars Mudhol	6.3	953	470	67.5	211.2	1.5
6	Renuka Sugars Dattaragi Afazalpur	6.2	500	297	21.3	192	9.3
7	Chikkodi Sugars	6.1	134	897	24.5	217.6	11.1
8	Jamakhandi sugars Padasalagi	4.3	830	500	34.8	28.8	25.5
9	Nandi Sugars Galagali	6.55	209	1200	19.36	193.6	25.5
10	Benur Sugars Indi	6.38	330	1900	85.2	25.6	18.6
11	Havinal Sugars Chadachan	5.97	241	1400	55.4	72.0	18.9
12	Prbhulingeshwar sugar factory Jamakhandi	7.0	206	1200	89.5	64.0	24.6
13	KPR Sugars Almel	3.86	233	1000	113.6	200.0	43.2
14	Jamakhandi Sugars	5.1	255	1300	34.8	19.2	21.3
15	Renuka Sugars Athani	4.39	290	1400	145.0	126.0	3.3
16	K.D. Nad Indi	10.3	212	2400	45.08	14.4	4.2
17	KPR Almel	8.78	130	500	347.9	78.4	39.3
18	Nandi Sugar Galagali	6.0	145	700	85.9	977.6	3.6
19	Hunashyal Sugars Gokak	8.5	14.7	800	78.1	524.8	9.9
20	Prabha Sugars Ghataprabha Gokak	8.0	18.9	1100	23.08	761.6	23.7
21	Kolavi Sugars Gokak	7.8	5.60	300	40.83	520	9.3

TDS of present samples varied from 147-2400mg/litre .On the basis of TDS, salinisation of groundwater is defined by Mehta et al.[12] The waters with TDS content ranging from 400 to >3000 mg /l have been designated as saline water. Hem.[13] classified water into four categories based on the TDS values. They are slightly saline (1000-3000 mg/l), moderately saline (3000-10,000 mg/l), very saline (10000 to 35000 mg/l) and brine (>35000 mg/l). By using the same criteria, the wells along the cross section of Pravara basin were classified.

CHLORIDE

The chloride concentration in the effluent water ranges from 19.36-347.9mg/l. Hence higher concentration of chloride in the area close to sugar-mill and other industries indicate contribution of chloride could be due to mixing of waste waters and severe contamination of groundwater from the chloride rich effluent as the source. The presence of chloride in natural water is attributed to dissolution of salt deposit, discharge of effluents from industries. Chloride is not toxic, but some people can detect a salty taste at 250 mg/l. Water with high chloride may also have high sodium content. High chloride may also speed up corrosion in plumbing (just as road salt does to your car).

CHEMICAL OXYGEN DEMAND

COD values of effluent water ranged from 14.4-977.6mg/l. The COD value of the effluent was 3140mg/L, while the recommended level set by BIS is 250 mg/L; the measured COD indicates the high organic load similarly other factors exceeded the permissible limits. Thus it is clear from the data that COD of untreated and treated effluents exceed the BIS limit. COD of sugar mill effluent is high because the presence of high amount of organic waste. Importance of organic matter in the ecology of bloom firming cyano bacteria has been reported by many workers. In a study, Saranraj,[14] analysed various parameters of sugar mill effluent and they have recorded the COD was 3260 mg/l. The COD test determines the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. It is a fact that all organic compounds with few exceptions can be oxidized by the action of strong oxidizing agents under acidic conditions COD is a useful in pinpointing toxic condition and presence of biologically resistance substances.

BOD

1.5-43.2ppm. BOD of both treated and untreated effluent exceeds the permissible limit. Jadhav et al.[15] analysed the BOD of sugar mill effluent 95-697 at different unit of sugar mill. The BO is a very slow process in oxidation; organic pollutants are oxidized by microorganisms into carbon dioxide, water using dissolved Oxygen. In the present study, the BOD of the untreated effluent was 86mg/lit. According to BIS Indian standard the BOD should not exceed the 50 mg/l.

CONCLUSION

Sugar industries are playing a significant role in the economic development of Indian and other developing countries, but the effluents produced by these industries contains a high degree of organic pollutant. Effluent released from these industries may alter the physico-chemical characteristics of the receiving aquatic bodies and also affect the life of aquatic flora and fauna. Results of present study concluded that physico-chemical parameters such as pH, EC,, TDS, chloride BOD and COD were relatively high in the treated effluent of studied sugar mill. The persistent discharge of the effluents may result into severe accumulation of the pollutants in environment. This may adversely affect the lives of plants as well as animals around the sugar mill. Hence, there is an urgent need to treat the effluents properly before the final discharge. Effluents which are released from sugar mill may be utilized for industrial processing again, after treatment and it is profitable for sugar industry. The sugar mill effluents are having higher amount of acidity, suspended solids (TSS), chloride, BOD and COD etc.

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