Global Scientific JOURNALS

GSJ: Volume 7, Issue 7, July 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

Assessment of Wastewater Quality of Selected Sugar Mills in Pakistan

Aijaz Panhwar[1]*, Khalida Faryal[2], Aftab Kandhro[3], Sofia Qaiser[1], Tooba Naveed[1], Niaz Memon[1], Zainulabdin solangi[1]

[1]Pakistan Council for Scientific and Industrial Research, Karachi, Pakistan
[2]Institute of Environmental Sciences, University of Sindh, Jamshoro, Pakistan
[3]M.A. Kazi Institute of Chemistry, University of Sindh, Jamshoro, Pakistan

Corresponding author email: aijazap@yahoo.com

ABSTRACT

The wastewater has becomes the biggest issue and threat to the world. In developing or less developed countries are victim of different diseases by wastewater. The wastewater from sugar industries is one of the complex issues throughout the world. It is also biggest challenge for environmentalist for economic and environment friendly treatment of wastewater. Thirty samples of wastewater were collected from ten different locations and analyzed in triplicate. Various parameters were determined such as pH, Temperature, EC, TDS, TSS, Color, BOD, COD, Cl, PO_4, NitratO_3, and oil & grease. These effluent samples contained high concentration of TDS, TSS, Cl, COD, BOD, and EC. These results were compared with NEQS limits and almost were exceeded the permissible limits as per standards. It was concluded that the sugar mills wastewater were highly polluted than the standards stipulated by the National Environmental Quality Standards & Environmental Protection Agency. It is suggested that without proper treatment of the effluent, is not suitable to discharge directly into canals, aquatic bodies as well as agriculture lands.

Keywords: pH, Wastewater, NEQS, EPA, Effects, Treatment, Characteristics, Environment.

1. INTRODUCTION

Pakistan is an agriculture based country. Majority of the population directly or indirectly connected and depend upon the agriculture sector. The sugar industry is one of the most important, organized industrial sector and second largest agro based industry, which is source of livelihood of majority of the population and accommodates huge number of population in the business. The focus of the current study was Sindh, a province of Pakistan, to assess the quality of sugar mills wastewater focusing on physico-chemical properties. Pakistan is 8th largest sugar producer with 7.42 metric ton in world. Consumption of sugar in Pakistan is 5.40 metric ton. Basically it is seasonal industry in nature. It operates only for 120-180 days (November- April) in a year. [1]. There is huge demand during the production of sugar. It is also vital sources for human diet. Sugar industry is large water consuming as well as largest wastewater producer industry during the manufacturing of sugar. Sugar can be produced from sugarcane and sugar beet. Out of 120 nations nearly 65 nations produced from sugarcane, nearly 40 from sugar beet and 10 from both [2]. Wastewater is another issue from this industry and threats to our environment. Water quantity required can vary due to the application of new technology and quality of raw material used. An average of 30,000 - 40,000 liters of effluent generate from per tons of processed sugar [3]. Physico chemical analysis of polluted water sample is very important to get exact idea about the quality of water. It is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Wastewater from sugar mills with its high value of BOD rapidly depletes available oxygen supply when discharged into water bodies endangering fish and other aquatic life [37]. The effluent discharge by sugar industries has complex features and biggest threat to treat and utilization [36]. The high value of BOD also creates septic conditions, generating foul-smelling hydrogen sulfide. Currently, the wastewater is typically stored in unlined lagoons, posing a groundwater contamination problem, which is of particular concern in areas where drinking water comes from groundwater supplies [4]. The outcome of the study is that from raw to end product of sugar processes have many challenges and require proper management, otherwise causes a major effect on the environment. The UN also estimates that the amount of wastewater produced annually is about 1,500 km^3, i.e. 06 times more water than exists in all the rivers of the world [5]. The effluents from sugar mills are discharging without treatment into fresh water bodies which makes poor water quality. This polluted water is utilized by human for drinking, domestic, agriculture and industrial purposes. Sugar factories are based on agriculture which are playing major role for strengthening national

economy and social development of a country [6]. Chemicals used in sugar processing are toxic; if not well treated might ultimately find their course into the streams which make poor quality of fresh water bodies [8]. The wastewater generated from sugar mills infiltrate into soil and leaches into ground water forming contaminated pool which disturb the groundwater quality by changing its chemical composition properties [9]. Discharge of wastewater with a high TDS level would have an adverse impact on aquatic life, render the receiving water unfit for drinking and domestic purposes, reduce crop yields if used for irrigation, and exacerbate corrosion in water systems and pipe [10]. The sugar mill is coming under those agro-industries which require a large quantity of fresh water for processing and discharge half of the ratio as effluent. It required 1500–2000 L of water to crush one tone of sugarcane and generated 1000 L of wastewater [11]. Disposal of industrial waste has created dual problem that has degraded the soil fertility and contaminated the food- chain [12]. Large amount of effluent generated during the manufacture of sugar contains a high amount of pollution load particularly suspended solids, organic matters, press-mud, bagasse and air pollution [13, 14]. Discharge of sugar industry effluent to the land of irrigation influences the physico-chemical properties of soil [15, 16]. Chopra and Pathak have showed that the sugar mill effluent can be a source of contamination to the soil as some toxic metals may also be transfer to roots and then to leaves [17]. The polluted soil by sugar industry becomes unsuitable for agriculture crops [18].

1.1 Research Area

The Hyderabad & Thatta region covers the areas of eight (08) districts including Hyderabad. Population of the region is approximately 10.592635 million, [19]. There are 17 sugar mills in this region out of 38 mills in sindh [20].

2. MATERIALS & METHODS

2.1 Sampling and its preparation

The effluent samples were collected from the final drain carrying waste water at the time of production before discharging into their disposing locations. Thirty samples of effluent were collected from ten selected sugar mills. The cleaned and air tight plastic were selected for wastewater samples. Some physical parameters analysis was done on site; while the samples were preserved for chemical testing and transported to maintain the sample container temperature at 4^0C. Standard protocols/procedures have been used for the collection, transportation, storage and chemical analysis of the samples; before analyzing the samples in laboratory and subjected to physico- chemical parameters by using standard procedures [21].

2.2 Reagents and glasswares

Ultrapure water obtained from milli purifier system (USA) and used all over the study. All chemicals were used of analytical reagent grade by E. Merck. The samples were digested by concentrated HNO_3 and H_2O_2. Working standard solutions were prepared immediately from stock standards; and stored at -4°C until needed for analysis. Plastic and glasswares were cleaned by soaking in 2M of HNO_3 solution for overnight.

Table 1.Experimental Instrumentations [35]

Parameters	**Results**	**Instruments**
pH	1-14	pH Meter
Total Dissolve Solids (TDS)	ppm	Gravitational Method
Total Suspended Solids (TSS)		Standard method
Dissolve Oxygen (DO)	ppm	D.O. Meter, Hanna, U.K,
Electrical Conductivity (Ec)	(µs/cm)	Conductivity meter WTW LF 330/SE
Chemical Oxygen Demand (COD)	ppm	Hach digestion device (Model: DRB200: Digital Reactor Block) and Hach spectrophotometer (Model: DR 3900 Benchtop spectrophotometer)
Biological Oxygen Demand (BOD)	ppm	BOD5 Track Method
Chlorides	ppm	Standard Titration Method
Nitrate	ppm	UV/Visible spectrophotometer, Perkin Elmer Lambda 2
Phosphate	ppm	UV/Visible spectrophotometer, Perkin Elmer Lambda 2

2.3 Measurement of Physico-chemical parameters:

The purpose of this study was to measure various Physical Parameters such as pH, turbidity, temperature, color, odor, EC, TDS, TSS, COD, BOD, DO, Cl, SO_4, NO_3 and oil & grease, by standard methods [22].

2.4 Statistical analysis:

All experimental data were examined in triplicate and calculations (mean+std) were done by Excel.

2.5 Software used:

MS office Excel software used for results.

3. RESULTS & DISCUSSION

Table 2. Physico-chemical results of Sugar Mill effluent .

Parameters	**S-1**	**S- 2**	**S- 3**	**S- 4**	**S- 5**	**S- 6**	**S- 7**	**S- 8**	**S- 9**	**S- 10**
pH	5.2	4.1	8.9	7.1	6.9	6.2	5.7	5.9	7.4	6.8
Color	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Temp	34	36	39	39	35	39	37	38	33	40
Ec	2605	3690	7613	3760	5260	4034	3686	3919	3976	7698
TDS	1298	1841	3808	1870	2626	2011	1840	1957	2002	3840
TSS	187	570	514	921	289	210	306	704	809	706
DO	2.9	2.7	1.6	1.5	1.2	3.4	4.5	3.6	4.4	2.1
BOD	639	809	2362	1573	2056	1912	810	918	612	907
COD	1480	1207	3602	3516	2800	1310	1208	1629	1738	2216
Oil & Grease	101	107	291	386	491	102	210	303	127	287
Chlorides	230	303	460	316	408	390	288	307	290	206
Sulphate	660	390	490	416	360	411	376	409	388	398
Nitrate	6.1	5.9	6.2	5.8	5.5	6.8	7.2	7.9	7.7	6.6

The pH measure was range varying from 4.1 to 8.9 within PEPA [38] and NEQS [39] limit. Some sugar mills 1, 2, 7, 8 show pH value below the lower limit. The lower pH values of these mills may cause of degrading of water quality. In the present investigation the colour of the untreated effluent was Brown. It was observed visually. The water discharged from these industries, higher temperature varies from 34 to 40 ^{0}C. The upper limit of the temperature in discharged industrial wastewater should not above 40◦C; the chemical changes in oxygen may accelerate due to increase of the temperature. The EC is denotes for dissociated dissolved substances and it depends upon degree of dissociation of ions and their concentration, temperature, and change of ions in the electric field [23]. The results of electrical conductivity of analyzed samples were in range from 2605 to 7698 mg/l. The results show that there is a no single sugar industry whose sample's

results are within permissible limit within the permissible limit of NEQS [39] which is 680 mS/cm. The analyzed TDS values of samples of sugar industries are ranging from 1298 to 3840 mg/L. The values of TDS of these samples are higher than permissible limits of NEQS [39]. Maybe the highest limit of TDS in wastewater to be used for agriculture practices ought to be within the range of 1850 - 2000 mg/l [24]. TSS is aesthetically displeasing and may destroy aquatic life. Results show 187 to 921 mg/l are not within permissible limits of NEQS [39]. Sample collected from mill number 4, shows highest values of 921 mg/l. The results 1.2 to 4.5 show that there is very low oxygen for aquatic life in water bodies which may cause death of aquatic life. The BOD is also an important parameter that point out the extent of water pollution and in the present study BOD of the untreated effluent is varying from 612 to 2362 mg/, which is much higher from all sugar mills. All organic matter content in the effluent sample which includes both biodegradable fraction and non-biodegradable fraction that survive bacterial attack but it can be oxidized by strong chemical oxidants [25, 26, 27]. The analytical time of the parameter is about three hours. The result of these sugar mills effluents is varying from 1207 to 3602 mg/l. Among analyzed parameters the oil and grease is one of the most complicated pollutants [28]. They are non-polar and hydrophobic in nature [29]. The existence of oil and grease stops transfer of oxygen from atmosphere to water and reduces the amount of DO [30]. In the present study oil and grease was 101 mg/l to 491 mg/l. The analyzed values of chloride parameter of untreated effluents were 230 mg/l to 460 mg/l. The highest value of chloride may be due to use of chlorine compounds such as hydrochloric acid, hypochloric acid and chlorine gas in various processes [31]. The results of the sulphate parameter in present study were within the range of 360-660 mg/l. [32, 33, 34] Observed that the distance increases from the outlet, the value of sulphate decreases. Sulphate is a colorless odorless compound of sulfur and oxygen and occurs as a dissolved salt in natural water, polyatomic ion, and using different industries. While the analysed values for nitrate were between the range of 5.5-7.9.

4. CONCLUSION

It is revealed in this work that achieved results are greater as compared to other studies conducted by different researchers in different countries. The values obtained are much higher limits set by NEQS for discharging wastewater into water bodies. The presence of high amounts of COD, BOD, TSS, TDS, and low contents of DO is responsible for the depletion of the oxygen. There is need to be proper monitoring of the effluents characteristics for better environmental protection and to save the fresh water resources and fertile agriculture lands. It

was observed that there was not single flow meters were installed at inlet and outlet of discharging point. It is recommended that wastewater flow may properly monitor using flow meter and NEQS limits implemented. Results of all sugar mills effluent revealed that wastewater treatment plant working properly. Attention is required on advanced treatment technologies to treat the wastewater.

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