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PHYSICO-CHEMICAL CHARATERIZATION OF SUGAR INDUSTRIES EFFLUENT IN SINDH, PAKISTAN

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ABSTRACT

Physico-chemical profile of sugar industries effluents in Sindh has been studied in this paper, this is in fact an attempt to bring in factual position in this area of concern. The concerns are addressed to Eight sugar mills which is spread over upper, middle and lower Sindh. Only those parameters have been studied which have greater impact on environment such as pH, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Suspended Solid (TSS), oil and grease.

All the parameters found in the effluent are far beyond the Sindh Environmental Quality Standards (SEQS) limits. This is in return rendering the effluents highly toxic and is damaging our underground water and the water in the irrigation canals at large. All effluents before being discharged into the mainstream of the public system should be extensively treated and made sure for being absolutely safe for further use.

Key words: Chemical Oxygen Demand, Dissolved Oxygen, Waterborne Disease, Toxic, Pollution

INTRODUCTION

For sustaining life on the planet earth, access to clean water is the most vital and significant need for human life. Since, fresh water accounts for only about 2–3% of all water on Earth, while the remaining volume of water is salt water (Kundzewicz, 2008; Lohmann and Lorenz, 2000; Ruini *et al*., 2013). Since, fresh water is divided unevenly between the continents which consist of ice, groundwater, and surface water (Lohmann and Lorenz, 2000). Nearly 800 million people lack safe drinking water globally (UNICEF, 2014) and among them a vast majority of those who lack access to high-quality water live in rural areas. On the other hand, billions of liters of various types of environmentally problematic industrial wastewater are generated daily on a global scale (Linares Hernandez *et al*., 2009).

Sugar industry is known to be one of the best organized industrial sectors in the country. In Pakistan it is also among the country's leading economic enterprises, which is directly or indirectly employing over 10 million people. (Hagler Bailly, 1999).

Effluent water generation by the sugar industry creates environmental issues pertaining to water and land pollution. The groundwater quality is changed by changing its chemical composition due to the infiltration of waste water into subsoil. The waste water (effluent water) generated from sugar industry leaches into groundwater forming contaminated pool and degenerating the ground water (Agale, 2013). By product, of different sugar industries are used as raw material. Therefore, the greatest impact on environment is caused by our sugar industry. Discharging of effluent into the water body is directly associated to the chemistry of water which is changed drastically due to this imbalance.

The releases of effluent without treatment into the water in sugar industry results in obnoxious smell and color. This action of the industries reduces the health of soil and also damages the eco-system of water bodies.

High temperature of water is associated due to the high levels of total suspended solids and decrease in dissolved oxygen (DO) level in terms of water quality. Water molecules will absorb less heat as compared to suspended particles. This resultant heat is then transferred to the surrounding water by conduction. Cold water absorbs more dissolved oxygen as compared to warmer water, so DO levels will drop. Due to increase in surface temperature, stratification, or layering, takes place. The upper and lower layers do not mix when water stratifies. Since, decomposition and respiration are caused in the lower layers, as a result of this they become too hypoxic (low dissolved oxygen level) for organisms to survive. Available, oxygen level rapidly depletes due to high Biological Oxygen Demand and Chemical Oxygen Demand.

Since, fish and other aquatic life is endangered due to this depletion, which is also a cause of septic conditions. Foul-smell of hydrogen sulfide is generated due to this reason. Because, of the precipitation of Iron and any dissolved salts, the water will turn black and highly toxic for aquatic life. An adverse impact is rendered due to the high Total Dissolved Solids (TDS) level, which in turn makes the water unfit for drinking and domestic purposes. If this water is used for irrigation purpose crop yield will reduce and exacerbate corrosion in water systems and pipe (ETPI, 2001).

Highly colored water causes lower light penetration, and is also unacceptable aesthetically; this reduces production of phytoplankton and, by association, zooplankton, and fish and dissolved oxygen.

The pH directly affects the solubility of many toxic and nutritive chemicals. The availability of these substances affects the aquatic organisms. As a result of the increase in acidity, most metals become more water soluble and more toxic. Due to the decrease in pH (increase in acidity) the toxicity of cyanides and sulfides also increases. Because ammonia becomes more toxic due to slight increase in pH such changes can tip the ecological balance of the aquatic system, therefore excessive acidity particularly; can result in the release of hydrogen sulfide. As a result of the domestic uses of eutrophied water dermatitis, skin disease or other water borne disease have become a common health complain (Nadia and Mahmood, 2006).

MATERIALS AND METHODS

Eight samples collected from the different sugar mills located in upper, lower and middle Sindh in the year of 2012 and in 2013. All waste water samples were collected in 1000mL plastic bottles for testing and 500 mL sample was taken in glass bottles for oil & grease. Before use the bottles were cleaned with detergent then washed and rinsed with distilled water. The bottles were dried, capped and labeled. Samples were immediately brought in the laboratory and refrigerated at 4^oC.

Analytical Procedure

Analytical grade chemicals were used for performing the standard analytical methods for the estimation of testing parameters. The pH was measured immediately in the field with the help of digital pH meter and all other testing was completed within 5 days. COD, BOD and TSS were measured by the standard method of HACH, while Oil & Grease was analyzed by gravimetric method.

RESULT AND DISCUSSION

Effluents of the different sugar mills were analyzed for various important Characteristics such as pH, total suspended Solids, Biological oxygen demand, Chemical oxygen demand (COD), oil & grease.

pH

The pH is a measure of the acidity or basicity of an aqueous solution. Solutions with a pH less than 7 are said to be acidic while solutions with a pH greater than 7are basic or alkaline. According to chemical analysis of industrial effluents the SEQS limit of pH was found to be in the range: 6.5-8.5 and the ranges mentioned in Sindh Environmental Quality Standards (SEQS) is from 4.60-7.80. The pH value in the effluents of these Industries were beyond the permissible limit of SEQS therefore, this increase in pH value will adversely affect the aquatic life due to its high acidic nature.

Chemical Oxygen Demand (COD)

The amount of oxygen required to completely oxidize the organic matter in waste water and then converting it to CO_2 and H_2O is known as Chemical oxygen demand (COD) .According to SEQS limit the COD should be within 150-400mg.L^{-1} before discharge .The COD of the various industrial effluents range from 576-6785mg.L^{-1}, comparing with SEQS standards the COD value in the effluents of these Industries were beyond the permissible limit therefore this will be a major cause for affecting the aquatic life and marine life.

Biological oxygen demand (BOD)

B**iod**egradable materials in water is measured by Biological Oxygen Demand which helps in the development of bacteria and other organic byproducts (Manahan, 1994). In natural source oxidize able matter enters into biogeochemical cycle. BOD does not work independently, hence it performs well depending on so many called factors. Low value of BOD in comparatively wider months may be due to lesser quantity of total solids, dissolved solids, suspended solids in water as well as to the quantitative number of microbial pollution (Avasan and Rao, 2001). The SEQS limits for BOD from various industrial effluents before discharge ranges from 80-250 mg. L^{-1}. The biological oxygen demand in various industrial effluents ranges from 240-3200 mg. L^{-1}. It will have an aadverse effect on aquatic life due to depleted O_2 level in water. Comparing with SEQS standards, the BOD value in the effluents of these Industries were beyond the permissible limit.

Table 1. Physico-chemical properties of Sugar industries Effluents in Sindh, Pakistan.

S. NO	SUGAR INDUSTRIES		pH	COD mg/L	BOD mg/L	TSS mg/L	OIL & GREASE mg/L	AREA
SEQS	LIMITS	1	**6—9**	**150**	**80**	**200**	**10**	
		2	**6—9**	**400**	**250**	**400**	**10**	
		3	**6—9**	**400**	**80****	**200**	**10**	
1	Industry 01		6.41	6785	3200	622	7	Hyderabad
2	Industry 02		7.67	1097	500	8	3	Sukkur
3	Industry 03		5.86	880	552	315	8	Tando Mohd Khan
4	Industry 04		4.81	3650	1540	625	6	Shaikh Barkhio
5	Industry 05		6.02	680	295	235	BDL	Noro Koro Khairpur
6	Industry 06		7.8	1130	500	355	4	Mirpurkhas
7	Industry 07		4.6	1818	800	99	5	Thatta
8	Industry 08		6.41	576	240	87	3	Khairpur sukkur

SEQS= *Sindh Environmental Quality Standards.*

1 = *SEQS for Municipal and Liquid Industrial Effluents into Inland Waters*

2 = *SEQS for Municipal and Liquid Industrial Effluents into Sewage Treatment*

3 = *SEQS for Municipal and Liquid Industrial Effluents into Sea*

**** =** *The Value is 200 mg/L for Industry*

Total suspended solids (TSS)

Suspended solids are the cause of suspended particles inside the water body which influences turbidity and transparency and also affects the light intensity of water. Devi (1980). Recorded total plankton, showed a very close relationship with suspended solid. Effluent from different industries have different amount of solid particulate matter either as suspended solids or total dissolved solids. The stream health and aquatic life is affected due to high concentrations of suspended solids. The SEQS limit for TSS is 200-400 $mg.L^{-1}$. The total suspended solids in various industrial effluents ranged from 8.0-625 $mg.\ L^{-1}$. It is evident from the results that the wastewaters of various industries had high TSS and were above the permissible limits of SEQS.

Oil and Grease

Oil and grease (O & G) is a measure of a variety of substances including fuels, motor oil, lubricating oil, hydraulic oil, cooking oil, and animal-derived fats**.** The concentration of these substances is typically measured within a body of water. Lakes, river, storm water runoff, and wastewater were all monitored for oil and grease. Oil and Grease is debilitating in that it is insoluble in water. When cooled, grease thickens and sticks to the metal piping, accumulating upon itself. The SEQS limit for Oil & Grease is $10 mg.L^{-1}$. The oil & grease in various industrial effluents ranged from BDL-8.0 $mg. L^{-1}$.

Conclusion

For evaluating the pollution load of industrial effluents in the Industries of Sindh samples were drawn from different sugar industries which were analyzed for various physico-chemical parameters and results were compared with values of Sindh Environmental Quality Standards (SEQS, 2000) for industrial effluents. The values of pH, TSS, COD, BOD were found to be beyond the permissible limits as compared with the SEQS values. The characterizing of effluent load is effective in quantifying the loadings from the industries. If the suspended solids are greater than 300 mg/L, the concentrations of parameters associated with suspended solids. The Quality Assurance /Quality Control procedures are an important component of the characterization procedure particularly for parameters near the detection limits or within 10 times the minimum detection limit. Waste water discharged from the sugar industry is highly polluted and exceeds the prescribed NEQS limits for irrigation and public use, therefore it has been proven that it cannot be used for both purposes.

REFERENCES

American Public Health Association (APHA (1995). *Standard Methods for the Examination of Water and Wastewater.* Lenore S C, Greenberg A E, Eaton A D, (Eds.), 19th Edition, American Public Health Association, NW, Washington, DC.

Maruthi, a. and S. R. K. Rao (2001): Effect of sugar mill effluent on organic resources of fish. *Poll. Res.*, 20 (2): 167 – 171.

Devi (1980). *Ecological studies of lemon plankton of three fresh water body, Hyderabad*. Ph. D. thesis Osmania University, Hyderabad.

Environmental Technology Program for Industry (ETPI) (2001). Environmental Technology Program for Industry. Environmental Report on Sugar Sector. Monthly Environmental News 5, Issue 7, pp. 11-27.

Hagler Bailly – Sustainable Development Policy Institute (SDPI) (1999). Pollution Prevention and In-Plant Control Measures in Sugar Mills – A Guidebook for Technical and Operational Staff. Islamabad: Sustainable Development Policy Institute (SDPI).

Kundzewicz, Z. W. (2008) Climate change impacts on the hydrological cycle. *Ecohydrology & Hydrobiology*, 8(2–4): 195–203.

Linares-Hernández, I., C. Barrera-Díaz, G. Roa-Morales, B. Bilyeu and F. Ureña-Núñez (2009). Influence of the anodic material on electrocoagulation performance. *Chemical Engineering Journal*, 148(1): 97–105.

Lohmann, G and S. Lorenz (2000). On the hydrological cycle under paleo climatic conditions as derived from AGCM simulations. *Journal of Geophysical Research*, 105(D13): 417–436.

Manahan, S.E. (1994). *Lewis Publisher, Environmental Chemistry*, 6th. Ed., CRC Press Inc. USA

Agale, M. C., N. G. Patel and A. G. Patil (2013). Impact of sugar industry effluents on the quality of groundwater from Dahiwad village, District Dhule (M.S.). *Archives of Applied Science Research*, 5 (2): 58-60.

Nadia M A. and A K. Mahmood (2006). Study on Effluent from Selected Sugar Mill in Pakistan: Potential Environmental, Health, and Economic Consequences of an Excessive Pollution Load, Sustainable Development Policy Institute (SPDI).

Ruini, L., M. Marino, S. Pignatelli, F. Laio and L. Ridolfi (2013). Water footprint of a large-sized food company: The case of Barilla pasta production. *Water Resources and Industry*, 1– 2: 7–24.

United Nations International Children's Emergency Fund (UNICEF) (2014). http://www.unicefusa.org/ stories/ mission/survival/water/tap-project/ infographic world-water-crisis/ 7556.

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