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EVALUATION OF EFFLUENT QUALITY OF A SUGAR INDUSTRY BY USING PHYSICO- CHEMICAL PARAMETERS

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Abstract: *Water is an essential part of all living organisms. In this connection water plays a most valuable and important role in the natural cycle. Among the whole water availability, only 3% fresh water is available on the earth. In the available fresh water sources, entries of pollutants have been significantly increased from industries and domestic/anthropogenic activities. In this scenario the conservation strategies plays an important role in the conservation of fresh water bodies as well as water quality. Huge quantity of fresh water will be consumed for the production process which will be held in the industry. In the mean while the amount of consumption of fresh water is equal to the amount of discharge of wastewater as effluent. In this aspect the present study pointed out the pollutants concentration in the sugar industry effluent. Once determine the concentration of pollutants in the effluents, the wastewater treatment system can also be modified as per the modern technology to remove the maximum concentration of pollutants in the wastewater. As per the CPCB direction every industry should adopt the Zero Liquid Discharge (ZLD) in their industry premises to avoid discharge of effluent without treatment. In the present study the influent and effluents was analysed of a sugar industry and revealed that the pollutant concentration was comparatively high and by adopting the Biological treatment process with Activated Sludge Process (SAP) the treatment efficiency looks better treatment for the wastewater released by sugar industry. The analysed parameters of the treated effluent are well within the prescribed by the CPCB for the discharge of effluent to on-land standards and discharged wastewater could be used for the agriculture purposes or any domestic purposes in the industry.*

Key words: *Fresh water, Effluent, ZLD, ASP, Sugar industry.*

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INTRODUCTION

In the recent era great concern has been given throughout the universe regarding the environmental pollution from so many aspects since of rapid industrialization and subsequent urbanization (] RA Sail *et al*., 2006). But as for the earlier concept of disposal of treated/untreated wastewater from the industry, treated/untreated wastewater has been drained into the rivers, nearby lakes or streams and by that river body it may spreading over a huge area till that water reaches its final destination (SK Chatterjee *et al.,* 2010; NK Chaurasia *et al.,* 2011). Therefore, the polluted water directly or indirectly affects the lives of flora and fauna which are situated nearby the water sources not only in the industrial area but also in agricultural fields, river and river beds (K Nath *et al.*, 2005). In some of the industries the wastewater may have high level of nutrients, heavy metals and hazardous substances which may help to the microorganisms during the biological treatment of the wastewater (P Malaviya *et al.,* 2007). However, effluents containing various types of metallic and non-metallic elements act as nutrients but at the higher concentration they may show toxic nature on seed germination and seedling growth, ultimately adversely affecting plant growth and yield in agricultural field (YM Avasn *et al.,* 2000).

In countries like Cuba, Jamaica and India the sugar is mainly produced by sugarcane whereas in many countries they will use the beetroots as the raw material instead of sugarcane. There are two categories of sugar manufacturing process viz (i) Carbonation process. (ii) Sulphitation process. But most of the sugar industries in India adopted double sulphitation process for the production of white sugar. The present study sugar industries have following operations:

(i) Milling (ii) Clarification (iii) Evaporation (iv) Crystallization (v) Centrifugation

During the production of sugarcane huge amount of water will be discharged as wastewater to the surrounding with partially or without treatment even the industry has proper treatment plant. The discharged wastewater may release onto surface nearby the industry or water sources such as river or streams. Once the wastewater mixed with water course within in few days it liberates the bad odour and this is common phenomenon.

Sugar industries have an important place in the Indian economic development. However, the wastewater generated from these industries bear a high degree of pollution load. Sugar industries in India generate about 1,000 L of wastewater for one ton of sugar cane crushed.

Wastewater from sugar industry, if discharged without treatment, poses pollution problems in both aquatic and terrestrial ecosystems. In this review, the sugar industry wastewater generation sources, characteristics, recent advancements in the aerobic, anaerobic, and physico-chemical treatment technologies, and the areas needing further research have been explored. Most of the research work for sugar industry wastewater treatments has been carried out by anaerobic treatment processes. However, oil and grease are not easily degraded by anaerobic processes. Also, an anaerobic process partly degrades nutrients whereas, aerobic processes consume higher energy. Anaerobic-aerobic combined systems can remove organics completely. Unfortunately, very few studies are available for anaerobic-aerobic combined systems, and more work is needed in this field.

SOURCES OF EFFLUENTS

The wastewater generated from different process in the industry can be classified as follows:

(**1) Mill House:** The effluent consists of water used from cleaning the mill house which is likely to be converted by spills and pleased sugar juice. Water used for cooling of mills also forms part of the waste water from this source. Basically this water contains organic matter like sucrose, bagacillo, oil and grease from the bearings fitted in to the mills.

(**2) Wastewater from Boiling House:** The waste water from boiling house results from leakages through pumps, pipelines and the washings of various sections such as evaporators, juice heaters, clarification, and pans.

(3) Wastewater from Boiler Blow-down: The water used in boiler contains suspended solids dissolved solids like calcium salts, magnesium salts, sodium salts, fatty salts etc.

(4) Condensate water: The excess condensate does not normally contain any pollutant and is used as boiler feed water and the washing operations. Sometimes it gets contaminated with juice due to entertainment of carryover of solids with the vapours being condensed in that case if goes in to the waste water drain.

(5) Condenser cooling water: Condenser cooling water is re-circulated again unless it gets contaminated with juice, which is possible due to defective entrainment separators, faulty operation beyond the design rate of evaporation etc. if gets contaminated the water should go into the drain invisibly. This volume of water is also increased by additional condensing of vapour of trained from the boiling juice the pan.

(6) Soda and Acid Wastes: The heat exchangers and evaporator are cleaned with caustic soda and hydrochloric acid in order to remove the formation of the deposits of scales on the surface of the tubing. In India, most of the sugar factories let this valuable chemical go into drains. The soda and acid wash contribute considerable amounts of organic and inorganic pollutions and may cause shock loads to waste water treatment.

WASTEWATER TREATMENT TECHNIQUE

Primary treatment: Primary treatment is usually the first stage of wastewater treatment. Many advanced wastewater treatment plants in industrialized countries have started with primary treatment, and have then added other treatment stages as wastewater load has grown, as the need for treatment has increased, and as resources have become available. It is designed to remove gross, suspended and floating solids, oil and grease from raw wastewater. It includes screening of solid material and sedimentation by gravity to remove suspended solids. This level is sometimes referred to as mechanical treatment, although chemicals are often used to accelerate the sedimentation process. Primary treatment can reduce the BOD of the incoming wastewater by 20-30% and the total suspended solids by some 50-60%.

Secondary treatment: In this process it removes the dissolved organic matter that escapes from primary treatment. This can be achieved by using microbes, consuming the organic matter as food, and converting it to carbon dioxide, water, and energy for their own growth and its reproduction. The biological process is then followed by additional settling tanks to remove more of the suspended solids. About 85% of the suspended solids and BOD can be removed by a well running plant with secondary treatment. Secondary treatment technologies include the basic Activated Sludge Process (ASP).

Tertiary treatment: The tertiary treatment can remove more than 99 percent of all the impurities from sewage, producing an effluent of almost drinking water quality. Disinfection, typically with chlorine, can be the final step before discharge of the effluent. However, some environmental authorities are concerned that chlorine residuals in the effluent can be a problem in their own right, and have moved away from this process. Disinfection is frequently built into treatment plant design, but not effectively practiced, because of the high cost of chlorine, or the reduced effectiveness of ultraviolet radiation where the water is not sufficiently clear or free of particles.

Sludge treatment

The purpose of sludge treatment is to destroy the pathogens contained in the sludge and to reduce its objectionable characteristics prior to ultimate disposal. The most common treatment methods are aerobic and anaerobic biological processes.

Aerobic digestion consists of continuously pumping compressed air into a tank containing the waste sludge, allowing the microorganisms present in the waste to further stabilize or treat it. This is typically done for a period of 15 to 30 days. Following this the air is turned off, allowing the remaining solids to settle to the bottom. The clear water is decanted from the top, and the solids withdrawn from the bottom.

Anaerobic digestion consists of mixing the waste sludge in a closed tank for a period of 15 to 30 days. Anaerobic bacteria present in the waste convert much of the waste materials to carbon dioxide and methane gas during this period. This active digestion period is followed by a settling period during which the solids settle to the bottom of the tank. The water is then withdrawn from the top and the digested sludge solids from the bottom.

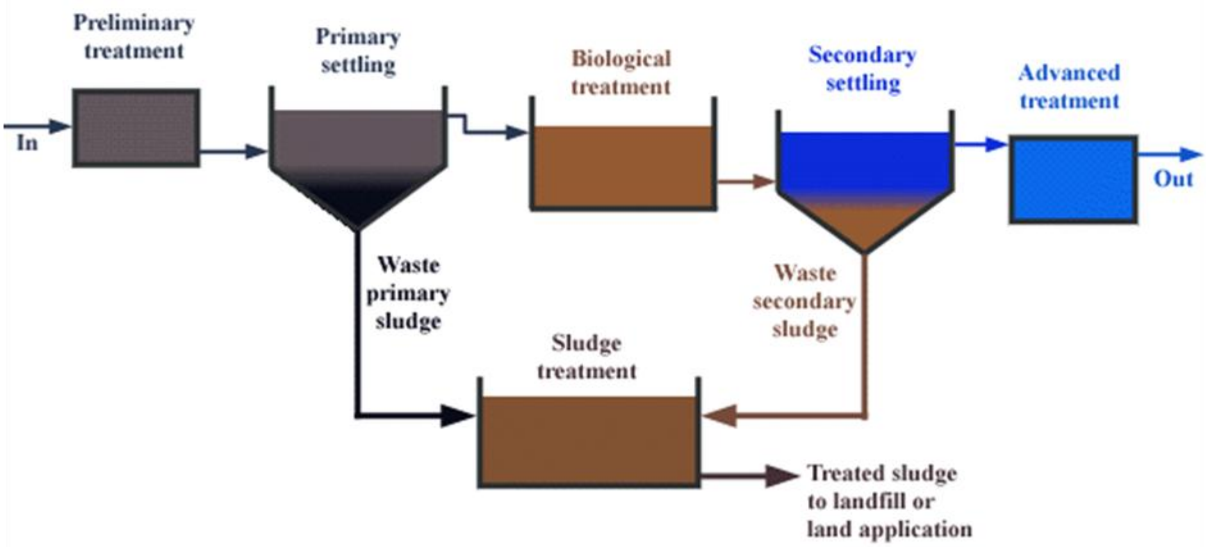

Fig 1: Treatment plant of sugar industry.

Characteristics of Effluents

The characteristics of individual and combined effluents vary from mill to mill and from time to time. All the individual effluents excluding spray pond overflow are acidic and coloured posters disagreeable older, high BOD and suspended solid. The oil and grease content is also high. The characteristics of effluents of a typical sugar mill are given in the following table.

TABLE 1: General characteristics of sugar mill effluent

Sl.No	Parameters	Range
1	pH	6.5-8.8
2	Dissloved Oxygen	0-2.0
3	Biochemical Oxygen Demand (BOD)	300-2,200
4	Chemical Oxygen Demand (COD)	1360-2,000
5	Chlorides	18-40
6	Total Solids (TS)	870-1950
7	Total dissolved Solids (TDS)	400-1650
8	Suspended Solids (SS)	220-790
9	Sulphate	40-70
10	Oil and Grease	60-100

All values except pH are expressed in mg/lit.

MATERIALS AND METHODS

The effluent from sugar mill was collected in glass bottles from the inlet and outlet of treatment plant. Immediately the samples were preserved by adding alkali azide and $MnSO_4$ of 2ml each to fix the dissolve oxygen in the field. For the determination of other physico-chemical characteristics, the effluent and influent were brought into the laboratory.

RESULT AND DISCUSSION

The analysed results were tabulated in Table No.02. The temperature plays a basic factor for determining the quality of effluent its effect on certain biochemical reactions taking place in aquatic condition for aquatic organisms (R Chandra *et al.,* 2011). In the general phenomenon of aquatic condition the temperature lies between the 20^0C - 27^0C, but the effluent of sugar industry has 48^0C and 30^0C in untreated and treated respectively. The increased temperature may accelerate the rate of chemical reaction and chemical changes in the aquatic condition and adverse effect on the agricultural field and yield of the crop (AK Beruch *et al.,* 1993).

pH is one of the very important tool in the aquatic system and its a indicator for the sustainability for the aquatic organisms. Alteration in the pH value of effluent can affect the rate of biological and chemical reaction and survival of various microorganisms. The presence or absence of various ionic special can have direct relation with pH of the effluent. Subsequently the effluent can influence the quality of soil. In the present work the pH varies from 4.8 in the raw effluent and 6.9 in the treated effluent. This increase in the pH of the effluent is due to the addition of the lime during in the equalization tank. The Electrical Conductivity also changes with alteration in the pH. The presence of high chemical constituents the concentration of DO varied between 1.1mg/l to 3.6mg/l for untreated and treated effluents respectively. The increased concentration of DO is due to the proper aeration process during the treatment of effluents. Increased DO related to the BOD and COD removal. Hence the amount of DO is inversely proportional to the amount of COD and BOD load. Once the concentration of DO increased it directly affects on the concentration of chemical composition of the effluents. This aeration technique was provided by fixed aerators in the two tanks. During the removal of chemical constituents in the effluents, microorganisms play a vital role. Hence these microbes will be provided some nutrients during the effluent treatment process. Once the effluents passed from the aeration tank, it moves towards the clarifier. In the clarifier, due to the centrifugal force created by scrapper at the bottom of the clarifier, the denser particles moves towards the bottom of the clarifier. The sludge collected at the bottom will be passed to the sludge drying bed. But subsequently the removal of oil and grease is still require some of the important technique due to insufficient removal of oil and grease content till today in the treated effluent. Without removing the oil and grease in the wastewater it may cause serious water pollution problems in the surrounding water bodies due to formation of oil layer on the surface. Once the formation starts it negatively impact on the aquatic organisms and plants by deteriorating the oxygen level. This oil layer prevents the entry of oxygen in to the interior system of water bodies. Once DO deteriorate its results with anaerobic condition. For the determination of the heavy metals, AAS was used by adding 2ml aquaregia to the effluent sample.

Table 2: The Physico-chemical parameters of treated and untreated sugar mill effluent

Sl.No	Parameter	Untreated	Treated	BIS standards
1	Colour	Dark Brown	Light Brown	-
2	Temperature	48^0C	30^0C	-
3	pH	4.8	6.9	6.5-9.0
4	Dissolved Oxygen	1.10	3.6	4-6
5	BOD	98	76	50
6	COD	385	190	250
7	TDS	3120	1489	2100
8	TS	2150	1460	2700
9	TSS	96	68	600
10	Chlorides	178	140	600
11	Sulphate	580	310	1000
12	Oil and Grease	52	15	10

All values except pH and temperature are expressed in mg/lit.

Table 3: The concentration of Heavy Metals in the sugar mill effluents

Sl.No	Heavy Metals	Untreated (ppm)	Treated (ppm)
1	Cu	0.14	0.06
2	Cr	0.18	0.04
3	Cd	0.14	0.10
4	Zn	1.60	1.10
5	Ni	0.11	0.05

CONCLUSION

In the recent era great concern has been given throughout the universe regarding the environmental pollution from so many aspects since of rapid industrialization and subsequent urbanization. But as for the earlier concept of disposal of treated/untreated wastewater from the industry, treated/untreated wastewater has been drained into the rivers, nearby lakes or streams and by that river body it may spreading over a huge area till that water reaches its final destination. Therefore, the polluted water directly or indirectly affects the lives of flora and fauna which are situated nearby the water sources not only in the industrial area but also in agricultural fields, river and river beds. However, effluents containing various types of metallic and non-metallic elements act as nutrients but at the higher concentration they may show toxic nature on seed germination and seedling growth, ultimately adversely affecting plant growth and yield in agricultural field. Wastewater from the sugar industry contains high concentrations of organic materials which are sometimes discharged into the water sources which is surrounded to the industry. This study examined the treated and untreated effluent characteristics. As per the CPCB direction every industry should adopt the Zero Liquid Discharge (ZLD) programme in their industry premises to avoid discharge of effluent without treatment/partial treatment. In the present study the influent and effluents was analysed of a sugar industry and revealed that the pollutant concentration was comparatively high and by adopting the Biological treatment process with Activated Sludge Process (ASP) the treatment efficiency looks better treatment method for the wastewater discharged by sugar industry. The removal percentage of BOD slightly low than the BIS standards. At the mean time the treated effluents have the some shortage of dissolved oxygen. It may be due to the presence of oil and grease even after the primary treatment. Hence the oil and grease content should be removed for much better treatment of the effluent. Inspite of that the analysed parameters of the treated effluent are well within the prescribed by the CPCB for the discharge of effluent to on-land standards and discharged wastewater could be used for the agriculture purposes or any domestic purposes in the industry. The removal of heavy metals also a good indication of biological treatment method. Effluents which are released from sugar industry should be thoroughly treated and then it may be utilized for industrial processing again.

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