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Performance and Evaluation of Sugar & Distillery Effluent Treatment Plant

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Abstract - *At present Sugar and Distillery Industries are the polluting industries in the environment. The distillery industry wastewater is characterized by its brown colour, low pH, high temperature, high BOD, high COD, odor problem, total solids, and high percentage of dissolved organic and inorganic matter. The sugar industry wastewater is characterized by its high BOD, high COD, brown colour, high percentage of dissolved organic and inorganic matter, low pH, high temperature, odor problem, total solids. So this untreated wastewater will create problem to the environment. The analyzed parameters are pH, COD, BOD, TS, TSS, TDS for Sugar & Distillery Effluent Treatment Plant. Initial concentrations of distillery Spent Wash for COD, BOD, TSS, TS, TDS, are 96,568 mg/l, 41,673 mg/l, 6448 mg/l, 98,883 mg/l, and 92,435 mg/l respectively. After treatment of effluent the removal efficiency of plant for COD,BOD,TDS,TSS,TS is 99.7%,99%,99.7%,98.5,99.6% as it is a zero discharge plant. The low grade potash powder is generated from molasses distillery spent wash .This potash powder is used as fertilizer. It is also a solution for zero water pollution. The powder contains 14.70% of potash. Initial concentrations of Sugar Factory Effluent for COD, BOD, TSS, TS, TDS are 5186 mg/l, 2104 mg/l, 856mg/l, 5779mg/l, 4924 mg/l respectively. After treatment of effluent the removal efficiency of COD,BOD,TDS,TSS,TS are 97%,95%,77.5%,88.8%,79.23% respectively.*

Key Words: BOD, COD, Sugar Industry, Distillery Industry, Potash Powder, TSS, TS, Zero Discharge

1. Introduction

Sugar Industry is one of the most important agro based industries in India and is highly responsible for creating significant impact on rural economy in particular and countries economy in general. Sugar industries rank second amongst agro based industries in India [1]. The industry uses sugarcane as their raw material along with various chemicals added to increase the face value of the final product. During the process a huge amount of water is also used per day and as a result industry generates waste water (effluent) on daily basis [2].Waste water from sugar industries, if not treated properly, contains significant amount of TDS and TSS. This water may not be useful for crop land irrigation. There are reports which indicate that infiltration rate decreases with increased loading of BOD and TDS & TSS. The high value of TSS can cause decrease in soil porosity due to salt deposition. High TDS value in waste water may also have adverse effect on crops. A TDS of 500-1000 ppm may have detrimental effect on sensitive crops. Another important factor in studying the pollution effect is that the sugar industry is seasonal industry and the waste flow is mainly during the crushing season. This causes difficulty in employing biological pollution abatement systems which should otherwise remain very suitable for treating such wastes. [3].

The distillery industry is based on sugar industry. The Indian distillery units use sugarcane molasses as a preferred raw material because it's easy and large scale availability for alcohol production of ethyl alcohol in distilleries based on cane sugar molasses constitute a major industry in Asia and South America. In India there are 285 distilleries, producing 2.71 billion liters of alcohol & generating 40 billion liters of wastewater annually. The wastewater generated from distillery units known as Spent Wash is nearly 15 times the total alcohol production. This Spent Wash is produced as a result of fermentation and distillation of the molasses. Spent Wash is characterized by its reddish brown coloured, high temperature, low pH (3.94-4.5), high ash content & contains high % of dissolved organic and inorganic matter of which 50% may be present as reducing sugars. The Spent Wash contains very high amount of potassium, sulphate, chloride, BOD (40,000-50,000 mg/l) & COD (1,00,000-1,25,000 mg/l) [4].Molasses Spent Wash (MSW) conventionally treated by anaerobic digestion for generation of methane and then aerobically using Trickling Filter or by using Activated Sludge process prior to disposal. But the disposal of these conventionally treated MSW is quite hazardous as they contain brown

coloured recalcitrant compound which have antioxidant properties and are toxic to many Micro Organism [5].Disposal of distillery spent wash on land reduces soil alkalinity and inhibit seed germination [6]. Color of the spent wash reduces sunlight penetration in water bodies causing reduced photosynthetic activity, lower pH value of the stream and dissolved oxygen concentration which affects aquatic life, bad smell [7]. Color of spent wash is largely due to melanoidin [8] .Melanoidin is one of the biopolymers, which are difficult to decompose by microorganisms. The paper contains the study of removal efficiency of BOD, COD, TS, TSS, TDS in Sugar Effluent treatment plant and how Spent Wash management is carried out and zero discharge is achieved. The removal efficiency of BOD, COD, TS, TSS, TDS in digester, lagoon and in plant.

1.1 Material and methodology

Sampling Technique

Water sample will be collected in such a manner that the sample truly represents the water source or the main body of water or wastewater. Sampling is one of the most important and foremost steps in collection of representative wastewater sample from an effluent treatment plant. The reliability of laboratory analysis and tests depends upon the method of sampling. A factor involved in the proper selection of sampling site depends on the objective of the study. A sample volume between 2 and 3 liters is normally sufficient for a fair complete analysis. The total number of samples will depend upon the objectives of the monitoring program. During the study, the samples were collected in clean polyethylene containers. A total of 3 grab samples were collected in each shift and mixed to make a composite sample.

The present study is carried out in M/s. Ugar Sugar Works Ltd. Its sugarcane crushing capacity is 20,000 TCD and a distillery of 75KLPD

1.2 Physical and Chemical methods of analysis for distillery industry wastewater

Some generalized parameters are to be tested to determine the performance and evaluation of distillery industry effluent treatment plant.

Table-1: Analytical Methods adopted for Distillery Industry Wastewater Analysis

	Parameter	Method Used	Experiment Used
1.	pH	Electrometric	Digital pH meter
2.	BOD_5 @ 20°C	Dilution Method	Volumetric glassware's, BOD Bottles, Incubator
3.	COD	Open reflux method	COD apparatus, Round Bottom Flask
4.	Total Solids	Gravity metric method	Gooch Crucible and electronic Balance, Burner
5.	Total Dissolved Solids	Gravity metric method	Gooch Crucible, Centrifuge machine, Electronic Balance, Burner
6.	Suspended Solids	Gravity metric method	Gooch crucible, Electronic Balance, Burner, Centrifuge Machine

Table-2: Typical Composition of Distillery Industry Wastewater

Sl. No	Parameter	Raw Effluent Spent wash	Final treated Effluent Condensate water from multy effect evaporator & dryer(ZLD)	KSPCB standards for Treated Effluent
1.	pH	3.5	8.2	5.5-9
2.	COD(mg/L)	1,18,000	500	-
3.	BOD(mg/L)	41,380	75	100 max
4.	TS(mg/L)	1,00,000	300	-
5.	TDS(mg/L)	99,000	200	2100 max
6.	TSS(mg/L)	1000	100	100
7.	Sulphate (SO_4)	4500	4.34	1000 max
8.	Chlorides	7000	230	600 max
9.	Colour	Dark Brown	Colourless	Colourless

2. Zero Pollution Plant General Description

The Evaporator Plant: The plant is designed for 1060 m^3/d post bio methanated effluent feed is received in a level controlled balance tank and passed through pre-heaters, calendrias and vapor separators of various effects.

The evaporation takes place under vacuum, which is maintained mainly by vacuum system. Steam is supplied as a heating medium to high heater and through thermal vapor recompression (TVR) to the first effect jacket. The concentrated product at the desired concentration is continuously taken out from the plant.

The spray drying plant: The concentrate is sprayed through spray nozzle with the help of high-pressure pump into the drying chamber. The droplets of feed are atomized with the help of steam. The resultant powder is collected in 50 Kg bags. The powder is sold out as manure. The Condensate which comes out of this plant is used for Wet Scrubber.

The system has three advantages namely : 1) 100% achievement of the pollution control parameters prescribed by Ministry of Environment, Government of India and State Pollution Control Board. Being distillery unit comes under highly polluting industry under 17 categories.

2) The bye product is a complete water soluble, fine, brownish colour powder containing mainly potash and other nutrients useful for agriculture purpose.

3) The 100% treated effluent water is recycled for other processes in the factory thereby saving fresh water requirement.

Table-3: Typical Composition of Sugar Industry Wastewater

Sl. No	Parameter	Average Values	Effluent Standard for discharge on inland Surface Water	Effluent Standard for discharge on land for irrigation
1.	pH	5.82	5.5-9.0	5.5-9
2.	COD	5186(mg/L)	250	-
3.	BOD	2104(mg/L)	30	100
4.	TS	5779(mg/L)	-	-
5.	TDS	4924(mg/L)	-	-
6.	TSS	856(mg/L)	100	200

3. Result & Discussion

Distillery

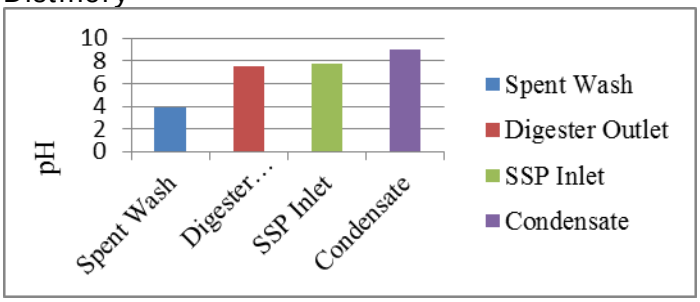

Chart -1: pH of each unit

The BOD, COD, TS, TSS, TDS reduction is 80%,73.68%,65.63%,24.22%,68.62% respectively due to anaerobic digestion takes place in digester.

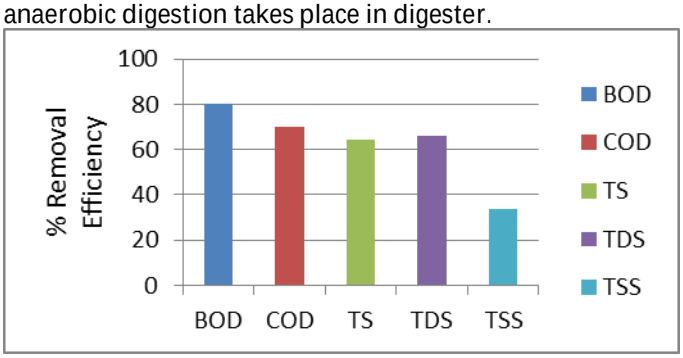

Chart -2: removal efficiency of Digester

The BOD, COD, TS, TSS reduction is 8.35%, 7%, 6%, 49.82% respectively in lagoon. The post biomethanation effluent from lagoon is sent through sand filter bed and sent to Zero Liquid Discharge (ZLD) plant because Total solids required for ZLD plant is 4%.

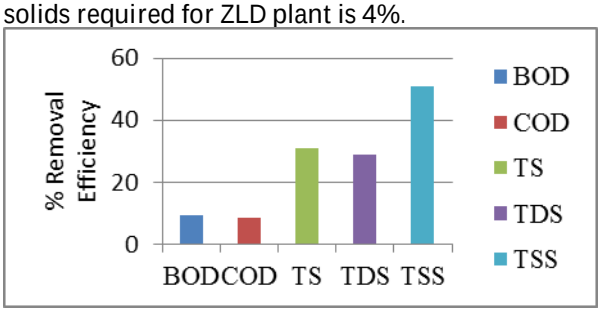

Chart -3: removal efficiency of Lagoon

The overall efficiency of the plant for BOD, COD,TS, TSS, TDS reduction is 99%, 98%, 99%, 94.90%, 99% respectively.

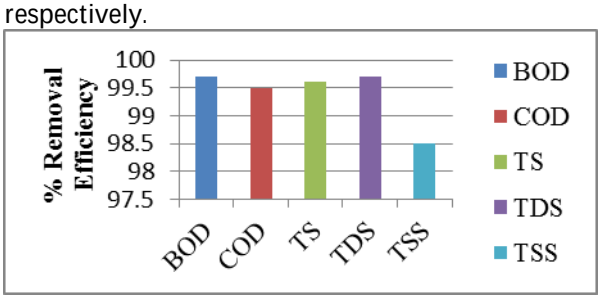

Chart -4: removal efficiency of plant

The powder which is generated from distillery Spent Wash contains=Potassium-14.70%,Phosphorus-0.21%, Nitrogen-1.66%,Gross Calorific Value-2549cals/gm., Organic Matter-26.17%.

Sugar Industry ETP: Generally sugar industry effluent is acidic in nature. The lime is added to the effluent to increase pH value so effluent become alkaline in nature, and then it will easy to treat.

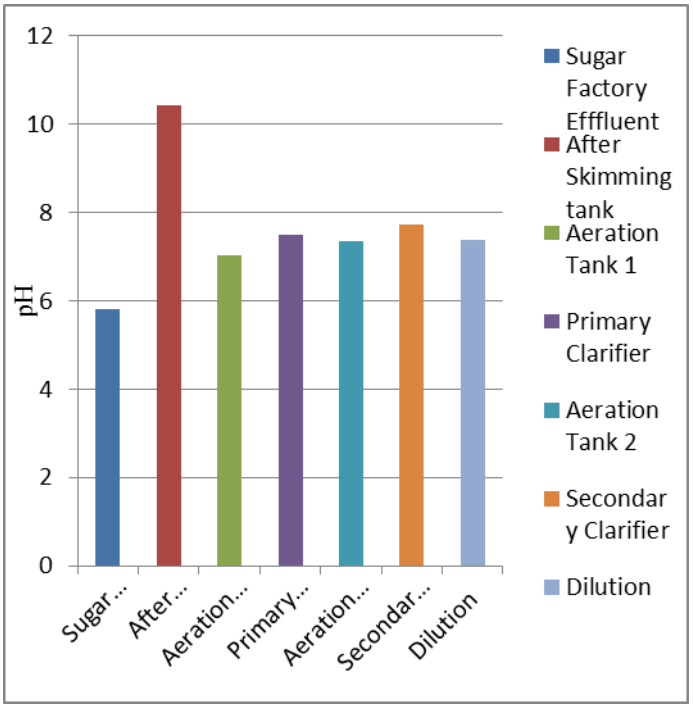

Chart-5: pH of each unit

Since quality and quantity of Sugar mill effluent keeps on fluctuating, therefore an aerated equalization tank is a must. This tank would be aerated. Here reduction of BOD is45%

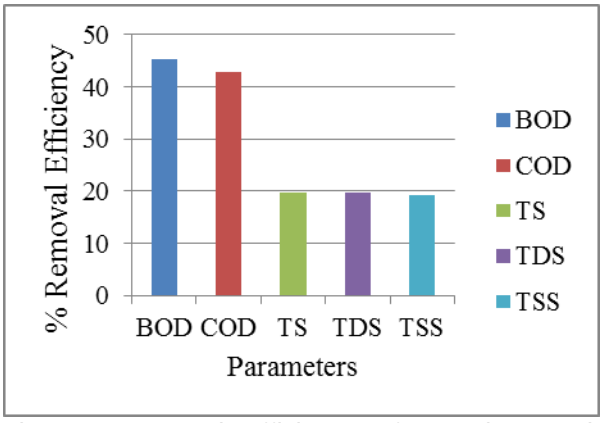

Chart-6: Removal efficiency of Aeration Tank cum equalization tank

Poly electrolyte would be dosed for binding of flocks and their quick settlement in the primary clarifier.

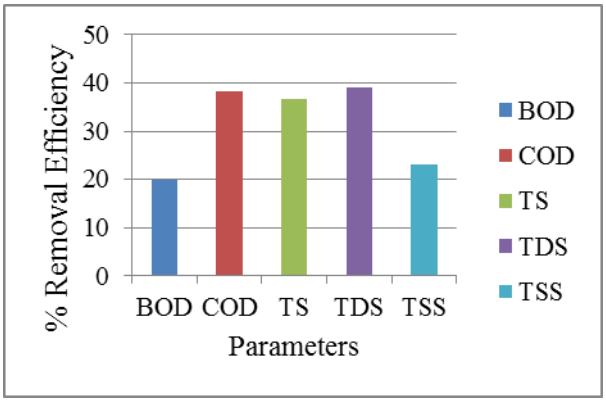

Chart -7: Removal efficiency of Primary Clarifier

The aeration Tank is provided for degradation of organic matter with the help of micro-organism, especially grown and maintained in the Aeration Tank in conjugation with oxygen transferred through Diffused Aeration System. The homogenized effluent is first aerated and agitated continuously in the Aeration Tank. During this process, a mass of biologically active flocks called "Activated Sludge" is formed. Here reduction of BOD is 82%.

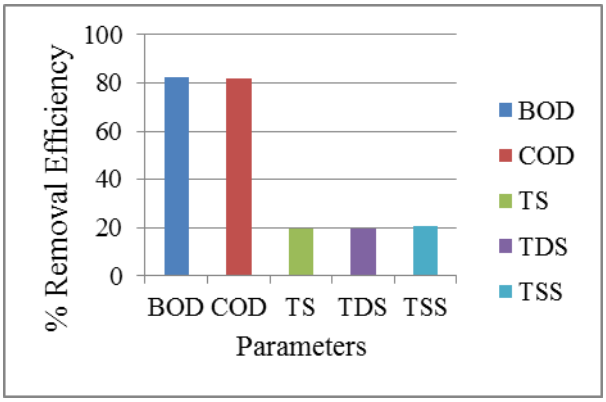

Chart-8: Removal efficiency of Aeration Tank 2

In the 2nd Step of the above process, the mixed liquor passes through Secondary Clarifier where separation of the activated sludge from aerated water takes place. Settled Activated Sludge is removed from the clarifier. One stream, called return activated sludge is sent back to the aeration tank near to the inlet and acts as seed for the formation of more activated sludge and simultaneously maintain the MLSS between 2500- 3000 mg/l. The other stream is excess activated sludge, which is sent for percolation and drying on Sludge Drying Beds.

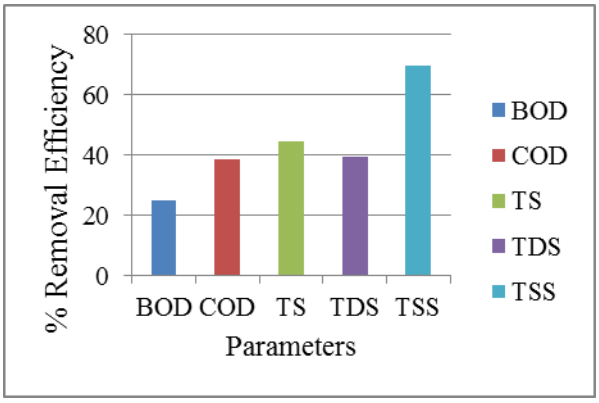

Chart-9: Removal efficiency of Secondary Clarifier

The treated effluent from Secondary Clarifier will be drained out or used for Horticulture/ irrigation after enough dilution with river water.

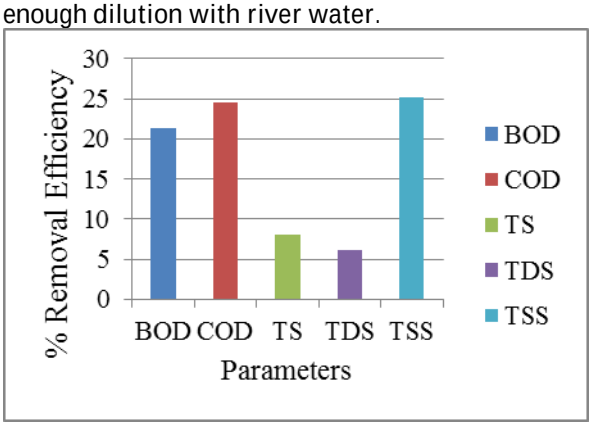

Chart-10: Removal efficiency of Dilution point

3. CONCLUSIONS

The overall efficiency of the plant for BOD, COD, TS, TSS and TDS reduction is 99%, 98%, 99%, 94.90, 99% respectively. The zero discharge of Spent Wash is adopted and from distillery Spent Wash potash powder is generated. This low grade potash powder is used as fertilizer. The condensate which generated from multy effect evaporator and dryer (ZLD) is recycled and reused for wet scrubber inside the factory. After treatment of effluent from Sugar ETP, the removal efficiency of COD, BOD, TDS, TSS, TS are 97%,95%,77.5%,88.8%,79.23% respectively. The final Sugar ETP outlet has following characteristics- COD-155 mg/l, BOD-95 mg/l, TDS-1104 mg/l, TSS-96 mg/l, TS-1200 mg/l.

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