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Neutralization of Acidic Effluent from Sugar Mill using Sodium Hydroxide Flakes

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Abstract - *The Sugar industry is one of the most polluting industries, not only in terms of the volume of effluent generated but also in terms of its characteristics as well. Most of the sugar industries uses lime as a neutralizer in ETP. In this experiment, Sodium hydroxide flakes (NaOH) were used to neutralize acidic effluent from the sugar mill. The performance of sodium hydroxide flakes used for effluent neutralization was evaluated. The experiment was performed using a jar test and its effects on parameters such as pH, total dissolved solids, total suspended solids, total solids, Chemical Oxygen Demand (COD), and Biochemical Oxygen Demand (BOD). During the production of sugar, a large amount of water is used by the sugar mill for processing, thus generating a large amount of effluent. The amount required for sodium hydroxide to raise pH to 7.5 was 0.20 mg/L which is two to three times lower than the amount required for conventional alkalis to raise pH. The results of the experiment show that the removal efficiency of TDS, TSS, TS, COD, and BOD are 82%, 95%, 86%, 96%, and 98%.*

Key Words: Sodium hydroxide flakes, pH, TDS, TSS, TS, COD, BOD.

1.INTRODUCTION

The sugar industry is one of the most important Argo-based industries in India and has a high impact on the rural economy. India continued to rank second among the countries of the world in sugar production. In India, the sugar industry ranks second in Argo-based industries. The sugar industry is seasonal and operates for 5-6 months in a year. The effluent from the sugar mill is primarily generated from the mill house, boiler blow down, filter cloth, condensates, condensers washing, occasional leakages, and molasses mixed water. The Sugar industry is one of the most polluting industries, not only in terms of the volume of effluent generated but also in terms of its characteristics as well. It generates about 1000 liters of effluent per ton of processed sugar. The volume, concentration, and composition of the effluents arising in the sugar industry are dependent on the type of product being processed, the production program, operating methods, the design of the processing plant, the degree of water management being applied, and subsequently the amount of water is conserved.

Sugar mill effluent is characterized by high temperature, high biochemical oxygen demand (BOD), and chemical oxygen demand (COD) concentrations, and generally contains low pH, total dissolved solids, total suspended solids, and total solids. The effluent from sugar mills contains carbohydrates, nutrients, oil, grease, chlorides, sulfates, and heavy metals. As a result, all of these components contribute significantly to their high biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Sugar wastes are dull white in color and usually acidic in nature. The Total suspended solids affect the light intensity of water; suspended solids are the cause of suspended particles inside the water body influencing turbidity and transparency. The pollution effect of sugar waste is attributed to the immediate and high oxygen demand.

The characteristics of a sugar effluent contain Temperature, Color, pH, DO, BOD, COD, total dissolved solids, total suspended solids, total solids, chlorides, sulfate, oil & grease. It depends largely on the quantity of sugar processed. Sugar mill effluent is highly polluting, which makes industries discharging untreated/partially treated effluent a serious environmental threat. As part of the Indian government's environmental protection measures, very strict regulations are in place for effluent discharge. As a result, proper treatment methods are required to comply with effluent discharge standards. Most of the sugar industries uses lime as a neutralizer in ETP. The purpose of this experiment is to determine the effectiveness of Sodium Hydroxide flakes as a neutralizer for effluent shown in figure 1 and its effects on parameters such as TDS, TSS, TS, COD, and BOD.

Fig. 1. Sodium Hydroxide Flakes

2. METHODOLOGY

2.1 Sample Collection

Samples were collected from the inlet tank in a polyethylene plastic can with a capacity of 10 liters. All samples were carried to the laboratory and analyzed within 30 minutes. All parameters were analyzed in accordance with MPCB.

2.2 Experimental Material

The effluent was obtained from The Saswad Mali Sugar Factory Limited, Malinagar, Maharashtra, India. The sodium hydroxide flakes used for effluent neutralization was analytical grade and was obtained from Thermo Fisher Scientific India.

2.2 Experiment Method

Before the neutralization process, the effluent's pH was 4.7, which was raised to 7.5 with 0.20 mg/L of NaOH as a neutralizer. pH was measured by a digital pH meter. TDS, TSS, TS, and COD were measured by Hach DR 3900 Colorimeter. BOD_5 at 20 °C was measured by dilution method. The experiment was repeated three times and the average values were taken as final data.

3. RESULT AND DISCUSSION

The sugar mill effluent characteristic as well as Maharashtra Pollution Control Board is shown in Table 1. Based on the data in table 1, it is clear that observed parameters are out of the limits set by MPCB. Being acidic, pH which is low than 5.0, sugar mill effluent also contains a highly suspended solid as indicated by high turbidity, TDS, TSS, COD, and BOD. The COD, BOD, TSS, as well as turbidity of effluent, was decreased, while TDS increased after the addition of NaOH to neutralize effluent as shown in figure 2. The increase in TDS was mainly due to the increase in the level of dissolved ions present in the effluent which is derived from Na+ ions. Meanwhile, the decrease in TSS and turbidity was due to a small number of suspended solids that precipitate during the addition of the neutralizer.

Sr. No.	Parameters	Average Values	Effluent Standard for discharge on inland surface water	Effluent Standard for discharge on land for irrigation
1	pH	4.7	5.5 – 9.0	5.5 – 9.0
2	TS	756 (mg/L)	-	2300
3	TDS	465 (mg/L)	-	2100
4	TSS	291 (mg/L)	30	100
5	COD	1848 (mg/L)	250	-
6	BOD	554.4 (mg/L)	30	100

Table 1. Typical composition of Sugar Mill Effluent

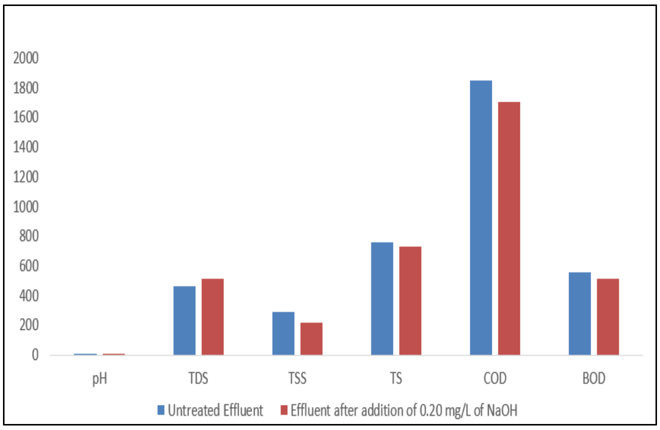

Fig. 2. Observed Parameters before and after the addition of NaOH

3.1 pH

The pH of the untreated effluent from the inlet tank was 4.7, after the addition of NaOH the pH was raised to 7.5, and the pH of the treated effluent was 7.25 as shown in figure 3. So, the pH of treated effluent was within the permissible limit. Untreated effluent has a low pH due to the use of phosphoric acid and sulfur dioxide in sugar cane juice clarification. A wide range in pH values can affect the rate of biological reaction and the survival of microorganisms. The pH of effluent is influenced by the presence or absence of different ionic species. Consequently, soil quality can be strongly affected by such effluent.

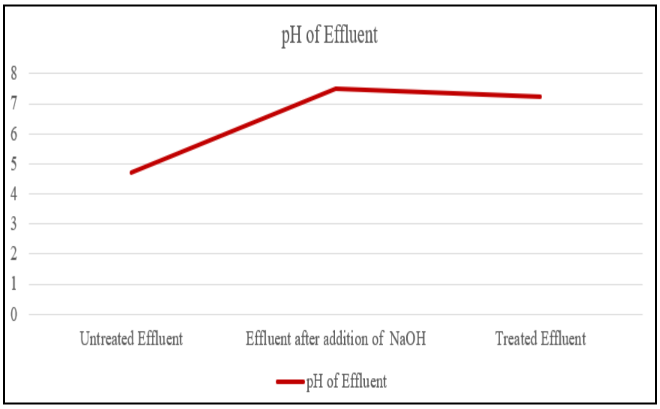

Fig. 3. pH of Effluent after different stages of the experiment

3.2 TDS

The total dissolved solids (TDS) of untreated effluent was 456 mg/L, after the addition of NaOH the TDS of effluent was 516 mg/L, and the TDS of treated effluent was 92.12 mg/L as shown in figure 4. So, the TDS of treated effluent was within the permissible limit. Organic and inorganic materials, such as metals, minerals, salts, and ions, are dissolved in water as TDS. The increase in TDS was mainly due to the increase in the level of dissolved ions present in the effluent which is derived from Na+ ions.

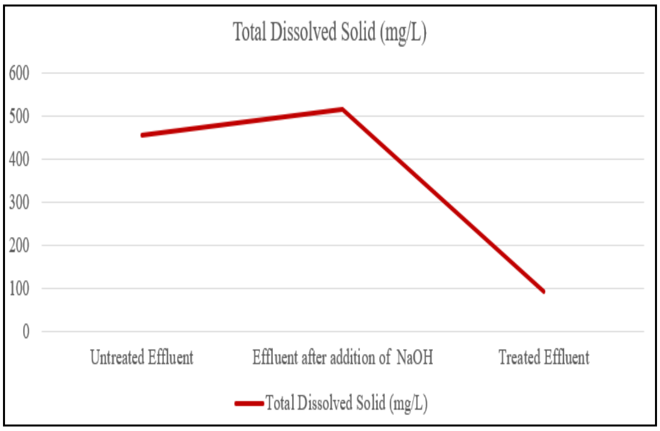

Fig. 4. TDS of Effluent after different stages of the experiment

3.3 TSS

The total suspended solids (TSS) of untreated effluent was 291 mg/L, after the addition of NaOH the TSS of effluent was 216 mg/L, and the TSS of treated effluent was 10.80 mg/L as shown in figure 5. So, the TSS of treated effluent was within the permissible limit. The Total suspended solids affect the light intensity of water; suspended solids are the cause of suspended particles inside the water body influencing turbidity and transparency.

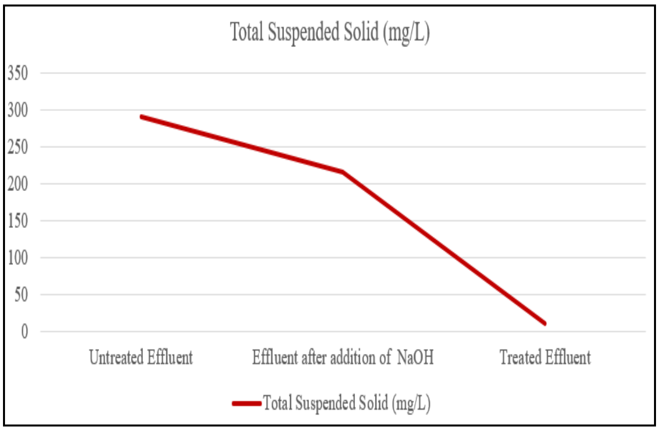

Fig. 5. TSS of Effluent after different stages of the experiment

3.4 TS

The total solids in water are the sum of dissolved solids and suspended solids. The total solids (TS) of untreated effluent was 756 mg/L, after the addition of NaOH the TS of effluent was 732 mg/L, and the TS of treated effluent was 102.92 mg/L as shown in figure 6. So, the TS of treated effluent was within the permissible limit. Solids refer to a matter that can be filtered or remains as residue after drying at a defined temperature on filter paper. n effluent, total solids are mainly made up of carbonates, bicarbonates, chlorides, sulfates, nitrates, calcium, magnesium, sodium, potassium, and manganese and organic matter silts.

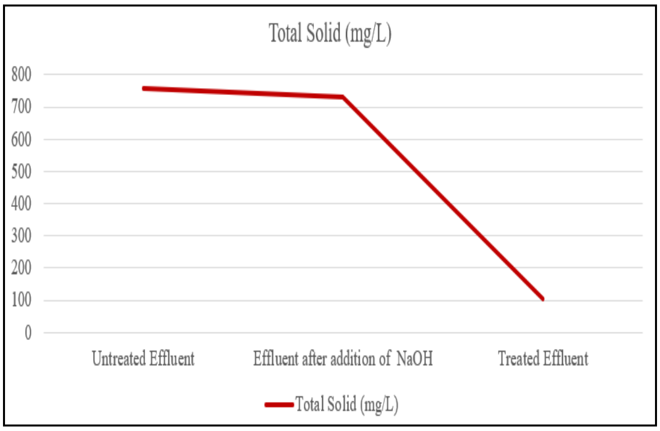

Fig. 6. TS of Effluent after different stages of the experiment

3.5 COD

Chemical Oxygen Demand (COD) of untreated effluent was 1848 mg/L, after the addition of NaOH the COD of effluent was 1703 mg/L, and the COD of treated effluent was 67.90 mg/L as shown in figure 7. So, the COD of treated effluent was within the permissible limit. Sugar mill effluent has a high COD due to the presence of organic waste. COD tests measure the oxygen required to oxidize organic matter using strong oxidants. All organic compounds may be oxidized under acidic conditions by strong oxidizing agents. COD is useful for identifying toxic conditions and biologically resistant substances.

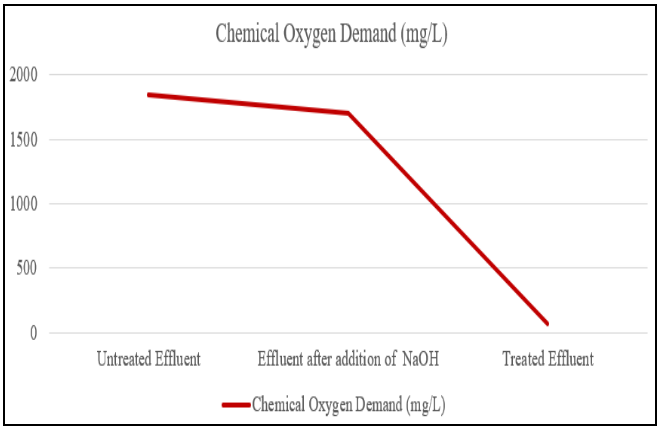

Fig. 7. COD of Effluent after different stages of the experiment

3.6 BOD

Biochemical Oxygen Demand (BOD) of untreated effluent was 554.4 mg/L, after the addition of NaOH the BOD of effluent was 510.9 mg/L, and the BOD of treated effluent was 10.20 mg/L as shown in figure 8. So, the BOD of treated effluent was within the permissible limit. It is defined as the amount of oxygen required by microorganisms in wastewater to decompose organic matter under aerobic conditions. As a result, the BOD is measured by a decrease in dissolved oxygen values at a specific temperature over a specific time. Organic waste is oxidized by natural microorganisms at a high rate, resulting in high BOD levels. The greater the decomposable matter present, the greater the oxygen demand and the greater the BOD values. BOD measures the amount of organic matter and oxygen used to oxidize inorganic materials that are released into the water.

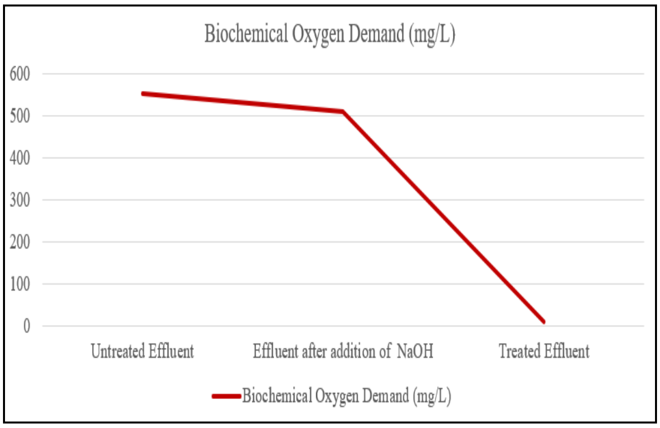

Fig. 8. BOD of Effluent after different stages of the experiment

3.7 REMOVAL EFFICIENCY

The overall efficiency of the effluent treatment plant for TDS, TSS, TS, COD, and BOD are 82%, 95%, 86%, 96%, and 98% as shown in figure 9.

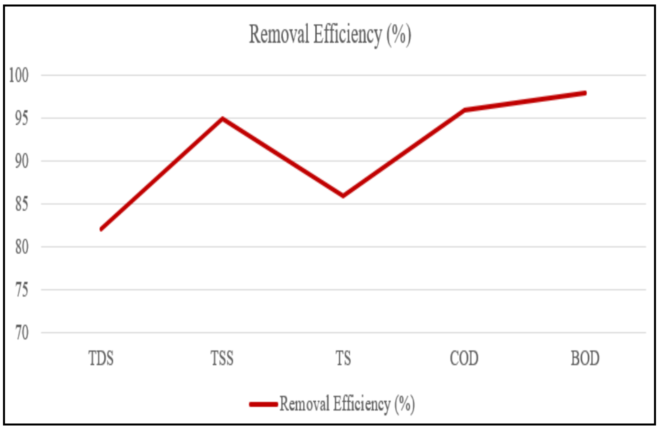

Fig. 9. Removal efficiency of the effluent treatment plant

4. CONCLUSIONS

The amount required for Sodium hydroxide to raise the pH from 4.7 to 7.5 was 0.20 mg/L, two to three times lower than conventional alkalis used for effluent neutralization. The removal efficiency of the Effluent Treatment Plant using Sodium hydroxide as a neutralizing base was 82%, 95%, 86%, 96%, and 98% for TDS, TSS, TS, COD, and BOD_5. From the above results, it can be concluded that the parameters such as pH, TDS, TSS, TS, COD, and BOD obtained were within the permissible limits of Maharashtra Pollution Control Broad (MPCB) and were fit to be discharged in water bodies or can be used for irrigation.

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