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A Review on Sugar Factory Wastewater : Parameters and it's Treatment Technologies

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Abstract - *For the Indian Financial development the sugar industries performs the essential role. Sugar industry play a significant role in India's economic development. However, the wastewater generated by these enterprises is very polluted. For every tons of sugar cane crushed in India, around 1,000 litres of effluent are produced. It causes pollution if sugar industry waste water is dumped without treatment, it cause pollution. Both aquatic and terrestrial ecosystems are impacted. The wastewater from the sugar industry is examined in this article. Sources of generation, features, and recent advances in the aerobic, anaerobic, and physico-chemical treatment technologies. The reuse of treated wastewater was also looked at. The majority of the study Anaerobic treatment was used to treat wastewater from the sugar industry processes. On the other hand, oil and grease are to decompose via anaerobic processes. Anaerobic processes destroy nutrients to some extent, whereas aerobic processes burn more energy. Organics can be entirely removed using anaerobic-aerobic mixed systems. Unfortunately, there are few studies on anaerobic-aerobic combination systems accessible, and further research is needed in this area.*

***Key Words*: Effluent Treatment Plant, Sugar Industry, Wastewater, Aerobic / Anaerobic treatment, Physicochemical properties.**

1. INTRODUCTION

India is the world's largest sugar consumer and second largest sugar producer. The sugar industry landscape in India is depicted by the rise of sugar factories and the sugar industries (figure 1)[3].Amongst many agro-based industries, the sugar industry is the most common industry in over 130 countries, particularly in developing countries. At present, this industry contributes significantly to economic development and is the main source of job creation in many developing countries in Asia, Africa and South America. The industry is involved in the processing of sugar cane to produce raw sugar from more than 70% of the world's sugar cane production [1].Around 85% (688 BCM) of water use is diverted for irrigation (Figure 1), which could increase to 1072 BCM by 2050.The primary source of irrigation is underground water. Water consumption can be the amount of water used in a household or country [2].India's farming industry has 43% of India's geographic region, and contributes 16.1% of India's GDP. Agriculture continues to make a significant contribution to India's GDP despite its falling share of GDP [4].

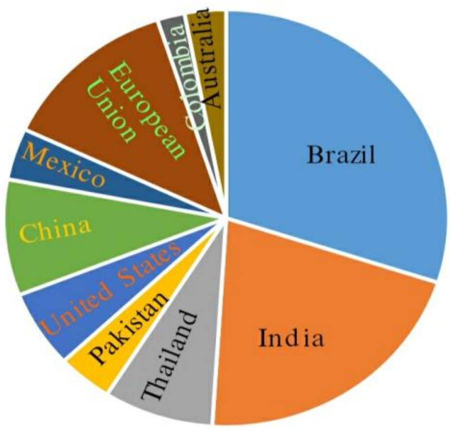

Fig 1. Sugarcane Worldwide Distribution [3].

The cane growing areas have expanded to 5,086,000 hectares in 2011-12, up from 5,055,000 hectares in 2007-08. An additional 516 industries were active in 2007-2008. In 2011-12, this number has risen to 529, producing 26.0 million tonnes of sugar [5].As a result, the quantity of waste water produced by these industries has also increased.

Sugar factory produce both sugar and a lot of effluent. They produce one cubic metre of effluent per tonne of crushed cane, on average. The discharge of effluent from sugar mills into surface water bodies with high TDS has a negative impact on aquatic life. During the sugar producing period in November-April, the irrigation water for the majority of the Rabi crop got unsuitable water surrounding the sugar mill locations. The terrible impacts of untreated sugar industry effluents also damage human life [9].Waste water in the sugar industries is characterised by high biological oxygen demand (BOD), chemical oxygen demand (COD) and total dissolved solids. The carbohydrates, nutrients, oil and grease, chlorides, sulphates and heavy metals are present in the sugar wastewater [6-8].

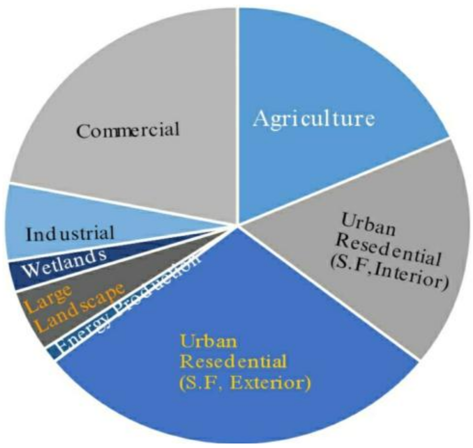

Fig. 2. Sugarcane worldwide distribution [4].

Furthermore, in order to safeguard the environment, the Indian government implemented highly rigorous norms and regulations regarding effluent disposal (Table 1). To achieve the effluent discharge regulations, appropriate treatment technologies are necessary.

Table 1. Standards limits suggested for discharge of effluents from the sugar industry

Parameter	Maximum value mg/l	
	World Bank Guidelines	CPCB India
pH	6-9	6.5-8.5
BOD5	-	30 for disposal in surface water 100 for disposal on land
COD	150-250	250
TSS	50	1000
Oil and Grease	10	10

Therefore, goal of this study was to review the literature on the sugarcane industrial process, including water consumption rates, effluent characteristics, and environmental consequences. The report also assesses the most prevalent wastewater treatment efforts made to reduce the environmental impact of effluent.

2. SUGAR FACTORY WASTE WATER :

The sugar production process in the cane factory includes juice extraction, clarification, evaporation, crystallisation, and centrifugal operations. Hence , Water is used for cleaning purposes in various sections of the sugar industry, resulting in wastewater. There are no single units that generate wastewater, but wastewater is produced primarily by washing on the milling house floor, boiling house units such as evaporators, clarifers, vacuum pans, centrifugation, and so on. Additionally, periodic cleaning of lime water and SO2 producing houses, as well as periodic descaling of heat exchangers and evaporators using NaOH, Na2CO3, and HCl for heater descaling and neutralisation, contribute to the massive volume of wastewater [11].Sugar industry wastewater contains wash water with lost cane juice from various operations, detergents, bagasse particles, lubricant oil and grease, and lost sugar solids in process. It is distinguished by high nutrient concentrations, organic and inorganic content [12].Mill house and process house are the two primary portions of wastewater generated in a sugar production, respectively. The mill house wastewater is primarily contaminated with oil and grease as well as suspended solids, whereas the process house wastewater is contaminated with high organic matter such as COD, BOD5, and pH [13].Due to the complicated nature of the wastes generated and the limited technology to remove all contaminants at once, inappropriate management of industrial wastewater is one of the most serious environmental concerns facing emerging countries. Sugar factories make contributions drastically to water and land pollutants via way of means of discharging tremendous quantities of wastewater as effluent, which incorporates excessive ranges of solids, BOD5, COD, chloride, sulphate, nitrate, calcium, and magnesium.

3. DIFFERENT PARAMETERS AND IT'S VARIATIONS

It can be observed that there is significant variation in COD (11012,211.44 mg/L) and BOD (605,103 mg/L) . Most of the COD loading to wastewater is owing to the lost cane juice and sugar solids. The pH and total solids (TS) concentration varies in the extent of 4.510 and 6,062 62 mg/L, respectively [23]; and considerable amount of nutrients, 1540 mg/L of total Kjeldahl nitrogen (TKN) [17] and 1.312 mg/L of total phosphorous are also observed in sugar industry wastewater. Except this, extremely high quantity of chlorides (483,195 mg/L), ca (CaCO3), SO4 + , Na+ , K+ , and heavy metals (Zn2+, Ni2+,Cu2+,Mn2+, Pb2+, Cd2+, Cr3+, and Fe2+) [20] have also been described in literature.

4. TREATMENT METHODS :

To reduce the amount of suspended solids (SS) in sugar industry wastewater, screening, grit removal, flow equalisation, sedimentation, or dissolved air flotation are used. For the reduction of soluble organic matter and disinfection, biological treatment methods are used [16].Aerobic and Anaerobic processes are included in biological treatment. Physico-chemical methods, in addition to biological methods, are used for sugar industry wastewater treatment.

4.1 Biological Methods :

Because sugar industry wastewater contains mostly sugars and volatile fatty acids, both of which are easily biodegradable, all biological (anaerobic and aerobic) treatment processes are appropriate [16].

4.1.1 Anaerobic Treatmemts :

The anaerobic treatment process for concentrated wastewater for pollutants (e.g. wastewater from the sugar industry) is a process widely used in industry. It has several advantages over aerobic methods, including lower energy requirements; the production of methane due to the decomposition of organic matter,which is a source of energy; and lower sludge production, which indirectly greatly reduces sludge disposal costs [24–26].The anaerobic treatment process for concentrated wastewater for pollutants (e.g. wastewater from the sugar industry) is a process widely used in industry. It has several advantages over aerobic methods, including lower energy requirements; the production of methane due to the decomposition of organic matter, which is a source of energy; and lower sludge production, which indirectly greatly reduces sludge disposal costs [24–26].With Sanchez Hernandez Travieso Cordoba AFR for treating wastewater from different sugar factories Hydraulic dwell time (HRT) (0.5, 1.0, 2.0 and 4.0d). It turns out that the increase in HRT increases Removal of organic matter and more than 90% COD Removal was found on HRT on the 4th [21] .Most sugar industries do Only solid matter separation pretreatment by clarification / clarification Dissolution flotation system [16] Doke et al. reported that plant growth and crop yield were reduced and soil health was affected if irrigated with wastewater treated with this method Therefore, complete removal of pollutants is necessary [22]. Nacheva et al. investigated and evaluated the mesophilic UASB reactor for the treatment of previously treated sugar cane mill wastewater in this regard. They reported more than 90% COD removal at organic loading rates (OLR) of up to 16 kg COD/m3 d while producing a lot of biogas. Finally, they concluded that discharge standards for COD concentration can be found if the UASB reactor is operated at a lower OLR of 4 kg COD/m3 d; however, at a higher OLR, an additional biological treatment stage is required [16] .The efficiency of anaerobic digestion is affected by waste characteristics, reactor configurations, and operational parameters [18].Co-digestion is one of the alternatives used to improve the anaerobic degradation of wastes with different characteristics if the waste characteristics are unsuitable for anaerobic treatment.

4.1.2 Aerobic Treatments :

In general, aerobic biological treatment involves the degradation of organics in the presence of oxygen. Activated sludge, trickling filters, aerated lagoons, or a combination of these are used in conventional aerobic treatment [19].Wastewater from the sugar industry, with the exception of fats and oils, is biodegradable and is not easily decomposed by anaerobic processes [27]. The oil produces long-chain fatty acid during the hydrolysis step, causing a delay in methanogenesis [28]. Long-chain fatty acids have been shown to be inhibitors of methanogens [29].

Ahmad and Mahmoud [30] led tests in cluster reactor to show whether the oxygen consuming treatment for sugar industry wastewater is adequate. It was accounted for that the oxygen consuming biodegradation of wastewater is pleasing. It was additionally revealed that the COD decrease can be anticipated at given boundaries with the assistance of relationship recommended by Tucek et al. [33].To investigate the contamination of stream because of this movement, Moses' et al [inspected the examples for temperature, pH, Body, COD, TDS, and TSS and reasoned that the qualities were well above than release limits characterized by NEMA and the World Wellbeing Association (WHO) [34] . Hamoda and Al-Sharekh inspected the exhibition of a system,aerated submergedd fixed-film (ASFF), in which bio-film was connected on lowered fired tiles with diffused air circulation condition. It was reasoned that the ASFF cycle is equipped for taking care of extreme natural loadings of 5-120 g Body/m2 d with minute lessening from 97.9 to 88.5% in Body expulsion proficiency and from 73.6 to 67.8% in COD evacuation effectiveness. Nitrification rate was additionally diminished however at higher rates [31] .

Nothing unless there are other options studies showed totally/almost complete organics evacuation. Subsequently, an extra organic treatment stage is required. Half breed frameworks of containing anaerobic and oxygen consuming medicines have been supported fit for giving high COD expulsion proficiency with more modest required energy [5,10,14]. Yang et al.detailed a joined anaerobic (UASB) and oxygen consuming (EAFB) treatment framework for emanating from essential treatment of sugarcane plant wastewater for its application for dribble water system, and P99% organics and solids evacuation were accounted for at HRT of 2 d. This treated wastewater hold better water quality for dribble water system [21].

4.2 Physico-chemical Methods :

Coagulation/flocculation with inorganic coagulants furthermore, adsorption are broadly utilized for the expulsion of suspended, colloidal, and disintegrated solids (DS) from wastewaters. By and large, coagulation/flocculation is utilized in the essential filtration of modern wastewater (now and again as optional and tertiary treatment)[27].In coagulation process, insoluble particles or potentially disintegrated natural materials total to be bigger, and are eliminated by sedimentation/filtration stages.

Electro-compound (EC) treatment process is an arising wastewater treatment innovation. EC treatment strategy includes electro-oxidation, electrocoagulation, and electrofloatation. In electrooxidation (EO) treatment, natural materials are oxidized to carbon dioxide and water or different oxides by electrochemically created receptive oxygen or potentially oxidizing specialist. Though, electro-coagulation process includes age of anode material hydroxides or potentially poly hydroxides which eliminate the organics by coagulation. Electro-buoyancy process eliminates toxins with the assistance of light gases bubbles created during electrolysis, which take with them the poison materials to the outer layer of fluid body [32].

Only one study of lime coagulation followed by activated carbon adsorption has been reported in published literature .BOD and COD removal efficiencies have been reported to be 96% and 95%, respectively [12].In another review, Guven et al. channeled EC examinations to treat reproduced sugar-beet industrial facility wastewater. The impact of different functional factors like applied voltage, electrolyte fixation, and squander fixation was read up for rate COD expulsion and starting COD evacuation rate. Most elevated COD evacuation and COD introductory expulsion rate were accounted for as 86.36% and 43.65 mg/L min, individually, after 8 h at the applied voltage of 12 V, 100 percent squander concentration with 50 g/L NaCl. At upgraded set of interaction factors and at 100 percent squander focus, rate COD evacuation and COD introductory expulsion rate were viewed as 79.66% and 33.69 mg/L min, separately. In EC process, the cathode material plays a very significant job in nature of treatment [33].

5. CONCLUSIONS:

However, anaerobic processes are commonly used .This for the treatment of wastewater from the sugar industry Process is limited due to the production of long chains Fatty acid in the hydrolysis of fats and oils. Similarly, Do not completely eliminate the anaerobic process Nutrients / Organics; Therefore, they are treated anaerobically Waste water needs further treatment. Aerobic SBR Promising sugar processing technology Industrial wastewater due to aerobic SBR Reportedly, it provides excellent removal efficiency in the following ways: Both nutrients and other organic matter. Membrane-assisted treatment is very effective Where high quality wastewater needs to be produced Reuse. But the wastewater from the sugar industry is heavily polluted. For DS and SS, this leads to a lot of memory pollution. Therefore, from the point of view of good quality manufacturing Treated wastewater for reuse, including hybrid systems .Membrane of aerobic / anaerobic treatment method And / or physicochemical methods may be promising.

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