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# PHYSICO-CHEMICAL PROCESS OF WASTEWATER TREATMENT IN THE SUGAR INDUSTRY

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**Abstract**

Sugar industry is an important industry in India and one of the most important substrates of human nutrition. Sugar plays an important role in our daily life. Sugar Industry Various chemicals are used in the production of sugar. In addition to chemicals, water also plays an important role in the sugar manufacturing process of the sugar industry. In the sugar industry, two types of water are used in the production of sugar. First internal water (cold water) and second internal water. External water such as cooling water is used to condense and cool power plant turbines, mill turbines, mill bearings, crystallized sulfur burners, air compressors, vacuum pumps, hot liquid pumps, etc. The agricultural sector and industry are major sectors with water consumption rates of freshwater supplies indicated by the ubiquitous nature of sugar production and require large amounts of freshwater. Freshwater is used in various units of the sugar manufacturing process in sugar mills, producing wastewater that varies greatly in both quantity and quality. Wastewater from these sugar industries is treated by biological processes, and wastewater is also treated by physicochemical processes. At present, the sugar factory properly treats and reuses the wastewater.

## Sugar industry

One of the most significant building blocks of human nutrition and a necessity for existence is sugar. Sugarcane is an useful crop for organic goods because it yields both sugar, which is in high demand on the market, and bagasse, which offers energy in the form of fuel for the creation of power and steam. In 80 nations that grow sugar cane, bagasse is used as an input.[1] In the past, the sugar business solely produced sugar; today, it also produces ethanol and electricity. As a result, the sugar industry is now known as the sugar cane industry.

## India's sugar industry

The Poaceae family includes sugar cane, which is grown in India as the Ka plant. The ideal climate for growing sugar cane is one that is hot and humid with average temperatures between 21 and 27 degrees

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Celsius and rainfall between 75 and 150 centimetres. Wherever there is moist soil, sugarcane will grow. A rich loamy soil is the best soil for sugarcane. In India, the sugar sector is very large. India's second-largest agricultural sector and biggest user of sugar is the sugar cane sector. During the 2018/2019 period, India also overtook other countries as the world's leading producer of sugar.

The Indian Sugar Mills Association estimates that 35.5 million tonnes of sugar will be produced in India during the final grinding session of 2018–19.[2] The team will generate electricity using biogas from the sugar cane sector. This produces a by-product that is used to produce power. [3]

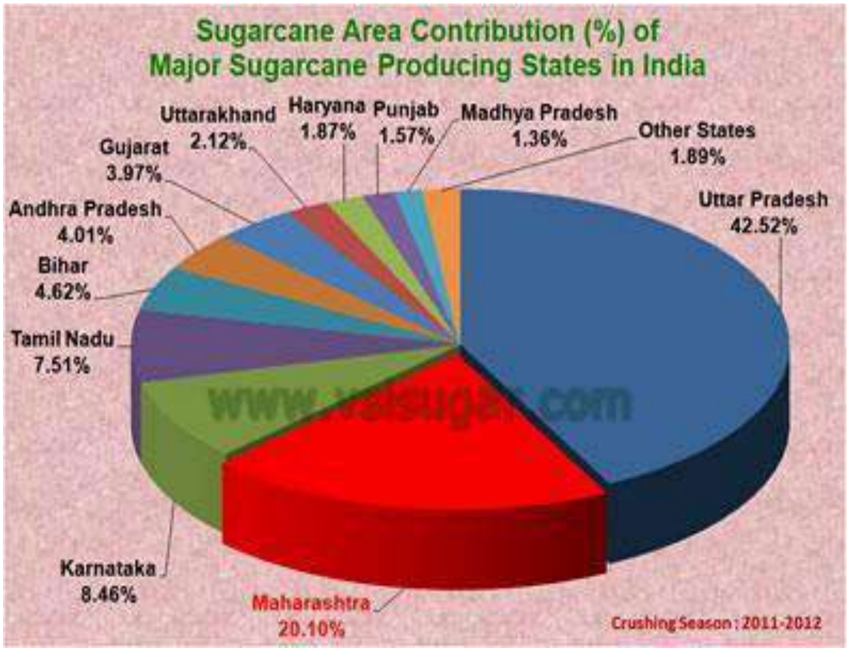

**Figure -** The sugarcane-producing state

**Sugar manufacturing process**

These are his two categories for sugar producing techniques. (I) The carbonization process. (II) Sulfite procedure To create plantation white sugar, the majority of sugar mills in India use the double sulfation method. The primary unit operations are grinding, clarifying, evaporation, crystallisation, and centrifugation. source of water balance

(1) Rivers, canals, wells, and dam excavations are examples of external sources for water.

(2) Sugar cane is packaged with water.

Uses: There are two types of water used in the sugar production.

1) Outside water 2) Internal water

**Waste water from the sugar industry**

As seen by the pervasive nature of sugar production, the agriculture sector and industry are large consumers of freshwater and demand enormous amounts of freshwater. In several parts of the sugar-making process, freshwater is used, resulting in effluent that varies greatly in both quantity and quality. The raw ingredients, finished goods, and chemicals employed in the process all affect how variable the effluent is. Two sources of water are used in the sugar business. Water is primarily recovered during sugar cane processing procedures like evaporation, crystallisation, and refining. Other water sources are primarily barometric condensers, dedusting in chimneys and scrubbers, and turbines, including wash water obtained from the cooling of Water is utilised in the sugar industry for cleaning tasks in various plant areas where waste water is produced. Wastewater is typically produced by washing in boiling houses, including mill house floors, evaporators, clarifiers, vacuum pans, and centrifuges. In reality, there is no single unit that produces wastewater. Additionally, regular demineralization of heat exchangers and evaporators utilising NaOH, Na2CO3, and HCl for heating and neutralisation is required, as well as routine cleaning of lime water and SO2 producing facilities.[4] It produces an enormous amount of waste water. The two main areas of wastewater that build up in sugar mills are, in fact, millhouses and processhouses. Grease and suspended particles are the main contaminants in the effluents from millhouses, whereas COD, BOD, and pH are present in the effluents from processhouses.[5]

**Table1.1: Sugar industry waste water characteristics and its average ranges[6]**

| S.N. | Parameters Average Range | Parameters Average Range |
|---|---|---|
| 1. | PH | 5.5.to7.52 |
| 2. | Chemical oxygen demand (COD) | 1800to3200mg /lt. |
| 3. | Biological oxygen demand (BOD) | 750to1500mg /lt. |
| 4. | Total Dissolved Solids (TDS) | 500to600mg/lt. |
| 5. | Total Suspended solids (TSS) | 1000to2500 mg/lt. |
| 6. | Oil and grease | 10to50mg/lt. |
| 7. | Sulfates | 500-1000mg/lt. |
| 8. | Temperature | 25to35°C |

(Note – This parameter of sugar industry wastewater average ranges varies from industry to industry)

**Table1.2: Standard parameters of treated effluent water**

| S. No. | Parameters | Inland surface water | Land for irrigation |
|---|---|---|---|
| 1. | pH | 6.5-8.5 | 6.5-8.5 |
| 2. | Chemical oxygen demand (COD) | <250 | <250 |
| 3. | Biological oxygen demand (BOD) | <30 | <100 |
| 4. | Total Dissolved Solids (TDS) | <2100 | <2100 |
| 5. | Total Suspended solids (TSS) | <30 | <100 |
| 6. | Oil and grease | <10 | <10 |
| 7. | The final waste water discharge limit | 200 Liter per tonne of cane crushed | |

### Sewage impact

Sugars and other carbohydrates are organic pollutants found in wastewater. Anaerobic conditions emerge from the immediate oxygen requirement of these effluents, which causes dissolved oxygen in the entering stream to break down quickly. This results in an offensive smell, hydrogen sulphide, the precipitation of iron as black sulphide, and is unattractive. Because of all these consequences, fish and other aquatic life cannot survive in the water. Agricultural activities directly utilise wastewater from the sugar industry. It influences plant development and seed germination in addition to soil fertility when used for irrigation.[7]

Utilizing activated sludge techniques, stabilisation ponds, and artificial wetlands are just a few of the wastewater treatment options.[8] In order to avoid this problem, industry decides to release untreated effluent into the environment. A procedure combining physical, chemical, and biological treatments is necessary for the wastewater treatment in the sugar sector. Total suspended solids (TSS) are eliminated from wastewater in the sugar industry by the use of bar screening, levelling, sedimentation, sand removal, and other processes.[9] The final requirements of the treated water are taken into account when choosing the biological and physico-chemical processes that will be used in the process design. Pharmacochemical therapy The seed germination of sugar cane mill wastes is influenced by physico-chemical factors such as pH, conductivity, COD, sulphates, chlorides, TDS, calcium, and magnesium. In physico-chemical treatment methods, flocculation and coagulation are mainly employed to remove dissolved solids, suspended solids, and colloidal solids from wastewater. Flocculation and flocculation are frequently employed in wastewater treatment for the initial cleaning of wastewater.[10]

**Biological methods of sugar industry waste water**

Pollutants are removed from wastewater during biological treatment or bioremediation by assisting potential microorganisms. Chemical, physical, or biological components of wastewater may have an effect on the environment and may alter species composition, aquatic habitats, biodiversity, and water quality. In order to degrade wastewater contaminants, such as sulphates, N, PO4, Cl, organic, heavy metals, etc., which are present in wastewater, it is crucial and challenging to identify potential consortia of microorganisms and treatment systems for different types of effluents.[11] In order for microorganisms to convert unstable organic pollut ants like CO2, CO, NH3, CH4, and H2S into stable chemicals, a biological treatment system needs waste water that may be high in unstable organic materials. [12]

**Biological Treatment**

**Anaerobic Process:**

Anaerobic Process: Compared to direct aerobic treatment, anaerobic treatment is more appealing due to the effluent from the sugar cane industry's high organic content. Therefore, biomethanation is the first stage of treatment, and two-stage aerobic treatment is frequently done after that before the waste is released into a body of water or used to irrigate land. Due to the substantial energy needed for aeration, cooling, etc., aerobic therapy alone is not practical. Over half of the COD in the effluent is turned into biogas during anaerobic treatment.

**Physico-chemical treatment**

A BOD of 250–500 mg/l can still be found in sugarcane molasses that have undergone biological treatment using both anaerobic and aerobic methods. Additionally, the effluent still has a black tint even after biological treatment significantly reduces COD. Options for physical-chemical treatment have been investigated in this area.[13]

**Adsorption**:

Although it is a commonly utilised adsorbent for removing organic contaminants from wastewater, activated carbon's relatively high cost limits its application. It was studied whether synthetic melanoidin could be decolored using activated carbon that was both commercially accessible and made from bagasse from sugarcane. [14]

**Flocculation and coagulation**

Additionally, research on the coagulation of spentwash following anaerobic-aerobic treatment have been carried out utilising bleaching powder and aluminium sulphate. The ideal dosage was 5 g/l bleaching powder followed by 3 g/l aluminium sulphate, which removed 96% of the colour and reduced BOD and COD by up to 97%.[15]

**Procedure for oxidation:**

For biologically treated waste wash, oxidation by ozone could produce 80 colorization with a concurrent COD reduction of 15–25%. Additionally, it made wastewater more biodegradable. The degradation of dark macromolecular substances in wastewater is not accomplished by ozone; it merely changes chromophores. [16]

**Treatment for membranes:**

CODs of 36,000 to 18,000 mg/l have been reported to be produced by pre-treating wasted lavage fluid using ceramic membranes before anaerobic digestion. The system's operating data indicated that the transmembrane pressure was 0.5 bar, and the total membrane area was 0.2 m2. The flow velocity was 6.08 m/s. Pretreatment, presumably by eliminating inhibitors, not only decreased COD but also increased the anaerobic process's effectiveness. [17]

**Electrodialysis:**

Using cation and anion exchange membranes, stainless steel cathode, titanium alloy NaCl as anode, and 4% w/v electrolyte, electrodialysis has been studied to desalinate used clothing. This method reduces the potassium content of the water by 50–60%. The pH 9.5 range allowed for a COD decrease of up to 88%. With larger wastewater flow rates, however, the rate of COD removal slowed down.

**Evaporation/Combustion:**

A five-effect evaporation system using thermal vapour recompression may concentrate a 4% solids molasses effluent up to 40% solids. You can utilise condensate in the fermenter with a COD of 280 mg/l. Venus can be disposed of on-site by incineration, which also yields potassium-rich ash that can be applied to soil. The goal of this work is to investigate how physical, chemical, and physicochemical factors—such as pH, EC, TDS, temperature—as well as salt, potassium, calcium, magnesium, chloride, carbonate, bicarbonate, sulphate, and others—as well as biological oxygen demand (BOD)—determine the properties of the wastewater.

**Conclusion**

The ultimate goal of wastewater management is to protect the environment in accordance with public health and socioeconomic concerns. Based on the nature of the wastewater, it is suggested whether primary, secondary and tertiary treatment should be carried out before final disposal. Understanding the properties of wastewater helps design appropriate wastewater treatment processes, employ appropriate processes, determine acceptance criteria for residues, determine the level of assessment required for process validation, and test residues for toxicity. It forms the basis for target decisions. It is necessary to ensure the safety, efficiency and quality of treated wastewater. Standard scientific literature describes industrial wastewater management as inherently enhancing ecosystems. However, industries need to practice wastewater reuse for various activities so that freshwater consumption can be reduced. It is also economically advantageous and reduces the amount of water pollution. Sugar factories are now treating and reusing wastewater properly, so the pollution rate is lower than before.

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