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# Analysis of Sugarcane waste water by Continuous Stirred Anaerobic Digester

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**Abstract**

*The sugar mill in India is a key factor in rural economy of the state. Sugar factory is one of the most important agro based industry in India. India is the largest sugar producing country in the world. The sugar industry plays an important role in India's economy. It is the second largest industry in the country, next to textiles and provides direct employment to more than 3.6 lakhs person. Sugar industry is a seasonal industry which operates for maximum 4-5 months a season. The industry use sugarcane as the raw product along with other various chemicals to increase the face value of the final product. Sugar is the main product that we receive from the industry. In addition we also receive waste water which is highly contaminated and polluted in untreated condition. It may highly affect the health of human, the air we breathe, the water we drink, and the land we live. Hence it is necessary to treat the water and convert it into useable biogas.*

## INTRODUCTION:

### Sugarcane Effluent

Milling of cane stalks for the extraction of raw sugar yields several by-products of various uses. These by-products include waste water, molasses, bagasse and mill mud. During this process a huge amount of water is used. As a result it also generates a huge amount of waste water. To be specific the waste water generated at mill house in sugar mill is of huge quantity. In this mill house it is mostly contaminated by oil and grease. The waste water which is produced from the process house mainly results from equipment washing is highly contaminated with the additive and other chemical used at the different stages. Boiler house mainly contributes in the air pollution and have a little share in water pollution. Based on the ratio, a sugar mill having a capacity to crush 4500 tonnes of cane a day requires 9000 m3/per day of water with the ratio 1:2 and hence the mill generates the waste water in the range of 180 cm3/day. The sugar mill waste water is characterized by its brown colour, unpleasant odour, high temperature, low pH, high ash or solid residues and contain high % of dissolved organic and inorganic matter. Hence if they are normally discharged by water courses, it creates the odour nuisance, affect the aquatic life in water bodies and also not eligible for the irrigation purposes.

### Need of Industrial water Treatment

Effluents obtained from industries are generally more polluted than the domestic or even commercial wastewater. Hence in today's world each small scale as well as large scale industries is discharging their effluents into a natural river bodies, through an unauthorised connection. Such a tendency on the part of the industries may pollute the entire aquatic and terrestrial region, and its bioremediation is almost not imaginable.

**Method of Treating Industrial Effluent**

Industrial wastewater contains several chemical pollutants and toxic substances in too large proportion. It is generally necessary to isolate or remove the troubling pollutant from wastewater.

Depending upon the quantum, concentration, and toxicity, its treatment may consist of following processes:

- Equalisation;
- Neutralization;
- Physical treatment ( sedimentation, floatation );
- Chemical treatment (RO, Adsorption, Electro Dialysis, Chemical Precipitation);
- Biological treatment;

**Continuous Stirred Anaerobic Digester**

Anaerobic digestion (AD) is a bioprocess that is commonly used to convert complex organic wastes into a useful biogas with methane as the energy carrier. Increasingly, AD is being used in industrial, agricultural, and municipal waste (water) treatment applications. The use of AD technology allows plant operators to reduce waste disposal costs and offset energy utility expenses. As the application of AD technology broadens for the treatment of new substrates and co-substrate mixtures, so does the demand for a reliable testing methodology at the pilot- and laboratory-scale. Anaerobic digestion systems have a variety of configurations; including the continuously stirred tank reactor (CSTR), plug flow (PF), and anaerobic sequencing batch reactor (ASBR) configurations. The CSTR is frequently used in research due to its simplicity in design and operation, but also for its advantages in experimentation. Compared to other configurations, the CSTR provides greater uniformity of system parameters, such as temperature, mixing, chemical concentration, and substrate concentration. Ultimately, when designing a full-scale reactor, the optimum reactor configuration will depend on the character of a given substrate among many other nontechnical considerations. However, all configurations share fundamental design features and operating parameters that render the CSTR appropriate for most preliminary assessments. If researchers and engineers use an influent stream with relatively high concentrations of solids, then lab-scale bioreactor configurations cannot be fed continuously due to plugging problems of lab-scale pumps with solids or settling of solids in tubing. For that scenario with continuous mixing requirements, lab-scale bioreactors are fed periodically and we refer to such configurations as continuously stirred anaerobic digesters (CSADs).At the same time the continuous stirring may also catalyze the microbes‟ reaction for the reduction of heavy metal and other toxins.

**Requisite of Biogas**

Biogas normally refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as

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agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. It is a mixture of methane (55-75 vol%) and carbon dioxide (25-45 vol%) that can be used for heating, upgrading to natural gas quality or co-generation of electricity and heat. Digestion installations are technologically simple with low energy and space requirements. The biogas yield varies with the type and concentration of the feed stock and process conditions. For the organic fraction of municipal solid waste and animal manure biogas yields of 80-200 $m^3$per tonne and 2-45 $m^3$per tone are reported, respectively. Co-digestion is an important factor for improving reactor efficiency and economic feasibility. Maximizing the sale of all usable co-products will improve the economic merits of anaerobic treatment. Furthermore, financial incentives for renewable energy production will enhance the competitiveness of anaerobic digestion versus aerobic composting. Worldwide a capacity up to 20,000 MW could be realized by 2018.Environmental pressures to improve waste management and production of sustainable energy as well as improving the technology's economics will contribute to broader application.

Fabricated pilot scale reactor

**Applicability of anaerobic process wastewater**

To study the applicability  anaerobic process for wastewater, first, the characteristics of wastewater has to be understood. The important parameters which has to be noted include COD, nitrogen, alkalinity & fatty acids, sulfate, suspended solids, flow rate, concentration of chlorinated compounds (Mergaert, 1992), presence of surfactants and size of particles (Tarek,2001).

**1. COD**

Min and Zinder (1989) suggested that there is a threshold concentration of substrate, below which the microorganisms will not be provided with enough energy to support its uptake and metabolism. This threshold concentration determines the outcome of competition for traces of hydrogen and acetate.

**2. Nitrogen**

Due to the low biomass yield of anaerobic microorganisms, the nutrient requirement to support them is usually low. The minimum amount of nitrogen necessary for the growth of anaerobic biomass is a COD to N ratio of 100 is to 1.25 (Lettinga et al., 1981). Therefore, nitrogen concentration in municipal wastewater does not pose a problem for anaerobic treatment.

**3. Alkalinity & fatty acids**

Alkalinity is defined as the acid-neutralizing capacity of water. It exists primarily in the form of biocarbonates which are in equilibrium with the carbon dioxide in the gas at a given pH.

**4. Sulfate**

Sulfate is a preferred electron acceptor compared to other anoxic electron acceptors. In addition, Widdel (1988) has found that the optimum temperature of sulfate-reducing bacteria is between 30 and 35 $^{o}$Cwhile the optimum temperature for methane-producing bacteria is between 35 and 40$^{o}$ C (Huser et al., 1982; Vogels et al., 1988). Thus, treatment at temperature less than 35 $^{o}$C, the sulfate-reducing bacteria is likely to outcompete the methane-producing bacteria.

**5. Suspended solids**

De Baere and Verstraete (1982) wrote that the development of high-rate reactors like the CMR made it possible for low hydraulic retention times and efficient treatment. However they were specifically designed to treat wastes with a low suspended solids concentration, for example, distillery and sugar factory wastewaters. They might not be suitable for municipal wastewater

Which has a high level of suspended solids.

**6. Flow rate of the wastewater**

It is well known that municipal wastewater has large fluctuations in organic matter, suspended solids and flow rate. Biochemical oxygen demand, chemical oxygen demand and suspended solids concentration may range with a factor of 2 to 10 in half an hour to a few hours (Alaerts et al., 1989)

**7. Temperature of wastewater**

Microorganisms in anaerobic systems, especially the methanogens, perform only in a specific range of temperature. The optimal temperature for Methanothrix soengenii, Methanosarcina and most other methanogens is between 35 and 40 $^{o}$C.Temperature dependence of methane production from acetate by Methanothrixsoengenii (Huser et al., 1982).

**8. Concentration of chlorinated compounds**

Domestic wastewater may contain dry cleaning products or cleaners with organic solvents which has chlorinated compounds. Most of the chlorinated compounds are toxic and can seriously hamper anaerobic treatment, even at concentrations as low as 1 mg/L (Lettinga et al., 1981).However, the anaerobic process is also known to be able to remove chlorinated organics which aerobic process cannot.

**9. Presence of surfactants**

Municipal wastewater contains a certain amount of surfactants due to detergent from domestic households. Surfactants are known to adsorb at both solid/liquid and liquid/air interfaces and will affect the anaerobic biodegradability of particles. They can emulsify poorly soluble hydrophobic compounds in water and improve the accessibility of these substrates to microorganisms (Rouse et al., 1994). Wagener and Schink (1987) and Rouse et al. (1994) concluded that surfactants inhibit anaerobic biodegradation of organic compounds.

**10. Size of particles**

The size of particles in domestic sewage affects both biological and physical processes (Levine et al., 1985). For larger particles, gravitational and drag forces predominate over colloidal forces(van der Waals attraction and electrostatic repulsion), while for smaller particles (less than a few µm), colloidal forces are more predominant (Gregory, 1993).
Elmitwalli et al. (2001) found that the maximum conversion to methane at 30 oC was the highest(86%) for the colloidal fraction, the next is suspended fraction (78%) and the lowest is dissolved fraction (62%).

**CONCLUSION**

The organic waste generated during the sugar productions have different characteristics which taken into account during the design of the anaerobic digestion process.

- This study demonstrated the performance analysis of methane production and toxic metal reduction from sugarcane juice in a non-sterile CSTR augmented with Enterobacter asburiae.
- The characterization result could show off the rigid variation in the level of contaminants and the toxic bodies were largely reduced during the treatment.
- The biogas produced is about for 45 days 747 ml along with days; further treatment could increase the productivity of gas.
- The initial and final chromatography is discussed which shows clearly the reduction of heavy metals and other disagreeable compounds.
- Thus the effluent treated may utilize for industrial purposes.

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