TREATMENT OF DAIRY WASTEWATER BY UP-FLOW ANEROBIC SLUDGE BLANKET

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College ***:*** *Smt. Kamala and Sri Venkappa M Agadi College of Engineering and Technology, Lakshmeshwara*
Branch ***:*** *Department of Civil Engineering*
Guide(s) ***:*** *Mr. Arun Tandi*
Student(S) ***:*** *Ms. Anusha Shetteppanavar*
Mr. Gireesh Karadagi
Mr. Huttanagouda V Hosamani

Keywords:

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Introduction:

Water management in dairy industry is well documented, but effluent production and disposal remain a problematic issue for the dairy industry. To enable the dairy industry to contribute to water conservation, an efficient and cost-effective effluent treatment technology has to be developed. To this effect, anaerobic digestion offers a unique treatment option to the dairy industry. Not only does anaerobic digestion reduce the COD of an effluent, but little microbial biomass is produced. The biggest advantage is energy recovery in the form of methane and up to 95% of the organic matter in a waste stream can be converted into the biogas. Many high-rate digester designs are currently available and some have successfully been used for the treatment of dairy effluents. Lettinga and Hulshoff-Pol reported the use of full-scale up flow anaerobic sludge blanket digesters in use worldwide. Dairy industry uses 2 to 5 L of water per L of milk processed.

In recent years there has been a growing interest in anaerobic treatment of wastewaters. Compared to aerobic growth, anaerobic fermentation produces much less biomass from the same amount of COD removal. Up flow anaerobic sludge blanket (UASB) reactor is a popular anaerobic reactor for both high and low temperature. The UASB reactor is by far the most widely used high-rate anaerobic system for anaerobic sewage treatment. In the case of a relatively low strength wastewater such as sewage, the hydraulic retention time rather than organic loading rate is the most important parameter determining the shape and the size of the UASB reactor.

Objectives:

1. To collect waste water from dairy industry.
2. To examine physical, chemical characteristics of waste water.
3. To set up UASB reactor.

4. To measure the quantity of effluent.

5. To measure various parameters and evaluating the performance of the reactor.

Methodology:

Reactor:

The UASB reactor used in the present study was made up of Plastic. The working volume of the reactor was 120.12 m3. The reactor consisted of four sampling ports; one inlet, which was further diverged into three channels; one effluent outlet; one gas outlets and a gas-solid-liquid separator. The feed loading rates were controlled with pumps.

Analysis:

The sample pH was measured with pH meter (accuracy ± 0.01 pH units), Chemical Oxygen Demand (COD) of the samples were analysed by open reflux method in which the adequately diluted sample was strongly digested in the presence of strong oxidant (K2Cr2O7) and was titrated against standard solution of ferrous ammonium sulphate. BOD was assessed by the direct method and volatile fatty acids (VFAs) were analysed by the Distillation method followed by titration with 0.1N NaOH with a phenolphthalein indicator. Total Suspended Solids (TSS) were measured by Imhoff cone experiment, respectively. All the chemicals were of analytical reagent grade unless otherwise stated. Distilled water in all-glass units of borosil design, was used for all purposes.

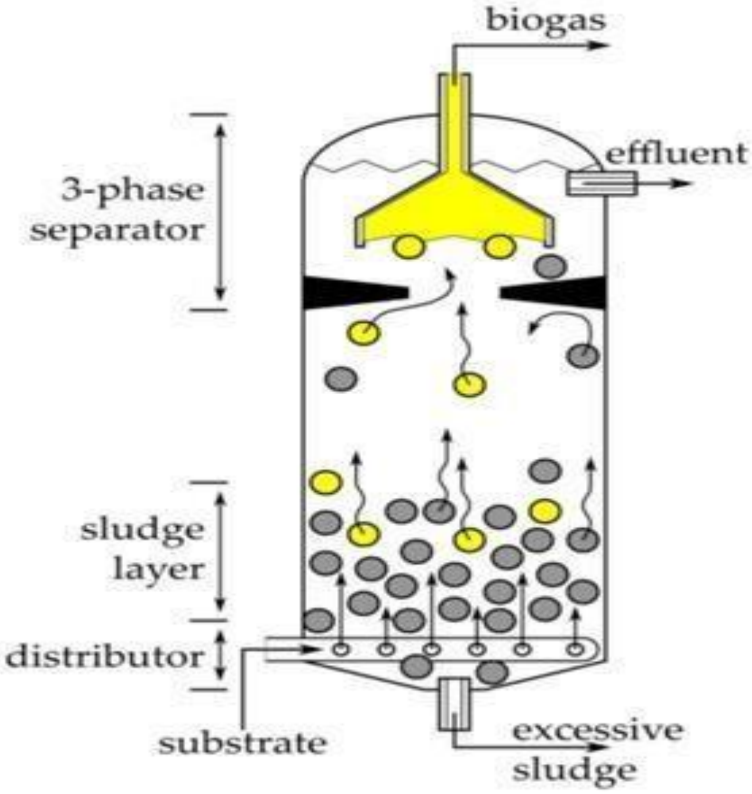

Fig: Schematic UASB Reactor

Conclusion:

Waste Water Characterization

The wastewater collected from dairy industry; we conducted a test to know characterises of wastewater. Properties of wastewater and its initial value, final value and efficiency are given in a below table.

PROPERTIES	BEFORE	AFTER	EFFICENCY
Biochemical Oxygen Demand (Bod) [mg/L]	850	449	89.3%
Total Dissolved Solids (TDS) [mg/L]	883	465	89.8%
Chemical Oxygen Demand (COD) [mg/L]	1700	988	72%
Total Suspended Solids (TDS) [mg/L]	520	270	92.5%

Table 1: Waste Water Characterization

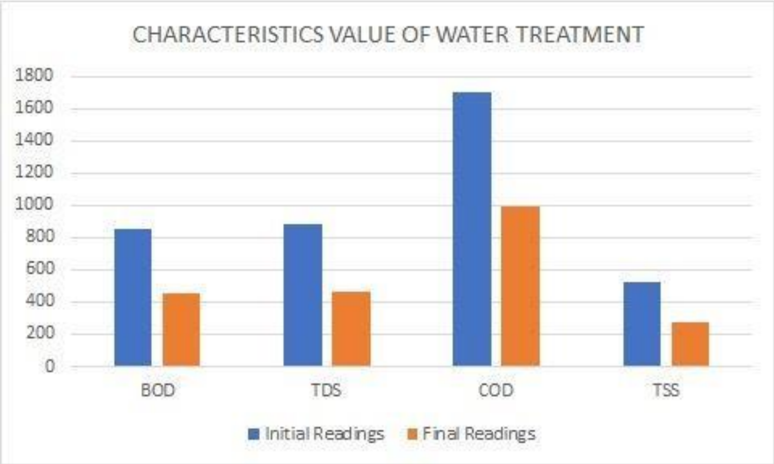

Fig (a) Characteristics value of wastewater treatment

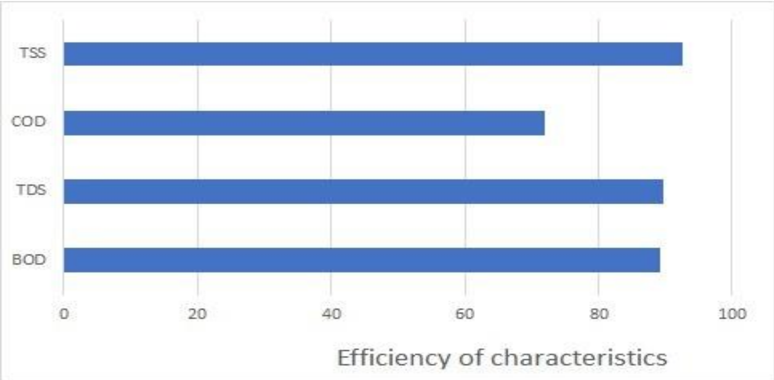

Fig (b) Efficiency of Characteristics

Total Suspended Solids (TSS): TSS removal across the UASB reactor is expected due to straining effect of the formed granules. As shown in Fig.(a) the average range of TSS at inlet of UASB reactor was found to be 520 mg/L and at outlet of UASB reactor was found to be 270 mg/L. The slightly low efficiency of TSS is due to excessive turbulence in the UASB reactor; therefore, the likelihood of entrapping suspended and colloidal solids is reduced.

Biochemical Oxygen Demand (BOD): The BOD removal is generally high in the UASB reactor. It generally varies between 60 to 90%. Fig.(a) Shows that the average range of BOD at inlet of UASB reactor was found to be 850 mg/L and at outlet of UASB reactor was found to be 449 mg/L and BOD % removal efficiency of UASB reactor found to be 89.3% which is satisfactory as per performance of the reactor shown in Fig.(b).

Chemical Oxygen Demand (COD): The BOD removal is generally high in the UASB reactor. It generally varies between 60 to 90%. Fig.(a) Shows that the average range of BOD at inlet of UASB reactor was found to be 1700 mg/L and at outlet of UASB reactor was found to be 988 mg/L and BOD % removal efficiency of UASB reactor found to be 72% which is satisfactory as per performance of the reactor shown in Fig.(b).

Total Dissolved Solids (TDS): The TDS removal is generally high in the UASB reactor. It generally varies between 90 to 92%. Fig.(a) Shows that the average range of TDS at inlet of UASB reactor was found to be 883 mg/L and at outlet of UASB reactor was found to be 465 mg/L and TDS % removal efficiency of UASB reactor found to be 89.8% which is satisfactory as per performance of the reactor shown in Fig.(b).

Scope for future work:

The Up flow Anaerobic Sludge Blanket (UASB) reactor is a widely used technology for wastewater treatment, particularly effective for high-strength industrial effluents. The future scope of UASB technology includes various promising areas for development and application:

1. Expansion to Various Industries:
    - Broader Industrial Applications: UASB reactors can be adapted for use in a wider range of industries beyond the traditional sectors like sugar, distilleries, and breweries. Industries with high organic content in their wastewater, such as pharmaceuticals, textiles, and food processing, can benefit from UASB technology.
    - Municipal Wastewater Treatment: Increasingly, UASB reactors are being considered for municipal wastewater treatment due to their low energy requirements and effective organic matter removal.
2. Energy Recovery and Sustainability:
    - Biogas Production: UASB reactors produce biogas (methane) as a byproduct of anaerobic digestion. This biogas can be captured and used as a renewable energy source, contributing to energy self-sufficiency and reducing greenhouse gas emissions.
    - Carbon Footprint Reduction: The use of UASB technology can help reduce the carbon footprint of wastewater treatment processes by minimizing the need for external energy inputs and generating renewable energy.

3. Technological Advancements:
    - Improved Reactor Designs: Ongoing research aims to optimize UASB reactor designs for better performance, including enhancements in sludge retention, hydraulic efficiency, and biogas collection.
    - Hybrid Systems: Combining UASB with other treatment technologies, such as aerobic processes or membrane filtration, can enhance overall treatment efficiency and effluent quality.
    - Microbial Consortia: Advances in understanding the microbial communities within UASB reactors can lead to improved reactor stability and performance through targeted bioaugmentation and process control.
4. Environmental Regulations and Policies:
    - Stricter Discharge Standards: As environmental regulations become more stringent, there will be a greater need for efficient and effective wastewater treatment solutions like UASB reactors to meet compliance requirements.
    - Incentives for Green Technologies: Government policies promoting sustainable and environmentally friendly technologies can drive the adoption of UASB systems.
5. Global Adoption and Scalability:
    - Developing Regions: UASB technology is particularly suited for use in developing regions due to its relatively low operational costs, simplicity, and effectiveness. Expanding its use in these areas can improve sanitation and environmental health.
    - Scalability: UASB reactors can be scaled to treat wastewater from small-scale operations to large industrial plants, making them versatile for various applications.
6. Integration with Circular Economy:
    - Resource Recovery: UASB reactors can be integrated into a circular economy model, where wastewater is not just treated for disposal but also as a source of valuable resources like biogas, nutrients, and water for reuse.

In summary, the future scope of UASB technology is promising, with potential for broader industrial applications, enhanced energy recovery, technological advancements, compliance with stricter environmental regulations, global adoption, and integration into circular economy practices. Continued research and innovation will further enhance the efficiency and effectiveness of UASB reactors in wastewater treatment.