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TREATMENT OF SUGARCANE WASTE EFFLUENT BY UASB REACTOR AND BIOGAS Recovery

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Abstract: Up flow Anaerobic Sludge Blanket (UASB) process is known to be energy conservative process. Anaerobic treatment of domestic wastewater is recently gained worldwide attention due to its effectiveness, low cost and low energy requirements. In this study wastewater from sugarcane industry was selected for the anaerobic treatment with UASB reactor. This work was performed to minimize the pollutants from the sugarcane waste and to recover biogas from the treatment. The lab scale reactor with an effective volume of 35.5 liters was operated under the normal temperature. At the end of the treatment with UASB reactor that lasted for 45 days the system achieved 78.49 % of COD removal and 73.80% of BOD removal. The recovery of biogas from this treatment was found as 0.12 m^3. UASB reactor showed better removal efficiency for pollutants such as Chemical Oxygen Demand (COD), Bio-chemical Oxygen Demand (BOD), and Total Suspended Solids (TSS). Further studies are required for the optimization of Biogas generation**.**

Key words: Anaerobic Process, BOD, COD, Biogas Generation, UASB reactor**.**

I Introduction

Anaerobic Process

Anaerobic process is an attractive technology for waste water treatment. The high costs of aeration and sludge handling associated with aerobic sewage treatment are dramatically lower as no oxygen is need and production of sludge is 3 – 20 times lower. However its use is usually limited to high strength industrial waste water with soluble substrates. Domestic waste water has typically low concentration of COD, resulting in relatively small methane production that is insufficient to heat the reactor to more favorable mesospheric temperatures. Moreover , the relatively high concentrations of particulate matter present in domestic waste water requires an initial hydrolysis step, which is significantly affected by temperature and is usually the rate limited step in sub – tropical climate regions. In Tropical countries UASB reactor for domestic waste water have found wide acceptance.

1.2 Up flow Anaerobic Sludge Blanket (UASB) Reactor

An up flow anaerobic sludge blanket reactor is basically a tank that has a sludge bed in which organic material dissolved in the wastewater is degraded, and as a consequence of this digestion, biogas is produced. Wastewater enters at the bottom of the reactor. At the top, biogas is collected and the effluent of treated water leaves at the upper part of the reactor, above the sludge bed, a blanket zone is formed where some particles of biomass are suspended. This zone acts as a separation zone between the water flowing up and the suspended biomass. Once of the advantages of this kind of reactor is the low sludge production.

Seghezzo reported that only one discharge of sludge from a UASB is required per year for a four-meter-high reactor. The expanded granular sludge bed reactor is a modification of a conventional UASB reactor. The EGSB reactor work with a higher up flow velocity and higher loading rate than a UASB reactor. The EGSB usually has an effluent recirculation, improving mixing at the bottom of the reactor.

In this study UASB reactor is designed for the treatment of sugarcane waste in an anaerobic condition and the recovery of biogas production.

II. Materials and Methods

2.1 Reactor Fabrication

The Reactor was designed with reference to research journals as the height of the reactor is 50 cm, and the volume of 35.5 litres. The diameter of the reactor is 3 inches. It has inlet and 2 outlets. The inlet is connected by a tube with the waste water bucket. The gas collection set up is on the top of the reactor. It has a few plastic beats inside the reactor which acts as a growth medium.

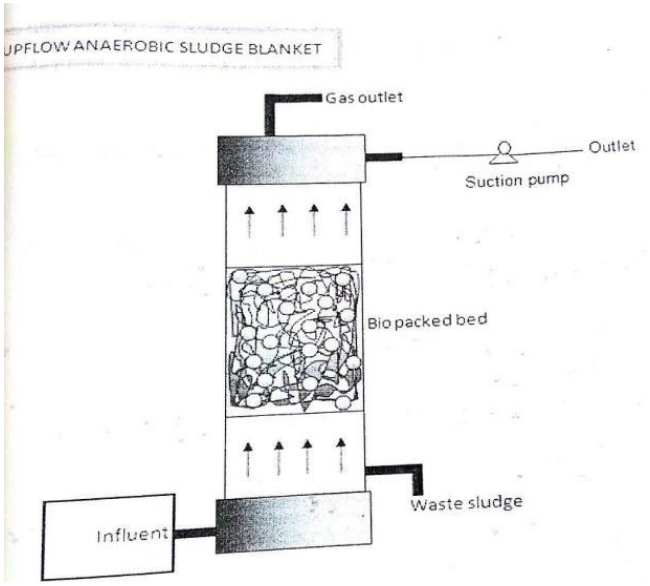

Fig.2.1 UASB reactor

2.2 Waste Water

Sugarcane waste waters are generally having higher organic content. If it is disposed without proper treatment it will affect the environment badly. The Sample is collected from the Sugar mill which is located at Cuddalore district. Wastewater samples are analyzed for the various physical and chemical parameters using standard Environmental testing methods.

2.3 Inoculums Preparation

The inoculum was prepared using cow dung with mixing proportion of 1:1 with the water.

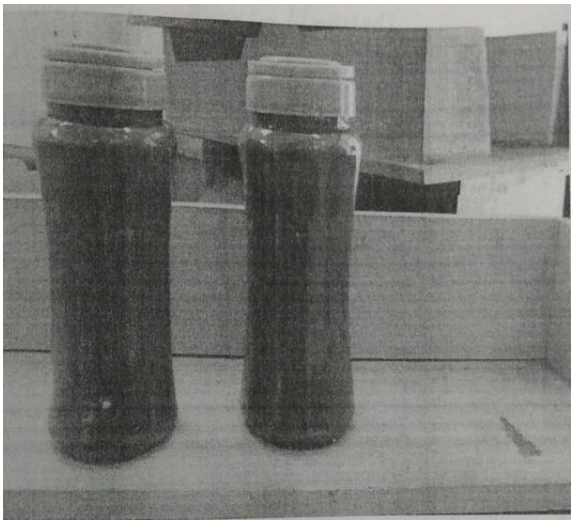

Fig. 2.2 Cow dung for Inoculum

2.4 Sludge Blanket Preparation

The sludge blanket was prepared with having 1 cm diameter and 2 cm long hallow plastic tubes. Sludge bed was established in a period of 2 weeks.

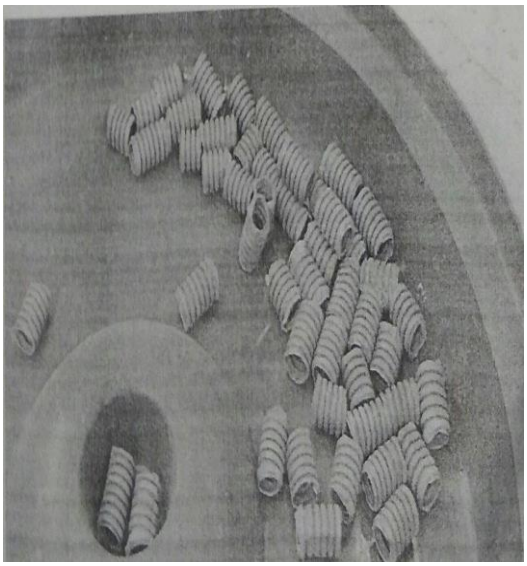

Fig. 2.3 Plastic Medium for bacterial growth

2.5 Estimation of Biogas Production

The estimation of Biogas production from the treatment was done by using water dispersed method. In this method 1 litre of measuring jar was used to measure the produced Biogas.

Fig. 2.4 Reactor Setup with Biogas Recovery

III Results and Discussion

3.1 Initial Characterization

The Raw wastewater and Treated wastewater are tested for their Physical and chemical characteristics. Results are given below.

S.No.	Name of the Parameter	Concentration
1	Colour	>1 hue
2	Odour	Agreeable
3	Turbidity	989 NTU
4	Temperature	$32^{O}C$
5	Total solids(mg/l)	3016
6	Total suspended solids(mg/l)	0
7	Total dissolved solids(mg/l)	2892
8	pH	7.26
9	Electrical conductivity(dsm^{-1})	4.52
Heavy Metals		
10	Chromium(ppm)	10.23
11	Copper(mg/l)	0.05
12	Cobalt(mg/l)	-
13	Lead(mg/l)	0.04
Cations and Anions		
14	Chloride(mg/l)	1695
15	Sulphate(mg/l)	298
16	Phosphate(mg/l)	0.02
17	Sodium(mg/l)	1345

3.2 Intermediate Characterization

The Partially treated wastewaters are tested for their physical and chemical characteristics. Results are given below.

S.No	Name of the parameter	Concentration
1	Colour	>1 hue
2	Odour	Agreeable
3	Turbidity	25 NTU
4	Temperature	$32^{O}C$
5	Total solids(mg/l)	1210
6	Total suspended solids(mg/l)	0
7	Total dissolved solids(mg/l)	1210
8	pH	7.26
9	Electrical conductivity(dsm^{-1})	1.89
10	DO(mg/l)	0.2
11	BOD(mg/l)	450
12	COD(mg/l)	175
Anions		
13	Carbonate(mg/l)	Nil
14	Bi carbonate (mg/l)	175
15	Chloride(mg/l)	298
16	Sulphate(mg/l)	69
17	Phosphate(mg/l)	0.02
18	Nitrate(mg/l)	11.47
19	Silicate(mg/l)	0.03
20	Nitrite(mg/l)	0.01
21	Fluoride(mg/l)	5.29
22	Ammonium(mg/l)	0.25
Cations		
23	Calcium(mg/l)	181
24	Magnesium(mg/l)	126
25	Sodium(mg/l)	236
26	Potassium(mg/l)	0.18
Heavy metals		
27	Zinc(mg/l)	0.08
28	Copper(mg/l)	0.05
29	Iron(mg/l)	0.02
30	Cobalt(mg/l)	NIL
31	Lead(mg/l)	0.04
32	Cadmium(mg/l)	0.03
33	Mercury(mg/l)	0.02

3.3 Final Characterization

Treated wastewater are tested for their Physical and chemical characteristics. Results are given below.

S.no.	Name of the Parameter	Concentraion
1	Colour	>1 hue
2	Odour	Agreeable
3	Turbidity	780 NTU
4	Temperature	$34^{O}C$
5	Total solids(mg/l)	1216
6	Total suspended solids(mg/l)	6
7	Total dissolved solids(mg/l)	1210
8	pH	7.62
9	Electrical conductivity(dsm^{-1})	1.89
10	DO(mg/l)	0.4
11	BOD(mg/l)	520
12	COD(mg/l)	285
Anion		
13	Carbonate(mg/l)	Nil
14	Bi carbonate (mg/l)	426

15	Chloride(mg/l)	353
16	Sulphate(mg/l)	112
17	Phosphate(mg/l)	0.10
18	Nitrate(mg/l)	0.08
19	Silicate(mg/l)	3.52
20	Nitrite(mg/l)	0.02
21	Fluoride(mg/l)	5.16
22	Ammonium(mg/l)	0.05
Cations		
23	Calcium (mg/l)	486
24	Magnesium(mg/l)	206
25	Sodium(mg/l)	548
26	Potassium(mg/l)	0.22
Heavy metals		
27	Zinc(mg/l)	0.08
28	Copper(mg/l)	0.02
29	Iron(mg/l)	0.15
30	Cobalt(mg/l)	0.22
31	Lead(mg/l)	0.32
32	Cadmium(mg/l)	0.14
33	Mercury(mg/l)	0.001

3.4 Discussions

Many researchers have identified that UASB reactors are effective when it is used to treat the lower strength waste water such as municipal sewage and dairy waste water etc.In our study the waste water from sugarcane industry molasses which is having higher strength was selected for the treatment. Due to the higher organic content in the waste water an anaerobic treatment was effectively achieved in the UASB reactor.

The start-up period that is sludge blanket formation was done by using a mixture of cow dung .At the end of ten days the sludge blanket was effectively formed and the reactor was ready for treatment of sugarcane waste. The waste water is inoculated for the detention time of 30 days.

The treated effluent were tested for their characteristic and the results shown that that effective removable of pollutants. The removal of TSS from waste water is 2486 mg/l to 1216 mg/l and the removal efficiency of TSS is 51.08%. UASB reactors effectively reduced the TDS from 2355mg/lit -1210mg/lit. Its removal efficiency is 48.61%.BOD and COD are important parameters of wastewater and their values indicate the organic pollution concentration. In this treatment BOD is removed effectively with the initial value of 1985mg/l to the final value of 520 mg/l. The percentage of removal is 73.80 %. COD level is also decreases from 1325 mg/l to 285 mg/l and the removal efficiency is 78.49 %.

The Sulphate removal ranges from 209 mg/l to 112 mg/l having the efficiency of 46.41%. The removal of Chloride ranges from 1486 mg/l to 353 mg/l. The effective removal of phosphate in this treatment varies from 0.186 mg/l to 0.02 mg/l. The efficiency is 89.24%. There is an effective removal of oil which varies from 0.416 mg/ l to 0.05 mg/l. The removal percentage is 87.98%. The pH values varies from 8.65 to 7.16 and the efficiency is 17.22%.

3.5 Biogas Recovery:

The total amount of biogas recovered during the whole project was 0.12 m^3 by the water displacement method.

IV Conclusion

Our project comprised of environmental friendly waste water purification processes in single stage setup performed, gave efficiency. Its low operating power cost make it worthwhile to consider. If power failure occurs, the process does not suffer, as it was already anaerobic in nature.. Based on the result of this research project it can be concluded that the UASB reactor is more economical and feasible. Earlier studies suggests that the UASB reactors are effective when it is used for treatment of low strength wastewater. However in our project it is evident that UASB reactors can also be used for treating the higher strength wastewater such as sugarcane waste.

The removal efficiency of organic pollutant parameters BOD and COD is 73.80% and 78.49% respectively makes the UASB good and economical. Other Pollutants like Phosphates, Sulphates, and oil and grease are also reduced effectively with the help of UASB reactor. Apart from the effective treatment, by product of Biogas produced in an anaerobic condition. The amount of Biogas produced from the treatment is 0.12 m^3. Further studies are needed for the effective removal of pollutants in UASB reactor and the Optimization of process parameters for the Biogas generation.

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