Performance Evaluation of Upflow Anaerobic Sludge Blanket Reactor for Treating Sugar Mill Effluent

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Abstract : Sugar industry is one of the most important food industries in India. The wastewater discharged from the sugar industry is highly biodegradable. The main aim of this study is to develop the anaerobic digestion process for the generation of biogas from the sugar mill effluent in the UASB reactor. The attempts were made to optimize the pH, temperature, organic loading rate, Hydraulic retention time, and the removal of COD and BOD. The influent COD of sugar mill effluent was varied from 2000 to 3500 mg/lit. The OLR for the operating flow rates were ranged from 0.008 to 0.079 Kg COD/m^2.day for HRT ranges from 4 to 24 hrs. The maximum COD removal efficiency is 89.88% with the maximum biogas yield was observed at 0.28 m^3/kg COD removed. This experimental works consists of a laboratory model of the anaerobic UASB reactor having 15.6 litres of effective volume to evaluate its treatment performance.

IndexTerms **- Sugar industry, UASBR, HRT, OLR, COD removal efficiency.**

I. INTRODUCTION

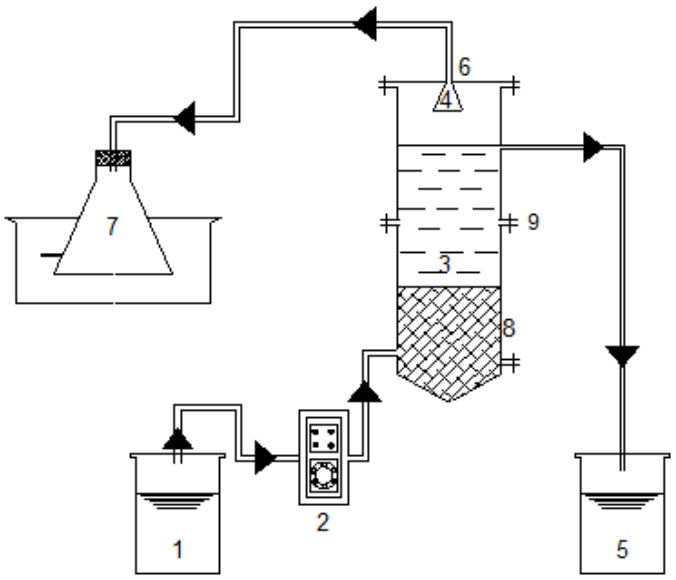
Sugar industry is the agro based industry, which plays an important role in the strengthening of nation's economy and social development of a country. India is the world's largest sugar-consuming country and takes second place in the production of sugar. As a result, the amount of wastewater generated from the sugar industry also increased. The manufacturing of sugar involves massive amounts of water and energy. Wastewater from Sugar industries are characterized by high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Dissolve Solids (TDS). Generally, a sugar industry effluent contains chlorides, sulphates, carbohydrates, oil and grease, and heavy metals. The BOD/COD ratio causes rapid depletion of oxygen content of the waters, creates foul smell, causes the stream unfit for drinking, aquatic life, and for other purposes. The upflow anaerobic sludge blanket (UASB) reactor is the most extensively used high rate anaerobic treatment system for treating the variety of wastewater. The main objective of this study is to evaluate the performance of UASBR for the treatment of sugar industry effluent and as well to recover energy from sugar industry effluents.

II. MATERIALS AND METHODOLOGY

The experimental set up consists of UASB reactor having effective volume of 15.6 litres. The physical description and process parameters are listed in Table-1. The schematic diagram of the experimental setup is presented in Fig 1 and Table 1.

Table 1: UASBR – The physical description and process parameters of experimental model

DESCRIPTION	MEASUREMENTS
Total volume of the reactor, lit	20.80
Effective volume of the reactor, lit	15.6
Total height of the reactor, m	1.8
Effective height of the reactor, m	1.2
Effective diameter of the reactor, m	0.12
Peristaltic pump (miclin's make)	pp-30 model
Influent flow rate lit/hr	0.875, 1.850, 2.825, 3.800, 4.75
Influent average COD mg/lit	2003.66, 2584.86, 3060.26, 3556.62
Organic loading rate kg/COD/m^2.day	0.026, 0.0345, 0.0412, 0.0479



1. Influent tank
2. Peristaltic pump
3. Granulated UASB reactor
4. Gas/liquid/solid separator
5. Effluent tank
6. Gas outlet
7. Gas collection system & measurement of the displaced gas
8. Granulation zone
9. Sampling port

Figure. 1: Experimental model of the hybrid UASB reactor

The experimental set up consists of functional components like peristaltic pump, influent vessel, effluent collection vessel, and measuring jar. The collected gas was measured by water displacement method. The effluent was allowed into the reactor with an average OLR 0.0748 kg COD/m^2.day; during this study the COD was measured. The process was frequently monitored and the removal efficiency of the COD under different hydraulic retention time was noted. The following two conditions were used for interpreting the reactor Hydraulic Retention Time (HRT in hrs) and organic loading rate (OLR in kg/COD/m^2 day).

The reactor performance was studied and the steady state conditions were observed to achieve with the reduction of COD for an average value of 79.28%. All samples were tested for pH, BOD, TSS, COD and they are analysed according to Standard Methods for the Examination of Water and Wastewater.

The experiment is taking place with the domestic wastewater for the stabilization process. After the stabilization process, the sugar mill effluent is introduced into the reactor. The experiment was ran for different operating parameters conditions, such as hydraulic loading rates, m^3/m^2.day (0.042, 0.033, 0.024, 0.016, 0.007), organic loading rates at (0.079, 0.064, 0.048, 0.031, 0.015 kg/COD/m^2 day) HRT (4, 8, 12, 18 and 24.00 hrs) and the Gas production was measured by the water displacement method.

III. RESULT AND DISCUSSION

The experimental model on anaerobic UASB reactor has been evaluated in terms of COD removal efficiency and the biogas generation. The performances of the model with respect to % removal efficiency of COD, the experimental results were interpreted for OLR and HRT.

The COD removal efficiency under different HRT (4.00, 8.00, 12.00, 18.00, 24.00 hrs) for different COD (2003.66, 2584.86, 3060.26, 3556.62 mg/l), as shown in Fig 3. The COD removal efficiency under different OLR (0.026, 0.0345, 0.0412, 0.0479 kg/COD/m^2.day) for different COD (2003.66, 2584.86, 3060.26, 3556.62 mg/l), as shown in Fig 2.

The COD removal efficiency under different HLR m^3/m^2.day (0.042, 0.033, 0.024, 0.016, 0.007), for different COD (2003.66, 2584.86, 3060.26, 3556.62 mg/l), as shown in Fig 4.

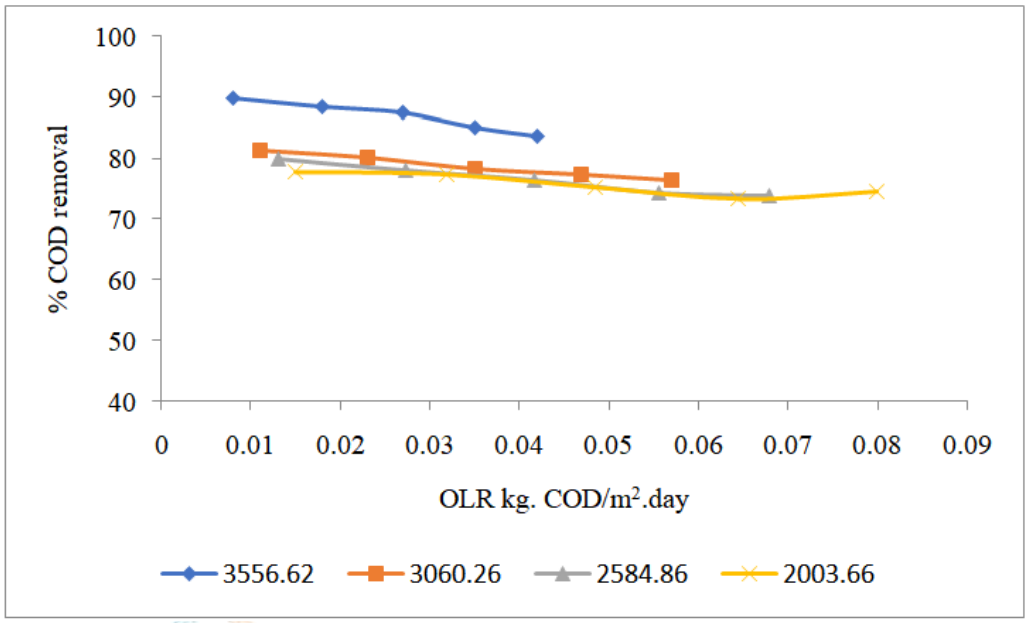


Figure. 2 OLR vs % COD removal

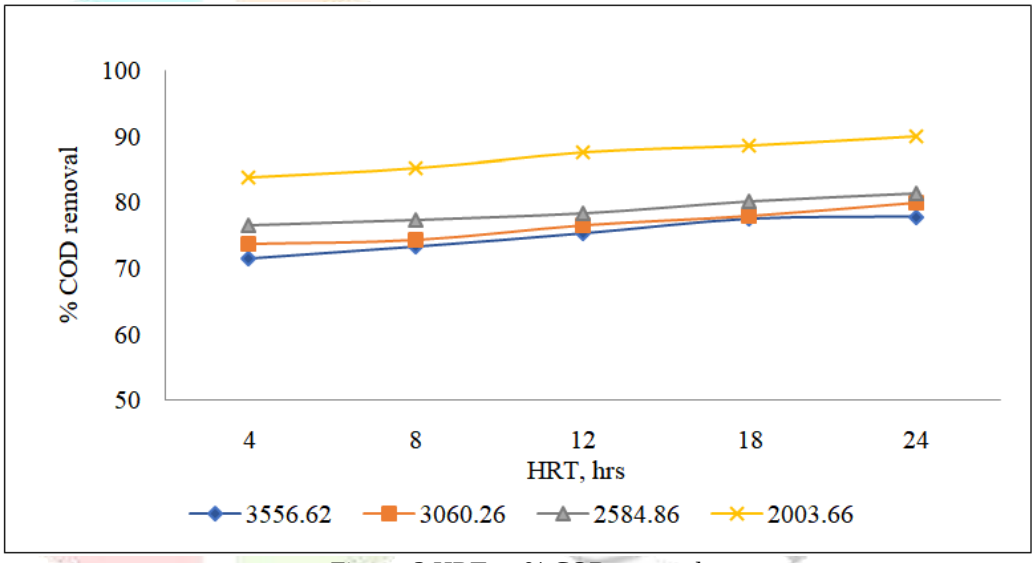


Figure. 3 HRT vs % COD removal

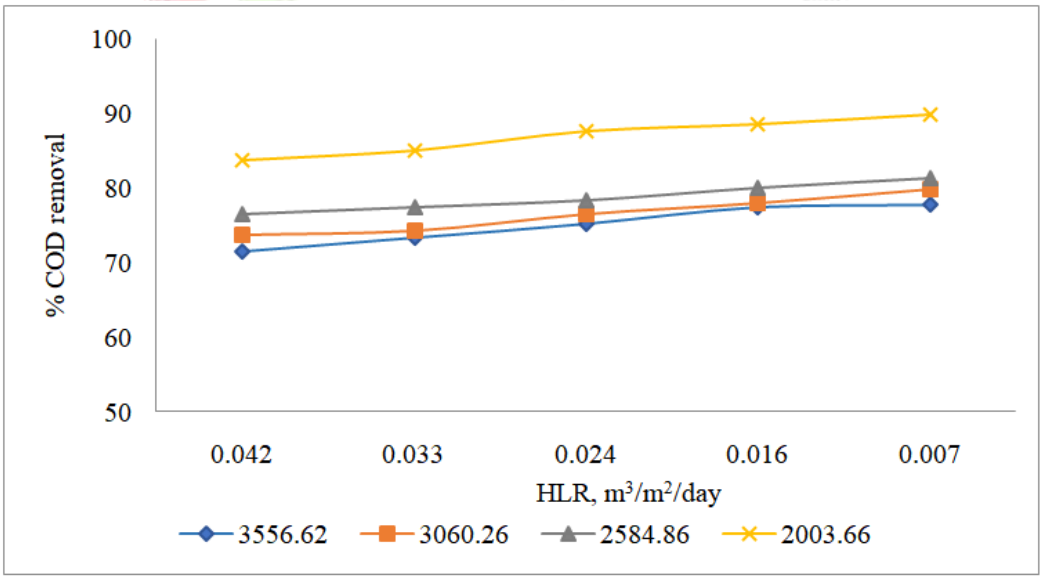


Figure. 4 HLR vs % COD removal

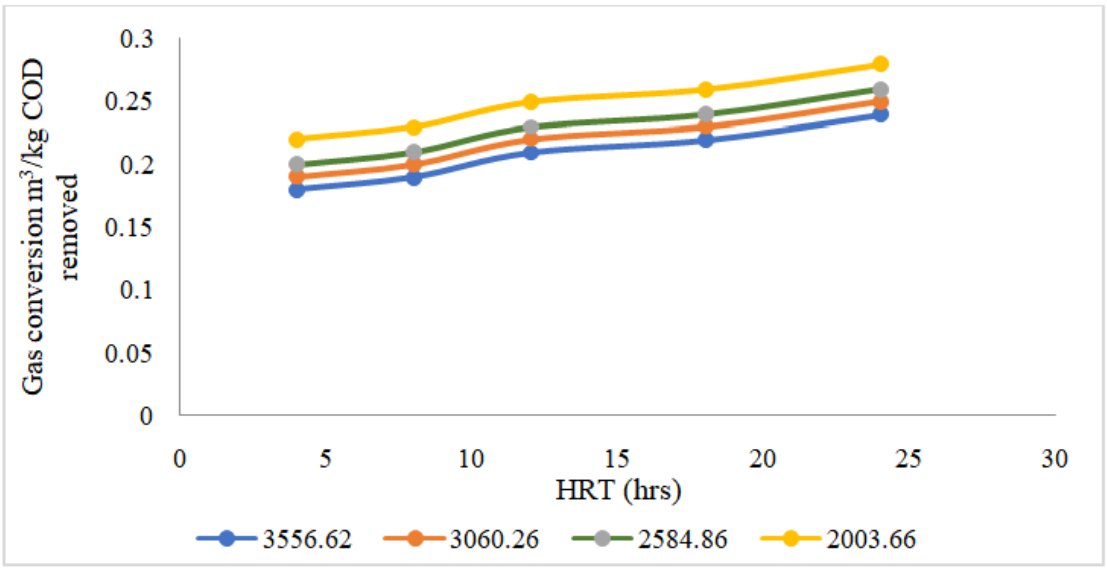


Figure. 5 HRT vs Gas conversion

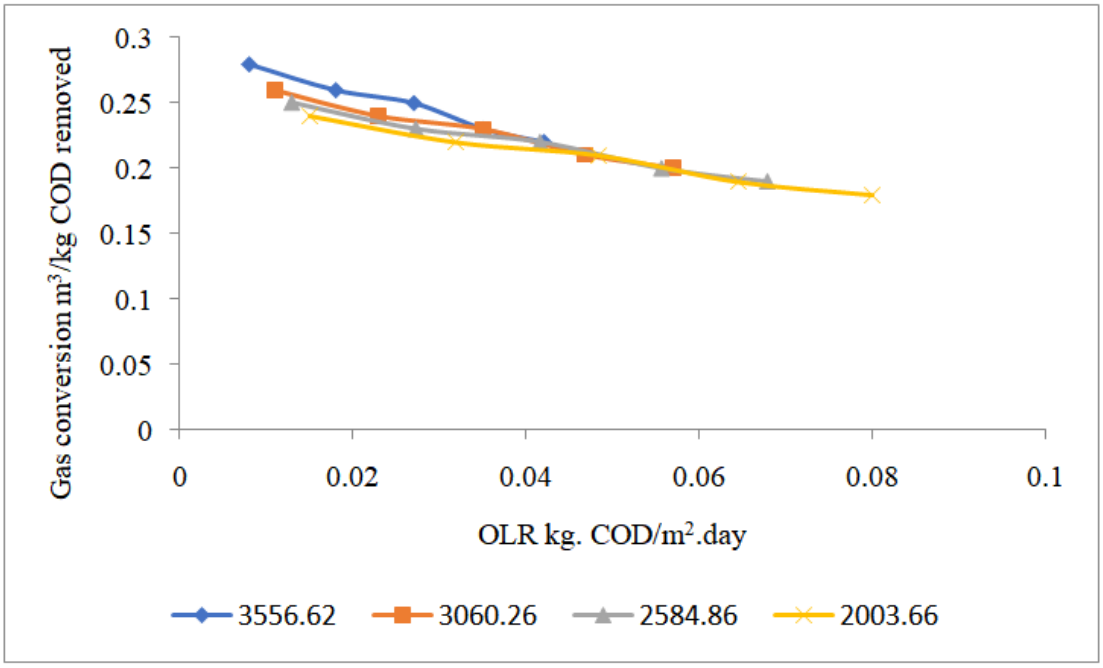


Figure. 6 OLR vs Gas conversion

The maximum % COD removal efficiency was observed at 89.88 for an operating OLR is 0.008 kg COD/m^2.day and HRT is 24 hrs. The minimum COD removal efficiency was observed at 71.49% for an operating OLR is 0.079 kg COD/m^2.day and HRT is 4.0 hrs.

The maximum of biogas generation was observed at 0.28 m^3/kg COD removal for an HRT is 24.0 hrs. The minimum of biogas generation was observed at 0.21 m^3/kg COD removal for an HRT is 4.0 hrs.

CONCLUSION

The maximum COD removal efficiency was observed at 89.88 % under the OLR is 0.008 kg COD/m^2.day and HRT is 24 hrs. The maximum biogas was collected at 0.28 m3/kg COD removal for an HRT is 24.0 hrs. The anaerobic UASB reactor for the treatment of sugar industry wastewater is appropriate for the reactor model.

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REFERENCES

[1].Anusuya M, Dr.Mathiyazhagan R. "Performance study on anaerobic fluidized bed reactor for treating sugar mill wastewater", International Research Journal of Engineering and Technology (IRJET). Volume: 03 Issue: 04 Apr-2016 www.irjet.net.

[2].Banu J.R, Kaliappan S, Yeo I.T. "Treatment of domestic wastewater using upflow anaerobic sludge blanket reactor", Int. J. Environ. Sci. Tech., 4 (3): 363-370, 2007 ISSN: 1735-1472.

[3].GonzAleza J.S, Riveraa A, Borjab R., Unchez E. "Influence of organic volumetric loading rate, nutrient balance and alkalinity: COD ratio on the anaerobic sludge granulation of an UASB reactor treating sugar cane molasses", International Biodeterioration & Biodegradation 41 (1998) 127-131.

[4].Hampannavar U.S, Shivayogimath C.B. "Anaerobic treatment of sugar industry wastewater by Upflow anaerobic sludge blanket reactor at ambient temperature", International Journal of Environmental Sciences Volume 1, No 4, 2010.

[5].Hina Rizvi, Nasir Ahmad, Farhat Abbas Iftikhar Hussain Bukhari, Abdullah Yasar, Shafaqat Ali, Tahira Yasmeen, Muhammad Riaz (2015). "Start-up of UASB reactors treating municipal wastewater and effect of temperature/sludge age and hydraulic retention time (HRT) on its performance", Arabian Journal of Chemistry 8, 780–786.

[6].Jafarzadeh M.T, Talebiazar L, Jamshidi N, Aslaniavali R. "Performance evaluation of an anaerobic hybrid reactor treating petrochemical effluent", International Conference on Environment, Energy, Ecosystems and Development 2013.

[7].Kaviyarasan K. "Application of UASB Reactor in Industrial Wastewater Treatment – A Review", International Journal of Scientific & Engineering Research, Volume 5, Issue 1, January-2014 584 ISSN 2229-5518.

[8].Kolhe. "Physico-Chemical Analysis of Sugar Mill Effluents", International Research Journal -Issn-0974-2832.

[9].Lavanya R, Dr.Jodhi C. "A Study on Variations in Biological Treatment Methods under Different Temperature on Hybrid Anaerobic Reactor for Treating Dairy Wastewater", Journal of Environmental Science, Computer Science and Engineering & Technology. Vol.5. No.2, 194-204 2016 E-ISSN: 2278–179X.

[10].Mijaylova Nacheva P, Moeller Chávez G, Matías Chacón J and Canul Chuil A. "Treatment of cane sugar mill wastewater in an upflow anaerobic sludge bed reactor", Water Science & Technology- WST 60.5 2009.

[11].Sanchez Riera F, Cordoba P and Sifierizt F. "Use of the UASB Reactor for the Anaerobic Treatment of Stillage from Sugar Cane Molasses", Biotechnology and Bioengineering, Vol.XXVII, Pp.1710-1716 (1985).

[12].Sathiyaraj S, Soundharya S, Prabavathi S, Alvinraj S, Santhiya S. "Treatment of sugarcane waste effluent by UASB reactor and biogas recovery", International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:2682 Vol.6, No.9, September 2017.

[13].Tanksali A.S (2013), "Treatment of Sugar Industry Wastewater by Upflow Anaerobic Sludge Blanket Reactor", International Journal of Chem Tech Research, Vol.5, No.3, pp 1246-1253.

[14].Vamsi Krishna Reddy. "A Review on Treatment of Sugar Industry Effluents by Up-Flow Anaerobic Sludge Blanket Reactor", I-Manager's Journal on Future Engineering & Technology, Vol. 9. No. 3 2014.