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Performance of an Up-Flow Anaerobic Sludge Blanket Reactor (Uasbr) In the Treatment of Brewery Effluent

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ABSTRACT: *Brewery waste stream is a high biodegradable with BOD in the range of 2500 to 3500 mg/l and COD from 4600 to 7000 mg/l. This waste stream suffers substrate inhabitation in conventional biological treatment process. Up flow anaerobic sludge blanket reactor (UASBR) is versatile and proven to be a high rate anaerobic reactor. The substance of the sludge blanket which is more dependent on the biodegradability and nutrients offers an edge for treating highly biodegradable waste stream such as brewery. The present study evaluated the performance of UASBR through a laboratory model (25 liters of effective volume) for treating the brewery effluent. This model was studied for its treatment efficiency in terms of COD reduction. The experiment was conducted for varying influent COD 3227, 4332, 5180, 5748, 6191, 6662 and 7177 mg/l with corresponding flow rates of 7.20, 14.40, 21.60, 28.80 and 36.00 mg/d . This work on UASBR model for treating brewery waste stream was found to be successful with COD removal of 79.85 % for the operating conditions of OLR at 0.0922 kg COD kg VSS per Day and HRT at 3.47 days.*
***KEYWORDS*:** Anaerobic, brewery wastewater, upflow anaerobic sludge blanket reactor, UASBR.

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I INTRODUCTION

Breweries are the long-established industries in agro and food sectors using cost effective techniques to produce the best quality product. In the process, beer undergoes three chemical and bio-chemical reactions like mashing, boiling, fermentation and maturation after that it is subjected to solid–liquid separations phases like wort separation, wort clarification and rough beer clarification. The first stage in the process of beer production is the preparation of the wort. As a result, the water consumption and wastewater offer real economic chances for the overall enhancement in the processes of brewing industries. In order to minimize the consumption of water and wastewater generation the mass balance concepts plays a vital role. The outcome resulted in mounting awareness within the brewing industry in environmental pollution and it continues to cause change of colour and odour in the underground water of affected areas. As a solution, anaerobic systems have become an attractive option, among other advantages, because of their high COD content removal. Up flow anaerobic sludge blanket reactor (UASBR) is proved to be a high rate anaerobic reactor. However, the use of UASBR in treating the effluent from brewery industries deserves much focus, as it is an unsolved problem in over the world. Hence, the present work evaluated the performance of UASB reactor for treating brewery effluent.

In UASB reactor the upflow movement of influent and the raising gas keeps the biomass in a very active and suspended state (Fig.1). The fundamental principle of a UASB reactor is that a heavily flocculated sludge is developed which can act almost as a separate fluidized bed and withstand relatively high mixing forces. This sludge produced is of such a granular in nature. The UASB system relies on the agitation brought about by biogas production since there is no mechanical mixing. The UASB is a simple process to operate.

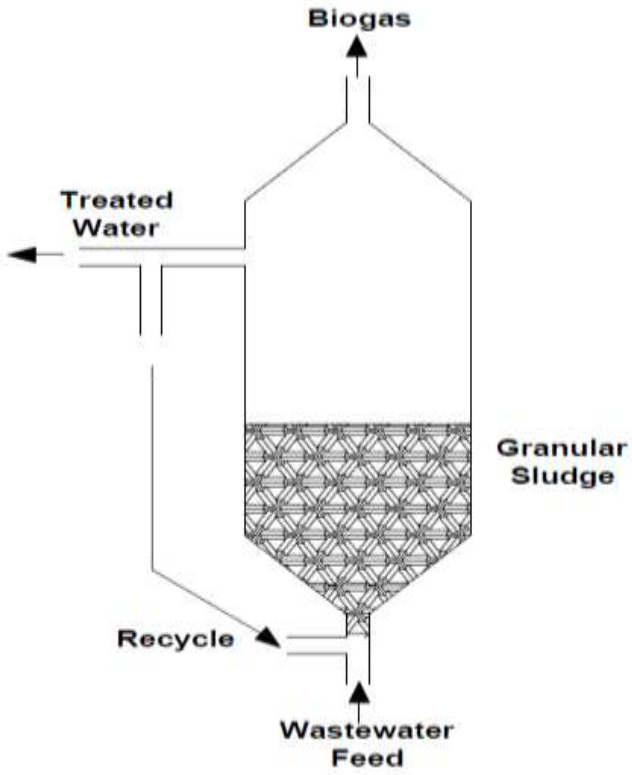

Fig.1 Schematic of UASB reactor (EPA 2011)

Simate et al., (2011) have reviewed the process involved in treatment of brewery wastewater and also its potential application of reuse. In recent days, anaerobic systems have turned into an appealing alternative, among other advantages, as a result of their high COD substance evacuation. This biological technique has widespread application for the treatment of the characteristically high organic content of the brewery wastewater. Drissen (2003) and Vereijken. (2003) have stated that waste water to beer ratio is around 2.0 m^3/m^3 based on mass balance concept which is complicated to accomplish, because part of water is disposed off as by-products and lost by evaporation. The effluents discharged are found to have high organic and acidic content, which increases the BOD, COD and high organic load in the waste water that contribute to result dissolved carbohydrates, alcohols, suspended solids, yeast *etc*., which considerably pollute the water bodies (Chaitanya kumar et al., 2011). While studying the performance of UASB reactor in treating brewery effluent, Sharda et al., (2013) have reported that effluent after treatment is found to meet the effluent discharge standards and the authors have also suggested that the secondary settling rates can be enhanced by providing regular sludge recirculation in aeration tanks. While investigating the effect of sulphate on methanol conversion in a mesophilic UASB reactor when fed with an influent containing sulphate (2 #I) and methanol (1.33 #I), in this reactor, Weijma et al (2003) have found that 90% of methanol is mineralized to methanol and only 5% - 10% of the methanol is used for sulphate reduction and also observed that on an average 0.4 g ~0~~'l"&da~ is reduced when this parameter is independent of short-term pH variations in the range from 5 to 8, addition of acetate as co-substrate and type of granular seed sludge.

Experimental setup

The experimental setup consists of a UASB rector, made of acrylic material with a cylindrical portion having 60 cm height and diameter of 20 cm, whose top widens to accommodate a gas liquid solid separator (GLSS) as shown in the Fig. 2. The reactor feeds the influent tank by means of peristaltic pump (Miclin's make and model PP-20). The influent to the reactor is "t" at its bottom, and the reactants move from the bottom to the gas liquid solid separator at the top where the gas get separated and collected in a gas collector. The reactor is proved with sampling ports at zones viz., Hydrolysis, Acidogenesis and Methogenesis in the reactor. The influent tank is provided with an agitator to ensure proper mixing of the wastewater. The treated effluent from the top of the reactor is obtained by overflow through the launder provided at the top of the reactor.

The dimensions of the reactor model were assessed using an empirical approach for an effective reactor volume of 9 liters with an overall volume of 25 liters. The design approach is made on the basis of influent flow rate,

hydraulic retention time, upward velocity, influent COD and organic loading rates. The physical dimensions and process parameters of the experimental model of UASBR is presented in the Table1. Chemical composition of synthetic brewery wastewater sample collection is presented in Table 2.

Table 1 process parameters of the experimental model [UASBR-25 Lit]

Description	Measurements
Total volume of the reactor, lit	25
Total height of the reactor, mm	69
Effective height of the reactor, mm	60
Effective dia, mm	20
Dia of the reactor at top, mm	7.2
Dia of GLSS top and bottom, mm	17
Height of the GLSS, mm	9
Dia of Influent & Effluent pipe, mm	1
Width of the launder, mm	2.5
Peristaltic pump	pp - 30 model
Influent Flow Rate, liter/day	7.2,14.4,21.6,28.8,36
Influent COD.mg/l	3237, 4332, 5180, 5748, 6191, 6662 and 7177
Volumetric loading Rate,KgCOD/m.day	1.22 to 10.31
Organic loading Rate, Kg COD/kg VSS. Day	0.05 to 0.55

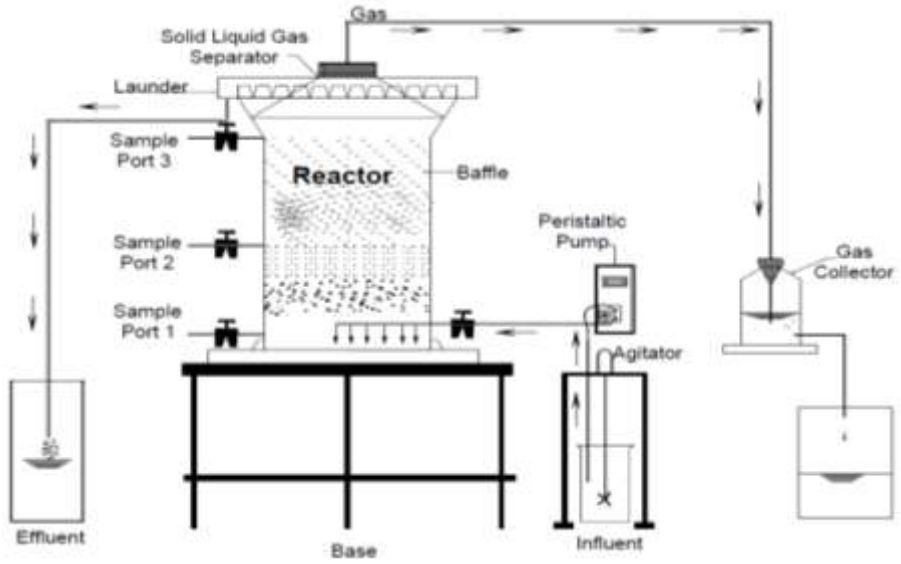

Fig.2 Schematic Diagram of Experimental Setup

Table 2 Chemical composition of synthetic brewery wastewater Sample collection

Barley Powder	Varied
NH4CI	Varied
$MgSO_4.7H_2O$	50mg/l
$FeCl_3.6H_2O$	3mg/I
$CaCl_2.H2O$	0.4 mg/1
KC1	60 mg/1
$(NH_4)2.PO_4$	Varied

While collecting the sample, much care and observation are essential. In the brewery industry, the hourly variations of different streams of flow and characteristics vary considerably throughout the day. Forty liters of wastewater were taken at a two hour intervals over a period of 24 hours and mixed according to their flow rates, then the integrated samples was used for analysis to find out various parameters. Sample analysis report for brewery effluent is presented in Table 3.

Table 3 Sample analysis report for brewery effluent

S.No	Parameters	Sample
1.	pH	5.8
2.	Total suspended Solids, mg/I	2780
3.	Total Dissolved Solids, mg/1	3670
4.	Total Solids, mg/1	6450

5.	BOD_5@20°C,mg/l	3490
6.	COD, mg/I	6720
7.	Nitrogen, [as N] mg/1	48
8.	Phosphorus, [as P] mg/I	52

II RESULTS AND DISCUSSION

The performance of the UASBR Model was assessed in terms of its efficiency of COD removal. The model was run for various combinations of influent COD and flow rates. Under each condition of operations, the parameters like influent COD, effluent COD, concentration of solids in the sludge blanket zone and cubic meter of gas per kg COD removal were noted. The influent COD co-relation with the follow rate and effective reactor volume for the evaluation of organic loading rate (Kg COD applied / Kg VSS in the sludge Blanket zone day) and volumetric organic loading Rate (Kg COD applied / effective volume of the reactor day). The performance study was made with the model run under continuous mode.

Performance of the UASBR model

The UASBR model, through a completely mixed reactor by virtue of its granular sludge blanket, is essentially immobilizing the microbial culture to envisage very high mean cell residence time. The rising gas bubbles from the sludge blanker offer much required mixing and solid conversion was as high as 44900 mg/1 in the sludge blanket zone.

The model was essentially brought to steady state condition of treatment using domestic wastewater after continual operation of the model for 2 months. The effluent was drawn from the brewery industry for process acclimatization and steady state conditions of the model operation. The steady state condition of the model during the experiment using synthetic effluent was achieved over operation of Two weeks. The experiment was continuously operated for specified time.

Performance of Model for Treating Brewery Effluent

The synthetic brewery effluent was used for the system performance for varying characteristics (as COD, mg/1) and influent flow rate (lit/day), The varying influent COD applied over the model were 3237,4332,5180,5748,6191,6662 and 7177 mg/1. The influent flow rate applied over the model for each concentration of influent COD were 720,14,40,21,60,28,80 and 36.00 lit/day. Different streams applied over the model were correlated with the specific volume of the reactor and it was found that inflow rate of the feed, the hydraulic retention time (HRT) was 3.47, 1.74, 1.16, 0.87 and 0.69 days. Under each conditions of model operation, influent COD, effluent COD, concentration of Volatile Solids in the Sludge Blanket Zone, and amount of gas per kg COD removal were recorded through suitable samples drawn and using standard methods of analysis. The observed values and interpreted for the process parameters of OLR and VLR are tabulated for each conditions of the model operation. The system performance curves of UASBR for treating Brewery effluent are presented in Figs. 3 to 7.

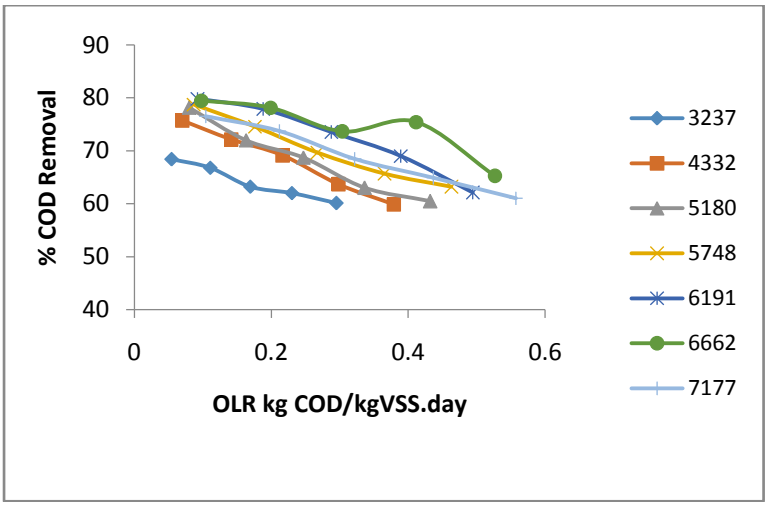

Fig. 3 OLR Vs % COD Removal

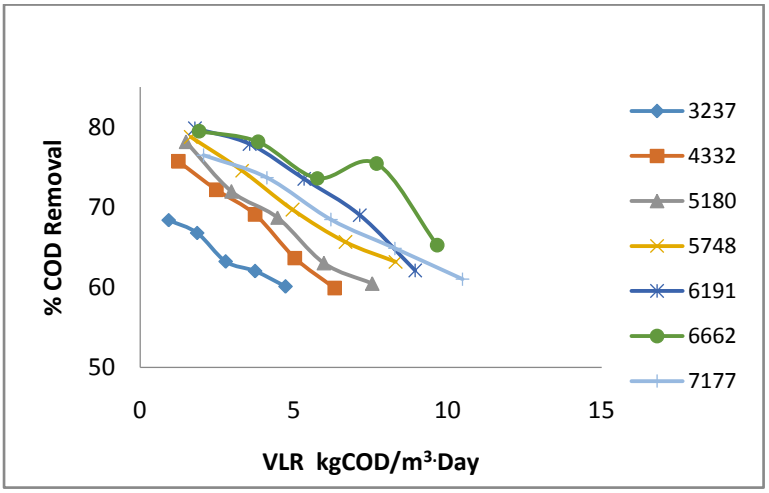

Fig. 4 VLR Vs % COD Removal

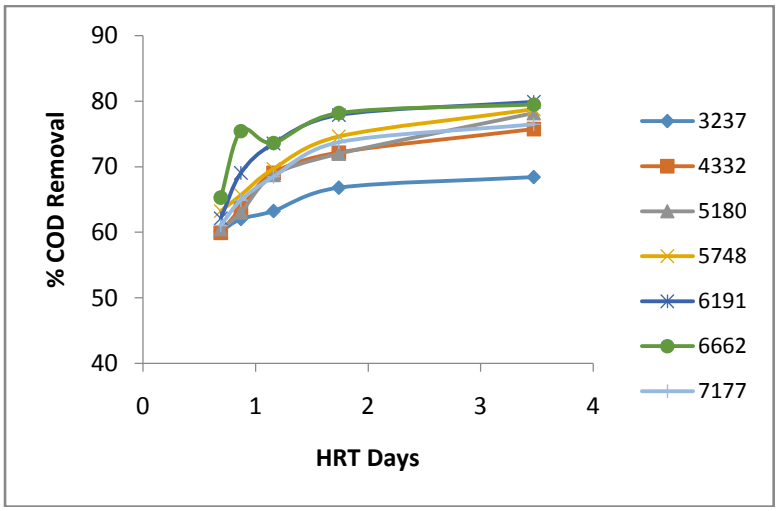

Fig. 5 HRT Vs % COD Removal

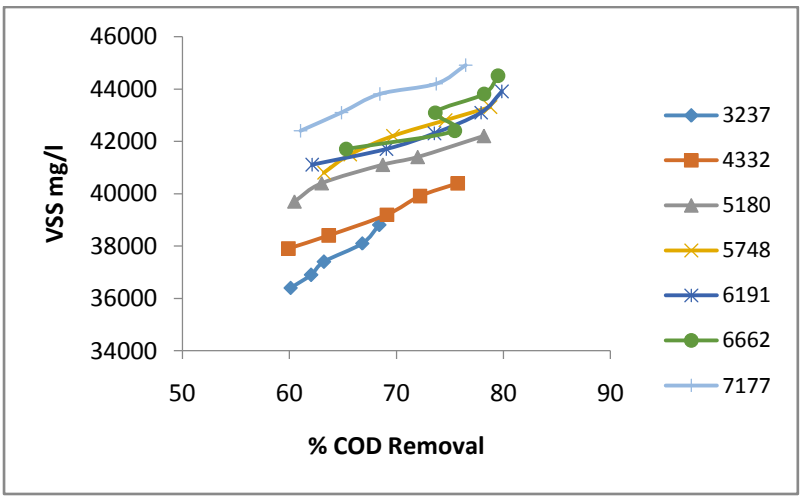

Fig. 6 % COD Removal Vs VSS

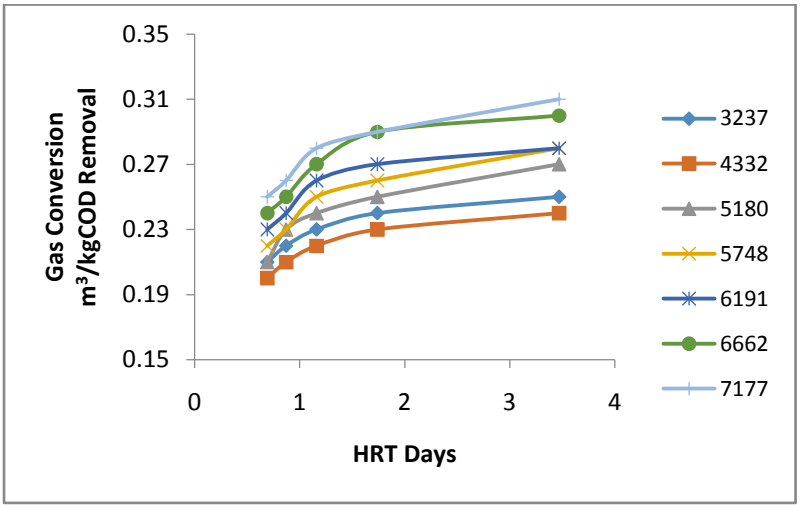

Fig. 7 HRT Vs Gas Conversion

In the Brewery Effluent treatment, the maximum efficiency of the UASBR for COD removal was observed at 79.85%. The maximum concentration of VSS in the Sludge Blanket of the model observed was 44900 mg/1. The maximum gas conversion ratio was assessed at 0.31m3 of gas /kg of COD removal.

Similar to the present study, Mosquera-Corral et al. (2003) have reported that 80% COD removal is achieved using the UASB reactor, which can be suitably employed for the post-treatment of the effluent to reduce the organic carbon content and produce an effluent suitable for the subsequent nitrification process.

III CONCLUSION

The experiment work on UASBR model for treating brewery waste stream was proved to be successful with COD removal of 79.85 % for the operating conditions of OLR at 0.0922 kg VSS per day and HRT at 3.47 days. Thus UASBR is one of the best options to treat brewery wastewater for the removal of COD. Further efforts are required to meet the standards for disposal of treated effluent from UASBR.

REFERENCES

[1]. Ahn, Y.H., Min, K.S. and Speece, R.E., 2001. Full scale UASB reactor performance in the brewery industry. *Environmental technology*, *22*(4), pp.463-476.
[2]. Arceivala, S.J. and Asolekar, S.R., 2006. *Wastewater treatment for pollution control and reuse*. Tata McGraw-Hill Education.
[3]. Basu, A.K. and Leclerc, E., 1975. Comparative studies on treatment of beet molasses distillery waste by thermophilic and mesophilic digestion. *Water Research*, *9*(1), pp.103-109.
[4]. De Heredia, J.B., Torregrosa, J., Dominguez, J.R. and Partido, E., 2005. Degradation of wine distillery wastewaters by the combination of aerobic biological treatment with chemical oxidation by Fenton's reagent. *Water Science and Technology*, *51*(1), pp.167-174.
[5]. Brito, A.G., Peixoto, J., Oliveira, J.M., Oliveira, J.A., Costa, C., Nogueira, R. and Rodrigues, A., 2007. Brewery and winery wastewater treatment: some focal points of design and operation. In *Utilization of by-products and treatment of waste in the food industry*, pp. 109-131. Springer, Boston, MA.
[6]. Rittmann, B.E. and McCarty, P.L., 2012. *Environmental biotechnology: principles and applications*. Tata McGraw-Hill Education.
[7]. Sharda, A., Sharma, M.P. and Kumar, S., 2013. Performance Evaluation of Brewery Waste Water Treatment Plant. *International Journal of Engineering Practical Research*. 2(3), pp. 105-111.
[8]. Simate, G.S., Cluett, J., Iyuke, S.E., Musapatika, E.T., Ndlovu, S., Walubita, L.F. and Alvarez, A.E., 2011. The treatment of brewery wastewater for reuse: State of the art. *Desalination*, 273(2), pp.235-247.
[9]. Driessen, W. and Vereijken, T., 2003, March. Recent developments in biological treatment of brewery effluent. In *The Institute and Guild of Brewing Convention, Livingstone, Zambia, March* pp. 2-7.
[10]. Mosquera-Corral, A., Campos, J.L., Sánchez, M., Méndez, R. and Lema, J.M., 2003. Combined system for biological removal of nitrogen and carbon from a fish cannery wastewater. *Journal of Environmental Engineering*, *129*(9), pp.826-833.

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