Available Online at http://www.recentscientific.com

ISSN: 0976-3031

International Journal of Recent Scientific Research
Vol. 7, Issue, 6, pp. 11837-11840, June, 2016

International Journal of Recent Scientific Research

Research Article

TREATMENT OF DISTILLERY SPENTWASH USING DOWNFLOW STATIONARY FIXED FILM REACTOR WITH PUF AS PACKING MATERIAL

Noorahmed A. Hosmani[1]* and Amar S. Byakodi[2]

[1,2]Department of Civil Engineering, Angadi Institute of Technology and Management Belgaum, India

ARTICLE INFO

Article History:

Received 20th March, 2016
Received in revised form 29th April, 2016
Accepted 30th May, 2016
Published online 28th June, 2016

Key Words:

Spentwash, HRT, OLR, DSFF, distillery wastewater, BOD, COD, Biogas, Anaerobic treatment

ABSTRACT

Ethanol manufacture from molasses generates large volumes of high strength wastewater, generally called as spentwash, which is serious environmental concern. The effluent is characterized by extremely high chemical oxygen demand (COD) (80,000–100,000 mg/l) and biochemical oxygen demand (BOD) (40,000–50,000 mg/l), apart from low pH, strong odor and dark brown color. During the present study, spentwash was treated in downflow reactor with Polyurethane Foam (PUF) as packing material. The ambient room temperature during the study period was between 27-32^{o}C. Parameters such as pH and biogas were analysed daily, COD was analysed every alternative day and BOD and solids were analysed during steady-state conditions. The optimum HRT was found 8 hours for the reactor. The initial COD concentration fed into the anaerobic reactor was 1 kg COD/m^3.d, further during the study the feed concentration was increased to 2, 3, 4, 5, 6, 7, 8 kg COD/ m^3.d for the reactor. The reactor showed maximum COD removal efficiency of 60% for OLR of 7kg / m^3.d. Maximum biogas production was observed 6.1L/d. The reactor showed maximum solids removal (71% - TS, 74% - DS and 77% - SS) for OLR of 7kg/ m^3.d.

INTRODUCTION

In India, there are a number of large-scale distilleries integrated with sugar mills (Pant Deepak and Adholeya Alok, 2007). Production of ethyl alcohol in distilleries based on cane sugar molasses constitutes a major industry in India (Nagaraj M. and Dr. Aravind Kumar, 2007). One of the most important environmental problems faced by the world is management of wastes. Different industries create variety of wastewater pollutants; which are difficult and costly to treat (Anupama S. *et al,* 2013). About 295 distilleries in India produce 2.7 billion litres of alcohol and generating 40 billion litres of wastewater annually (Pant Deepak and Adholeya Alok, 2007). The aqueous distillery effluent stream known as spentwash is a dark brown highly organic effluent and is approximately 12-15 times by volume of the product alcohol. Spentwash handling, treatment and disposal are of great importance and needs special attention (Pradeep N. V. *et al*, 2011) It is one of the most complex, troublesome and strongest organic industrial effluents, having extremely high COD and BOD values(Nagaraj M. and Dr. Aravind Kumar, 2007).

The major constituents of the distillery effluents are carbohydrates, organic acids, proteins, nitrogenous compounds and minerals (Coetzee G. *et al,* 2004). These types of wastewater may result in the pollution of soil, ground and surface water if the wastewater is disposed off without treatment (Chidankumar C. S. *et al*, 2009). Treatment of this spentwash is one of the serious pollution problems in the countries producing alcohol from the distillation of molasses (Gandhi Srikanth Chandragupta *et al*, 2011). Various physiochemical methods such as Incineration (Sunil Kumar Gupta, 2003), direct land application (Sheehan G. J. and Greenfield P. F., 1979) (Margot Alana Trerise, 2005), (Chidankumar C. S. *et al*, 2009), adsorption etc have been reported earlier but these methods have limited applications.
Various factors influence the choice of method used for treating wastewater (Sunil Kumar Gupta, 2003). Organic wastes can be aerobically or anaerobically treated. Anaerobic treatment converts the wastewater organic wastes into small amount of sludge and large amount of biogas as source of energy (Ayati, and Ganjidoust, 2006), (Margot Alana Trerise, 2005), (Rajeshwari K. V. *et al*, 2000) (Satyawali Y. and Balakrishnan M., 2008), (Moosavi G. R. *et al*., 2005); whereas aerobic treatment needs external input of energy for aeration (Hampannavar U. S. and Shivayogimath C. B., 2010).

Many researchers have demonstrated that anaerobic processes enabling recovery of biogas appear to be the most promising technology for the treatment of spent wash (Gupta Sunil Kumar and Singh Gurdeep, 2007). Anaerobic Digestion may be defined as a waste treatment in which liquor or slurried organic

*Corresponding author: *Noorahmed A. Hosmani*
Department of Civil Engineering, Angadi Institute of Technology and Management Belgaum, India

wastes are decomposed biologically under strictly anaerobic conditions (Nally D. *et al*,).

MATERIALS AND METHODS

Experimental Setup

Laboratory-scale downflow anaerobic reactor was fabricated with from PVC pipe of 150 mm (6 inch) internal diameter. The overall height of the reactor was 1400 mm, one inlet at 140 mm from the top of the reactor was provided for the influent. The outlet was provided at 140 mm above the bottom level of the reactor. An opening was provided at the top of the reactor for the collection of biogas. Three sampling ports are provided in between the inlet and outlet at a distance of 260 mm c/c. The effective volume of the reactor was 19.80 liters. Polyurethane foam was used as packing material in the reactor. The gas outlet was connected to the water seal through rubber tubing to avoid the escape of gas. Brass check-valve of 1 inch size was fixed at the bottom of the reactor to facilitate the sludge removal. The lid of the reactor and other fittings were sealed to maintain anaerobic conditions inside the reactor. The reactor was supported by mild steel framed structure; the schematic representation of this experimental set-up is shown in Figure 1.

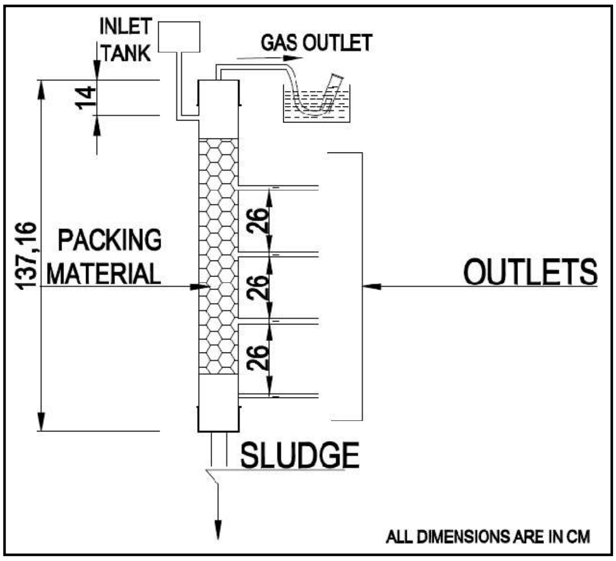


Figure 1 Schematic diagram of reactor

Anaerobically digested non-granular sludge from the septic tank was used as seed for the reactor. The sludge was sieved with a mesh of 1 mm to remove large debris and inert impurities of large size, which may hinder the reactor operation.

Analysis of wastewater

The spentwash mainly contains organic matter and solids. Hence most widely used and generalized parameters were selected for the analysis of efficiency of the filler material with downflow anaerobic reactor. pH, COD, total solids (TS), suspended solids (SS) and dissolved solids (DS) were analyzed every alternate day. The parameters were analyzed as prescribed in Standard Methods for the Analysis of water and wastewater.

RESULTS AND DISCUSSION

Analysis of Raw sample

Table 1 Typical parameters of raw spentwash

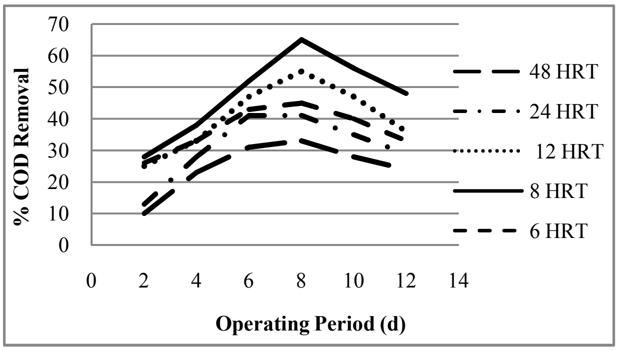
Parameter	Range
pH	5.1 – 6.5
Colour	Reddish Brown
Temperature	38ºC
BOD_3 @ 27^0C (mg/L)	40,000 - 50,000
COD (mg/L)	80,000 - 1,00,000
Total Solids (mg/L)	58,000 – 90,000
Suspended Solids (mg/L)	12,000 - 14,000
Dissolved Solids (mg/L)	45,000 - 75,000

Reactor operation

The total volume of reactor was 24.7 litres. The volume of packing material constitutes 80% of total volume of the reactor. Polyurethane foam pieces were used as packing material. Successful reactor startup with granulation was achieved within 65 days of operation. The initial COD concentration fed into the anaerobic reactor was 1 kg COD/m^3.d, further during the study the feed concentration was increased. Initial Hydraulic Retention Time (HRT) for the reactor was kept 48 hours and it was decreased stepwise to obtain the optimum HRT. Later, the HRT was kept constant and the Organic Loading Rate was increased to obtain the maximum COD removal efficiency of the reactor. The samples were collected from sampling ports every alternate day and analysed for the COD and solids removal efficiency. pH of the effluent was noted every alternate day. The pH range of effluent from the reactor was 5.1 – 7.9.

Optimum HRT

Initially the reactor was fed with an organic loading of 1 kg COD/m^3.d concentration. Hydraulic Retention Time (HRT) for the reactor was kept 48 hrs, it was decreased stepwise for 24 hrs, 12 hrs, 8 hrs and 6 hrs keeping the COD concentration constant at 1 kg COD/ m^3.d. The COD removal efficiency was 48% at 8 hrs HRT. Hence 8 hrs HRT was optimum when compared to other HRT's and is as shown in Graph 1.

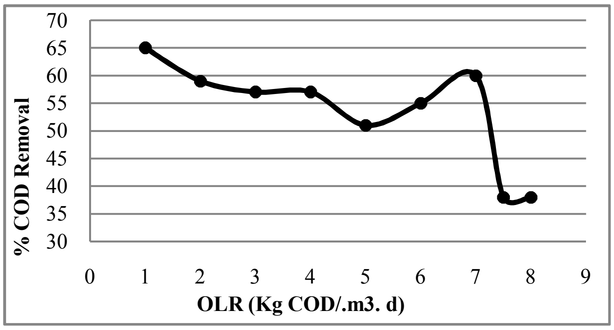


Graph 1 Percentage COD removal at different HRT

Effect of organic loading rate

The effect of organic loading rate was studied by fixing the HRT as 8 hrs and increasing the organic loading rate from 1kg COD/ m^3.d to 2, 3, 4, 5, 6, 7, 8 kg COD/ m^3.d.

The reactor fed with different organic loading rates and it was tested for COD removal efficiency for each OLR. The efficiency varied between 51% and 65% when the OLR increased from 1 to 7 Kg COD/ m^3.d. The results of this study are in line with the results of Satyawali and Balakrishnan (2008). The COD removal at varied OLRs are depicted in Graph 2.

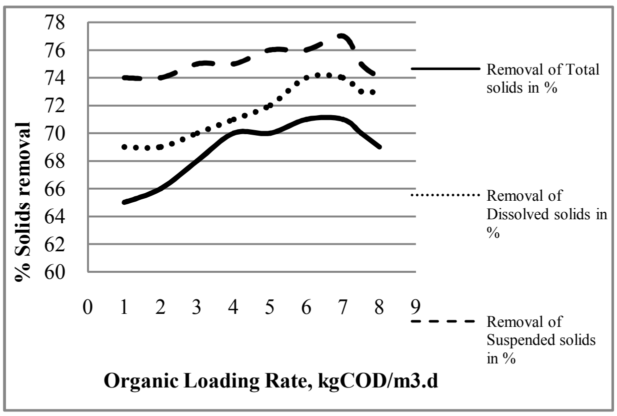


Graph 2 COD removal rate at different OLRs.

The COD removal efficiency varied marginally as the organic loading increased. The COD removal efficiency varied between 51 and 65% for OLRs between 1 and 7 kg COD/ m^3.d after successful startup. The efficiency decreased to 38% when the OLR was increased from 7 to 8 Kg COD/ m^3.d. Further, the OLR was set to 7.5 Kg COD/ m^3.d and the efficiency was found to be 38%. At OLR 7.5 and 8 kg COD/ m^3.d the reactor performance deteriorated. Hence, 7 kg COD/ m^3.d was considered as the optimum organic loading rate with an efficiency of 60%. The same pattern was observed during the study conducted by Hampannavar and Shivayogimath (2010) on treatment of sugar effluent in UASB reactor.

Removal of solids

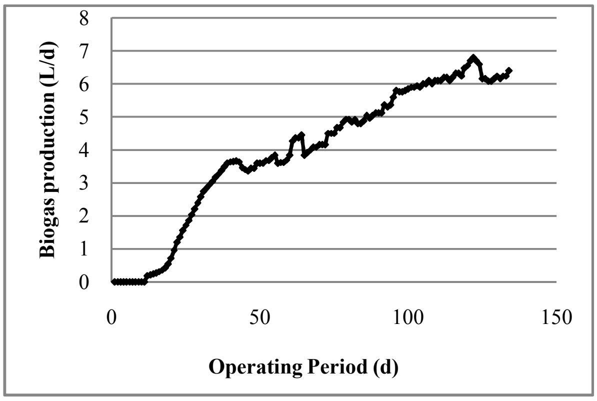
Total Solids (TS), Dissolved solids (DS) and Suspended solids (SS) removal was observed in this study at varied OLRs. The maximum solids removal efficiencies were 71%, 74% and 77% for TS, DS and SS respectively at 7 kg COD/ m^3.d. The Graph 3 shows the removal efficiency of solids for PUF reactor.



Graph 3 Percentage Solids removal at varied OLRs.

Biogas Production

The biogas production rate during the study period is shown in Graph 4. Initially the production of biogas was less in the range of 0.1 L/d. This was because initially the biomass required some time for acclimatization. As the time proceeded the gas production rate increased to around 6.1L/d. Malakahmad *et al*, (2011) reported 7.4 L/day and 9.1 L/day gas production using modified ABR for treating High strength wastewater. Gopal Krishna *et al*, (2008) reported that 0.21 to 0.31 L/day gas was produced in ABR for treatment of low strength complex wastewater. Strength of the wastewater plays an important role in biogas production.



Graph 4 Biogas Production during study period.

CONCLUSION

The following conclusions are drawn from the present study:

1. The spentwash was analysed and the results are as follows. pH, COD, BOD_3, total solids, suspended solids and dissolved solids were 5.1, 80160 mg/L, 41530 mg/L, 59555 mg/L, 12252 mg/L and 46210 mg/L respectively, which are higher than CPCB limits to discharge the waste water into the river or public sewers or inland irrigation. (As per The Environment (Protection) Rules, 1986, Schedule – VI, General standards for discharge of environmental pollutants Part-A: Effluents).
2. Downflow anaerobic reactor was designed and fabricated for treatment of distillery spentwash.
3. The successful startup of the reactor was observed on 65^{th} day under ideal conditions.
4. The optimum Hydraulic Retention Time (HRT) for the reactor was found to be 8 hours and this HRT was fixed for further operation.
5. Organic loading rate (OLR) was increased from 1 kg COD/ m^3.d to 2, 3, 4, 5, 6, 7, 8 kg COD/ m^3.d keeping the constant HRT of 8h. The maximum COD removal was 60% for an OLR of 7 kg COD/m^3.d at an HRT of 8h. Further increase in OLR decreased the efficiency.
6. Maximum biogas production of 6.8L/d was observed.
7. The maximum solids removal efficiencies were 71%, 74% and 77% for Total, Dissolved and Suspended Solids respectively at 7 kg COD/ m^3.d for 8h HRT.

References

Anupama S., Pradeep N. V., Hampannavar U. S., (2013). Anaerobic followed by aerobic treatment approaches for spentwash using MFC and RBC. Sugar Tech. 15(2): pp197-202.

Mantha Nagaraj, Dr. Arvind Kumar, (2007). Distillery Wastewater Treatment and Disposal. Environmental Engineering, IIT Roorkee.

Pant Deepak and Adholeya Alok, (2007). Biological approaches for treatment of distillery wastewater: A review. Bioresource Technology 98: 2321-2334.

Anupama, Pradeep N. V., Hampannavar U. S., (2011). Microbial fuel cell an alternative for COD removal of distillery wastewater. *Journal of Research in Biology*. Vol. 1(6): 419-423.

Gandhi Srikanth Chandragupta, Pandey Lopa Mudra Shashwat, Gupta Sunil Kumar and Singh Gurdeep, (2011). Comparative evaluation of high rate anaerobic processes for treatment of distillery spentwash. *Journal of Industrial Research & Technology* 1(1):17-23.

Gupta Sunil Kumar and Singh Gurdeep, (2007). Anaerobic treatment of distillery spent wash in uasb and hybrid Reactors. Environmental Science and Technology, (Vol. I):304-310.

D.Nally, S. Smith, F. Hackett, H. Mooney, (2010). Anaerobic Digestion: Industrial Applications.

Hampannavar U. S. and Shivayogimath C. B., (2010). Anaerobic treatment of sugar industry wastewater by Upflow anaerobic sludge blanket reactor at ambient temperature. *International Journal of Environmental Sciences*. Vol. 1(4):631–639.

Rajeshwari K. V., Balakrishnan N., Kansal A., Kusum Lata, Kishore V. V. N., (2000). State of the art of anaerobic digestion technology for industrial wastewater treatment. Renewable & Sustainable Energy Reviews, Vol.4:135-156.

Satyawali Y., Balakrishnan M., (2008). Wastewater treatment in molasses based alcohol distilleries for COD and colour removal: A review. *Journal of Environmental Management*. Vol. 86:481-497.

Moosavi G. R., Mesdaghinia A. R., Naddafi K., Mahvi A. H., and Nouri J. (2005). Feasibility of development and application of an Upflow Anaerobic/Aerobic fixed bed combined reactor to treat high strength wastewaters. *Journal of Applied Science*. 5 (1):169-171.

Sindhu S. K., Sharma A. and Ikram S. (2007). Analysis and Recommendation of Agriculture Use of Distillery Spentwash in Rampur District, India. E-Journal of Chemistry. Vol. 4(3): 390-396.

Chidankumar C. S., Chandraju S. and Nagendraswamy R. (2009). Impact of Distillery Spentwash Irrigation on the Yields of Top Vegetables (Creepers). *World Applied Sciences Journal*. Vol. 6(9): 1270-1273.

Coetzee G, Malandra L, Wolfaardt G. M and Bloom M. V., (2004). Dynamics of a microbial biofilm in a rotating biological contactor for the treatment of winery effluent. Water SA, Vol. 30 (3): 407- 412.

Murthy Z. V. P and Chaudhari L. B., (2009). Treatment of distillery spent wash by combined UF and RO processes. Global NEST Journal. Vol. 11(2): 235-240.

Sunil Kumar Gupta, (2003). Performance Evaluation of Hybrid Reactor for the treatment of Distillery spent wash. Ph.D thesis, IIT Bombay.

Sheehan G. J and Greenfield P. F., (1979). Utilisation, Treatment and Disposal of distillery wastewater. Water Research, Vol. 14: 257-277.

Margot Alana Trerise, (2005). Evaluation of Primary and Secondary Treatment of Distillery wastewaters. M.S thesis, University of Stellenbosch, South Africa.

****

How to cite this article:

Noorahmed A. Hosmani and Amar S. Byakodi.2016, Treatment of Distillery Spentwash Using Downflow Stationary Fixed Film Reactor With Puf As Packing Material. *Int J Recent Sci Res.* 7(6), pp. 11837-11840.