Efficiency of HUASB Reactor for Treatment of Different Types of Wastewater - A Review

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Abstract

This paper presents the findings of the study on treatment efficiency of different types of wastewater (domestic wastewater, pulp & paper mill effluent & fish processing effluent) using a laboratory scale Hybrid Upflow Anaerobic sludge Blanket reactor (HUASB). Initially, the reactor was loaded at an OLR of 0.12kg COD /m3. Hr & HRT of 24hrs. Loading rates were increased by reducing HRT 24, 20, 16, 14, 12, 10, 8, 6hrs which corresponds to the OLR of 0.12, 0.14, 0.17, 0.2, 0.23, 0.29, 0.34, 0.46kg COD/m3 hr. The reactor with a working volume of 2.3L & pleated PVC rings as packing media was operated at varying HRT (hydraulic retention time) for a period of 120 days, While the COD removal varied from 70-90%; the biogas production 2.0- 5.5l/day. HUASB system could be designed with very short HRT of 3.4hrs, which will reduce the treatment cost significantly. This article compares the efficiency of HUASB reactor for treating different types of wastewater (domestic wastewater, pulp & paper mill effluent & fish processing effluent). The results indicate that HUASB system can be effectively used for treatment of fish processing effluent than the domestic wastewater & pulp & paper mill effluent.

Key words: HUASB reactor, HRT, Pulp & paper mill effluent, fish processing effluent, biogas.

1. Introduction

Since the work of Young & Mccarty (1969) the application of anaerobic process for the treatment of industrial & municipal wastes has enjoyed a 20 year resurgence that has been it emerge as a practical & economical alternative to aerobic processing. High-rate anaerobic treatment has emerged as a viable alternative for treatment of many industrial & municipal wastewaters.

Wastewaters from the industries may be treated following the primary, secondary & tertiary treatment methods. The physico-chemical processes comes under primary treatment & generally accepted as expansive treatment methods. (Gohil, 1995; kavitha et al 2003). To overcome these problems, the secondary biological treatment method has been received much attention & considered as an efficient, low cost treatment system (Sastry 1995; kavitha et al, 2002). Aerobic treatment of industrial wastewater has become a viable technology in recent years due to rapid development of high rate reactors, low excess sludge production & enclosure of odours & aerosols (Prez et al 1999).

The UASB reactor is the most widely & successfully used high rate anaerobic technology for treating several types of wastewater. The success of UASB reactor can be attributed to its capacity to retain a high concentration of sludge & effluent solids, liquid & water separation.

Literature references indicate that most of the negative aspects of high rate anaerobic digestion can be overcome by restricting the supporting material to top 25 -30% of reactor volume (Guiot & van den berg 1984, 85). This would further help realize the advantages of both fixed film & up-flow anaerobic sludge blanket reactor (HUASB) & considered more stable for the treatment of a series of soluble (or) partially soluble wastewaters (Tilche & Vieira 1991). Over the years, HUASBs have been used to treat variety of industrial effluents (Coates & Colleran , 1990, Shivayogimath & Ramanujam, 1999).

In the present study, HUASB has been used to treat different types of wastewater like domestic wastewater, pulp & paper mill effluent & fish processing effluent.

2. Materials & methods

The schematic of HUASB reactor is illustrated in Fig. 1. Bench scale UASB reactor was fabricated using transparent plexi glass material with an internal

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dia of 9.5cm & overall height of 61cm. Total volume of reactor was 4.32L & its working volume was 2.3L. A gas headspace of 1L was provided at the top of the reactor & sampling ports were located at equal intervals. The top third of the reactor was filled with pleated PVC rings. These packing media were floating against fixed screen. The effluent pipeline in turn was connected to a water seal to prevent the escape of gas. A peristaltic pump was used for feeding wastewater into a reactor. The gas was measured by water displacement method. The reactor was supported by a frame structure made-up of metal. Details of HUASB reactor are given in table -1.

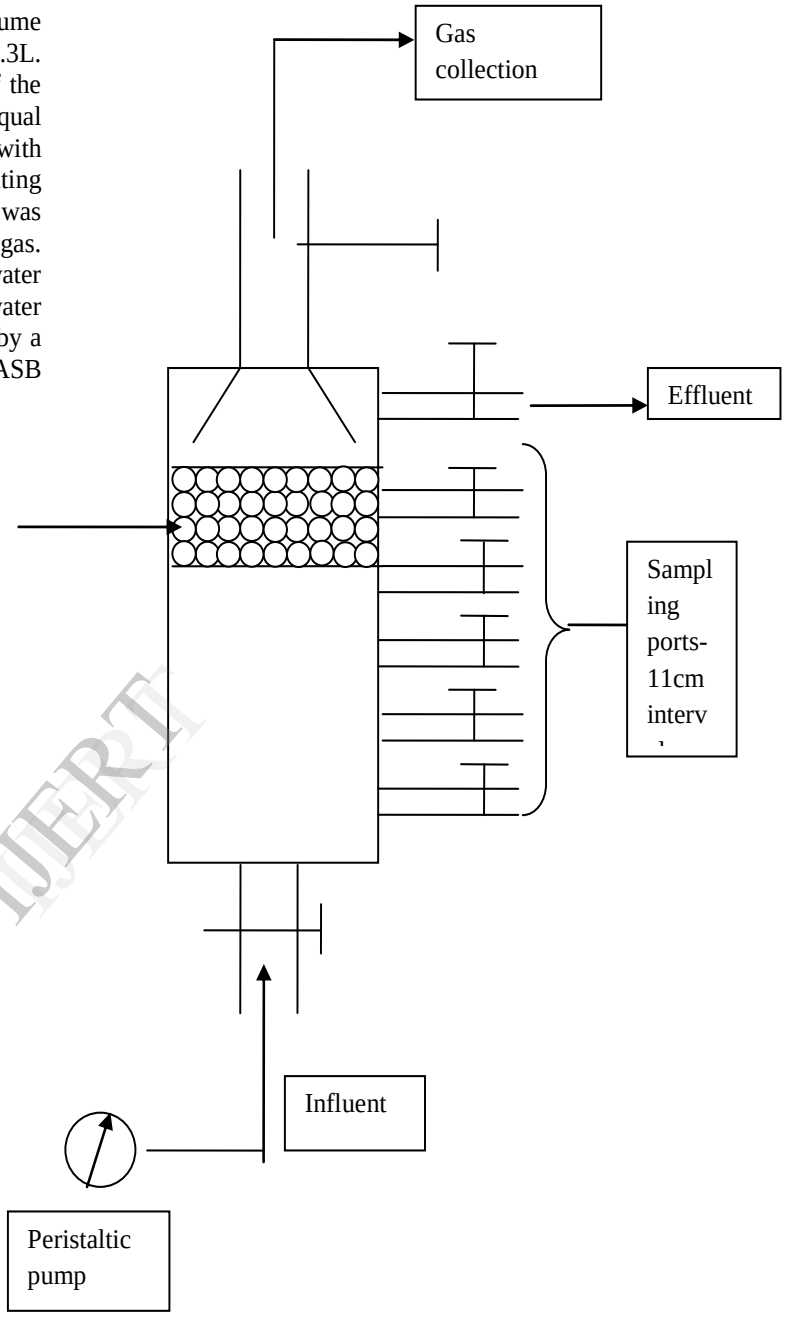

Figure 1. Hybrid Up-flow Anaerobic Sludge Blanket Reactor

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Table 1: Details of HUASB reactor

Sl.No	Particulars	Specifications
1	Reactor type	Circular cross section
2	Diameter	9.5cm
3	Total height	61cm
4	Working volume	2.3L
5	Total volume	4.32L
6	No. of sampling ports	5
7	Port interval	11cm
8	Packing media depth	15cm

2.1. Wastewater:

The domestic wastewater used for the present study was collected from kinathukadavu area, pollachi road, Coimbatore, India.

Paper mill wastewater generated from pulp & paper mill, locate d in karur district, Tamilnadu was used as a substrate. The wastewater used as feed was kept in plastic cans at 4◦C. The reactor was seeded anaerobically with a non-granular sludge obtained from wastewater treatment plant of the paper mill.

Fish processing units are mostly situated near the coastal area & wastewaters are directly discharged into the sea which will affect the aquatic life drastically. Wastewater was collected from the fish processing unit.

2.1.1. Characteristics of wastewater:

Characteristics of pulp & paper mill wastewater are summarized in Table 2. Feed total COD was maintained at approximately 2820mg/L throughout the start up period by dilution with tap water. Characteristics of fish processing effluent are summarized in Table 3. Characteristics of domestic wastewater are summarized in Table 4.

Table 2 : Characteristics of pulp & paper mill wastewater

Parameter	Values (mg/L)
pH	5
Total solids	4340
Total dissolved solids	3200
Total suspended solids	1020
Total fixed solids	3520
Volatile solids	1200
alkalinity	600

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Chlorides	895
COD	2875
BOD	675

Table 3 : Characteristics of Fish processing effluent

Parameter	Values (mg/L)
Kjeldhal nitrogen	43 -49.5
Ammonia nitrogen	25 -30
chloride	160 -188
sulphate	39 – 56
phosphate	15 – 16.5
potassium	13.5 – 17
COD	2000 -2500

Table 4 : Characteristics of domestic wastewater

Parameters	Quantity (mg/L)
Flow	95
pH	6.5 -7.5
Suspended solids	300-350
BOD	800-850
COD	1500 - 2280
Total dissolved solids	1900 – 2000
Residual chlorine	0.5 -1.0
Ammonia nitrogen	15 -30
Kjeldhal nitrogen	30 – 50

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3. Granulation of HUASB reactor

Good performance of HUASB reactor depends mainly upon the formation of a bed of well settling & highly active granular sludge, with a low sludge value index & a high methanogenic activity. (Gatz letttinga et al. 1980). The sludge obtained from paper mill treatment plant was used for the granulation process. To induce granulation process, 1L of cow dung was added before start-up of the reactor. The favourable environmental conditions were provided for the growth of anaerobic bacteria. Shock loading was avoided to prevent the loss of microbial biomass (Shivayogimathi 2003). During granulation process, suitable operational conditions were strictly followed. (Table 5)

Table 5: Operational conditions for granulation process

parameter	Amount (mg/L)
pH	6.5 -8.0
Total suspended solids	700 – 1000
COD	1700 – 2380
alkalinity	550 – 660

4. Results & Discussion:

The reactor was seeded with 1L of cow dung & 1L of seed sludge obtained from the wastewater treatment plant of paper mill wastewater & fed with paper mill wastewater at an OLR of 0.12Kg COD/m3.hr. Then the reactor fed with domestic wastewater at an OLR of 0.15Kg COD /m3.hr. Then reactor fed with fish processing effluent at an OLR of 0.22 Kg. COD/m3.hr.

4.1. Effect of pH:

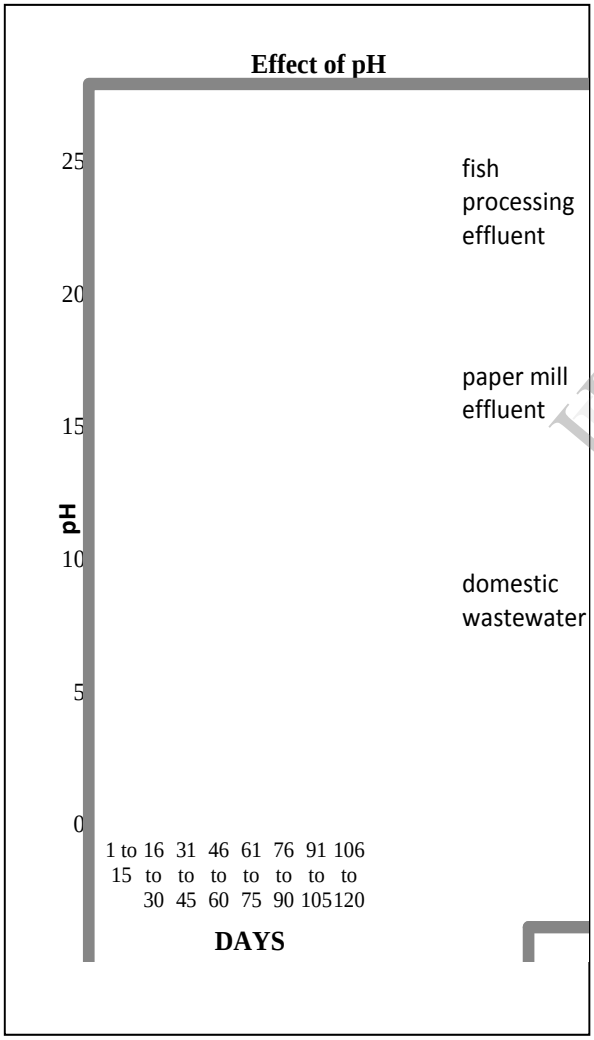

Figure-2 : Effect of pH

Fig. 2 represent variations in pH during start-up process. The pH of the effluent from the reactor was in the range of 7-8. It is known that pH values less than 6.8 & greater than 8.3 would cause souring of reactor during anaerobic digestion. (Strench et al 1986; wealthy, 1991). Consistent pH level of 7-8 was maintained in the effluent indicating healthy environment. The pH determines the growth of both methanogens & acidogens (Lettinga & Hulsoff pol, 1991). Based on the above fig.2, pH of the effluent is good in pulp & paper mill wastewater & domestic wastewater than the effluent of fish processing unit.

4.2. Effect of HRT in COD removal efficiency:

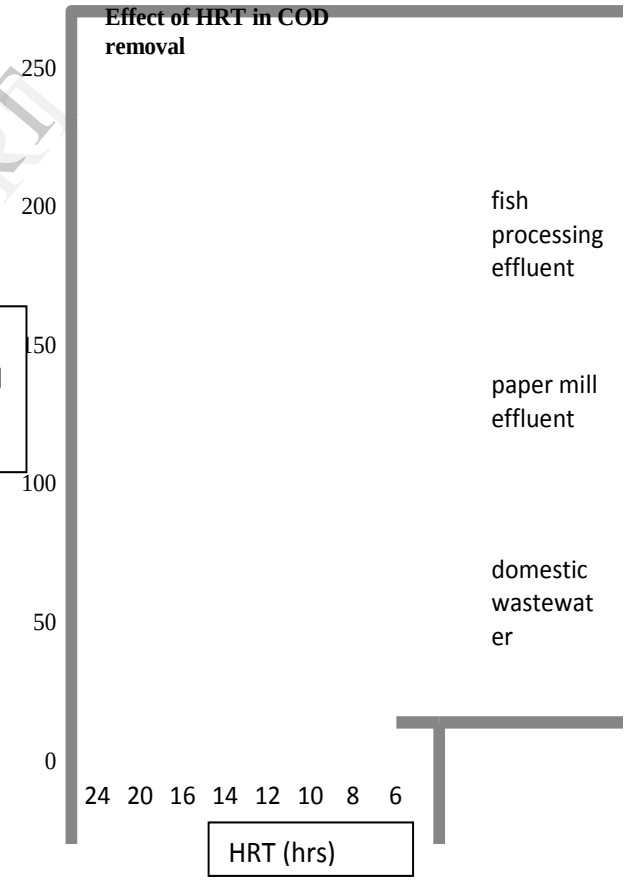

Figure -3 : Effect of HRT in COD removal

Based on the above fig. 3, COD removal is higher in fish processing effluent than pulp & paper & domestic wastewater.

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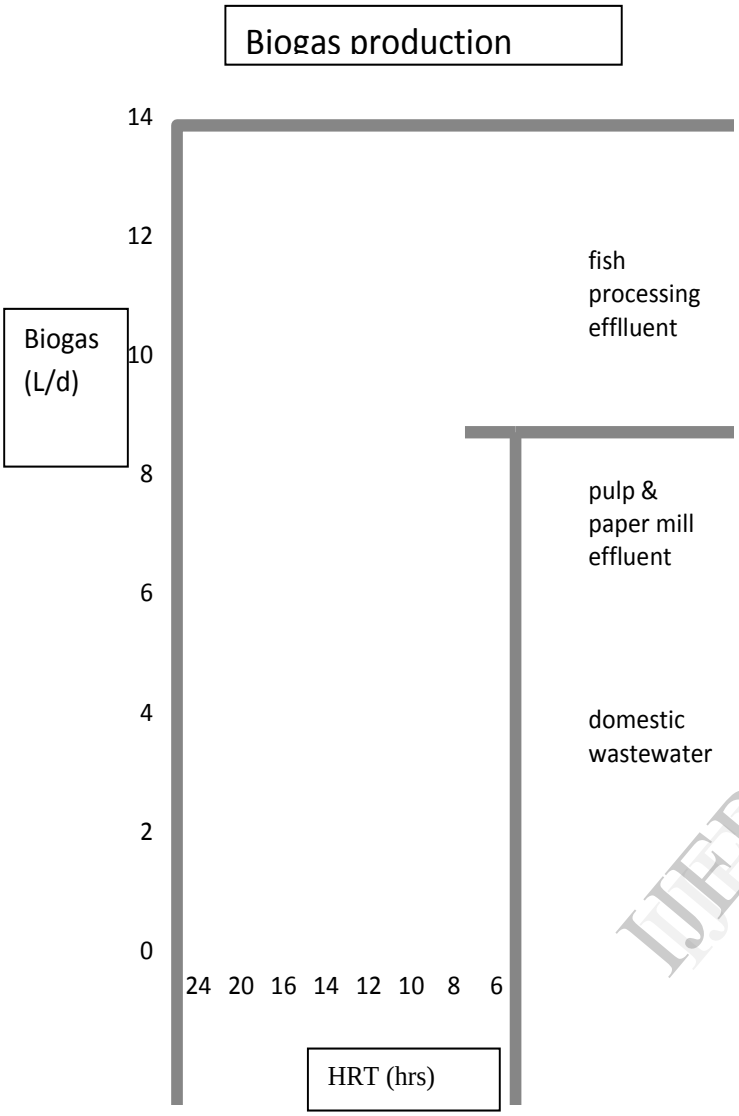

Figure - 4 : Biogas production

From the above fig., the biogas production is high in the fish processing effluent than the other than the two wastewaters.

5. Conclusion

Anaerobic treatment of various types of wastewater employing HUASB efficiently removed organics both COD & BOD in very short period of time. Comparatively lower organics removal efficiencies during the treatment of wastewater using UASB at different HRTs have been reported by several workers (65% at a HRT of 4hr- Haskoing; 1989; 53% at a HRT of 4.4hr, Viera, Garcia, 1991)

The reduction in COD removal efficiency at higher HRT may be attributed to higher upflow velocity of the wastewater & consequent reduction in contact time between organics in wastewater & microbes. Results obtained in the present study demonstrate that HUASB with PVC can promote enhanced COD removal from the above three types of wastewater. But, it is quite good for fish processing effluent nearly 90% COD removal & biogas production also high in this wastewater.

So, HUASB system can be effectively used for the treatment of fish processing effluent, since the system can be designed with relatively short HRT.

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