Available online at www.elixirpublishers.com (Elixir International Journal)

Renewable Energy

Elixir Renewable Energy 102 (2017) 44227-44229

ISSN: 2229-712X

# Integrated Biological Ozone Treatment of Textile Effluent Using Huasb Reactor

M.Sowntharya, T.Nivetha and M.P.Murugesan
Erode Sengunthar Engineering College, Thudupathi, Erode.

**ARTICLE INFO**

**Article history:**
Received: 23 December 2016;
Accepted: 5 January 2017;
Published: 10 January 2017;

**Keywords**
Aerobic process,
HUASB Reactor,
Ambient temperature,
Hydraulic retention time (HRT),
Organic loading rate (OLR).

**ABSTRACT**

The aerobic treatment is considered one of the most efficient methods for treating several types of effluents. This is due to its scope for treating high rate of simply biodegradable matters and wastewater. Several researches have been widely conducted in order to enhance the performance of the aerobic process. The up flow aerobic sludge blanket (UASB) technology was considered as the most popular method in which the highest rate of organic materials can be removed. Nonetheless, the long start up interval of UASB reactor requires more understanding of the biological process inside the reactor. A pilot scale study was set up to investigate the principle design parameters of up flow aerobic sludge blanket (UASB) reactors for treating waste water of small communities in the tropical regions of India. A steel pipe with a diameter of 7cm and a height of 65cm was used as the reactor in which a digestion and a three phase separator element have a volume of 2.157*10^3 respectively. During this study, which lasted for 70 days, two distinct phases were carried out according to the ambient temperature. The temperature of the waste water entering the reactor was naturally ranged from 260c to 300c and no heat exchanger was used. The hydraulic retention time including 2,3 ,4 ,5 ,6 ,7 & 8 hours with various loading rates of 56 to 197 mg of COD/lit/day were examined. On the basis of the results in optimal hydraulic retention time and organic loading rate BOD5, COD and TSS was removed respectively.



## Introduction

The modified up flow aerobic sludge bed (UASB) technique developed by industrial technology research institute (ITRI) has been applied to industrial waste water treatment. 25 full scale treatment plants and more than 50 modified UASB reactors have been installed for industrial waste water purification including food processing, brewery, distillery, pulp and paper textile, chemical and petro chemical industries. Aerobic processes characterized by its low production of sludge, and its generation of energy comparing with the anaerobic treatment. The development of use of aerobic waste water treatment had been started in Netherlands, whereby the UASB system was firstly used on treatment of beverage industry, distilleries and fermentation industries, food and paper industries. Recently, the use of aerobic technology has been expanded, where it comprised the treatment of chemical and petrochemical industry effluents, and the UASB concept is also considered more than suitable for the domestic waste water treatment especially in warm climates in tropical countries. Tropical, over the last decades, up flow aerobic sludge blanket (UASB) technology has been commonly used, due to its all- round performance for high-low organic content waste water treatment. The operational parameters that are specially mentioned in literature have been controlled the process.

This indicates that the design is well suited and efficient. But proper attention should be given towards reduction of algal cell. In recent years there has been a growing interest in aerobic treatment of sewage. Compared to aerobic growth, anaerobic fermentation produces much less biomass from the same amount of chemical oxygen demand removal by Tchobanoglous. [1]

Agrawal et al. [2] can be observed a 78% decrease in the gas production rate when the temperature was reduced from 27°C to 10°C. The low gas production and 25% lower COD removal at 10°C than at 27°C, indicating suspended solids accumulation in the reactor.

Anna KWARCIAK-KOZŁOWSKA, Jolanta BOHDZIEWICZ [3] this study attempted to determine the influence of the HRT and OLR on the treatment of wastewater from the meat industry and biogas production. If this works given minimum efficiency of COD and BOD removal at the HRT of 6 days the daily biogas production decreased with an increase in the HRT. Gangesh Kumar and asaudhan et al [4] has focused on the design analysis indicates that the design of the sewage treatment plant is adequate and appropriate. According to the standard design considerations the design criteria has been found complying. The hydraulic loading rates have been found frequently going beyond the designed capacity.

Sunny Aiyuk and Philip Odonkor et al [5] UASB process for the direct treatment of domestic sewage was effective in producing effluents with somewhat low amounts of organic matter, but not sufficient for efficient recycling/reuse. There were serious limitations inherent within the system: inefficiency in removing nutrients, and difficulties in removing suspended solids, leading to rapid rise in sludge bed height and frequent sludge removal. The high rate of sludge production, due to the accumulation of SS, was certainly a disadvantage, as sludge handling in full-scale installations can be expensive.

In recent years there has been a growing interest in aerobic treatment of waste water. Compared to aerobic growth, anaerobic fermentation produces much less bio mass from the same amount of COD removal. Up flow aerobic sludge blanket UASB reactor is a popular aerobic reactor for both high and low temperature. The UASB reactor is by far the most widely used high rate aerobic system for aerobic waste water treatment. In the case of relatively low strength waste water such as textile waste, the hydraulic retention time rather than organic loading rate is the most important parameter determining the shape and the size of the UASB reactor. The several favorable characteristics of aerobic processes, such as low cost, operational simplicity, low bio solid production and considerable biogas production, together with suitable environmental conditions are contributed to highlight aerobic systems for the treatment of textile waste in small communities of tropical regions. To compare the different aerobic treatment systems, the UASB concept looks the most attractive option for textile waste treatment. The present work evaluates an important design parameter for a UASB reactor that is hydraulic retention time (HRT). The performance of UASB reactor was assessed by applying various HRTs.

**Experimental Setup and Procedure**

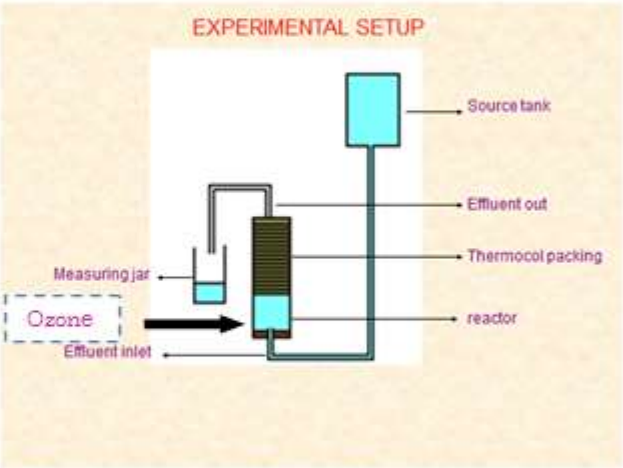
a) UASB Reactor: Up flow aerobic sludge blanket (UASB) technology, normally referred to as UASB reactor, is a form of aerobic digester that is used in the treatment of wastewater. The UASB reactor is a methanogenic (methane-Producing) digester that evolved from the aerobic digester. A similar but variant technology to UASB is the expanded granular sludge bed (EGSB) digester. A diagrammatic comparison of different aerobic digesters can be found here.

b) Construction details

| S.No | Particulars | Specification |
|---|---|---|
| 1 | Material of construction | Glass |
| 2 | Inner diameter | 6.5cm |
| 3 | Height | 65cm |
| 4 | Packing material | Foam |
| 5 | Packing height | 26cm |

i. Experimental Setup for HUASB Reactor Design

ii. Ozone




The main components of the HUASB are,

- ✓ Inlet and outlet distribution system
- ✓ Sampling port
- ✓ Packing media

UASB uses an aerobic process whilst forming a blanket of granular sludge which suspends in the tank. Wastewater flows upwards through the blanket and is processed (degraded) by the aerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. The blanket design to reach maturity at around 3 months and Small sludge granules begin to form whose surface area is covered in aggregations of bacteria. In the absence of any support matrix, the flow conditions create a selective environment in which only those microorganisms, capable of attaching to each other, survive and proliferate. Eventually the aggregates form into dense compact biofilms referred to as "granules". A picture of aerobic sludge granules can be found here.

c) Sludge: The sludge granules have many advantages over conventional sludge flocs are dense compact bio-film, High settle ability, High mechanical strength, Balanced microbial community, High methanogic activity, Resistance to toxic shock, Biogas with a high concentration of methane is produced as a by-product, and this may be captured and used as an energy source, to generate electricity for export and to cover its own running power. The technology needs constant monitoring when put into use to ensure that the sludge is maintained, and not washed out (there by losing the effect). The heat produced as a by-product of electricity generation can be refused to heat the digestion tanks. The blanketing of the sludge enables a dual solid and hydraulic (liquid) retention time in the digesters. Solids requiring a high degree of digestion can remain in the reactors for periods up to 90 day. Sugars dissolved in the liquid waste stream can be converted into gas quickly in the liquid phase which can exit the system in less than a day.

d) Sampling and analysis: The reactor is fixed and the set up was done as per the plan. This is followed by the loading of waste water for the formation of sludge blanket. The waste is prepared by mixing poultry waste and cow dung in equal proportions with water. The reactor is left undisturbed for the function of the sludge and growth of aerobic microorganisms on the foam packing provided at the top portion of the reactor. After two months it is observed that the reactor is at the start up stage. Now the reactor can be loaded with textile waste for treatment. Effluent from the textile industry has been collected. The effluent was analyzed to found various parameters like COD, pH, turbidity, TDS and amount of chromium. The initial values were found to be as follows;

COD = 31105 mg/l, Turbidity = 175.2, TDS = 11543 mg/l

Chromium = 2.25 mg/l and pH = 9.2

For experimental convenience the effluent is diluted with water. The samples after dilution, has the following values for different parameters. The COD value is found to be 448 mg/l. the amount of chromium found to as 0.23 mg/l. the dilution also helps to reduce the pH to a more favorable value 8.5. Then it would be difficult for the microorganisms to grow. The values of turbidity and TDS are found to be 1438 and 1752 respectively. The diluted effluent is then reached in the HUASB for different flow rates. The sample is analyzed at the end of each $7^{th}$ day. The experiment is repeated for another flow rate of the effluent. This procedure is repeated for 10 different flow rates and the results are tabulated.

**Results and Discussion**

The experiment shows there is considerable reduction in the amount of chromium. The reactor also shows effective reduction in the values of COD, TDS, pH and turbidity. It is noted that the reactor is more effective at very low flow rates.

a) Potentials for improvement: The textile waste contains heavy metals and toxic metals in it. The treatment in the HUASB is showing considerable reduction. This is due to the bio sorption of these elements by the aerobic microorganisms. By inoculating some other aerobic microorganisms which can be brown in the HUASB reactor there is a great chance of reducing the amount of harmful metals like chromium, copper, calcium, zinc etc., this can be increased the quality of the treated textile waste to further extent.

b) Measurement of TDS: The two principal methods of measuring total dissolved solids are gravimetry and conductivity. Gravimetric methods are the most accurate and involve evaporating the liquid solvent and measuring the mass of residues left. This method is generally the best, although it is time-consuming. If inorganic salts comprise the great majority of TDS, gravimetric methods are appropriate. Electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water. Ions from the dissolved solids in water create the ability for that water to conduct an electrical, which can be measured using a conventional conductivity meter or TDS meter. When correlated with laboratory TDS measurements, conductivity provides an approximate value for the TDS concentration, usually to within ten-percent accuracy.

c) UASB Design: In general there are two ways to design an UASB

✓ If input COD: 5000-15000 mg/l or more the design method is based on Organic Loading Rate (OLR)

✓ If input COD is <5000 mg/l, the design method should be based on velocity.

d) Organic loading rate: In wastewater treatment, the rate of introduction organic compounds is defined as organic loading rate. The organic loading rate can be calculated as follows.

a)

$$\text{Organic loading rate} = \frac{\text{Design flow x COD/day}}{\text{Vol ume}}$$

When input COD <5000 mg/l using the method based on OLR is not effective in operation process because the granular sludge will be hardly formed.

$$\text{Hydraulic retention time} = \frac{\text{Volume of Reactor}}{\text{Influent flow rate}}$$

The volume of UASB reactor V = Q × HRT

The area of the UASB reactor A = V/Q

iii. Experimental results

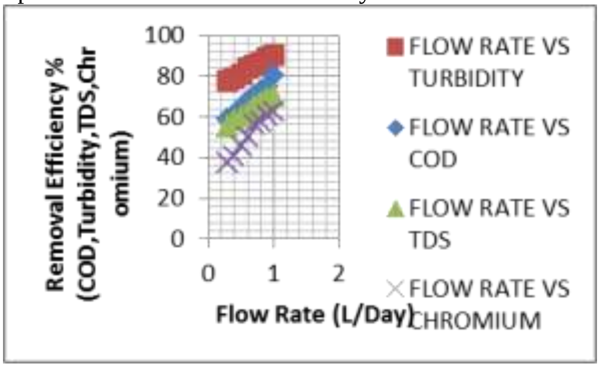
| S.No | Flow rate (L/day) | HRT (day) | Up flow velocity (m/day) | OLR (mg COD/L.day) |
|---|---|---|---|---|
| 1 | 1 | 2.157 | 0.301 | 242.93 |
| 2 | 0.9 | 2.397 | 0.271 | 218.637 |
| 3 | 0.8 | 2.696 | 0.241 | 194.344 |
| 4 | 0.7 | 3.081 | 0.211 | 170.051 |
| 5 | 0.6 | 3.595 | 0.181 | 145.758 |
| 6 | 0.5 | 4.314 | 0.151 | 121.465 |
| 7 | 0.4 | 5.392 | 0.12 | 97.172 |

The minimum flow rate is enhanced for higher microbial growth and reduced for Biological oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Turbidity, chromium and High rate of production of methane gas. The treatment efficiency of high up flow aerobic sludge blanket reactor is dependent on the flow rate.

Experimental results for removal efficiency of HUASB Reactor

| S.No | Flow rate (L/Day) | Removal Efficiency (%) | | | |
|---|---|---|---|---|---|
| | | COD | Turbidity | TDS | Chromium |
| 1 | 1 | 79.96 | 90.19 | 69.98 | 62.5 |
| 2 | 0.9 | 74.61 | 88.82 | 69.06 | 60.94 |
| 3 | 0.8 | 72.9 | 86.27 | 67.16 | 57.81 |
| 4 | 0.7 | 70.22 | 85.49 | 64.8 | 56.25 |
| 5 | 0.6 | 67.55 | 83.92 | 62.25 | 50 |
| 6 | 0.5 | 64.31 | 80.58 | 60.22 | 45.31 |
| 7 | 0.4 | 60.87 | 79.02 | 57.86 | 40.62 |

i. Experimental Results for Efficiency of HUASB Reactor




## Conclusion

In the high up flow aerobic sludge blanket reactor was studied for different operating and design parameters are hydraulic retention time (HRT), organic loading rate (OLR) for treatment characteristics of textile effluent. Operating temperature, pH value of the effluent, volatile fatty acid content, inoculum – substrate ratio, microbial population, presence of ammonia are the important factors affecting the performance of the reactor. In this experimental results showed that the chromium removal, COD and turbidity depend on the OLR and HRT of the reactor. The reactor achieved maximum chromium reduction of 65.22% at an OLR of 50-60 mg COD/l day and maximum COD removal of 81.25% is obtained in the HUASB reactor at an OLR range of 50-60 mg COD/l day.it is observed that the minimum flow rate is enhanced for higher microbial growth and reduced for Biological oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Turbidity, chromium and High rate of production of methane gas. The treatment efficiency of high up flow aerobic sludge blanket reactor is dependent on the flow rate. The study of contamination by the textile industries is done. It is observed that the untreated textile effluent have harmful effect on the environment. Operating temperature, pH value of the effluent, volatile fatty acid content, inoculum – substrate ratio, microbial population, presence of ammonia are the important factors affecting the performance of the reactor. Detailed survey suggested that the HUASB reactor is suitable to treat the textile effluent.

## References

Tchobanoglous, G, Burton, F. L, “Wastewater engineering: Treatment, disposal and reuse”, 3rd. Ed., New York, McGraw Hill, 394-426, 1991.

Agrawal, L.K, Ohashi, Y, Mochida, E, Okui, H, Ueki, Y, Harada, H. and Ohashi, A, “Treatment of raw sewage in a temperate climate using a UASB reactor and the Hanging Sponge Cubes process,” *Wat. Sci. Tech.*, 36(6–7), 433–440, 1997.

Anna Kwarciak-Kozłowska and Jolanta Bohdziewicz, “The application of UASB reactor in meat industry wastewater treatment” 2011.

Gangesh Kumar and asaudhan “Optimization of Municipal waste water treatment by UASAB reactor and polishing pond” ISSN: 2320-425.

Sunny Aiyuk and Philip Odonkoral, “Technical Problems Ensuing From UASB Reactor Application in Domestic Wastewater Treatment without Pre-Treatment” *International Journal of Environmental Science and Development*, Vol.1, No.5, December 2010, ISSN: 2010-0264, 2010.