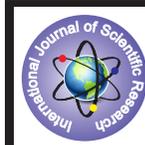


A Treatment Study Of Pharmaceutical Industrial Wastewater Using Uasb



Environmental Science

KEYWORDS : Pharmaceutical industrial Wastewater, Anaerobic Treatment, Antibiotic based Pharmaceutical, UASB.

Narsimha Rao. P*

Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad.

Habiulla .S

Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad.

K. Vishnu das Prasad

Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad.

Kumara Swamy Banda

Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad.

Lokesh Kumar Akula

Centre for Environment, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad.

ABSTRACT

Upflow anaerobic sludge blanket (UASB) reactor is widely used for treatment of industrial wastewater. In this study, performance of a lab-scale Up-flow anaerobic sludge blanket (UASB) reactor, treating an antibiotic chemical synthesis-based pharmaceutical wastewater, was evaluated under different operating conditions. A pipe with a diameter of 250 mm and total height of 120 cm and effective height of 100 cm with approximate volume of 50 liter was used as a reactor. The loading rates on reactor were increased in steps to assess the maximum loading capacity of the reactor to study the performance of reactor at different loading rates. The COD concentrations used in the present investigation ranges between 10,050 mg/L to 15,170 mg/L. The performance of the reactor up to 10.81 kg COD/m³.d was evaluated and the hydraulic retention times were examined. During this study, which lasted for 120 days, the temperature of the wastewater entering the reactor ranged from 30 to 35 °C and no heat exchanger was used. Finally the removal ratio of COD with hydraulic retention time of 33.7 hours and organic loading rate of 10.81 kg COD/m³.day were 54 percent respectively.

Introduction:

Among all the pharmaceutical drugs that cause contamination of the environment, antibiotics occupy an important place due to their high consumption rates in both veterinary and human medicine. In recent years, the incidence of antibiotics resistant bacteria has increased and may people believe the increase is due to the use of antibiotics. Antibiotics are emerging contaminants in the aquatic environment because of their adverse effects on aquatic life humans. Antibiotics wastewater has high COD and very low BOD and hence is difficult to treat biologically. Most of the antibiotics used today are manufactured through chemical synthesis techniques that involve a series of complex chemical reactions (1). The antibiotic synthesis-based pharmaceutical wastewater contain a variety of organic and inorganic constituents including spent solvents, catalysts, additives, reactants and small amounts of intermediates and products, and may therefore be high in chemical oxygen demand (1, 2). It is estimated that approximately half of the pharmaceutical wastewaters produced worldwide are discarded without specific treatment (3, 4). Major unit operations in synthesized organic chemical plants generally include chemical reactions in vessels, solvent extraction, crystallization, filtration, and drying. The waste streams generated from these plants typically consist of cooling waters, condensed steam still bottoms, mother liquors, crystal end product washes, and solvents resulting from the process (4). Synthesis-Based pharmaceutical wastewater is not suitable for physical and/or chemical treatment because of their low efficiency for dissolved COD removal and high consumption of chemicals. The high COD concentration in such pharmaceutical wastewaters makes them potential candidates for anaerobic technology (5, 6). Anaerobic processes have become a viable option for the treatment of medium-high strength industrial wastewaters. The most important merits of anaerobic treatment are the ability to treat high strength wastes, low energy input, low sludge yield, low nutrient requirement, low operating cost, low space requirement and net benefit of energy genera-

tion in the form of biogas (7, 8). These favorable characteristics of anaerobic processes together with suitable environmental conditions have contributed to highlight anaerobic systems for the treatment of synthesis-based pharmaceutical wastewater. Upflow anaerobic sludge blanket (UASB) reactor is a popular anaerobic reactor for both high and low temperature and among the recently developed high-rate processes, has probably attracted most commercial and research interests (9). Compared with other anaerobic technologies, UASB has some remarkable advantages such as high organic loadings, great efficiency, low energy demand, short hydraulic retention time (HRT) and easy reactor construction. One of the main obstacles for the application of UASB is long start-up time, usually 2–8 months, needed for the formation of granules. Performance and stability of these reactors depend a lot on sludge granulation, but the success of the self-immobilization process is not warranted, since several factors affect this process (10). In fact, these reactors are designed to pre-treating soluble non-complex wastewater and complex partially soluble wastewater. This research was carried out to study the feasibility of UASB process as a pre-treatment for Indian chemical synthesis-based pharmaceutical wastewater treatment. This factory is located in Hyderabad capital of Telangana state. In this factory produces among antibiotic synthesis intermediate materials.

Material and methods:

The UASB reactor used in this study was made with a pipe of 250 mm inner diameter, a total height of 120 cm, an effective height of 100 cm, and a total volume of 48.5 liter (Fig.1). An outlet was provided at the top, which is connected to the effluent tank. On the top of the reactor a gas solid separator is provided to separate gas and solid raised due to the upward movement of the feed. This reactor was fed with synthesis based pharmaceutical wastewater from the Wastewater Treatment Plant of Antibiotics factory that is located in Hyderabad. In order to develop the desired organic loading rate, parameter such as COD and the influ-

ent flow rate to the reactor was observed. Following each change in the organic loading rate the reactor was allowed to reach steady state. The waste-water was introduced at the bottom of the reactor through a tube with a 50 mm diameter and distributed over the cross-section by means of a perforated Plexiglas plate, which was placed about 25 cm above the feed tube. Sample ports were placed at 30 and 80 cm intervals throughout the height of column with an additional port at the bottom of the reactor (the port used for solids removal). The performance of the reactor in reduce COD was monitored through 24-hour flow weighted composite samples, taken from inlet and sample ports. It should be mentioned that the average wastewater temperature and pH were monitored daily and all the analyses were carried out according to the Standard Methods (APHA, 2005 (11)).

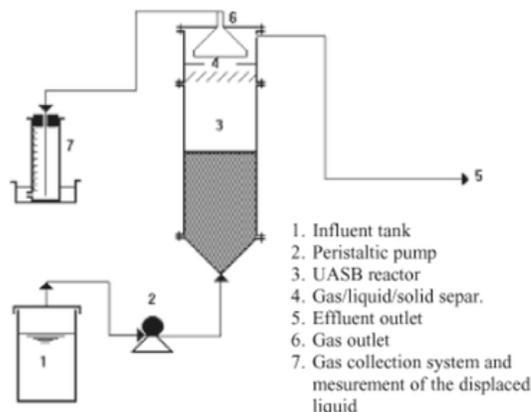


Fig 1: Schematic view of the UASB reactor

The inoculums for seeding the reactor were brought from waste of activated sludge from domestic waste-water plant. 40 liter sludge from this sample that characteristics is shown in Table 1, associated with 10 liter synthetic wastewater from antibiotics building mixed in vague plastic vessel and hold in anaerobic condition to produce biogas. To prevent transforming wastewater into septic, it was shacked daily and after 15 days was prepared. After that, 30 liter of this solution added to reactor.

Table1. Characteristics of utilized sludge for seeding of reactor

Source	VSS (mg/Lit)	TSS (mg/Lit)	VSS/TSS	pH
Domestic Waste	6680	10200	0.655	7
Pharma effluent	39	80	0.488	6.9

Results and Discussion:

The start up period of an anaerobic UASB reactor is directly proportional to the concentration of the mi-crobial population. Rate of start-up depends on the type of inoculums, the type and strength of waste, level of volatile acids maintained. Temperature was measured daily in UASB reactor inlet and outlet with an electronic temperature meter. The temperature was kept in mesophilic condition (30 to 35o C) by control-ling the temperature of room, where the UASB reactor was kept in it. Microbial groups involved in anaerobic degradation have a specific pH region for optimal growth. The desired pH for anaerobic treatment is between 6.6. and 7.6 (12). Values outside this range can be quite detrimental to the process, particularly to methanogenesis. Therefore, maintaining a suitable and stable pH within the digester should be a major priority for ensuring efficient methanogenic digestion. This is due to the fact that the hydrogen ion

concentration has a critical influence on the microorganisms responsible for anaerobic digestion, the biochemistry of digestion, alkalinity buffering and several other chemical reactions affecting the solubility and availability of dissolved ions. When an anaerobic process is overloaded an accumulation of VFAs often occurs, resulting in a decrease in the pH of the system if sufficient buffering capacity is not available. Generally, the alkalinity needed to maintain the pH is largely governed by the carbonate equilibrium (13, 16). The pH of the reactor feed is always maintained neutral by adding necessary amount of NaHCO3. The best operation of anaerobic re-actors can be expected when the pH is maintained near neutrality (14). Soluble COD in UASB reactor influent and effluent was measured per day and the reactor was operated in a continuous mode of operation. Also after experimental process analysis of alkalinity, sludge volume index (SVI) and COD were conducted in accordance with Standard Method (11). Best utilization of the reactor, respectively in organic loading rate of 10.81 kg COD/m3.day and hydraulic retention time of 33.7hr. Stable efficiency in this condition is 57 percent after 88 days. Summary results of experiments are shown in Table 2 and Figs 2.

Removal performance of the UASB reactor in terms of COD, HRT and organic loading rate is shown in Table 2. On the basis of the obtained results, the optimum removal of COD is 56% with an organic loading of 10.81 kg COD/m3.d, occurred at an HRT of 33.7 hr. Increasing the HRT from 46.2 to 33.7 hr resulted in additional removal of COD 10% & 16% respectively at temperature range of 30 to 35o C. In days leading 29-34 the efficiency of pilot dropped due to reduction in the alkalinity of reactor. This problem was resolved by re-setting the dosing pump through increasing salt NaHCO3 to the current input (15, 16).

Table 2. Results of experiments on pilot plant

Days	feed per day(L)	HRT	Flow	Maximum Efficiency
14-Jan	25.5	46.2	0.022	13
15-28	25.5	46.2	0.022	25
29-38	25.5	46.2	0.022	28
39-48	30	39.3	0.025	30
49-58	30	39.3	0.025	34
59-68	30	39.3	0.025	39
69-76	33	35.7	0.028	47
77-86	33	35.7	0.028	52
87-94	33	35.7	0.028	57
95-100	35	33.7	0.03	59
101-110	35	33.7	0.03	60
111-120	35	33.7	0.03	56

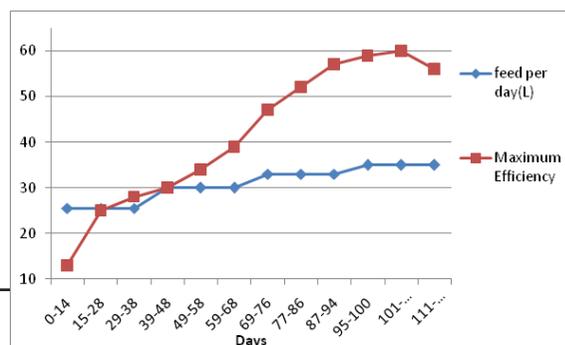


Fig. 2 Efficiency and influent per day**Conclusion:**

From the data presented in this experiment the following conclusions can be drawn:

- The UASB reactor could be used as an effective pre-treatment alternative for treatment of pharmaceutical wastewater,
- The efficiency of the pilot has been gradually rising through course of time,
- Due to the nature of wastewater, we preferred to add light nutrient such as sugar solution and Reduction of alkalinity can lead to lower efficiency of reactor

REFERENCE

1. Oktem, Y. A., Ince, O., Sallis, P., Donnelly, T. and Ince, B. K. (2007). Anaerobic treatment of a chemical synthesis-based pharmaceutical wastewater in a hybrid upflow anaero-bic sludge blanket reactor. *Bioresource Technol.*, 99, 1089-1096. | 2. Fent, K., Weston, A. A. and Caminada, D. (2006). Ecotoxicology of human pharmaceuticals. *Aquat. Toxicol.*, 76, 122-159. | 3. Lang, X. M. (2006). Pharmaceutical wastewater treatment with hydrolysis acidifying-UNITANK-BAF process. Ph.D. Thesis, Northeast University, China, pp. 1-12. | 4. Enick, O. V. and Moore, M. M. (2007). Assessing the as-sessments: pharmaceuticals in the environment. *Environ. Impact Assess. Rev.*, 27, 707-729. | 5. Enright, A. M., McHugh, S., Collins, G. and O'Flaherty, V. (2005). Lowtemperature anaerobic biological treatment of solvent – containing pharmaceutical wastewater. *Water Re-search*, 39, 4587-4596. | 6. Chelliapan, S., Wilby, T. and Sallis, P. J. (2006). Perfor-mance of an up-flow anaerobic stage reactor (UASR) in the treatment of pharmaceutical wastewater containing mac-rolide antibiotics. *Water Research*, 40, 507-516 | 7. Acharya, B. K., Mohana, S. and Madamwar, D. (2008). Anaerobic treatment of distillery spent wash – A study on upflow anaerobic fixed film bioreactor. *Bioresour. Technol.*, 99, 4621-4626. | 8. Mahmoud, N. (2008). High strength sewage treatment in a UASB reactor and an integrated UASB-digester system. *Bioresour. Technol.*, 99, 7531-7538. | 9. Lettinga, G., van Velsen, A. F., Hohma, S. M., de Zeeuw, W. and Klapwijk. A. (1980). Use of upflow sludge blanket (UASB) reactor concept for biological waslewater treatment. *Biotech. Bioengrg.*, 22,699-734. | 10. Kalyuzhnyi, S. V., Sklyar, V. I., Davlyatshina, M. A., Parshina, S. N., Simankova, M. V., Kostrikina, N.A. and Nozhevnikova, A. N. (1996). Organic Removal and Micro-biological Features of UASB-Reactor Under Various Organic Loading Rates. *Bioresource Technology*, 55, 47-54. | 11. APHA, 2005, 21st edition of Standard Methods for the Examination of Water and Wastewater. (American public health and association) | 12. B.E. Rittmann, and P.L. McCarty, *Environmental biotechnology: principles and applications*, McGraw-Hill International Edition, New York, USA, 2001. | | 13. A. Rozzi and A.C. DiPinto, "Start-up and automation of anaerobic digesters with automatic bicarbonate control," *Bioresource Technology*, vol. 48, 1994, pp. 215-219. | 14. Lettinga, G., van Velsen, A. F., Hohma, S. M., de Zeeuw, W. and Klapwijk. A. (1980). Use of upflow sludge blanket (UASB) reactor concept for biological waslewater treatment. *Biotech. Bioengrg.*, 22,699-734. | 15. G. Lettinga , L.W. Hulshoff Pol, I.W. Koster, W.M. Wiegant , W.J. De Zeeuw, A. Rinzema, P.C. Grin, R.E. Roersma& S.W. Hobma, 2013, High-Rate Anaerobic Waste-Water Treatment Using the UASB Reactor under a Wide Range of Temperature Conditions, *Biotechnology and Genetic Engineering Reviews*. DOI: 10.1080/02648725.1984.10647801. | 16. W. Parawira, I. Kudita, M.G. Nyandoroh, R. Zvauya () A study of industrial anaerobic treatment of opaque beer brewery wastewater in a tropical climate using a full-scale UASB reactor seeded with activated sludge. *Process Biochemistry* 40 (2005) 593–599 |