JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AN EXPERIMENTAL EXPLORATION OF HYBRID AEROBIC BIO-REACTOR DURING START-UP PROCESS FOR TREATING MUNICIPAL WASTEWATER

[1]Aruna C, [2]Asha B

[1]Research Scholar, [2]Associate Professor
[1]Department of Civil Engineering,
[1]Annamalai University, Chidambaram, India

Abstract : A laboratory scale Hybrid Aerobic Bio-Reactor was designed and fabricated for the treatment of Industrial wastewater. The Hybrid Aerobic Bio-Reactor (HABR) was accomplished with both suspended as well as attached growth process. Oxygen was supplied in the entire process of operation. The reactor has been continuously operated at mesosphilic range with an Influent Chemical Oxygen Demand (COD) of 848 mg/l, 824 mg/l, 864 mg/l, 856 mg/l, 872 mg/l, and 888 mg/l. The result showed that the HBR attained a steady state from 15th day to 18th day. During the start up period the pH and Dissolved Oxygen plays an important role. The COD reduction was attained 7% in the initial stage and it was incremental up to 12th day and decline from 12th to 14th day and then attains a steady state from 15th day to 18th day. The maximum COD removal efficiency was achieved at 96.45%.

***Index Terms* - Chemical Oxygen Demand; Hybrid Bio-Reactor; Municipal wastewater; Organic Loading Rate; pH.**

I. INTRODUCTION

Water is a vital natural resource for all living things. Humans, animals, and plants cannot exist without water. Water contamination has become a major issue all around the world. Humans, animals, and aquatic life all suffer greatly from water contamination. Depending on the type of chemicals, pollutant concentrations, and contaminated areas, the consequences can be devastating. The impacts of water contamination vary depending on which chemicals are released and where they are placed. Many water bodies surrounding cities and towns are extremely polluted. This is the consequence of both individual trash dumps and toxic substances dumped officially or illegally by industrial firms, health centres, schools, and markets. The biochemical method of biological wastewater treatment dates back millennia. Even today, as the volume of industrial effluents released grows and the types of contaminants contained in effluent streams diversifies, wastewater treatment technologies are being extensively researched and tested across the world. Combining wastewater treatment with waste utilization is always a good idea. In such a case, proposing and developing renovations in effluent handling and treatment procedures to increase their overall economy and energy efficiency becomes unavoidable.

The Hybrid Aerobic Bio-Reactor (HABR) was developed as a new high-rate system for the treatment of industrial and domestic wastewaters. To prevent acclimation of biomass in the reactor, the system is also accomplished with attached growth process. The research, presented here, consisted of fundamental studies on a new high-rate aerobic reactor for the biological treatment of various types of wastewater. The new reactor process is called the Hybrid Aerobic Bio-Reactor (HABR). The objective of the laboratory research was to gather data and fundamental knowledge on the performance of the HABR process that would lead to pilot-scale and proof-of-concept applications of the process. An extra focus was on finding a niche in which this new process could be beneficial compared with other high-rate aerobic processes. To retain biomass in a continuous process other workers had invented a compartmentalized reactor, which showed promising results (Bachman et al., 1982). These fluctuations can also result in large variations in the oxygen requirements and biomass production of the aerobic systems (Lettinga, 1995). In some cases, biological treatment must be discarded due to the inhibitory or even toxic nature of wastes. In such cases, physical/chemical treatment methods may be used, but these can be quite costly to operate. Notably, aerobic pretreatment systems have the potential to pay for themselves over a short period of time, especially in regions with high energy prices. In recent years, all presumed disadvantages of anaerobic high-rate systems, such as low stability of the digestion systems, slow speed of start-up, malodorous nuisance, and susceptibility to xenobiotic compounds have been overcome by increased amounts of research, operational know-how, and implementation of new techniques (Lettinga, 1995). High-rate systems, such as the widely used upflow anaerobic sludge blanket (UASB) (Lettinga et al., 1980) and more recently, the anaerobic sequencing batch reactor (ASBR) (Sung and Dague, 1992) along with others, were applied to different waste streams. However, anaerobic high-rate systems are designed for pretreatment of wastewaters and some form of post-treatment is required (Lettinga, 1995; Speece, 1988). Moreover, it must be realized that these methods are considered to be innovative technologies (Switzenbaum, 1995). There's no denying that aerobic reactors have grown in popularity over the last decade, but few studies have looked at reducing the start-up time. Lack of knowledge on sludge selection and kinetics involved during low and high strength wastewater treatment start-up are some of the reasons behind this. In under developed nations, the hybrid bio-reactor is an affordable wastewater treatment technology. The hybrid bio-reactor is an appealing alternative because it combines a simple design, cheap running costs, and effective pollution removal. Because of the technological simplicity and minimal amount of sludge produced, many developing nations prefer aerobic procedures for their household wastewater treatment over anaerobic systems.

The main objectives of the present study were to shorten the start-up time of the aerobic reactors with the better COD removal efficiency. Also, the goal of this study was to determine the efficacy of an aerobic biological treatment process using metrics such as pH, TDS, EC, TSS, and COD. In a given time span, aerobic circumstances accelerate biodegradation significantly faster and to a higher extent than anaerobic ones. Biological reactors also feature lower building costs and simple operation and maintenance processes. Because this technique has certain benefits over conventional treatment procedures, this study built a hybrid bio-reactor for wastewater treatment. The treatment process of the bioreactor might be heavily influenced by aeration, particularly the aeration rate and retention duration, and this should be investigated more in the future.

II. MATERIALS AND METHODS

The whole treatment process was performed in the laboratory where the temperature varied from 25ºC – 35ºC over two months. The Hybrid Aerobic Bio-reactor was accomplished with both suspended as well as attached growth process. Both reactor and mixing tank were connected with tubes to transfer the liquid. Hybrid Aerobic Bio-reactor was constructed with 6 mm thick transparent acrylic material with the total volume of 14 L with a working volume of 13.3 L. The reactor had 4 ports; two on the left side of the reactor were one is used for influent feed and one is used for sludge removal. Two ports on the right side of the reactor were one is used for effluent collection and another is used for sludge collection. The reactor was operated in a continuous mode with the influent feed of municipal wastewater and the oxygen was supplied in the entire process. After 20 days, the HRT was reduced from 48 to 24 hr with the same loading rate to see the effect of macro- and micro-nutrients. After achieving a stable COD removal of 99.9%, this reactor was used to treat industrial wastewater. The physical feature of the experimental setup is shown in **Table.1**. A variable speed of peristaltic pump (PP-30) was used to control the flow rate. A photographic view of a Hybrid Aerobic Bio-Reactor is shown in **Figure 1.**

Figure. 1. Photographic view of Hybrid Aerobic Bio-Reactor

Table .1 Physical features and process parameters of experimental model

Reactor	**Dimensions**
Length of the reactor	38 cm
Depth of the reactor	20 cm
Width of the reactor	19 cm
Compartment free board	6 cm top

Total Volume	14 litres
Working Volume	13.3 litres
Number of Compartment	2
Compartment Length	19 cm
Peristaltic Pump	PP-EX 30

During an aerobic reactor start-up, the biomass is acclimatized to new environmental conditions, such as substrate operating strategies, temperature and reactor configuration. The inoculums source granular sludge was taken from the active biomass plant located at Faculty of Agriculture, Annamalai University, Annamalai Nagar. The samples were characterized as per the Standard procedure (APHA 2017).

III. RESULT AND DISCUSSIONS

The influent and effluent samples from the reactor were collected once in three days and were analyzed immediately. The start-up stage of the process was began by continuous feeding of the reactor with an initial influent COD concentration of 848 mg/l, 824 mg/l, 864 mg/l, 856 mg/l, 872 mg/l, and 888 mg/l. The low initial loading rate was recommended for the successful start-up of HABR. A low initial organic loading rate was beneficial for the growth of aerobic active sludge. Prompt start-up is essential for the highly efficient operation of HBR, due to slow growth rates of aerobic microorganisms.

3.1Stabilization process

The start-up period is considered as the period taken for stable operation to be achieved. This is a crucial step for the stable operation of the HABR and other aerobic reactors at a designed organic loading rate (OLR). In addition, operating temperature is prominent during start-up. In this work, the HABR was operated at a temperature between 25°C and 35°C (Mesophilic range). The start-up stage of the process was began by continuous feeding of the reactor with an initial influent COD concentration of 848 mg/l, 824 mg/l, 864 mg/l, 856 mg/l, 872 mg/l, and 888 mg/l. The COD removal rate during first two days was low in the range of 7% to 13%. The low efficiency in removal at the beginning of the process is due to the biomass adaptation to the new environment. During the start up period the pH and DO plays an important role. The COD reduction was attained 7% in the initial stage and it was incremental up to 12th day and decline from 12th to 14th day and then attains a steady state from 15th day to 18th day with a COD removal efficiency of 96.45%. **(Figure .3.).**

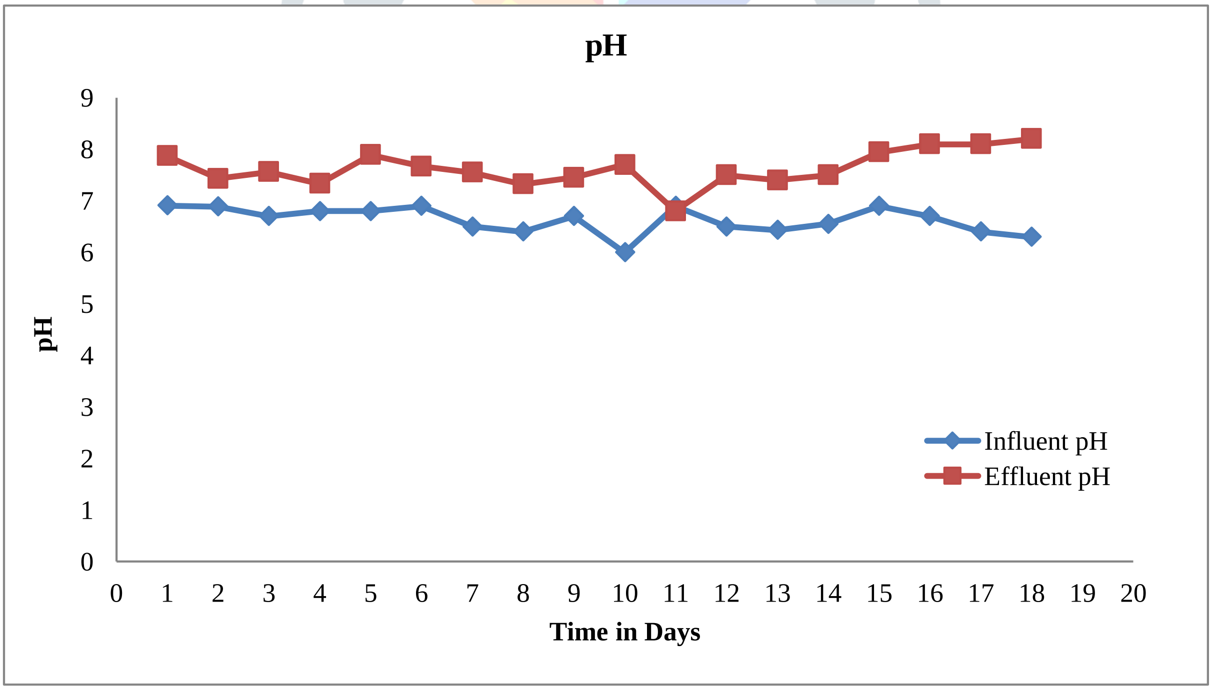

Figure. 2. No. of days' Vs. pH during start up process

The effluent pH during the start-up period is shown in **Figure 2.** The effluent pH value was from 6.8 to 8.2. These results indicated a good system of buffering and non-inhibition of micro organism at the beginning of the adaptation process.

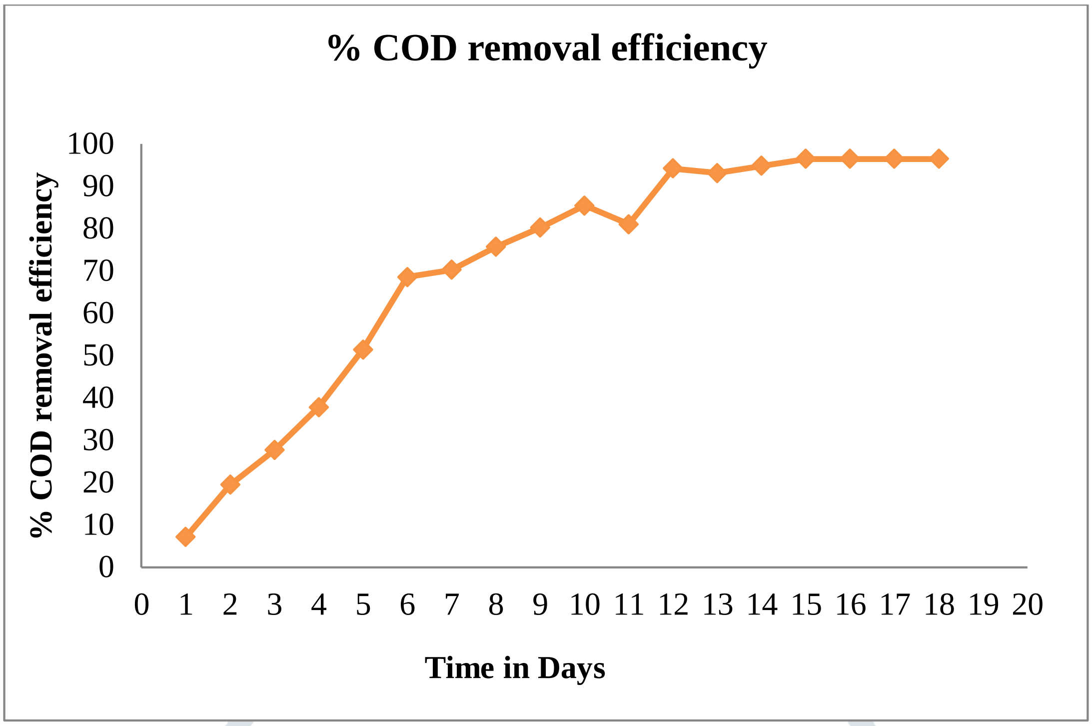

Figure. 3. No. of days' Vs. % COD removal efficiency during start up process

IV. CONCLUSIONS

Start-up is often considered to be the most unstable and difficult phase in aerobic digestion. Aerobic treatment plays an important role in the treatment efficiency. The low initial loading rate was recommended for the successful start-up of HABR and the low initial organic loading rate was beneficial for the growth of aerobic active sludge. Prompt start-up is essential for the highly efficient operation of HABR, due to slow growth rates of aerobic microorganisms. The result showed that the HABR attained a steady state from 15th day to 18th day. The COD reduction was attained 7% in the initial stage and it was incremental up to 12th day and decline from 12th to 14th day and then attains a steady state from 15th day to 18th day. The maximum COD removal efficiency was achieved at 96.45%.

.

REFERENCES

[1]. American Public Health Association APHA; American Water Works Association; and Water Environment Federation (2017). *Standard Methods for the Examination of Water and Wastewater*. 23rd Ed., Washington, D.C.

[2]. Bachman, A., Beard, V. L., and McCarty, P. L (1985). Performance characteristics of the anaerobic baffled reactor. *Water Research*. 19(99).

[3]. Bachman, A., Beard, V. L., and McCarty, P. L. (1982). Comparison of fixed-film reactors with a modified sludge blanket reactor. *In: Proceedings of the first international Conference on fixed-film Biological processes*. (Edited by Wu, Y. C., and Smith, E. D.), Arlington, VA, Noyes Publications, Park Ridge, N.Y., 1192.

[4]. Banik G C, Dague R.R. (1996). ASBR Treatment of Diltue Wastewater at Psychrophilic Temperature. *Proceedings of the 69th Annual Water Environmental Conference, Dallas, Tex*. 235-246.

[5]. Chang, H., (2008). Spatial analysis of water quality trends in the Han River basin, South Korea. *Water Research*, 42(13): 3285- 3304.

[6]. Dague, R. R., and Pidaparti, S. R. (1991). Anaerobic sequencing batch reactor treatment of swine wastes. *In: 46th Purdue Industrial Waste Conference Proceedings*, Purdue University, West Lafayette, Indiana, Lewis Publishers, Inc., Chelsea, Michigan.

[7]. Dague, R. R., Habben, C. E., and Pidaparti, S. R. (1992). Initial studies on the anaerobic sequencing batch reactor. *Water Science and Technology*. 26,2429.

[8]. David, C. (2004). *Small Water Supplies*. Cromwell Press, Trowbridge, Wiltshire. India.

[9]. Dubey, S. (2013). Analysis of Physico- Chemical Parameters of Kshipra River Water at Ujjain, India. *International Research Journal of Environment Sciences*, 2(7), 1-4.1.

[10]. E. Metcalf and I. Eddy. (2003). Wastewater Engineering Treatment and Reuse, McGraw-Hill Education, New York, NY, USA, 4th edition.

[11]. Garode, A.M., and Sonune, N.A. (2014). Screening and Identification of lipase producing bacteria from Domestic wastewater. *Int. J. Pharm Bio Sci.*, 5 (2): 265 268.

[12]. Goel, P.K. (1997). Water pollution causes, effects and control. *New Age International (P) Ltd., publishers*. New Delhi: 269.

[13]. Hack P. J. F. M., Vellinga S. H. J. and Habets L. H. A. (1988). Growth of granular sludge in the BIOPAQ IC-reactor. *In: Proc. GASMAT Workshop*. (Edited by Lettinga G., Zehnder A. J. B., Grotenhuis J. T. C. and Hulshoff Pol L. W.), pp. 211-215, Pudoc, Wageningen, The Netherlands.

[14]. Indian Standards Specification for drinking water as per BIS specifications is 10500-2012.

[15]. Lettinga, G. (1995). Anaerobic digestion and wastewater treatment systems. *Antonie van Leeuwenhoek*. 67(3).

[16]. Levenspiel, O. (1972). *Chemical Reaction Engineering*. 2nd ed. New York, Wiley.

[17]. Lokhande, R. S., Singare, P. U., Pimple, D. S. (2011). Study on Physico-Chemical Parameters of Waste Water Effluents from Taloja Industrial Area of Mumbai, India. *International Journal of Ecosystem*, 1(1): 1-9.

[18]. Paula, P., Mihaela, T., Mirela, V., Silvia, D., Catalin, T., and Lucian, P. G. (2012). Study of Physico-Chemical Characteristics of Wastewater in an Urban Agglomeration in Romania. *The Scientific World Journal*, doi:10.1100/2012/549028.

[19]. Rathore, D.S., Rai, N., and Ashiya, P. (2014). Physico Chemical Analysis of Water of Ayad River at Udaipur, Rajasthan (India). *International Journal of Innovative Research in Science, Engineering and Technology*, 3(4), 11660-11667.

[20]. Sangu, R. P. S., and Sharma, S. K. (1987). An assessment of water quality of river Ganga at Garmukeshwar. *Ind. J. Ecol.*, 14(20), 278-287.

[21]. Sonune N A, Mungal N A and Kamble S P. (2015). Study of physico-chemical characteristics of domestic wastewater in Vishnupuri, Nanded, India. *Int.J.Curr.Microbial.App.Sci*. 4(1): 533-536.

[22]. Sukumaran, M., Rama Murthy, V., Raveendran, S., Sridhara, G., and Netaji, S. (2008). Biodiversity of Microbes in Tannery Effluent. *Journal of Ecotoxicology and Environmental Monitoring*, 18: 313-318.

[23]. Sung, S., and Dague, R. R. (1992). Fundamental principles of the Anaerobic Sequencing Batch Reactor Process. *In: 47t/i Purdue Industrial Waste Conference Proceedings.* Purdue University, West Lafayette, Indiana, Lewis Publishers, Inc., Chesea, Michigan.

[24]. Sung, S., and Dague, R. R. (1995). Laboratory studies on the Anaerobic Sequencing Batch Reactor. *Water Environmental Research*. 67,294.

[25]. Switzenbaum, M. S. (1995). Obstacles in the implementation of anaerobic treatment technology. *Bioresource Technology*. S3, 255.

[26]. Wirtz, Gouranga C. Banik, Richard R Daguet. (1997). ASBR treatment of low strength industrial wastewater at psychrophilic temperatures. *Water science and technology*. 36(2-3), 337-344.