REVIEW PAPER ON INDUSTRIAL WASTEWATER TREATMENT PROCESSES

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Abstract -This paper reviewed five (5) researches on industrial wastewater treatment processes, the methods employed in these researches are aerobic, anaerobic or the combination of both methods. The paper tried to briefly discuss the motives of the researchers, their instrumentations and results. These researches include a combined anaerobic-aerobic system for treatment of textile wastewater conducted in Malaysia (2007) by Mahdi et al., Fayza et al., in 2004 conducted a research on chemical industrial wastewater treatment, a preliminary study on nitrogen and organic removal efficiency of a lab-scale system using aerobic and an-aerobic reactors by Florante et al., in 2009, a research on Wastewaters from olive mills and pulp and paper mill industries in Jordan conducted by Bashaar in 2004 and a survey on wastewater treatment plants in the Slovak Repulic by Gašpariková et al., in 2004..

***Key Words*:**optics, photonics, light, lasers, templates, journals

1.INTRODUCTION

The chemical industry is of importance in terms of its impact on the environment. The wastewaters from this industry are generally strong and may contain toxic pollutants. Chemical industrial wastes usually contain organic and inorganic matter in varying degrees of concentration. It contains acids, bases, toxic materials, and matter high in biological oxygen demand, color, and low in suspended solids. Many materials in the chemical industry are toxic, mutagenic, carcinogenic or simply hardly biodegradable. Surfactants, emulsifiers and petroleum hydrocarbons that are being used in chemical industry reduce performance efficiency of many treatment unit operations (EPA, 1998). The best strategy to clean highly contaminated and toxic industrial wastewater is in general to treat them at the source (Peringer, 1997) and sometimes by applying onsite treatment within the production lines with recycling of treated effluent (Hu et al., 1999). Since these wastes differ from domestic sewage in general characteristics, pretreatment is required to produce an equivalent effluent (Meric et al., 1999). In chemical industry, the high variability, stringent effluent permits, and extreme operating conditions define the practice of wastewater treatment (Bury et al., 2002). Hu et al. 1999 proposed concept to select the appropriate treatment process for chemical industrial wastewater based on molecular size and biodegradability of the pollutants. _ (1184) TESCE, Vol. 30, No.2 v s December 2004

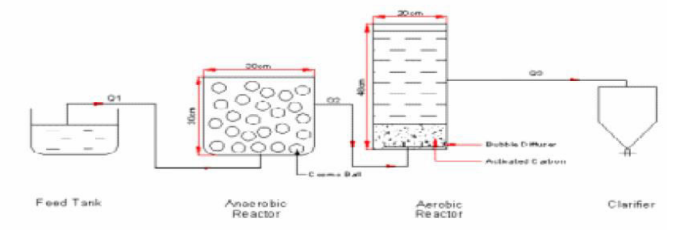
Chemical industrial wastewater can be treated by some biological oxidation methods such as trickling filters, rotating biological contactor (RBC), activated sludge, or lagoons (Nemerow, and Dasgupta, 1991; Jobbagy et al., 2000). Pollutants with a molecular size larger than 10,000-20,000, can be treated by coagulation followed by sedimentation or flotation (Hu et al., 1999). Waste minimization in the production process in chemical industry is the first and most important step to avoid waste formation during the production (Carini, 1999; Alvarez et al., 2004). Because of the fluctuation in the strength and flow rate, Bury et al; 2002 applied dynamic simulation to chemical-industry wastewater treatment to manage and control the treatment plant. Aerobic and Anaerobic Wastewater Treatment Aerobic, as the title suggests, means in the presence of air (oxygen); while anaerobic means in the absence of air (oxygen). These two terms are directly related to the type of bacteria or microorganisms that are involved in the degradation of organic impurities in a given wastewater and the operating conditions of the bioreactor. Therefore, aerobic treatment processes take place in the presence of air and utilize those microorganisms (also called aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass. The anaerobic treatment processes, on other hand take place in the absence of air (and thus molecular/free oxygen) by those microorganisms (also called anaerobes) which do not require air (molecular/free oxygen) to assimilate organic impurities. The final products of organic assimilation in anaerobic treatment are methane and carbon dioxide gas and biomass (Arun, 2011).

Aerobic Process Aerobic treatment systems such as the conventional activated sludge (CAS) process are widely adopted for treating low strength wastewater (< 1000 mg COD/L) like municipal wastewater. CAS process is energy intensive due to the high aeration requirement and it also produces large quantity of sludge (about 0,4 g dry weight/g COD removed) that has to be treated and disposed of. As a result, the operation and maintenance cost of a CAS system is considerably high. Anaerobic processes for domestic wastewater treatment are an alternative that is potentially more cost-effective, particularly in the sub- tropical and tropical regions where the climate is warm consistently throughout the year. Anaerobic wastewater purification processes have been increasingly used in the last few decades. These processes are important because they have positive effects: removal of higher organic loading, low sludge production and high pathogen removal, methane gas production and low energy consumption (Nykova et al., 2002).

2. LITERATURE REVIEW

In 2007, Mahdi, et al., conducted a combined anaerobic-aerobic system for treatment of textile wastewater. Textile manufacturing consumes a considerable amount of water in its manufacturing processes. The water is primarily utilized in the dyeing and finishing operations of the textile establishments. Considering both the volume generated and the effluent composition, the textile industry wastewater is rated as the most polluting among all industrial sectors. In their study, a combined anaerobic-aerobic reactor was operated continuously for treatment of textile wastewater. Cosmo balls were used to function as growth media for microorganisms in anaerobic reactor. Effect of pH, dissolved oxygen, and organic changes in nitrification and denatrification process were investigated. The results indicated that over 84.62% ammonia nitrogen and about 98.9% volatile suspended solid (VSS) removal efficiency could be obtained. Dissolved oxygen (DO), pH was shown to have only slight influences on the nitrification process; and for each 10% removal of nitrogen, only 3% of pH changes were achieved. Instrumentation A laboratory scale combined anaerobic-aerobic reactor was set up to investigate the effectiveness of the system to treat textile wastewater in term of nitrogen removal. Anaerobic reactor The anaerobic reactor, made of transparent PVC, has a diameter of 30 cm, height of 30 cm, and total working volume of 18 litres. The reactor was filled up with supporting particles (Cosmo ball) for immobilization of microorganism in the system, and a total of 2-liter active sludge from palm oil mill was collected from Hulu Langat, Malaysia and fed into the reactor. The total surface area of support material was 192.56m2. Aerobic reactor The aerobic reactor is made of transparent PVC, has a diameter of 20 cm, height of 48 cm, and total working volume of 9 litre. A total of 1-liter sewage sludge from Indah Water Konsortium (IWK) was collected and fed into the aerobic reactor. Acclimatization of the aerobic sludge was not as critical as compared to anaerobic reactor due to primary function of the aerobic reactor was meant for polishing only. Air was supplied by a fine bubble diffuser; flow was regulated at 6 mg/l/min by a flow meter.It is often important to refer back (or forward) to specific sections. Such references are made by indicating the section number, for example, "In Sec. 2 we showed…" or "Section 2.1 contained a description…." If the word Section, Reference, Equation, or Figure starts a sentence, it is spelled out. When occurring in the middle of a sentence, these words are abbreviated Sec., Ref., Eq., and Fig.

At the first occurrence of an acronym, spell it out followed by the acronym in parentheses, e.g., charge-coupled diode (CCD).



Schematic Diagram of Combined Anaerobic- Aerobic System

Fig -1: Schematic Diagram of Combined Anaerobic- Aerobic System

Schematic Diagram of Combined Anaerobic- Aerobic System They concluded that the combined anaerobic-aerobic system was able to treat high strength textile wastewater. The maximum removal of ammonia nitrogen, BOD, COD, VSS were 84.62%, 63.64%, 60% and 98.9% respectively. The concentrations level of ammonia nitrogen, BOD and COD in the final effluent were found to be 1.11 mg/l, 13.17 mg/l and 108.75 mg/l respectively. Dissolved oxygen, pH was shown to have only slight influences on the nitrification process; and for each 10% removal of nitrogen, only 3% of pH changes were achieved. The changes of COD/NO3 at 28% gave 0.06 mg NO3/VSS denitrification rate and this rate will decrease with increasing of dissolved oxygen concentration (Mahdi, et. al., 2007) Fayza et. al., in 2004 conducted a research on chemical industrial wastewater treatment. Building and construction chemicals factory and plastic shoes manufacturing factory was investigated. The two factories discharge their wastewater into the public sewerage network. The results showed the wastewater discharged from the building and construction chemicals factory

Florante et. al., in 2009 conducted a preliminary study on nitrogen and organic removal efficiency of a lab-scale system using aerobic and an-aerobic reactors. A simulated wastewater containing elevated levels of nitrogen was used. This paper aims to compare the efficiency of aerobic and anaerobic reactors in achieving nitrogen and chemical oxygen demand (COD) removal of nutrient-rich wastewater. It also presents the start-up experi-mentation conducted on simulated wastewater using two different reactors configured as aerobic and anaero-bic. Start-up experiments were carried out using a 5-liter acrylic aerobic reactor and a 4-liter flask anaerobic reactor containing activated sludge taken from De La Salle University (DLSU) wastewater treatment plant as a source of inoculum. Simulated wastewater was continuously fed to the two reactors and the time course of biomass growth was monitored by measuring the biomass concentration represented by mixed liquor volatile solids (MLVS). The time course of organic pollutant reduction by measuring the chemical oxygen demand (COD) was conducted until steady state condition was reached. On the other hand, COD and nitrogen tests such as Ammonia nitrogen (NH3-N), Nitrite nitrogen (NO2--N), Nitrate nitrogen (NO3--N) were also per-formed using 5 batch aerobic reactors containing different concentrations of wastewater and a single batch anaerobic reactor to see the effect of different feed concentrations in the removal of nitrogen. Preliminary results showed that 98% reduction in COD was obtained in aerobic reactor,as supported by increasing con-centration of MLVS, with a hydraulic retention time (HRT) of 5hours after 11 days while 34% reduction in COD was obtained in anaerobic reactor with the same HRT after 14 days.

3. INSTRUMENTATION

Experiments were carried out using aerobic and anaerobic reactors. A continuous aerobic reactor was made up of acrylic board with a working volume of 5 liters where an air pump was used for aerobic zone. On the other hand, a continuous anaerobic reactor was made up of a 4-liter Erlenmeyer flask equipped with magnetic stirrer and stir bar to facilitate continuous stirring within the reactor.

Batch reactors as shown in the picture below were made up of 5 1-liter imhoff cones supported by iron stand and iron ring with different concentrations of wastewater. Air pumps were also used for each reactor for aeration.

11 | P a g e

Batch reactors

From the experimental results obtained, the following conclusions were drawn:

Aerobic process requires longer aeration time and produces large amount of sludge but they can remove ammonium nitrogen. Anaerobic treatment methods usually offer advantages such as higher organic loading rates and production of usable biogas; however, a relatively higher effluent concentration and incapability to remove ammonium nitrogen are some of its disadvantages. At the same HRT, 98% reduction in COD was obtained in aerobic reactor against 34 % reduction in anaerobic reactor; therefore, anaerobic bacteria have a slower capability to degrade organics. Nitrite accumulation and low nitrate build up in aerobic reactor was observed because of the low activity of NOB maybe due to the presence of inhibitors or un-controlled pH in the reactor during nitrification. Therefore, based on the above findings, it is more attractive to use combined anaerobic and aerobic systems for simultaneous removal of nitrogen and COD (Florante et. al., 2009)

Bashaar, (2004), conducted a research on Wastewaters from olive mills and pulp and paper mill industries in Jordan have been characterized and treated using laboratory scale anaerobic and aerobic sequencing batch reactors, respectively. Nutrient requirements for these two industrial wastewaters were found to be less than what is usually reported in the literature for C:N:P ratio of 100:5:1 for aerobic treatment and 250:5:1 for anaerobic treatment. This was ascribed to the low biomass observed yield coefficients and relatively low removal efficiencies in these wastewaters. It was found that for anaerobic treatment of olive mills wastewater COD:N:P ratio of about 900:5:1.7 was able to achieve more than 80% COD removal. The observed biomass yield was about 0.06 kg VSS per kg of COD degraded. For extended aeration aerobic treatment of pulp and paper mill wastewater COD:N:P ratio of about 170:5:1.5 was able to achieve more than 75% COD removal. The observed biomass yield was about 0.31 kg VSS per kg of COD degraded. In both these wastewaters nutrients were not added. A simple formula is introduced to calculate nutrient requirements based on removal efficiency and observed biomass yield coefficient.

4. CONCLUSIONS

Anaerobic systems prove to be an excellent treatment technology for many areas of the world. In future the traditional system of WSP shall definitely compete more and more with UASB systems. Post-treatment still requires aerobic systems, which e.g. can be ponds, trickling filters or activated sludge plants. The bigger the plants, the more economical it might combine these technologies. Anaerobic biological treatment is well understood and used frequently as anaerobic digesters to treat complex organic solid wastes such as primary and secondary wastewater sludges. However, it has not been used much in the past to treat low strength organic wastewaters from industrial and domestic applications. Aerobic processes were preferred for treatment of these wastewater streams because they are easy to operate and can tolerate process fluctuations. In comparison, anaerobic reactors were assumed to be less stable under fluctuations,more expensive to install and require long start-up time. This belief was due to limited knowledge of the process and reactor design. Now the technology advances have significantly reduced the historical weakness of anaerobic treatment. With the work of Young and McCarty in the year 1969, application of anaerobic process for the treatment of industrial and municipal wastewaters has gradually increased in last three decades. Today the anaerobic treatment has emerged as a practical and economical alternative to aerobic treatment due to significant advantages over aerobic treatment.

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REFERENCES

1. Alvarez, D., Garrido, N. Sans, R. and Can-eras, I. (2004) Minimization optimization of water usein the process of cleaning reactors and containers in a chemical industry. Journal of Cleaner Production, 12, pp.781-787
2. Arun Mittal. (2011). Biological Wastewater Treatment, Fultide Articles, Water Today.
3. Bashaar Y. (2004). Nutrients Requirements in Biological Industrial WastewaterTreatment. African Journal of Biotechnology Vol. 3 (4), pp. 236-238, April 2004 Available online at http://www.academicjournals.org/AJB ISSN 1684–5315 © 2004 Academic Journals
4. Bury, S.J., Groot, C.K., Huth, C. and Hardt, N. (2002). Dynamic simulation of chemical industrywastewater treatment plants. Water Science & Technology, Vol. 45 No 4-5 pp 355-363
5. Carini, D (1999) Treatment of industrial wastewater using chemical-biological sequencing batchbiofilm reactor (SBBR) processes. Ph.D. thesis Swiss Federal Institute of Technology, Zurich, Switzerland.
6. EPA, (1998). Wastewater Treatment Technologies in: Pollution Prevention (P2) GuidanceManual for the Pesticide Formulating, Packaging and Repackaging Industry including implementing the P2 alternative, EPA, 821-B-98-017 June 1998, Pp. 41-46
7. Fayza A., Hala S., Hisham S., Saber A. (2004) Chemical Industry Wastewater Treatment, WaterPollution Research department, National Research Centre, Cairo, Egypt "Faculty of Engineering, Cairo University, Cairo, Egypt
8. Florante A., Magnaye, Pag-asa D., GASPILLO, Joseph L. (2009). Biological Nitrogen and COD
9. Removal of Nutrient-Rich Wastewater Using Aerobic and Anaerobic Reactors, J. Water Resource and Protection, 2009, 1, 376-380 doi:10.4236/jwarp.2009.15045 Published Online November 2009 (http://www.scirp.org/journal/jwarp)
10. Gašparikovál E., Kapustal Š., Bodíkl I., Dercol J., Kratochvíl K. (2004). Evaluation ofAnaerobic-Aerobic Wastewater Treatment Plant Operations, Polish Journal of Environmental Studies Vol. 14, No. 1 (2005), 29-34
11. Hu, H.Y., Goto, N. and Fujie, K. (1999). Concepts and methodologies to minimize pollutantdischarge for zero-emission production. Wat. Sci.Tech. Vol. 10-11, Pp. 9-16.
12. Jobbagy, A., Nerbert, N., Altermatt, R.H. and Samhaber, W.M. (2000) Encouraging filamentgrowth in an activated sludge treatment plant of the chemical industry. Wat. Res. Vol. 34, No. 2, pp. 699-703.
13. Mahdi A., Azni I., Aofah A. (2007). Combined Anaerobic-Aerobic System for Treatment ofTextile Wastewater. Journal of

Engineering Science and Technology Vol. 2, No. 1 (2007) 55-69 © School of Engineering, Taylor's University College
14. Meric, S., Kabdash, I., Tunay, O. and Orhon, D. (1999). Treatability of strong wastewaters frompolyester manufacturing industry. Wat. Sci. Tech., Vol. 39, No. 10-11, Pp. 1-7
15. Nemerow, N.L. and Dasgupta, A. (1991) "Industrial and Hazardous Waste Treatment "VanNostrand Reinhold, New York.
16. Nykova N., Muller T. G., Gyllenberg M., Timmer J. (2002). Quantitative analyses of anaerobicwastewater treatment processes: identifiability and parameter estimation. Biotechnology and Bioengineering, 78, (1), 89-103.