Extended Aeration Activated Sludge Process of Pharmaceutical Wastewater

Kamal Rana*, Mitali Shah**
*Student, ME Environmental Engineering, Sarvajanik College of Engineering & Technology, Surat
**Asst. Professor, Civil Engineering Department, Sarvajanik College of Engineering & Technology, Surat.

ABSTRACT:
Penicillin Gas a core pharmaceutical product. In the present study, an attempt has been made to evaluate the treatability study of the final discharge of the effluent with the use of fresh domestic sewage obtained from the local sewage treatment plant in a lab-scale activated sludge reactor along with the treatment efficacy of the existing facilities of effluent treatment plant. Studies on the efficiency of the activated sludge reactor was carried out by varying the hydraulic retention time (HRT) of 1, 2 and 3 days at solids retention time (SRT) of 2, 4, 6 days. The results showed that at 3 days HRT and 6 days SRT, the maximum reduction of COD was observed to be from 221 to 120 mg/l. This study has clearly shown the potential applicability of aerobic biological process in treating the final discharge of the effluent. Further, study of the efficacy of existing effluent treatment plant shows that stable performance of bio tower would helps to achieve the level of chemical oxygen demand (COD) below 120 mg/lt.

Keywords: Pharmaceutical product, SRT, HRT, biological treatment.

I. INTRODUCTION

Industry requires large amounts of water for their processes. Only a small fraction of it is incorporated in their products and some of it is lost by evaporation, while the rest of the water is released as wastewater. This wastewater contains organic pollutants as the major constituent and inorganic salts as dissolved solids. If this untreated wastewater is let into the water course, it severely effects the quality of the stream. This wastewater may contain toxic metals that directly effect the aquatic life or may contain nutrients that stimulate the growth of aquatic weeds or may have a high demand for dissolved oxygen resulting in anaerobic conditions. Under anaerobic conditions H_2S gas is produced which produces offensive odors. Thus to protect the environment from the undesirable toxic materials the wastewater must be suitably treated before discharge to neutral streams.

Pharmaceutical industry produces various types of products ranging from vitamins synthetic drugs to antibiotics. The production process in a pharmaceutical industry involves manufacture of various constituents of drugs for bulk drug manufacture. The volume of waste generated in bulk drug manufacture is higher than in formulation. In formulation, extraction and fermentation the wastewater comes mainly from washing operations consisting of carbohydrates and formulating materials. Organic synthesis generates various types of effluents like acidic, alkaline, organic and inorganic effluents in a combined form. These effluents from a pharmaceutical industry or more precisely from a bulk drug manufacturing industry contain mainly organic components.

Advantages of biological treatment:--

Biological treatment has several advantages over physico-chemical options in treating such wastes apart from its ease of handling and economic feasibility. The reaction specificity of the microorganisms in a biological treatment permits selective enrichment of microorganisms for the degradation of target compounds. Also, as reported by Koziorowski and Kucharski clarification in settling tanks or chemical coagulation cannot be employed to remove BOD completely. In case of waste taken from synthetic drug units, chemical treatment may be necessary to neutralize the acidic waste or segregation of toxic elements like cyanide, phenol etc., but it is found to be ineffective in BOD and COD removal. Thus, a biological treatment and more preferably a suspended aerobic growth system is the desired treatment mechanism for an effluent from a pharmaceutical industry. The choice of an

aerobic system over anaerobic system lies in the fact that a pharmaceutical industry produces a large volume of water coupled with a high concentration of BOD, COD and TDS.
Keeping in view the economy, time and efficiency, an aerobic treatment system is recommended for a pharmaceutical waste. This is due to the presence of aerobic organisms with a high respiration rate, which acclimatizes and treats the waste in a short period of time than in an anaerobic system.

II. MATERIALS AND METHODS

Grab sampling was carried out from the stage wise treatment component, i.e., UASB (anaerobic), equalization tank, bio-tower-I, clarifier-I, bio-tower-II, clarifier-II, diffused aerator, surface aerator and final discharge. In order to assess the performance of each component of ETP, Table 1 shows that percentage reduction range of COD was observed to be very high (20-65% and 10-40%) during the operation of bio tower-I and II due to fluctuating load of influent COD. Pertaining to this, influent COD should maintain in the uniform range to stabilize the function of bio towers.

Table 1. Treatment efficacy of the existing effluent treatment plant

Treatment methods	% COD Reduction	Range of COD, mg/lit
UASB	60-70	18000-40000
Biotower-I	20-65	2000-4000
Biotower-II	10-40	1000-3000
Aeration tank -I	70-80	1000-2000
Aeration tank-II	40-55	400-500

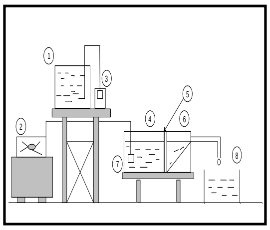
In particular, sample of final discharge of effluent was characterized for physical and chemical parameters such as Chemical oxygen demand (COD), Biochemical oxygen demand (BOD_3 at 27^o C),Total Solids(TS), Total Suspended Solids (TSS), Total dissolved solids(TDS), and pH using standard methods (APHA 1998) given in Table 2. The wastewater contained high organic content. The BOD: COD ratio of the wastewater was in the range of 0.12 to 0.20, which is amenable to biological treatment.

Table 2 Characteristics of in final discharge

Parameter	Value
pH	7.8
Total Solids	2790 mg/lit
Total Suspended Solid	20 mg/lit
Total Dissolved Solid	2770 mg/lit
BOD_3	27 mg/lit
COD	221 mg/lit
Chloride	1134 mg/lit
SO_4	410 mg/lit

Experimental Set up

The schematic diagram of the activated sludge reactor is shown in Figure 1. The reactor was made up of acrylic plastic consisted of two chambers, one for aeration (7.5 L) and the other for sedimentation (2.5 L). The aeration was carried out with the use of two diffuser stones so as to maintain dissolved oxygen concentration 2-3 mg/L. The aeration was instrumental in bacterial growth as well as maintaining homogeneity of the mixed liquor. The aeration section was separated from the sedimentation section with an adjustable baffle wall in order to facilitate to recycle the biomass. The settled sludge was returned to the aeration section by passing it under the adjustable baffle.



1. Feeding Tank 5. Adjustment baffle
2. Portable air pump 6. Settling tank
3. Peristaltic pump 7. Diffuser stone
4. Reactor 8. Effluent collection tank

Fig. 1 Schematic diagram of experimental set up

The start up of the activated sludge reactor was carried out in a three phased manner consisting of a seeding phase, an acclimatization phase and a bio mass build up phase. During the initial start up phase of the reactor, seeding of microbes was carried out using mixture of activated sludge collected from the local domestic wastewater treatment plant. Sufficient mixed liquor suspended solids was developed by adding continuously the fresh domestic sewage, from the local STP.

The acclimatization of the bacterial culture to the wastewater was established by gradual addition (2 liters/day) of final discharge to the reactor for the period of 5 days. The reactor took 15 days to develop sufficient mixed liquor suspended solid (MLSS) concentration. During the acclimatization phase the activated sludge reactor was monitored with respect to pH, DO, MLSS, SVI, Influent BOD, COD and effluent BOD, COD.

At the end of acclimatization phase, the biomass concentration (MLSS) was found to be 3200 mg/L, which was below the desired level for operating the activated sludge process. Hence the biomass build up phase determine a consistent MLSS concentration of about 4500 mg/L. During this period, the MLSS concentration was found to be high for operating the reactor under continuous feed mode of final discharge. The reactor was monitored for outlet BOD, COD, pH and MLSS daily to understand the activity of the reactor.

The MLSS concentrations during the acclimatization phase and biomass buildup phase while treating final discharge is shown in Fig. 2. During the acclimatizing phase, the MLSS showed a steady rise and reached a value of 3200 mg/L which was below at the end of Acclimatization phase. Hence the biomass build up phase determine a consistent MLSS concentration of about 4500 mg/L. This MLSS concentration was observed to be remaining constant after ten days.

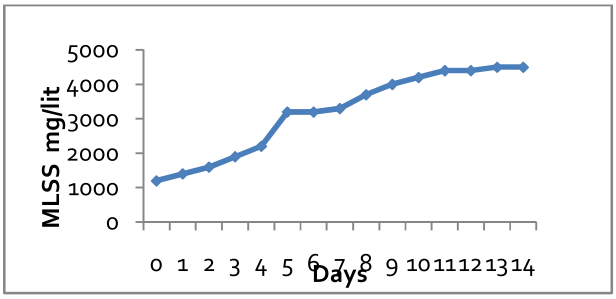


Fig. 2 Growth analysis of MLSS

III. RESULTS AND DISCUSSION

Performance Variation of SRT with HRT

After stabilization, the reactor was operated at a SRT of 2, 4, 6 days, the corresponding HRT was 1, 2 and 3 days respectively. The average BOD_3 and COD of influent wastewater were 27 and 180 mg/L, 26 and 152 and 26 and 120 mg/L respectively. The MLSS maintained in the reactor was around 4000 mg/L, 4200 mg/L and 4500 mg/L. The maximum COD removal achieved was 19 %, 31 % and 46 %. In this study it is observed that the maximum 46 % percentage of COD removal was attainable.

Optimization of operating conditions

During the period of study, the reactor was operated at hydraulic retention time ranging from 1, 2 and 3 days. The mixed liquor suspended solid concentration in the reactor at SRT of 2, 4, 6 days were 4000 mg/L, 4200 mg/L and 4500 mg/L, respectively. A maximum reduction in COD up to 120 mg/l was observed at solids retention time of 6 days and HRT of 3 days.

IV. CONCLUSION

- Biological treatability of final discharge of effluent obtained from the effluent treatment plant of pharmaceutical industry is satisfactory with process providing a reduced COD up to 120 mg/lit.
- The present study could be used for conducting pilot plant studies to establish the treatment of wastewater using the Activated Sludge Process under field conditions and to obtain necessary data for full scale design.

- Further, study of the efficacy of existing effluent treatment plant shows that stable performance of bio tower would help to achieve the level of chemical oxygen demand (COD) below 120 mg/lit.

REFERENCES

[1]. American Public Health Association (APHA). Standard methods for the examination of water and wastewater,20thEd. APHA, AWWA: Washington D.C. 1999.

[2]. Chernicharo CAL. [2007] Anaerobic Reactors. Volume 4, biological wastewater treatment Series. IWA Publishing, UK.

[3]. Hach Company. Water analysis handbook, 4th Ed. Hach Company, Loveland Colorado, USA. 2002.

[4]. Isa, M. H., Farooqi, I. H., and Siddiqi, R. H. Methanogenic activity test for study of anaerobic processes. Indian J. Environ. Hlth.1993.35 (1): 1-8.

[5]. M.C. Sharma and A.K. Chaturvedi "Simulation of Biological Treatment of Effluents by Activated Sludge Process at Laboratory Bench Scale".

[6]. Seghezzo L, Zeeman G, Van Lier JB, et al. [1998] A review: the anaerobic treatment of sewage in UASB and EGSB reactors. Bioresource Technology65: 175–190

[7]. Speece RE. [1996] Anaerobic biotechnology for industrial wastewater. Archae Press, Tennessee, USA Singh, K. S. Municipal wastewater treatment by upflow anaerobic sludge blanket (UASB) reactors. University of Regina. Canada. 1999.