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Acclimatization Of An Industrial Pharmaceutical Wastewater In An Aerobic Batch Mode Of Operation

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ABSTRACT

Manufacturing processes of pharmaceutical products lead to the release of toxic organic compounds and their metabolites into the environment. The present study aimed to compare the biodegradability of various ratios of pharmaceutical wastewater and the seed. The batch mode of operation was carried for a period of 150 days to understand the effect of acclimatization of the pharmaceutical wastewater. The ratios of wastewater : seed selected for the present study are : 1 : 1, 1 : 2, 1 : 3, 1 : 4, 3 : 1 and 1. 5 : 2. 5. The tests were conducted in plastic cans of 20 liters capacity. During acclimatization starch and glucose were added at regular intervals to enhance the growth of microorganisms. Variations in pH, Total Solids (TS), Total Dissolved Solids (TDS), Volatile Suspended Solids (VSS), and Chemical Oxygen Demand (COD) were measured for batch process. Conclusions were drawn for expressing the acclimatization based on the batch mode period, VSS and COD concentration. Of all the six ratios considered for acclimatization of wastewater, 1 : 4 (wastewater : seed) gives the best desirable result.

Key Words : acclimatization, aerobic batch reactor, batch process, pharmaceutical wastewater.

INTRODUCTION

The Indian pharmaceutical industries have established as one of the largest as well as fast growing industries in the priority sectors across the country. The effluent from chemical synthesis operation is the most complex to treat because of many types of operations and solvents[7]. In the chemical, pharmaceutical, plastic, and petrochemical industries, for some cases, production processes are in batch. Because of the high variations in flow and concentration of contaminants in industrial wastewater, usual

treatment processes do not obtain satisfactory removal efficiencies (Moreno-Andrade & Buitrón, (2004). Biological treatment is a practical and not very expensive solution to treat this kind of effluents compared to chemical one (not need to add chemicals); because various populations of microorganisms in the activated sludge are able to degrade organic compounds and most of effluents can be biological degraded (Marrot, Barrios-Martinez, Moulin & Roche2006). In aerobic microbial communities, the acclimation periods range from several hours to several days (Wiggings, Jones, &Alexander, 1987) In a favorable environment, when microorganisms are put in contact with toxic compounds, acclimation to these compounds may occur (Aelion, Dobbins, & Pfaender, 1989). The first step to make a continuous reactor operative is the acclimation, i. e. , the adaptation of the microorganisms to a specific substrate (Mesquita, Louvet, Potier, Amaral, Pons, Ferreira 2009). The biodegradation is therefore likely achieved by microorganisms with oligotrophic metabolism (Jones, Voulvoulis, & Lester, 2007). These microorganisms are slow growing which explains why an increase in the solid retention time in wastewater treatment plants enhances the removal efficiency. These microorganisms are also expected to be found in environments characterized by low concentrations of carbon sources (Daughton & Ternes, 1999). During acclimation, chemical parameters were measured in the influent, reactor and effluent, in order to verify the stability of the process.

MATERIALS

Selection of Wastewater :

An ‘analgesic’ based drug manufacturing industry which produces about 40 Kilo liters of wastewater per day was identified and selected for the present study.

Source and Collection of Wastewater :

The untreated wastewater was collected manually from the industry continuously for a period of over one year, as and when required for the experimental investigations. The wastewater (without treatment) was collected from a point where all the wastewater from the different stages of the pharmaceutical drug manufacturing process enters the equalization tank. Samples drawn from the above single source were continuously used for the entire experimental investigations. Wastewater was collected in 40 litres plastic cans (air tight containers) and brought to the laboratory where they are stored in a deep freezer to prevent the degradation and subsequent change of concentration of pollutants present in the sample.

METHODS

The experimental parameters considered for the study are : pH, total solids (TS), total dissolved solids (TDS), volatile suspended solids (VSS), and chemical oxygen demand (COD), are the parameters used to characterize the chosen wastewater based on the Standard Methods for the Examination of Water and Wastewater (APHA, 2005). The characteristics of the collected industrial pharmaceutical wastewater are summarized in Table1.

Table-1 : Characteristics of the Pharmaceutical Wastewater

Sl. No.	**Properties**	**Results**
1	pH	4. 67 - 7. 81
2	Electrical Conductivity (µS/Cm)	278 - 898
3	Total Solids (mg/L)	3000 – 7200
4	Dissolved Oxygen (mg/L)	2. 0 - 6. 3
5	Chemical Oxygen Demand (mg/L)	2000 – 6095
6	Biochemical Oxygen Demand $BOD_{(3, 27)}$ (mg/L)	50 – 200
7	Phosphate (mg/L)	10-40

Acclimatization of the Wastewater :

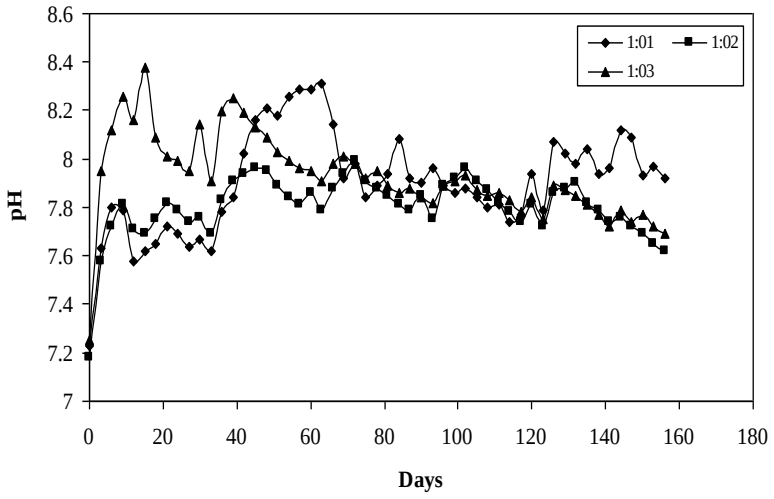
The pharmaceutical wastewater and the seed (sewage obtained from a local oxidation pond) are mixed in different pre-selected proportions, essentially, for the growth of sufficient aerobic micro-organisms which are required for the acclimatization studies. The various ratios of pharmaceutical wastewater and the seed considered in this study are : 1 : 1, 1 : 2, 1 : 3, 1 : 4, 3 : 1 and 1. 5 : 2. 5. During acclimatization starch (3g/L) and glucose (1g/L) were added at regular intervals to enhance the growth of microorganisms. Apart from the above, nutrients (potassium-dihydrogen phosphate and dipotassium hydrogen phosphate-1g/l) were also added so as to maintain the COD : N : P as 100 : 5 : 1 and to sustain the growth of microorganisms. For the batch study, commercially available plastic cans of 10 liters capacity were used, for each ratio. In all, six identical cans were used and the batch study was conducted simultaneously for all the ratios considered. Each can was filled with the wastewater and seed made upto three-fourth the volume of the can, leaving the remaining volume (or space) for the air to enter by diffusion and to sustain the aerobic reaction (Fig. 1). Locally available and a low-cost aquarium air pump was used for aeration. The photographic view of the batch mode of operation in lab scale is shown in Figure. 1. The batch mode of operation was conducted for 156 days. Various parameters such as pH, TS, TDS, TVS, and COD were estimated for the above at intervals of 3 days. During the batch mode, the COD rates were stepped up at approximately 500 mg/L for every 15 days from an initial value of 250 mg/L, to cover the entire range of influent COD concentration of the pharmaceutical wastewater. The above procedure was carried out for all the ratios of pharmaceutical wastewater and seed, considered.

Fig. 1 : Photographic view showing acclimatization of the wastewater

RESULTS AND DISCUSSION

pH :

The trends in the variation of pH during the entire period of acclimatization are almost similar, for all ratios of wastewater and seed. However, 1 : 1 and 1 : 4 ratios show relatively a slightly higher pH during acclimatization than the other ratios considered. pH is found to be within a narrow range ie. , 7. 68 - 7. 93, for all ratios considered, closer to the attainment of steady state condition as shown in Fig. 2 (a-b). This above range is still alkaline and hence favorable for acclimatization of the substrate.



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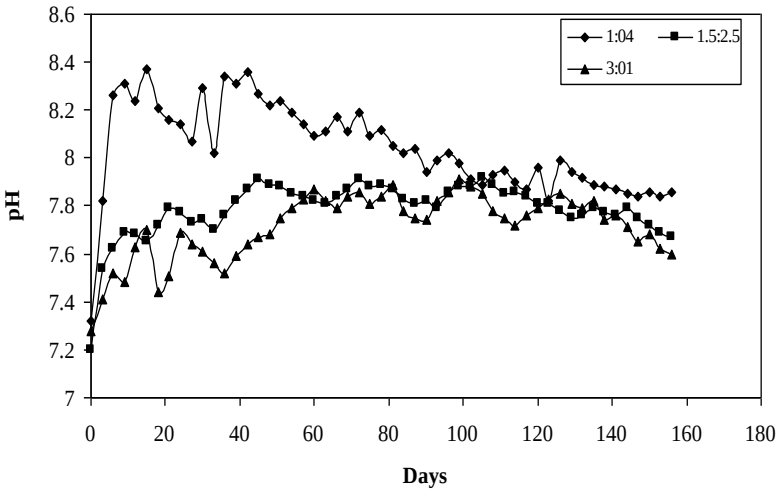

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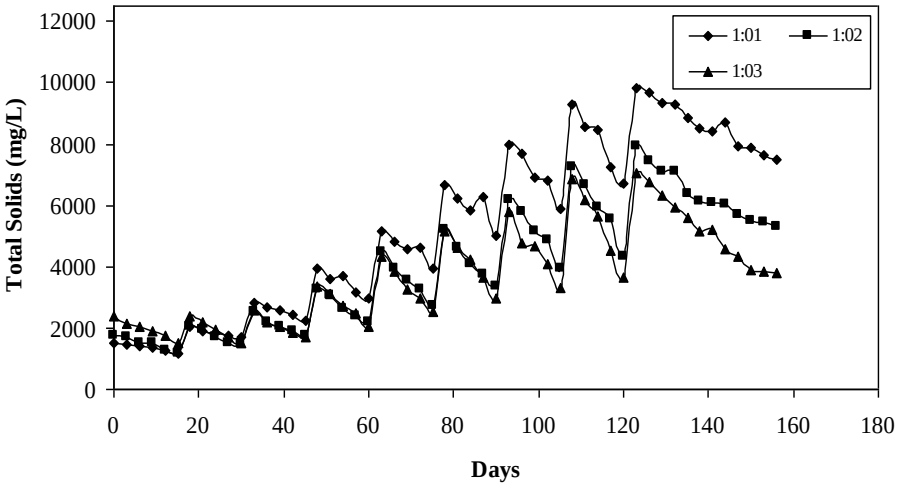
Fig. 2 (a-b) : Variation of pH during the acclimatization of pharmaceutical wastewater under batch mode

Total Solids (TS) :

The attained peak value of TS corresponds to the maximum influent concentration of 3994 mg/L for all ratios of wastewater and seed. However, after 120 days there is a gentle decrease in the concentration of TS, until the attainment of steady state condition, for all the ratios considered. At about 150 days, the concentration of TS is the lowest for 1 : 4, when compared to all the six ratios considered. Further, the reduction in TS was observed to be in the range of 40 – 58% of the influent TS concentration of the wastewater. From the above reduction in TS concentration, it is inferred that the ratio 1 : 4 (wastewater : seed) is very effective for the acclimatization of the wastewater.



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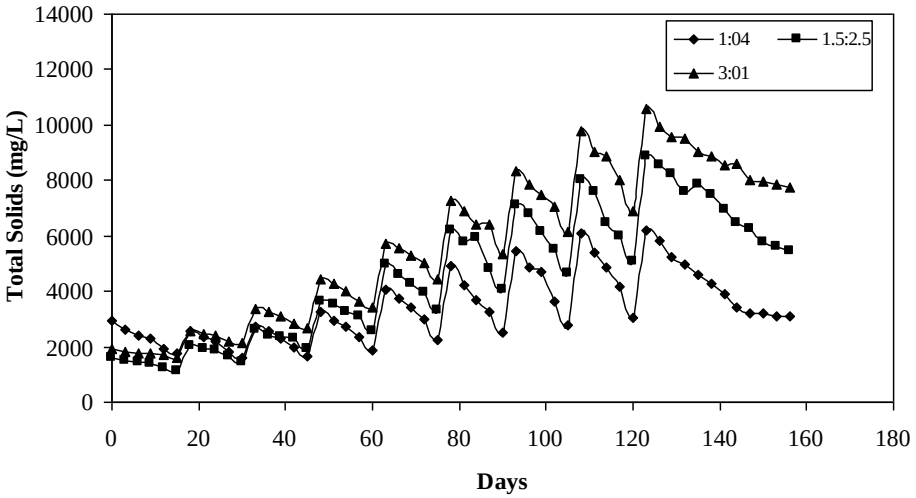
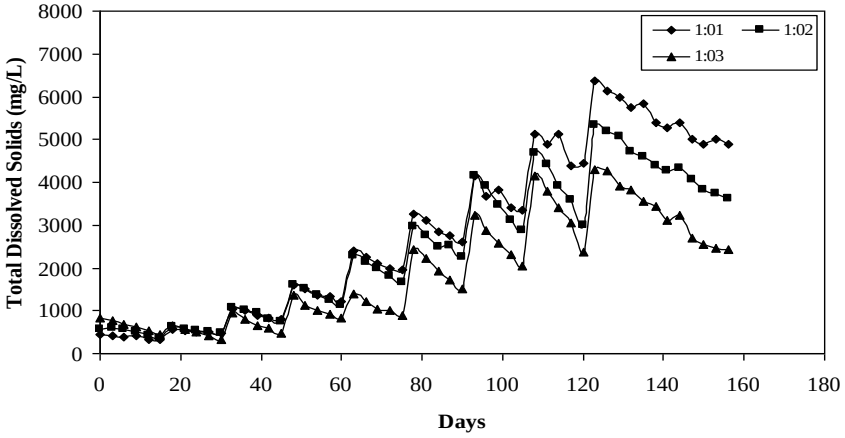


(b)

Fig. 3 (a-b) : Variation of Total Solids (mg/l) during the acclimatization of pharmaceutical wastewater under batch mode

Total Dissolved Solids (TDS)

After 120 days, there is substantial reduction in TDS concentration, until the attainment of steady state condition, only for 1 : 4, whereas, for all other ratios, either there is no reduction or no substantial reduction as shown in Fig. 4 (a-b). The reduction in TDS is comparable to the reduction in TS during acclimatization. However, the realization of a higher reduction in TDS may not be possible due to the combination of factors, namely (i) due to suspended solids (SS) in the wastewater; (ii) due to recalcitrance nature of the wastewater and (iii) due to the intermediates formed by the transformation of the recalcitrant compounds present in the wastewater.



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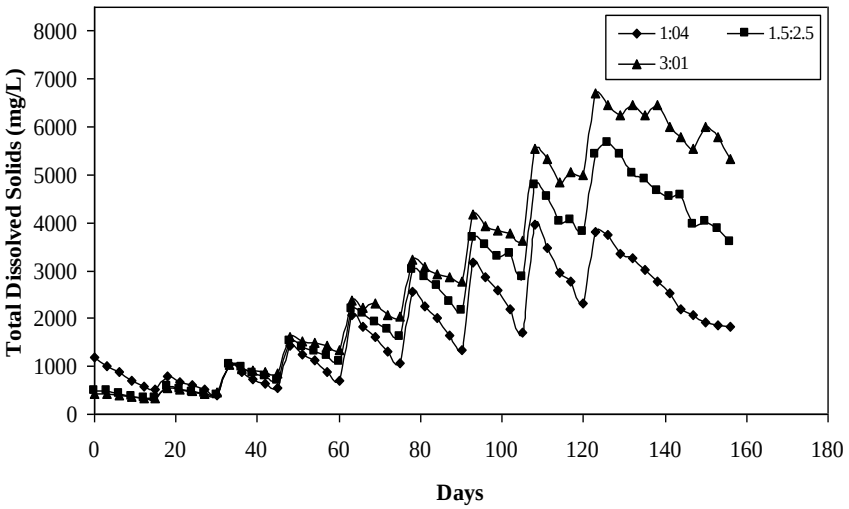

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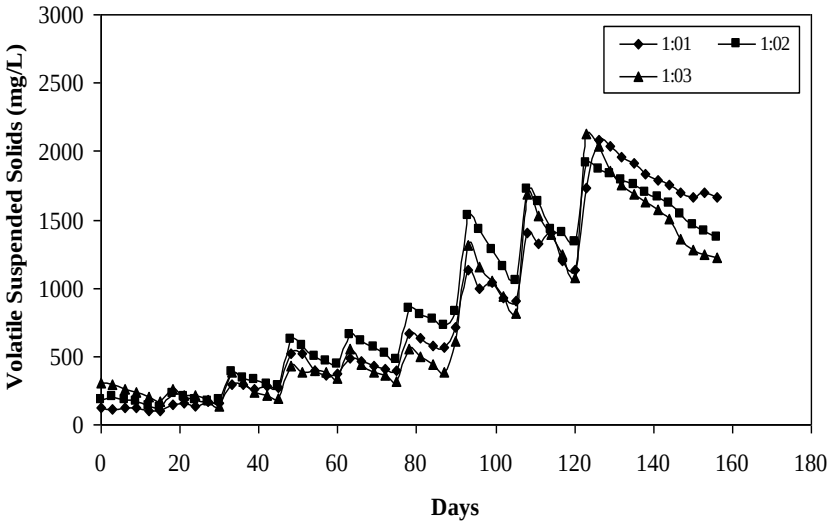
Fig. 4 (a-b) Variation of Total Dissolved Solids (mg/l) during the acclimatization of pharmaceutical wastewater under batch mode

Volatile Suspended Solids (VSS)

Beyond 120 days, there is consistent reduction in VSS concentration, especially for 1 : 4 and has the lowest concentration among the various ratios considered, during the acclimatization of the wastewater. Hence, 1 : 4 can be considered as the preferred ratio for the acclimatization of the wastewater. However, it is seen that the peak value of VSS is only about 25% (for 1 : 4), when compared to the peak value of TS at about 120 days, at identical concentration of the wastewater as shown in Fig. 5 (a-b).



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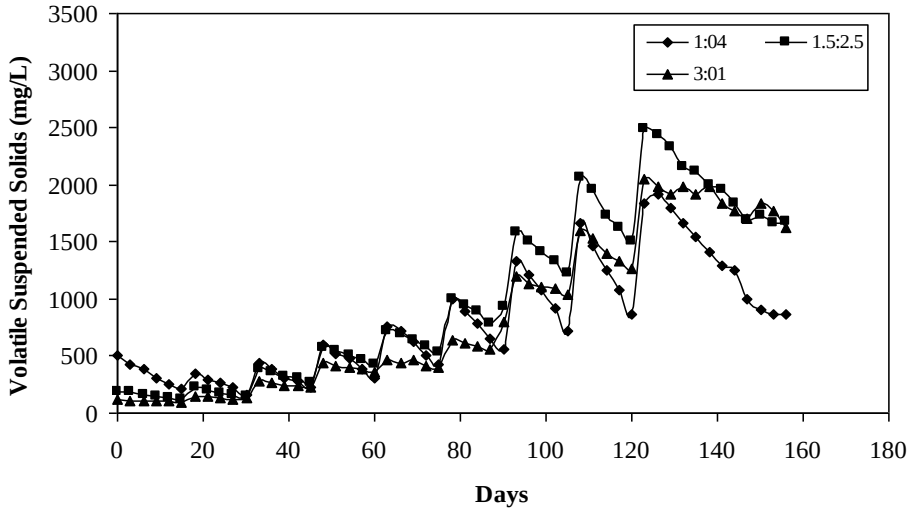

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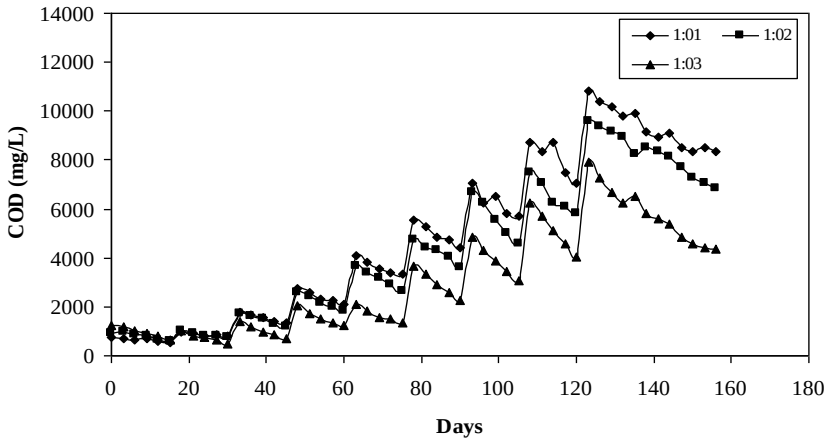
Fig. 5 (a-b) : Variation of Volatile Suspended Solids (mg/l) during the acclimatization of pharmaceutical wastewater under batch mode

Chemical Oxygen Demand (COD)

It is observed that the ratio of VSS : COD is in the range of 0. 28- 0. 30, for 1 : 4 and considering all the periodic increments in the influent COD, during acclimatization as shown in fig 6(a-b). This indicates that there is sustained biodegradation right from the beginning of the batch process. After 120 days, there is sustained reduction in COD, until the attainment of steady state condition, where the COD is minimum. On comparing the reduction in COD for the various ratios of wastewater and seed the reduction in COD is found to be maximum (ie. 50-58%) for 1 : 4, whereas, the reduction in COD is in the range of 18-45%, for all other ratios as shown in Fig. 6 (a-b). Hence, 1 : 4 can be considered as the desired ratio for acclimatization of wastewater.



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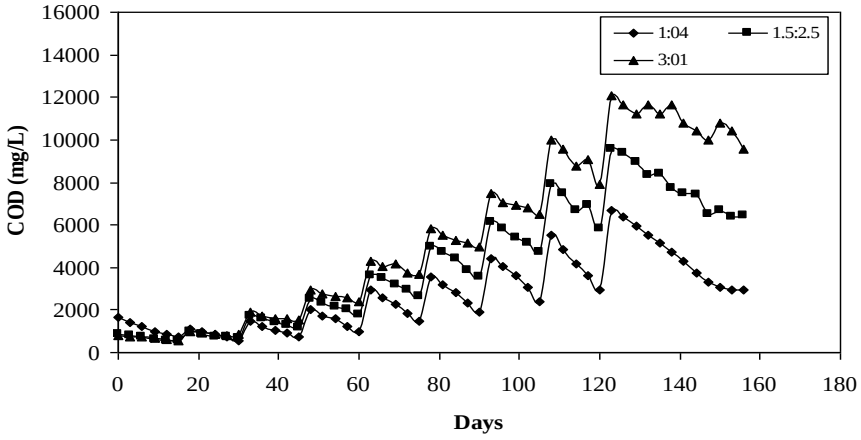

(b)

Fig. 6 (a-b) : Variation of COD (mg/l) during the acclimatization of pharmaceutical wastewater under batch mode

CONCLUSIONS

i. Steady state has attained at about 150 days;
ii. Of all the six ratios considered for acclimatization of wastewater, 1 : 4 (wastewater : seed) gives the best desirable result;
iii. The maximum COD removal that could be achieved using 1 : 4 and at the maximum influent concentration during the batch mode, is 50- 58%;
iv. The lower biodegradability may be attributed to the peculiar nature of the wastewater i. e. , its 'recalcitrant' nature, which inhibits the growth and sustainability of microorganisms which are necessary for the biodegradation of the wastewater.

REFERENCES

1. Aelion, C. M. , Dobbins, D. C. , & Pfaender, F. K. , 1989, "Adaptation of aquifer microbial communities to the biodegradation of xenobiotic compounds : influence substrate concentration and preexposure, " Environ. Toxicol. Chem. , 8, pp. 75–86.
2. Daughton, C. G. , and Ternes, T. A. , 1999, " Pharmaceuticals and personal care products in the environment : Agents of subtle change?, " Environmental Health Perspectives Supplements, 107.
3. Jones, O. A. H. , Voulvoulis, N. , and Lester, J. N. , 2007, "The occurrence and removal of selected pharmaceutical compounds in a sewage treatment works utilizing activated sludge treatment, " Environmental Pollution, 145 (3), pp. 738-744.
4. Marrot, B. , Barrios-Martinez, A. , Moulin, P. , and Roche, N. , 2006,

"Biodegradation of high phenol concentration by activated sludge in an immersed membrane bioreactor, Biochemical Engineering Journal, " 30, pp. 174–183.

5. Mesquita, D. P. , Louvet, J. N. , Potier, O. , Amaral, A. L. , Pons, M. N. , and Ferreira, E. C. , 2009, "Surveying activated sludge changes during acclimation with artificial wastewater, " http : //hdl. handle. net/1822/23842.
6. Moreno-Andrade and Buitrón, G. , 2004, "Variation of the microbial activity during the acclimation phase of a SBR system degrading 4- chlorophenol, " Water Science and Technology, 50 (10), pp. 251- 258.
7. Murugababdam, B. , Saravanane, R. , Lavanya, M. , Sivacoumar, R. , 2008, "Effect of Innoculum – Substrate Ratio on Acclimatization of Pharmaceutical Effluent in an Anaerobic Batch Reactor, " Journal of Environment Science & Engineering, 50 (3), pp. 191- 196.
8. Wiggings, B. A. , Jones, S. H. , and Alexander, M. A. , 1987, "Explanations for the acclimation period preceding the mineralization of organic chemicals in aquatic environments, " App. Environ. Microbial, 53, pp. 791–796.