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Treatment of Detergent Industries Wastewater

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Abstract
Surfactants are the most important gradients in detergent products. Environmental pollution can be caused due to the use of alkyl benzene sulfonate, if the wastewater is not treated. For this reason, chemical and physical methods of treatment should be employed. In this work wastewater treatment of one of the detergent industries in Iran containing surfactants are considered and treatment with use of chemical, physical and biological methods has been compared. In the chemical method, the best coagulant were, lime with alum which caused a 90% reduction of COD. Dissolved Air Flotation (DAF) as a physical procedure was employed and which 8.26% reduction of COD occurred. Biological method was based on the use of Sequencing Batch Reactor (SBR) which led to an 86% reduction of COD. Effluent water after treatment can be used for agricultural, landscape irrigation and garden watering.

Keywords: Industrial, Pollution, Surfactants, Treatment

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Introduction

Surfactants are in widespread use throughout the world. The use of surfactant is gradually increased day by day. A wide range of these products are actually synthesized and used in several domains such as textiles, fibbers, food, paints, polymers, cosmetics, detergents, etc. Anionic surfactants are the major class of surfactants used in detergents formulations and are among the most widely disseminated xenobiotics that may enter waste streams and the aquatic environment (Eichhorn, et al., 2001, 2002), they are harmful to human beings, fishes and vegetation and cause foam in rivers and effluent treatment plants and reduce the quality of water. They cause short term as well as long –term changes in ecosystem. Due to these reasons, many environmental and public health regulatory authorities have fixed limits for use of detergents. Surfactants removal operations involve processes such as chemical and electrochemical oxidation (Lissens, et al., 2003; Mozia, et al., 2005),membrane technology (Sirieix-Plénet, et al., 2003;Kowalska, et al., 2004; Fernández , et al., 2005), chemical precipitation (Talens-Alesson, et al., 2002), photo catalytic degradation (Zhang, et al., 2003),adsorption (Lin, et al., 2002; Adak,et al., 2005) and various biological methods (Dhouib, et al., 2003; Chen, et al.,2005).

Methods

Sampling of the wastewater is carried out according to standard methods for the examination of wastewater (APHA, 2005).

Laboratory scale evaluation of chemical coagulation and flocculation is performed using a six-place jar test apparatus. The experimental process consisted of three subsequent stages: initial rapid mixing stage at 100 rpm took place for 1 min, followed by a slow mixing stage for 20 min at 30 rpm, and the final settling step lasted for another 30 min.

In the physical method, flotation is used. It is consist of two cylinders, one of them under pressure and the other on the atmospheric pressure. Wastewater was guide to the under pressure tank up to 60% of its volume. After that the entrance was stopped and air tap was opened, until pressure gage show the pressure of 1-4 atmospheres then turn on the circulator pump for maximum air salvation. After 2-3 min. turn off the pump then realize wastewater to the under atmospheric tank. And operational specification of the system is according to the table 1.

Biological method, SBR technique was used for biological treatment. The specification of the sludge is according to the table 2. And operational specification of the system is according to the table 3.

Table1:Operational of specification of DAF

Parameters	range
Shape	cylinder
H(cm)	60
$\varphi_{cylinder}$(cm)	15
φ_{pipes}(cm)	2
$V_{reactor}$(L)	10.6
$V_{wastewater}$(L)	6
Material	PVC

Table2:Characteristic of sludge

Parameters	range
pH	7.5
MLSS(mg/l)	2200
COD (mg/l)	456

Table3:Operational specification of SBR

Parameters	range
pH	6.5-8.5
HRT(hr)	24
Current	Mixed Liquor
DO(mg/l)	3
Temperature(^oC)	15
$V_{reactor}$(L)	10
Material	PE

COD and other physicochemical parameters (BOD, NTK, Pt….) for wastewater characterization measurement are performed according to the Standard Methods (APHA, 2005).

Results and Discussion

Specification of detergent industry wastewater was shown in table 4

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Table 4: Physicochemical characteristics of effluents

Parameters	range	Iranian guide level (agriculture)
pH	7.00 – 7.60	6-8.5
color	Light green	-
Turbidity(NTU)	20-25	50
Sulphate (mg/L)	43-49	-
Pt (mg/L)	1.2-1.4	-
NTK (mg/L)	41.5-48.8	-
COD (mg/L)	1200	200
BOD_5 (mg/L)	412	100
Temperature(°C)	15	-
BOD_5/COD	0.33	-

Table4 show the result of wastewater analyze from one of the detergent industries in Tehran. COD/BOD_5 ratios indicate that a biological treatment seems to be not suitable (Metcalf and Eddy Inc, 2003; Al Momani; etal, 2002) and then a physicochemical process is required.

Chemical coagulation occurs with addition of inorganic material especially lime and alum. These material from past until now were used for elimination of suspended and dissolve pollutant in industrial wastes. This method also was used for reduction of pollution in detergent industries wastewater. The addition of different concentration of lime and alum and its effect on the COD reduction at PH= 8.5 and COD= 1200 mg/l was shown in figure1.

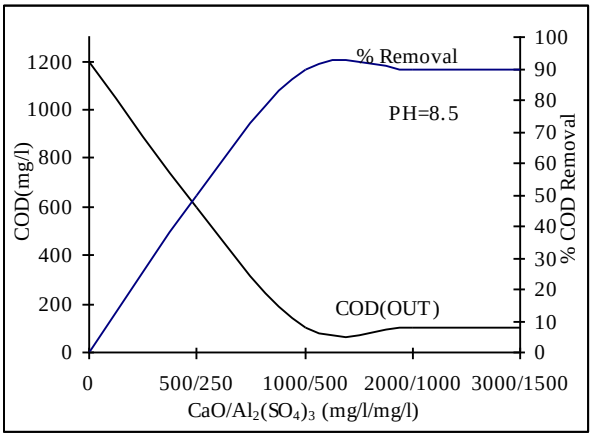

Figure1: Effect of $CaO/Al_2(SO_4)_3$ on COD reduction

The results show that when the concentration of $Ca(OH)_2$=1000 mg/l and $Al_2(SO_4)_3$=500 mg/l the condition is acceptable for treatment. In accordance to the figure1, addition of more coagulant has no effect on COD reduction.

In the physical method according to the figure2 and 3 in the pressures up to 1 atmosphere COD is reduce. May be this is because of the large amount of surfactant and the foam produced under atmospheric tank. From 1 to 2.5 atmospheres it is reversed and after 2.5 atmospheres again the quantity of the surfactant and foam to surfactant from under pressure tank to under atmosphere tank is increased.

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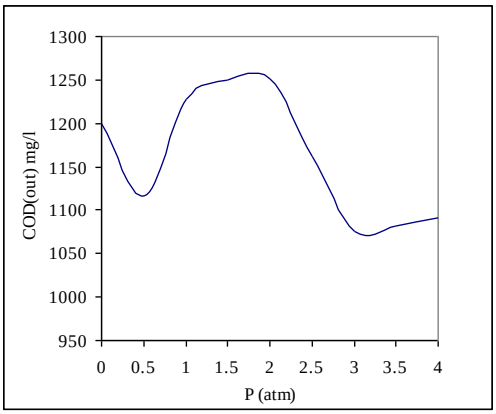

Figure 2: Effect of pressure on COD reduction

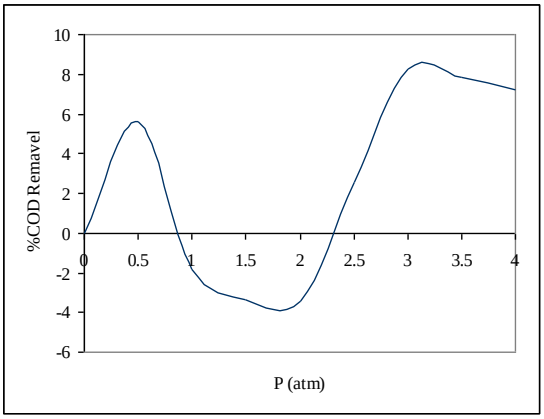

Figure3: Effect of pressure on % COD removal

In the biological method there were two stages from the first day to fifth day. COD influent concentration was added and by the end of fifth day the average COD was 864 mg/l. After steady state of the effluent system, second stage was started and the average COD for next days was 1200 mg/l. Then, detergents with COD concentration about 20 mg/l were added and with the adoption of microorganism COD of detergent was increased, and finally detergent influent COD was 625 mg/l. In accordance to the figure4, in the first stage with addition of detergents , COD amount was increased and the system efficiency was reduced, after the adoption of microorganism and reduction of COD, influent detergent concentration was increased and this addition causes incompatibility between microorganism and environment and again system change to its steady state.

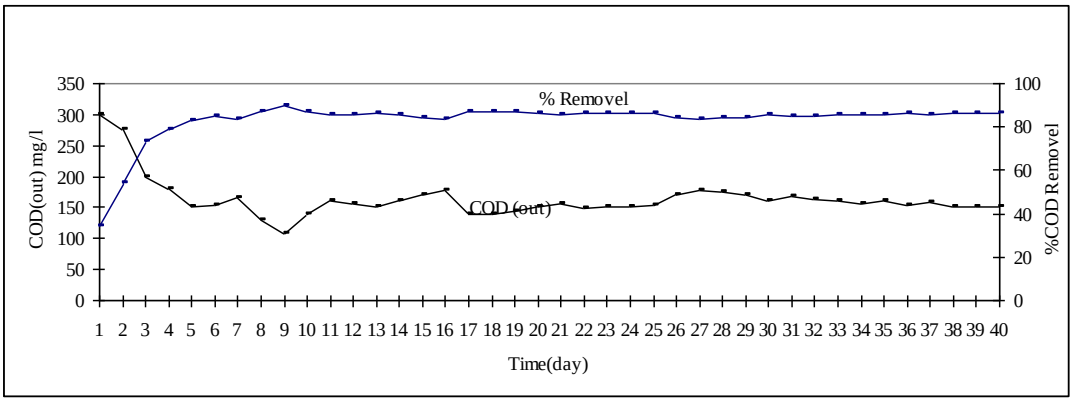

Figure4: COD effluent according to the time

Study of the MLSS graph in accordance to the figure5 there are multi stages. In the first stage (from first to fifth day) MLSS was reduced, because of the change in environmental condition. In the second stage because of adoption, the amount of MLSS up to 15th day was increased. In third stage because of the addition of detergent concentration in reactor, microorganisms can not biodegrade them and suspension of material happens. In the forth stage because of the readopting of microorganism, MLSS was increased and detergent removal was improved.

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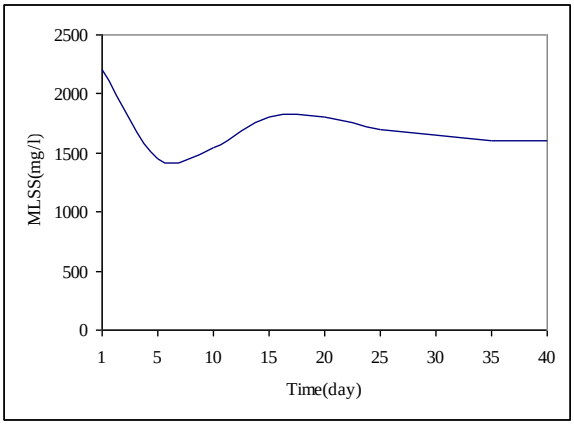

Figure5: MLSS graph according to the time

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Conclusions

Because the kinds of products of detergent company are different, the wastewater of each industry has its own specification. The amount and kind of detergents in the wastewater of each industry are different and has a large variety. If the concentration of detergents and suspended solids in wastewater were high, for its treatment, DAF, coagulation and SBR are recommended together.

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