Pak. j. sci. ind. res. Ser. A: phys. sci. 2015 **59** (1) 60-62

Short Communication

Activated Sludge Process and its Suitability for Treatment of Tannery Waste Water

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(receivd April 30, 2014; revised January 1, 2015; accepted January 14, 2015)

Abstract. This study was conducted for the treatment of tannery wastewater and to develop simple design criteria under local conditions. BOD_5, COD, total Cr, SO_4^{2-}, S^{2-}, SS, TDS and TS of the influent and effluent were measured to find process efficiency at various mixed liquor volatile suspended solids (MLVSS), dissolved oxygen (DO) and hydraulic detention time. Results of the study demonstrated that an efficiency of above parameters 93.0%, 92.5%, 94.9%, 62.6%, 98.2%, 87.9%, 82.1% and 82.4%, respectively, could be obtained if the activated sludge process (ASP) is operated at the MLVSS concentration of 3500-4500 mg/L, (DO) concentration of 4.1-5.5 mg/L keeping an aeration time of 12 h.

Keywords: activated sludge, biological treatment, tannery wastewater

Treatment of tannery effluent through the use of activated sludge process has been reported by many researchers (Ahmed *et al*., 2014; Al-Hussieny *et al*., 2014; Deepika *et al*., 2014; Pal *et al*., 2014; Shyam *et al*., 2014; Ambreen *et al*., 2013; Mouna *et al*., 2013; Niaz *et al*., 2012; Durai *et al*., 2011). All these studies indicate a BOD removal of 90-97% and COD 60-80% when combined with physicochemical pretreatment for the tannery effluent. The characteristics of tannery effluent vary considerably from tannery to tannery (Ilou *et al*., 2014). A survey was conducted in Pakistan for quality characteristics range of effluent from tanneries processing as given in Table 1 (Iqbal *et al*., 1998). Various parameters of importance relating to growth of microorganisms and substrate utilization on which the operation of the reactor is based has been studied by Bestawy *et al*. (2014); Khairnar *et al*. (2014) and Marco *et al*. (2014).

The present work was carried out that activated sludge process (ASP) for the treatment of settled tannery effluent and to develop general guidelines for the process design under local conditions. A bench scale continuous flow activated sludge reactor was used in this study. It consisted of an aeration tank of 300 L capacity and a settling portion of 200 L capacity.

The influent was subjected to settling in an underground tank. A peristaltic pump used to fill the settled influent to the aeration tank and pure oxygen cylinder was used to inject the oxygen to the aeration tank; a portion of gas was wasted from the tank to reduce the concentration of carbon dioxide. Pure oxygen was supplied by a fine bubble diffuser; flow was regulated at 4 mg/L/min by a flow meter. The reactor had to operate at different MLVSS and DO concentrations. Due to unavailability of mechanical return sludge facility, 100% of the settled sludge was daily removed from the final clarifier tank and manually returned to the aeration tank. In order to maintain the desired MLVSS and DO concentration in the reactor the calculated fraction of the volume of the aeration tank (ranging from one third to one tenth) was removed manually on daily basis and the tank was filled to the original volume by the treated effluent. No external nutrients were added to the influent (Vaiano *et al*., 2014; Pradyut *et al*., 2013).

Pure oxygen was supplied through diffuser stones to maintain a DO level of more than 3 mg/L. Temperature and pH values for settled influent and effluent were measured on daily basis while, MLVSS in the reactor, COD, BOD, total Cr, SO_4^{2-}, S^{2-}, SS, TDS and TS of influent and effluent were measured twice a week.

The three chosen operating parameters i.e. MLVSS concentration, detention time (è) and DO were varied during the course of the study keeping into consideration the generally applied range in activated sludge process for industrial effluent treatment (Pooja, 2014; Zahrim *et al*., 2009). The reactor was operated for an MLVSS concentration range of 1500-4500 mg/L, DO concentration 1.9-5.5 mg/L and è value of 4-12 h, respectively.

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During the course of study, pH of the reactor was varied between 7.8 and 8.23 which is a suitable range for biological treatment. DO of the reactor was maintained above 4 mg/L which is required for satisfactory biological treatment. A large amount of sludge is generated along with high energy consumption in the process (Table 1).

Table 1. Range of tannery effluent quality parameters

Parameters	Range
pH (unsettled effluent)	7.3-10
BOD_5, mg/L (30 min settling)	840-18,620
COD, mg/L (30 min settling)	1320-54,000
Suspended solids, mg/L (30 min settling)	220-1610
Settleable solids, mg/L (30 min settling)	11-40
Sulphate, mg/L (unsettled effluent)	800-6480
Sulphide, mg/L (at 0 time settling)	800-6480
Chromium, mg/L (unsettled effluent)	41-133

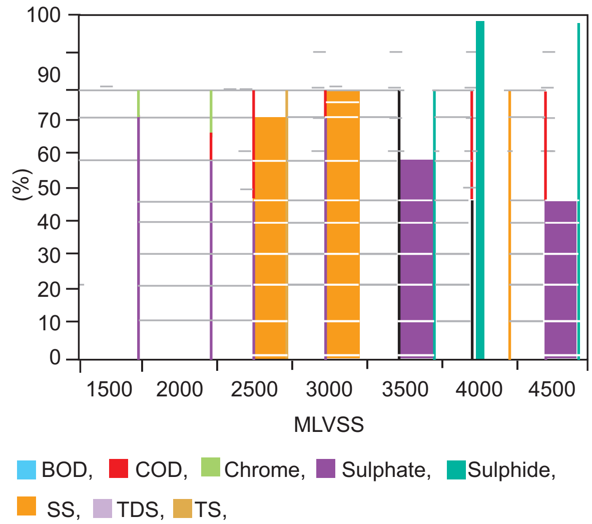

Fig. 1. Removal of pollutants.

Experimental work was performed for a period of 190 days. The treatment efficiency of the reactor in terms of BOD, COD, total Cr, SO_4^{2-}, S^{2-}, SS, TDS and TS removals was studied for MLVSS concentrations of 1500, 2000, 2500, 3000, 3500 and 4500 mg/L, DO 1.9, 1.8, 3.2, 3.1, 4.1 and 4.3 mg/L and retention time 2, 4, 6, 8 and 12 h. It was noted that the process efficiency improved with increase in MLVSS, DO concentrations and è. Under optimum conditions thus the results are showed, ASP should be operated at MLVSS concentration of 3500-4500 mg/L, DO concentration 4.5 mg/L and è value of 12 h. It is thus proposed to carry out bench scale studies for obtaining optimal values of the above said parameters for a specific tannery before designing a biological treatment system.

As shown in Fig. 1, maximum removal efficiency of 93.0%, 92.5%, 94.9%, 62.6%, 98.2%, 87.5%, 82.1% and 82.4% was achieved at MLVSS concentration of 3500-4500 mg/L and è of 12 h for BOD_5, COD, total Cr, SO_4^{2-}, S^{2-}, SS, TDS and TS, respectively, as summarized in Table 2. Furthermore, residual values of BOD_5 and COD at this MLVSS and è are 65 mg/L and 140 mg/L, respectively. It shows that BOD_5 and COD meet National Environmental Quality Standards (NEQS) limits, which are 80 and 150 mg/L. As indicated in Table 3, an average COD/BOD_5 ratio of 1.93 and 2.01, respectively. In the light of these results, it was concluded that a reasonably good approximation of BOD_5 can be obtained from a COD measurement once a relationship has been established between the two parameters from the available data.

Table 2. Removal efficiency at 3500-4500 MLVSS mg/L, 12 h time, 5.5 mg/L DO and pH 7.93

Parameters	Mean influent	Mean effluent	Removal efficiency (%)
BOD_5 (mg/L)	982	69	93.0
COD (mg/L)	1876	140	92.5
Total chrome (mg/L)	917	47	94.9
Sulphate (mg/L)	5378	2010	62.6
Sulphide (mg/L)	285	05	98.2
SS (mg/L)	1260	152	87.9
TDS (mg/L)	8536	1530	82.1
TS (mg/L)	9517	1668	82.4

Table 3. Influent and effluent COD and BOD_5 ratio

Average COD (mg/L)		Average BOD_5 (mg/L)		Average COD/BOD_5
Range	Mean	Range	Mean	
		Influent		
1700-2023	1861	901-1025	963	1.93
		Effluent		
140-1018	579	511-65	288	2.01

ASP is a feasible treatment technology for tannery wastewater especially where limited space restricts the use of other biological methods. ASP for Leather Research Centre may be operated with MLVSS concentration of 3500-4500 mg/L, DO concentration of 4.1-4.3 mg/L and è value of 10-12 h in order to obtain optimal removal efficiencies with respect to BOD_5, COD, total Cr, SO_4^{2-}, S^{2-}, SS, TDS and TS. However, for a specific tannery, bench scale studies to find out the optimal values of these parameters are needed prior to the design of biological unit. The effluent meets NEQS for BOD_5, COD, S^{2-} and SS at the above stated MLVSS, DO concentration and è value (Fig. 1). However, total Cr, SO_4^{2-}, TDS and TS limit for NEQS could not be qualified. In addition, it must be required with physicochemical pretreatment for the tannery effluent and it is suggested that Pakistan Environmental Protection Agency may consider modifying the NEQS limits. In addition, effect of different MLVSS, DO concentration and detention time on the efficiency of settling tank may be investigated.

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