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Stabilization of Chicken Slaughterhouse Wastewater in Batch Aerobic (Limited Aeration) Treatment System

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Abstract. Treatment of wastewater by means of biological process has been widely implemented from urban to industrial wastewater. However, biological treatments systems are effective and efficient for treating biodegradable wastewater, if good process control is ensured. This research is to study the relationships between pH, and dissolved oxygen (DO) during low intensity aeration of slaughterhouse wastewater and to determine the strategies for monitoring and/or control of this treatment process. The batch reactor (4 L) was used. The untreated fresh chicken slaughterhouse wastewater was placed in the batch reactor and aerated for eight hours to achieve the initial DO of 6.0 mg/L. The observation on the pH, DO, chemical oxygen demand (COD), total nitrogen (TN), ammoniacal nitrogen (AN), total Solid (TS) and total volatile solid (TVS) were done for different retention times (3, 4, and 5 days). Overall result showed that the best performances were observed for 5 days retention time for all parameters; occurred at low oxygen concentration indeed (DO less than 0.5 mg/L).

Keywords: Chicken slaughterhouse wastewater, Batch, Limited aeration.

1. Introduction

In most aerobic biological system such as nitrification processes, oxygen is the requisite oxidant and the presence of dissolved oxygen (DO) at specific level s a necessary condition for the process to proceed unimpeded [1]. The limiting amounts of DO (concentration below 2 mg/L) inhibit nitrification and cause nitrite accumulation or nitrous and nitric oxide production [2]. DO is widely used to monitor the biological process. However the performance of DO probes are quite erratic near their detection limit [1]. Numerous biological processes such as degradations of organic matter are essentially oxidation- reduction processes and past research has shown good correlations between biological activity and electrode potential [3]. The pH of biological systems responds to microbial reactions and hence, the pH status may also provide a good indication of the ongoing biological reactions [4, 5]. Knowledge of the effect of oxygen on nitrification and nitrifying populations has economic importance since aeration is one of the most costly items in the operation of a wastewater treatment plant [6]. The objective of an aeration treatment of livestock wastewater is the reduction of organic loading rates into secondary treatment system to oppose the complete stabilization. Low rate, low intensity or limited aeration has been recommended for economical reduction of odor and other gaseous emissions [7, 8, 9]. Most of the study on limited aeration has been conducted for piggery wastewater [9] and dairy wastewater [1] but no research has been conducted on chicken slaughter house wastewater.

2. Methodology

An untreated fresh chicken slaughter house wastewater was taken from the commercial slaughterhouse centre nearby to our university. This wastewater poured to the batch reactor (4 L volume) and retained for 5

days. The wastewater characteristics were done for pH, dissolved oxygen, temperature, COD, TN, AN, TS and TVS. The automatic meter (YSI 6600) was used to measure pH, dissolved oxygen and temperature. The COD, TN, and AN were measured using the Hach DR/4000 Spectrophotometer following the manual protocols, respectively: Method 8000 (Digestion Method); Method 10071; and Method 8038. The TS and TVS measurements were following the Standard Methods for the Examination of Water and Waste Water [10], respectively: Method 2540A-E. The wastewater was aerated for 8 hours, to increase the DO initial as 6.0 mg/L. The performance of the batch reactor was observed for several retention times (3, 4 and 5 days).

3. Results and Discussion

3.1. In-Situ Parameters Measurement.

The in-situ parameters were measured and were shown in Table 1. The average DO concentration considered low (2.50 mg/L). These characteristics had changed slightly due to the aeration process. DO concentration improved by 58% (from 2.5 to 6.0 mg/L). The temperature decreased from 24.1^{0}C (start) to 18.7^{0}C (after 8h aeration) with pH 6.9 increasing to 7.3.

Table 1: Untreated Fresh Chicken Slaughterhouse Wastewater Characteristics.

pH	^{0}C	DO (mg/L)
6.9	24.1	2.5

3.2. Observation on the Batch Reactor Performance.

Table 2 showed the wastewater composition after retained in the batch reactor for several retention times. The result indicated that DO concentration was reduced sharply (from 6.0 to 0.3 mg/L within three days). Not much different was observed for DO, pH and temperature for 4 and 5 days retention time. In the limited oxygen condition (DO less than 1 mg/L), the removal efficiencies were observed for all parameter. Our studies indicate that for low intensity aeration treatments of chicken slaughterhouse wastewater, an ultimate COD degradation of approximately 75.5 % occurred at approximately 5 days retention time (Figure 1). Generally, the 5 days retention time showed the best removal performance by 26.1%, 13.4, 12.5%, and 10.0% for AN, TN, TVS, and TS respectively. However, the batch reactor had removed the COD by 36.5 % at the 3 days retention time. The removal for TN, TS and TVS had occurred effectively (more than 10%) only on 5 days retention time.

Table 2: Water Quality Measurements for Batch Reactor.

Retention time	pH	^{0}C	DO (mg/l)	COD (mg/l)	TN (mg/l)	AN (mg/l)	TS (mg/l)	TVS (mg/l)
0 day	7.3	18.7	6.0	1249.3	66.6	29.9	97.9	97.4
3 days	6.8	21.8	0.3	793.33	63.1	27.0	97.3	93.5
4 days	6.7	22.4	0.4	549.44	62.8	26.5	97.2	90.9
5 days	6.7	21.9	0.5	305.89	57.7	22.1	88.1	85.2

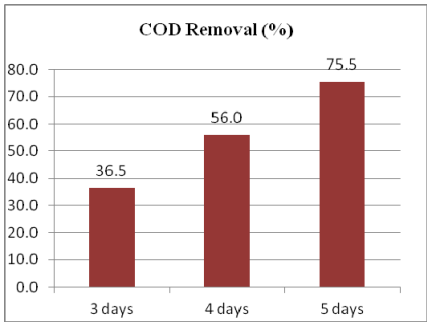

Fig. 2: COD Removal versus Retention Time

3.3. Wastewater Stabilization: COD, TN, AN, TS and TVS versus DO.

Wastewater stabilization is commonly characterized by the COD, TVS, AN of the wastewater. These parameters are difficult to monitor in real time and, therefore, cannot be used to monitor and/or control wastewater stabilization in real time. The changes in COD, TN, AN, TS and TVS as functions of DO of the chicken slaughterhouse wastewater are shown in Figure 1. Reasonably good coefficients of determinations ranging between 0.76 and 1.0 were obtained. The best parameter for prediction of both COD and TVS during the entire treatment was DO (R^2 of 1.0 and 0.96 for COD and TVS, respectively).

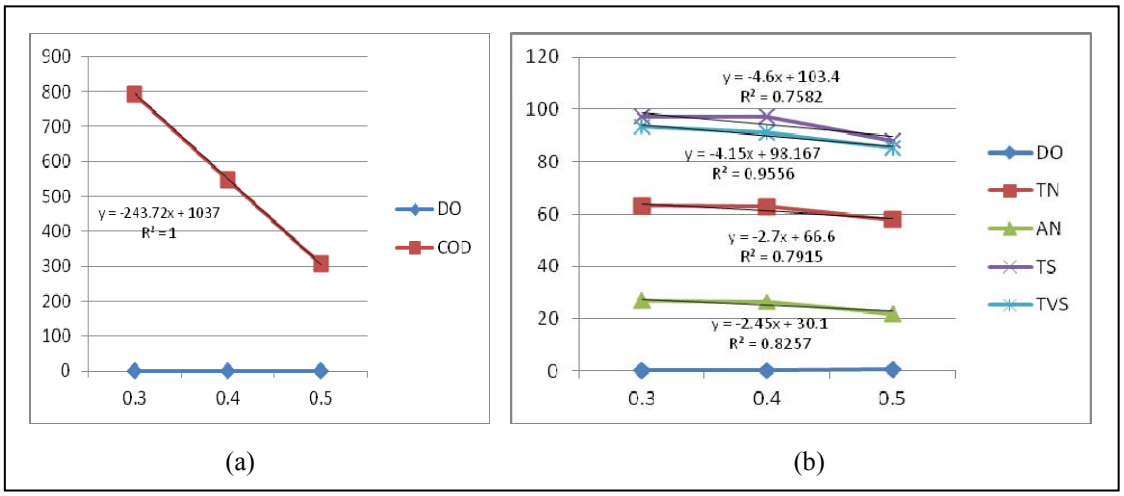

Fig. 2 (a–b) : Relationships of COD, TN, AN, TS and TVS of the chicken slaughterhouse wastewater to DO; during the treatment of the chicken slaughterhouse wastewaters.

4. Conclusion

Experiments were performed to study the relationships between pH, and DO, during low DO intensity batch systems of low-strength chicken slaughterhouse wastewaters. This study established that COD and TVS measurements are preferable during low-intensity oxygen condition. DO displays feature that can be used to define stabilization of chicken slaughterhouse wastewater during the batch study. DO decreases gradually during the stabilization of the more easily degradable organic matter. More rigorous experimentation would be needed before this number is adopted for limited aeration treatment of chicken slaughterhouse wastewater.

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