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Treatment of Swine Wastewater using Sequencing Batch Reactor*

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Abstract

The swine wastewater from Sunchon swine farm was decomposed using a sequencing batch reactor (SBR). The reactor body was fabricated using a plexi glass cylinder and its total volume was 20L with 15L of working volume. Each operating cycle consisted of five phases (fill, react, settle, draw and idle) with a total cycle time of 8 hours, thus resulting in three cycles per day (with 5 days of hydraulic retention time and 41 days of solid retention time). The cycles of the SBR system were controlled by a designed on-site computer and custom software. The results showed removal efficiencies of 85.5%, 80.3% and 87.2% for BOD, COD and TP respectively. It was found however that there were some non-satisfactory results, only attaining removal efficiencies of 61.0%, 31.2% and 54.5% for TN, NH_3-N and NO_3^--N respectively. This was possibly due to the lack of enough carbon source and the inadequate aeration rate. It was also observed that removal efficiencies of 61.4%, 62.8%, 77.6% and 73.2% could be obtained for TS, TVS, TSS and TVSS respectively. The study showed that the SBR system could be used to attain good removal efficiencies of BOD, COD and nutrients in swine wastewater treatment if it is supplied with sufficient carbon source for de-nitrification and optimum aeration for nitrification.

[Keywords] sequencing batch reactor (SBR), COD removal, BOD removal, swine wastewater, wastewater treatment, removal efficiency

I Introduction

The sequencing batch reactor (SBR) has gained wide acceptance for the removal of the biochemical oxygen demand (BOD), chemical oxygen demand (COD), and different nutrients from wastewater (Imura *et al.,* 1993, Rusten and Eliassen, 1993). Wastewaters from pig farms are characterized by their high BOD, COD and other nutrient contents. Many pig farms in Korea typically use an activated sludge treatment system for the decomposition of wastewaters. The activated sludge system however has problems with high energy consumption and biomass production, leading to a relatively high operation cost and the disposal of a large amount of sludge. It has been found that biological processes based upon a sequencing batch reactor (SBR) are effective for organic nutrient removal in domestic and industrial wastewater (A Mohseni and Bazari, 2004). In recent years sequencing batch reactors have become of great interest for wastewater treatment due to their simple configuration (all necessary processes take place within a single time sequence in a single basin). SBR can achieve nutrient removal by the nitrification and de-nitrification using alternation of oxic and anoxic periods. Due to its operational flexibility, it is simple to increase SBR efficiency in treating wastewater by changing the timescale of each phase. Several researchers have used SBR to remove nitrogen, phosphorus, COD and BOD from swine wastewater (Bicudo *et al.,* 1999; Kim *et al.,* 2000; Kim *et al*., 2004; Tilche *et al.,* 1999). Despite this SBR is not widely utilized to treat swine farm wastewater in Korea.

This research was conducted to evaluate the performance of an oxic-anoxic SBR system according to a specific time schedule in terms of reduction of COD, BOD and nutrients in treating slurry manure from swine farm.

II Materials and Methods

1. SBR construction and set-up

The experiment was carried out using a lab scale sequencing batch reactor (SBR), having a total volume of 20L with a working volume 15L. The SBR system was installed at the farm power lab in Sunchon National University, Korea. The SBR body was fabricated using a transparent plexi glass cylinder with an inner diameter of 190mm.

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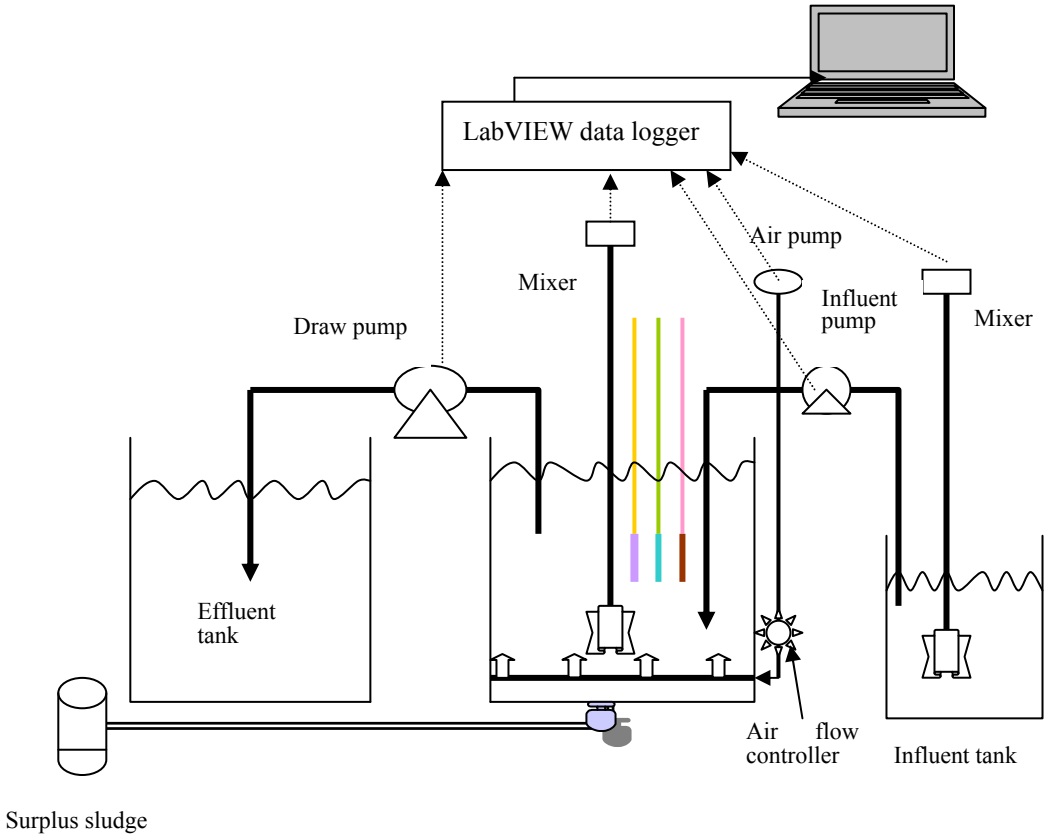

Fig. 1 A schematic diagram of the experimental arrangements for the sequencing batch reactor treatment system.

The system consisted of the reactor body, two peristaltic pumps (7524-45, Cole-Parmer Instrument Co.) for feeding influent and discharging effluent and 3 probes for the measurement of pH, temperature and the dissolved oxygen content (DO). Air was supplied into the reactor via two porous stone diffusers. Supplemental mixing was provided by turbine stirrers with four blades (radius 6 cm). The SBR system operation and data acquisition were accomplished by an on-site computer using LabVIEW software (National Instrument Corporation). A schematic diagram of the design of the SBR system is shown in Fig. 1.

2. Collection of swine wastewater

Wastewater for the experiment was collected from Suncheon swine farm located near Suncheon city. The collected wastewater was sieved to remove coarse materials (particles greater than 600 μm) and then stored at 4°C if not used immediately. The original wastewater had about 7% of total solids (TS), so it was diluted seven times with fresh water to decrease the quantity of total solids for this experiment. The characteristic compositions of the diluted wastewater are presented in Table 1.

Table 1 Basic properties of the influent wastewater fed into the sequencing batch reactor.

Parameters	Concentration
pH	7.47
Biochemical oxygen demand, mg/L	1500
Chemical oxygen demand, mg/L	1972
Total phosphorus (TP), mg/L	1058
Total nitrogen(TN), mg/L	1720
Nitrate-nitrogen(NO_3^--N), mg/L	377
Ammonia-nitrogen(NH_3-N), mg/L	948
Total solids(TS), %	1.20
Total volatile solids(TVS), %	0.67
Total suspended solids(TSS), %	0.67
Total volatile suspended solids (TVSS), %	0.33

3. Sampling and analytical method

During the experimental period (June 20–July 31; 2009), sampling was carried out every day for the first four days, one time every two days from the 5th to the 27th day and once every three or four days after that.