Removal of Refractory Pollutants of Swine Wastewater by Waste Concrete

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Abstract: In this study swine wastewater was treated with waste concrete to remove the refractory pollutants, which were difficult to be biodegraded. In Taiwan, most of the swine wastewater is treated with a three-stage process. The process includes solid separation, an aerobic reactor and aerobic reactor. Water after the aerobic reactor is partly recycled to wash the pig house for reducing water consumption. However, with the accumulation of some components that are difficult to be biodegraded, the COD of the effluent increased continuously. The refractory components in the effluent of the three-stage process were first identified by GC/MASS and FT-IR analysis. Analysis results showed that the refractory pollutants in the swine wastewater were amino acid with phenyl group. The waste concrete was chosen to remove these components. Experimental results showed that the refractory components could be removed efficiently by waste concrete. The used concrete particles have the pH value lower than 11. They can be used as a soil conditioner.

Key words: waste concrete; fixed bed; anaerobic reactor; aerobic reactor
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1 Introduction

Pollution by livestock wastes has been a great concerning problem. Several studies on the treatment of pig wastewater have been discussed. Separation of concentrated and diluted pig wastewater for further treatment were discussed by Goreckiet al[1]. Anaerobic treatment was the most discussed method. For example Yang and Kuroshima[2-4] had given discussion on this topics. Aerobic process was another frequently used process for swine wastewater treatment. Thomeby et al[5] used reverse osmosis to treat liquid effluent from dairy cattle and pig. A fixed bed reactor packed with waste concretes was used to remove the components that were difficult to be biodegraded. Experimental results showed that the components which were hard-biodegradable could be removed by waste concretes efficiently.

2 Experiments

The swine wastewater was taken from the outlet of water treatment plants of two farms. It was first analyzed with GG/MASS and FTIR. Because the anaerobic reaction will produce amino acid, the standard data bank of common amino acid was used for identifying the possible pollutants in the swine wastewater. For convenience, cement paste was prepared and air-dried in the room temperature to substitute the waste crumbed concrete. The dried pastes were then crushed to small pieces, so that they could go through #8— mesh sieve. The crumpled particles were then packed in a column reactor with the porosity about 0.4. The reactor was made of acrylate with the length 67 cm and the diameter 5.5 cm. The porosity of the packed reactor was about 0.4. The experimental apparatus was shown as Figure 1. In the experiments, the space velocities of the wastewater were controlled within the range of 0.207 ~

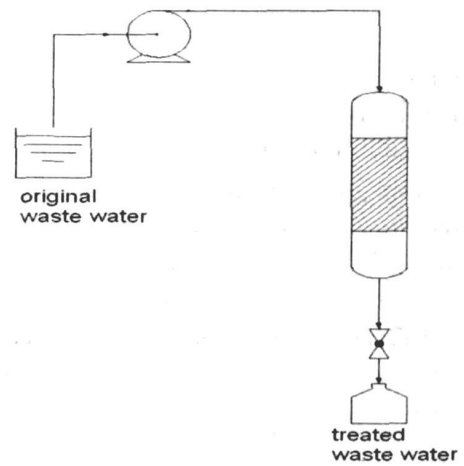

Fig. 1 The experimental apparatus

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0.414 (h^{-1}) by a pump. Water samples in the inlet and outlet of the reactor were taken for measuring their COD, pH, and electric conductivity.

3 Results and discussion

Swine wastewater was analyzed to know its possible pollutants. GC/MASS and FTIR were used in this procedure. Figure 2 shows the GC/MASS analysis results. According the data bank of amino acid, the possible main components of swine wastewater were amino acid with phenyl group and the molecular weight was less than 200. Figure 3 showed the FTIR spectrum of the swine wastewater. Absorbance at 700 cm^{-1} gave the evidence that phenyl group existed in the wastewater. Other functional groups such as C=O, C=N, N-H and C-OH etc were also found. With the evidences shown above, it is believed that the possible components of the wastewater were ammonia, phenylalanine and tyrosine etc. FTIR spectrum of the precipitated solids was shown in Figure 4. The existence of phenyl group in the precipitated solid was apparent as the absorbance at 700 cm^{-1}. It is well known that phenyl compounds are difficult to be biodegraded by the bacteria. Thus the recycling use of waste water will induce the accumulation of phenyl compound. To prevent the accumulation of these components, an experiment was designed to remove them.

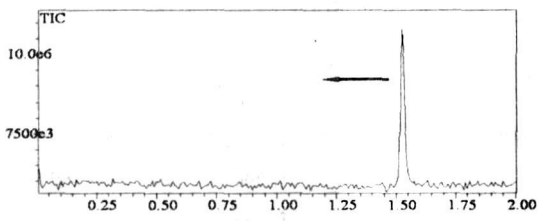

Fig. 2　The GC/MASS analysis results of original swine wastewater

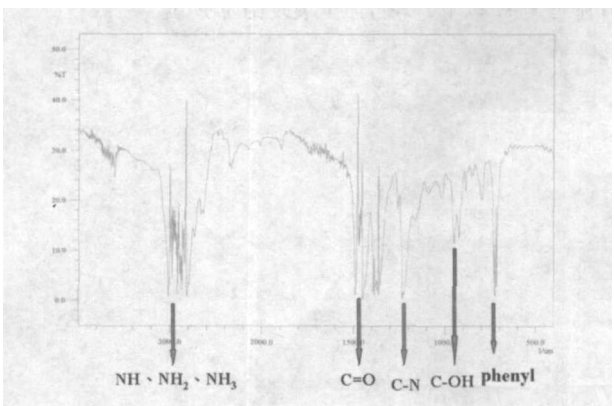

Fig. 3　IR spectrum of original swine wastewater

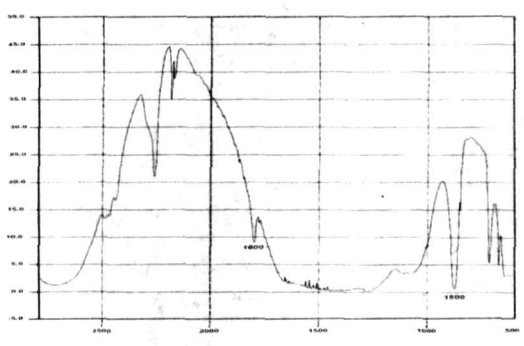

Fig. 4　IR spectrum of precipitated materials

To understand the performance of the removal of pollutants, experiments were conducted as Figure 1. The COD swine wastewater of reactor outlet was measured and plotted. Figure 5 is the COD break through curve of swine wastewater with WHSV kept at 0.414 h^{-1} and 0.207 h^{-1}. The COD removal capacity of concrete was about 10.5 ~ 11.15 mg/g concrete. The treated water could be used to wash pig house without the increase of COD. It means that the refractory components in the swine wastewater can successfully remove by the packed concrete.

The used concrete particles were unloaded. The pH value of used concrete particles was measured and shown in figure 6. Because there are many organic materials precipitated the used concrete and the pH value is lower than 11. The used concrete was crashed and mixed with soils to cultivate grass. Experimental results showed these used concretes could be used as soil conditioner to prevent soils from acidification.

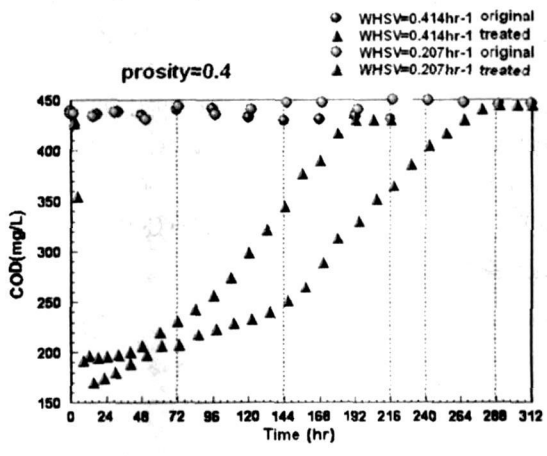

Fig. 5　Breakthrough curve of COD during the treating procedure.

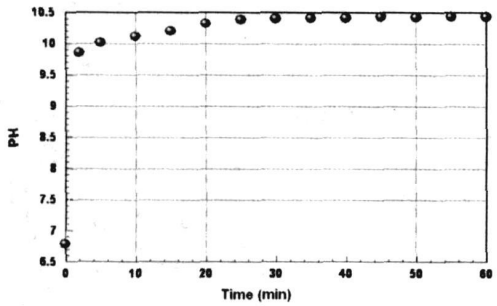

Fig. 6 The pH value of used waste concretes

4 Conclusions

The refractory components in the effluent of the three-stage process were first identified by GC/MASS and FTIR analysis. Analysis results showed that the refractory pollutants in the swine wastewater were amino acid with phenyl group. The waste concrete was chosen to remove these components. Experimental results showed that the refractory components could be removed efficiently by waste concrete. The used concrete particles have the pH value lower than 11. They can be used as a soil conditioner.

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应用废混凝土处理养猪废水中难分解之污染物

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摘 要: 以水泥混凝土废料, 用来处理养猪事业废水中难以生物分解的污染物。在台湾, 大多仅以固体分离、厌氧处理、耗氧处理三个阶段来处理养猪废水。并且为减少事业用水量, 所以再将处理后的废水用来清洗猪舍。然而, 废水中有些成份及堆积物, 是难以被微生物所分解的, 所以废水回收再利用后, 水中的化学需氧量将不断累积。在本研究中使用气相层析质谱仪 (GC/MASS) 及红外线光谱分析仪 (FT-IR) 对三个不同处理阶段中的废水进行大量的成份分析, 分析结果显示, 难以降解的污染物主要是以含苯基的氨基酸为主, 并选择将混凝土废料置入废水中来去除这些成份。实验结果显示, 难以处理的成份可被混凝土废料有效的去除, 亦可将混凝土废料的 pH降低至 11以下, 并可当土壤改良剂使用。

关键词: 混凝土废料; 厌氧处理; 耗氧处理

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