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ELECTROCHEMICAL TREATMENT OF PIGGERY WASTEWATER

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Abstract

In recent years, increasing emphasis has been placed upon developing sustainable agricultural production systems. Animal production is constrained not only by technical factors (feed supply, animal health, management and genetics make-up) but also by environmental and socio-economic factors. In many parts of Vietnam, especially, in the south, farmers are turning their farms into specialized production systems. The production level per animal and the production of animal product per ha of land as well as farm size has been increased considerably. However, this high intensification has recently witnessed a rapidly growing public concern about environmental pollution. One of the unsolved issues is matter of pollution control.
This paper describes a research to use an innovative electrochemical process that rapidly and economically remove suspended solids from wastewater generated from pig operation. In a pilot system, the wastewater was either treated chemically or/and electrochemically. The research show a result of 95% and 74% suspended solids removal by electrochemical or chemical flocculation, respectively. This is concluded that electrochemical coagulation can be used as a simple method to treat wastewater from animal operation.

Keywords: Animal, Electrochemical, Environment, Piggery, Pollution, Treatment, Wastewater

Introduction

The development of livestock production facilities is the combination of innovative production methods. As a result, the livestock performance per unit of human labor input has increased efficiently. A long with growth and efficiency has come the concern for environmental pollution. One of the unsolved issues is matter of the need for pollution control. Application of cleaner productive technology including wastes management and treatment is the most advanced solution for developing a sustainable livestock production system.

In some industrialized countries, animal production is one of the most sources of pollution. According to V. Klooster, 1996, the amount of NH_3 emitted from animal facilities into atmosphere is about 45×1012 g N per year, which become the most source of emission compared the other sources. In order to produce 1 000 kg of pork, the animals can produce 39 kg of feces, 84 kg of urine, 11 kg of total solid (TS), 3.1 kg of biological oxygen demand (BOD_5) and 0.24 kg of NH_4-N, (ASAE standards: DATA D 384.1).

By the end of 2001, Ho Chi Minh City had a total of 4 744 100 animals. From 190 880 pigs, the amount of wastes produced per day was estimated about 600 000 kg of feces and 800 000 kg of urine and a great amount of wastewater from cleaning and washing (Canh, 1999). This is the biggest amount compared to which produced by any other types of industries. Animal wastes cause serious environmental problems effecting the soil, air and ground and surface water in many parts of Vietnam, especially in the south. This becomes a growing public concern about environmental pollution. So far, there is no suitable technology for treatment of animal wastes in Vietnam. There is a need to find an appropriate solution (cheep and applicable) for treatment of animal wastes. Therefore, the objectives of this study are to investigate the effectiveness of a biochemical technology for treatment of wastewater from pig farm.

Materials and Methods

A pilot plant was built in the pig farm named September 2 in Ho Chi Minh City. This system was initially designed to treat 70 m^3 of wastewater per day (Figure 1).

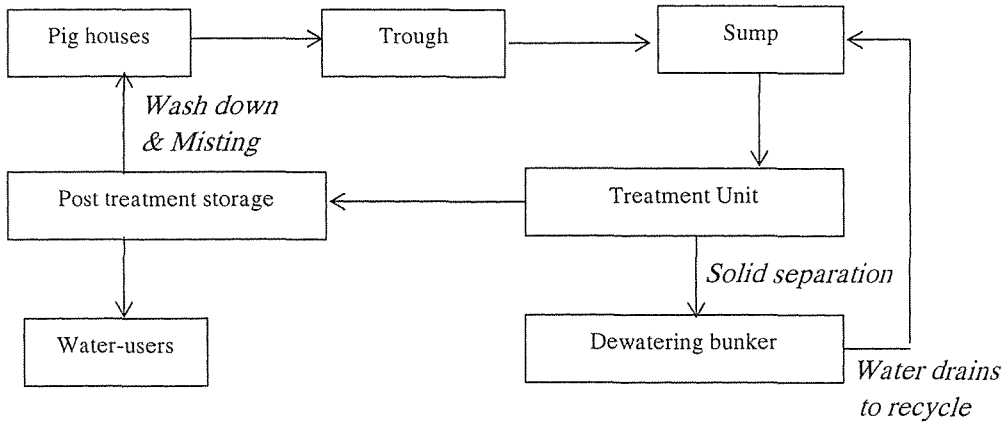

Figure 1. Technological process

The wastewater from pig houses was collected into a collection tank. They were prescreened firstly to mechanically remove coarse solids before being processed to remove the majority of the suspended solid materials within that water stream by one of the two following methods:

- The chemical method: Wastewater was treated by a flocculating unit called "bioloc". This unit was a plastic pipe with an internal spiral surface enable creating a long and well-mixed flow of wastewater and reagents. The reagents were ferrous sulphate and peroxide based on TS. A polymer was then added to cause suspended solids to form into floc so a mechanical separation can remove them. All chemical doses was control by a computer program

- The electrochemical method: The wastewater was prior to exposure to an electrolytic cell before treating chemically by the bioloc.

The study was conducted for three months. During this 3 month-period, samples of slurry and treated wastewater were taken. The samples were analyzed for pollutants (TS, SS, COD, BOD_5, H_2S, N, $N\text{-}NO_2$, $N\text{-}NH_3$, P) according to Standard Methods for Examination of Water and Wastewater (American Public health Association, 19th edition, 1995).

Results and Discussion

During spiral movement of wastewater in the pipe, under facilitating of dissolved oxygen and oxygen generated from peroxide, ferric hydroxide was formulated as a bulky. Gelatinous floc was formulated fast by an additional facilitating of polymer. The efficiency of suspended solid removal was about 74 % for the chemical method. This increased significantly, 95 % when wastewater was primarily prior to exposure to an electrolytic cell before treating chemically by the bioloc.

The results of treatment by chemical and electrochemical methods are given in Table 1 and 2.

Table 1. Treatment efficiency

Pollutants	Treatment efficiency (%)	
	Chemical method	Electrochemical method
TS	62,4	72,8
SS	73,9	95,1
COD	66,9	70,8
BOD_5	61,5	70.0
$N\text{-}NO_3$	41,1	69,4
$N\text{-}NH_3$	39,9	35,4
H_2S	59,4	75,0
Nt	42,5	45,1
Pt	48,4	72,4

Figure 2. The treatment efficiency related the concentration of TS

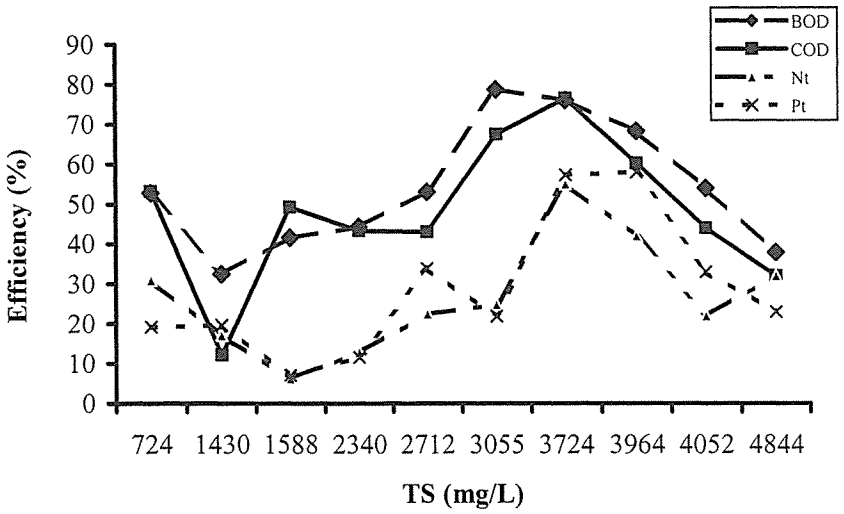

Table 2. Pollutant components of slurry and treated wastewater

Component	Slurry	Treated wastewater	
		Chemical	electrochemical
TS (mg/L)	3669	1318	43
SS (mg/L)	2806	553	152
COD (mg/L)	4452	1092	602
BOD_5 (mg/L)	2450	694	238
$N\text{-}NO_3$ (mg/L)	4,97	2,47	0,24
$N\text{-}NH_3$ (mg/L)	165	100	72
Nt (mg/L)	277	164	124
Pt (mg/L)	150	69	23

When the wastewater contains high level of charged organic substances, the floc forming process increased strongly with an electrolytic force. However, due to the natural separation of the floc, the efficiency of solids removal was limited. The efficiency of solid removal could be increased when having a mechanical separation is added.

The treatment efficiency of most of main pollutants (Figure 2) was highest when concentration of slurry were from 3000-4000 mg/L.

Conclusion

Increased mixing, oxygen and precoagulation by an electrolytic force can improve the formation of ferrous gelatinous floc during chemically treatment of piggery wastewater with ferrous sulphate. Using electrochemical method can remove most of suspended solid in the slurry. This method of treatment can apply for the pig farms with a limited land area.

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