Post Date: Wednesday, 10 March 2010

Application of Effective Microorganisms in a New Hybrid System of Biogas Production

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Abstract

A new hybrid system of biogas production was developed for treating the piggery wastes at Kasetsart University Animal Research Farm. The system is a combination of a settler, a low rate anaerobic digester (generally known as biogas plant) and a newly developed aerobic digester (namely bio-contact aeration system). The settle separates piggery waste water into two parts : a low-volume solid portion with high TS concentration flowing into the low rate digester and a high-volume liquid portion with low TS concentration flowing into the aerobic digester. After one month of successful operation of the system, EM (in form of Bokashi has been added in feed at 1%) for pigs to control the odor problem at source of production. When the system operation was continued, no adverse effect was found both on the biogas production and the performance of the aerobic digester. The results of this experiment clearly demonstrated that EM can be used in coupling with anaerobic digester and aerobic digester for treating animal wastes.

Introduction

Kasetsart University (KU) is involved in research, development and consulting in animal waste management technology on the family farm and industrial scales. In cooperation with the Asia Institute of Technology (AIT), two pilot plants of biogas production were successfully constructed and operated for research and demonstration purposes. A new hybrid system of biogas, consisting of a low rate anaerobic digester (generally known as biogas plant) and a newly developed aerobic digester, is currently being designed for treating highly diluted pig manure. Effective Microorganisms (EM) technology is another animal waste treatment system being studied and disseminated by KU. Research works at KU have shown that EM is practicable for treating pig wastes, particularly for controlling the odor problem (Chantsavang et al., 1993). Laboratory scale research results in KU also revealed that EM can be applied in combination with biogas digester (Sawanon, 1996). The main objective of this study was to evaluate the combination effects of biogas and EM technologies for environmental control and biogas recovery at farm scale.

Materials and Methods

The treatment system was designed to recover wastes from 20 sows, 200 finishers and 200 weaners and was built for research, training and demonstration purposes at the Kasetsart University Animal Research Farm. The system consists of a fiberglass sedimentation tank, a low rate anaerobic digester or biogas digester (50 m3 hemispherical fixeddome type digester is used in this system) and an aerobic digester of a particular type called Bio-contact Aeration System (constructed from cylindrical fiberglass tank with a diameter of 3.5 m and a length of 8 m packed with newly developed plastic media). The configuration and system layout are depicted in Figure 1.

The slurry is flushed out of the manure pit inside the house once a day. This minimizes the emissions of noxious gases and also ensures a good climate inside the house. Next, the slurry is pumped into the sedimentation tank where it is separated into a low volume portion with high total solids concentration (solids fraction) and a high volume portion with low total solids concentration (liquid fraction). Treatment of the solids fraction is performed at ambient temperature in the biogas digester. The liquid fraction from the sedimentation tank is treated in the Bio-contact aeration tank. The treated effluent from the biogas digester and the aeration tank is led to a

holding lagoon. The effluent, which still contains some fertilizer compounds, is used for biofertigation and recycling to the piggery unit as washing and flushing water. The biogas produced is used in the process of pig and chicken slaughtering in the Animal Research Farm.

After one month of successful operation of the system, EM, in form of Bokashi, was added in to feed for pigs at 1 percent to control the odour problem at source of production. Samples of raw waste water, influent and effluent at different stages of the system were collected for chemical analyses, after the system operation was continued for one more month. Determination of standard parameters were mainly performed according to APHA (1971).

Results and Discussion

Fresh pig waste has a TS concentration of approximately 10 percent. The degree of dilution of the incoming pig waste to the treatment plant was influenced by the amount of washing and flushing water. In the present study, the average composition of the raw pig waste is shown in Table 1. The mean values of BOD and COD of raw pig waste were 1,600 and 10,321 mg/l, respectively. The COD/BOD ratio of 6.45 indicated that the biodegradability of the organic material was relatively low. The TSS content of raw pig waste was 6,675 mg/l and the VSS content 1,375 mg/l, which showed that the content of suspended organic material in raw pig waste was relatively low. The nitrogen content of raw pig waste was found to be 324 mg/l.

Table 1. Composition of the Raw Pig Waste, the Influent to Digester, the Effluent from the Digester and the Treatment Efficiency in the Digester

Parameter	Raw Pig Waste	Biogas Digester		Efficiency(%)
		Influent	Effluent	
PH	7.31	6.4	7.24	-
BOD (mg/l)	1,600	18,500	80	99.57
COD (mg/l)	10,321	93,896	365	99.61
TSS (mg/l)	6,675	59,775	55	99.91
VSS (mg/l)	1,375	15,700	17	99.89
TKN (mg/l)	324	178	190	-6.74

Treatment of the Solids Phase in Anaerobic Digester

The influent to the biogas digester had the composition shown in Table 1. The BOD content of the influent to the digester was 18,500 mg/l and the COD content was 93,896 mg/l. The ratio COD/BOD was 5.08, an indication that biodegradability of the influent was relatively low. The TSS content of the solids phase was 59,775 mg/l and the VSS content 15,700 mg/l, which showed that the sedimentation tank works relatively well.

The solids phase was anaerobically treated at ambient temperature. The treatment results are shown in Table 1. The BOD content of the effluent from the biogas digester was 80 mg/l and the COD content 365 mg/l. The efficiencies of BOD and COD reduction were 99.57 and 99.61 percent, respectively, which are substantial. The TSS content of the effluent from the digester was 55 mg/l (a reduction efficiency of 99.91 percent), the VSS content 17 mg/l (a reduction efficiency of 99.89 percent).

No effort was made in this present study to evaluate gas production and methane content of biogas produced from the system. However, the gas pressure and therefore the amount of gas available as depicted by a manometer installed in the slaughter house clearly showed that efficient gas production was obtained in the biogas digester. The results obtained from chemical analyses of the influent and effluent of the biogas digester and the amount of biogas produced from the digester as shown by gas pressure measured by manometer clearly indicated that adding EM in feed for pigs at 1 percent to control the odour problem had no adverse effect on the performance of the biogas digester.

Treatment of the Liquid Phase in Aerobic Digester

The liquid phase from the sedimentation tank was treated in the Biocontact aeration reactor at ambient temperature. The liquid phase had an overall composition suitable for treatment in an aerobic reactor. The BOD of the influent was 60 mg/l, the COD 300 mg/l. The TSS and VSS contents of the influent were 123 and 10 mg/l, respectively.

Table 2. Composition of the Influent to the Aerobic Reactor and the Effluent from the Aerobic Reactor

Parameter	Aerobic Reactor		Efficiency (%)
	Influent	Effluent	
pH	7.8	7.67	-
BOD (mg/l)	60	13	78.33
COD (mg/l)	330	248	24.85
TSS (mg/l)	123	1	99.19
VSS (mg/l)	10	non detected	100
TKN (mg/l)	118	81	31.36

The treatment results in the aerobic reactor are shown in Table2. The BOD,COD, TSS and VSS of the effluent from the reactor were 13, 248, 1 and non detected, respectively. The treatment efficiency was high for BOD, TSS and VSS (78.33, 99.19 and 100 percent, `respectively), but low for COD and TKN (24.85 and 31.36 percent, respectively). These figures distinctly indicated that adding EM in feed for pigs at 1 percent to control the odour problem at source of production had no adverse effect on the performance of the Bio-contact aerobic reactor.

References

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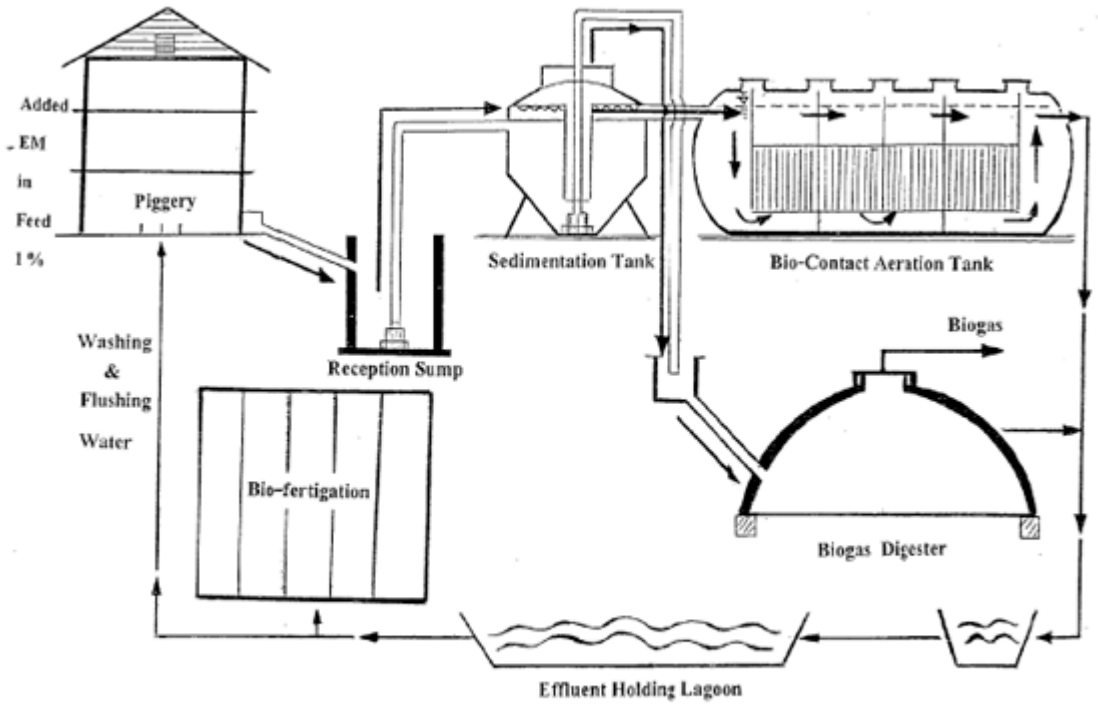

Figure 1. Schematic diagram of animal waste management system at Kasetsart University Animal Research farm