PRELIMINARY STUDY ON COMPOSTING OF THE CATTLE MANURE AND RICE HULLS MIXTURES BY NEGATIVE AERATION

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ABSTRACT

Composting by negative aeration is a reasonable proposition to control odor generated during composting process. Cattle manure and rice hulls mixtures were composted in a bin composting system by negative aeration. Continuous(CA) and intermittent(IA) aeration methods were applied to analyze the composting characteristics. The composting temperature and the ammonia emission during composting were investigated according to the aeration methods. The main problem for the negative aeration was the generation of condensate in the suction line of blower. The quantity of condensate was significant for continuous aeration. The aeration method should be modified to escape from the cooling effect of continuous aeration at the initial stage of composting. It took a longer time to finish a composting for intermittent aeration on account of lower aeration. It was concluded that the composting by negative aeration could be accomplished by either continuous or intermittent aeration method if the flow rate would be controlled more efficiently and the water vapor in suction line of blower could be removed effectively. Ammonia emission increased up to maximum value of 675ppm for continuous aeration while 300ppm for intermittent aeration. However, the cumulative value of ammonia emission was larger for intermittent aeration than for continuous aeration.
Key Words : Solid Composting, Negative Aeration, Intermittent and Continuous Aeration, Odor Generation

INTRODUCTION

Oxygen is required to biodegrade the compost. Usually oxygen is supplied by a forced positive aeration for composting. During composting of livestock manure, however, biodegradation of manure generates odor such as ammonia(NH_3) and hydrogen sulfide(H_2S) giving bad smell. Biofilter is used to reduce the odor. Positive aeration generates exhaust gas from the pile. To diminish odor quantity by filter, another suction system is required to gather the exhaust gas from the pile. Negative aeration system can be utilized efficiently to draw the exhaust gas from the compost mass while supplying the air to the compost.

With negative aeration system, condensate of water vapor drawn from the composter must be removed before the air reaches the blower(Rynk, 1992). Intermittent aeration(IA) may be a practical way compared with continuous aeration(CA) to reduce nitrogen loss and ammonia emissions during composting of swine manure with sawdust(Hong *et al.*, 1998)

MATERIALS AND METHODS

Experimental Materials

To compost the cattle manure and rice hulls mixtures, pilot scale composter(200L) was made as shown in Figure 1. Suction type blower draws the air through the compost mass from the eight holes of the reactor side walls and discharges the exhaust gas to the filter system. Bin is insulated by polystyrene to prevent the heat from flowing out to the outside.

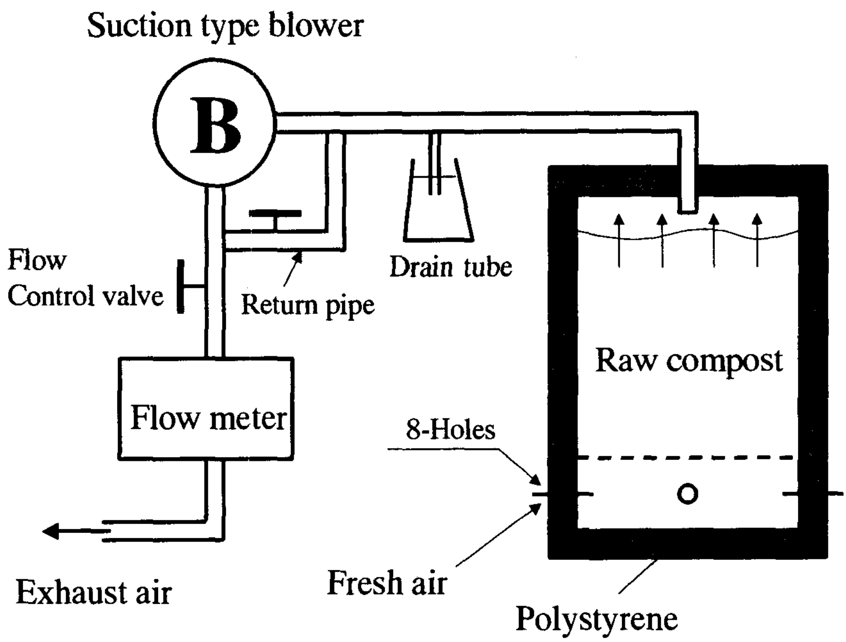


Figure 1. General layout of bin composting system

Personal computer and 21X Data Logger(Campbell Inc.) system were used to monitor and store the measured data. K type TC sensor was used to measure the temperature of the compost and HMP 35C sensor was used for the ambient temperature. Temperature readings were recorded every one hour with Data Logger.

Cattle manure was mixed manually with rice hulls in the weight ratio of 5 : 1 to get the optimum moisture ratio. The physicochemical properties of initial and final compost materials were analyzed for mass, moisture content, pH, T-C, T-N, C/N by the standard methods of Office of Rural Development(ORD, 1988).

Experimental Procedures

Composting experiments were done in the laboratory during 11 days from April 1 to 11, 2000 by continuous aeration(CA) and during 22 days from April 12 to May 3, 2000 by intermittent aeration(IA). Air was supplied to the compost by a suction type blower of available capacity of 40-80L/min. Aeration rate was adjusted by the flow control valve and air return pipe as shown in Figure 1.

For continuous aeration, air of 1.0L/min kgDM(25L/min for the reactor) was supplied continuously except for the initial stage. At the initial stage of continuous aeration, air was controlled according to the composting temperature as shown in Figure 2. When the composting temperature went down abruptly, aeration was stopped four times during one hour to avoid cooling effect of aeration. For intermittent aeration, air of 0.095L/min kgDM(28L/min for the reactor) was supplied intermittently during 5 minutes a hour using a preset timer.

RESULTS AND DISCUSSION

Physico-chemical properties of compost

The initial mass of the composting mixtures were 84.1kg for continuous aeration(CA) and 77.9kg for intermittent aeration(IA). The physico-chemical properties of compost materials are as shown in Table 1. The data of properties are the average values of two samples.

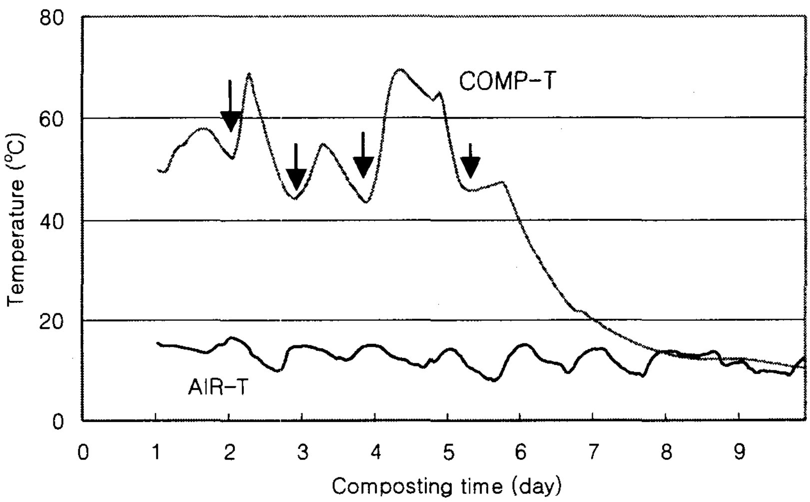
The moisture ratios of the final compost were reduced from 70.01 and 68.48% to 62.66 and 63.20% respectively, but still represented higher values than that required as a commercial compost. C/N ratios appeared optimum values of 17.85 and 15.59 respectively. The values of pH were 7.92 and 7.44 respectively representing optimum values. No significant differences existed in the physical and chemical properties of the compost between continuous aeration and intermittent aeration

Table 1. Physico-chemical properties of compost materials

Properties	Cattle manure	Rice hulls	Initial compost		Final compost	
			CA	IA	CA	IA
pH(-)	6.42	7.09	8.19	7.92	7.92	7.44
MC(%, wb)	81.94	8.69	70.01	68.48	62.66	63.20
T-C(%, db)	41.57	39.94	40.85	40.85	39.82	40.07
T-N(%, db)	2.30	0.6	2.07	1.98	2.23	2.57
C/N(-)	18.07	66.57	20.02	20.63	17.85	15.59
Ash	2.34	14.96	4.39	4.73	6.41	7.47

Variation of Temperature

The temperature variation of compost are shown in Figure 2 and 3.



↓ : Stop position of aeration for one hour

Figure 2. Variations of compost and ambient temperatures during composting by continuous aeration(CA).

For continuous aeration(Figure 2), temperature rose up to 57℃ on the 2nd day. However, the temperature started to go down by the cooling effect of aeration. After stopping the blower, the temperature went up again reaching the maximum value of 69℃. At the initial stage of 5 days there were 4 times of cooling effect. From the 6th day the temperature went down below 40℃ and reached ambient temperature at 8th day. The aeration rate of 1.0L/min· kgDM seemed too much for continuous aeration.

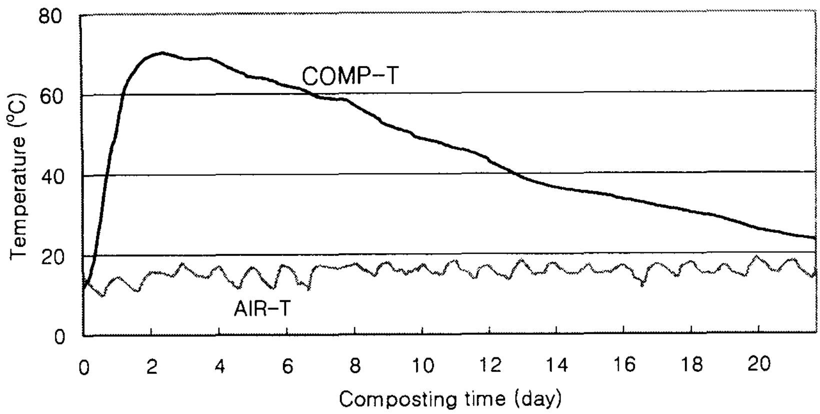


Figure 3. Variations of compost and ambient temperatures during composting by intermittent aeration(IA).

For intermittent aeration(Figure 3), temperature rose up constantly to 70℃ on the 2nd day. The temperature was maintained above 60℃ during 5 days from the 2nd day to the 6th day. It did not reach ambient temperature during the experiment period of 22 days. The aeration rate of 0.095L/min· kgDM seemed too low for intermittent aeration.

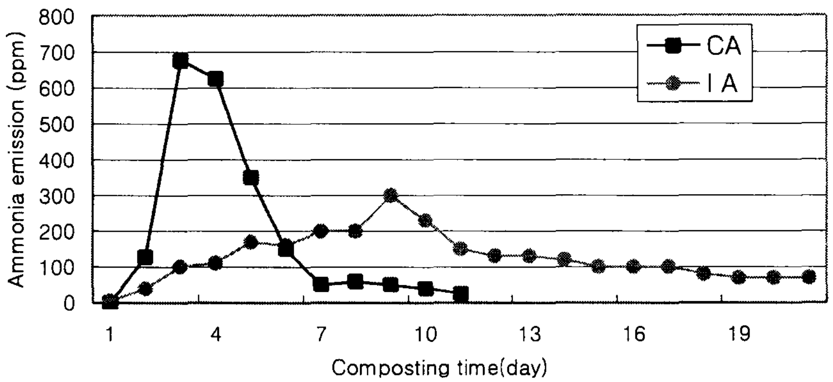


Figure 4. Ammonia emission during composting by continuous aeration(CA) and intermittent aeration(IA).

Ammonia emission

Ammonia emission during composting was measured once a day by a gas detector(Gastec No. 3). Figure 4 represents the variation of ammonia emission for the continuous and intermittent aeration. For continuous aeration, maximum value of 675ppm appeared on the 3rd day while for intermittent aeration 300ppm appeared on the 9th day.

For continuous aeration, from the 7th day the emission dropped down below 60 ppm and appeared 25 ppm on the 11th day. However the emission for intermittent aeration continued much longer periods.

Figure 5 represents the cumulative ammonia emission representing total generation. The cumulative values till the 11th day were 2151 ppm for continuous aeration and 1665 ppm for intermittent aeration representing lower value for intermittent aeration. However the total value for 22 days showed higher value of 2695 ppm for intermittent aeration.

Water vapor

The main problem for negative aeration composting was the generation of condensate. The water vapor from composting reactor was condensed in the suction line of the blower. The quantity of condensate was larger for continuous aeration than for intermittent aeration.

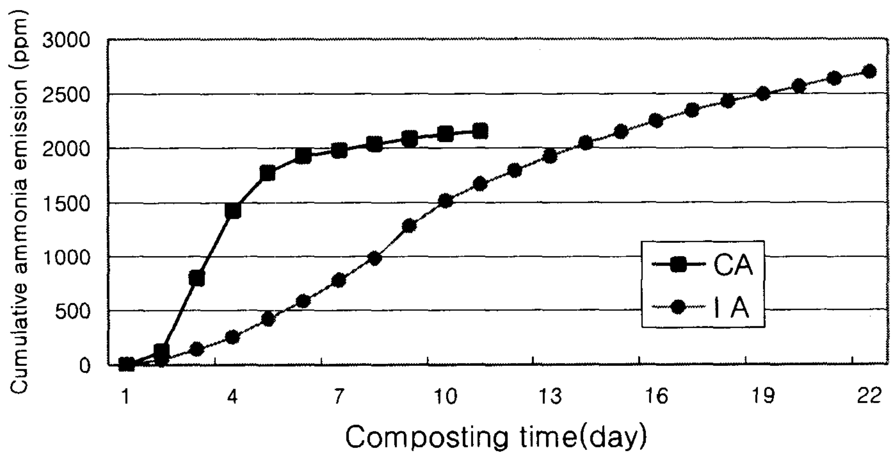


Figure 5. Cumulative ammonia emission during composting by continuous aeration(CA) and intermittent aeration(IA).

CONCLUSIONS

Cattle manure and rice hulls mixtures were composted in a bin composting system by negative aeration. Continuous aeration(CA) and intermittent aeration(IA) methods were applied to analyze the composting characteristics.

The following conclusions could be drawn from the study:

1. The temperature was dropped down during active composting period because of cooling effect for continuous aeration. The temperature could be controlled by stopping the blower when the temperature dropped down. The temperature was maintained above

60℃ during the 5 days for intermittent aeration. It took a longer period to finish the composting for intermittent aeration.

2. The main problem for the negative aeration was the generation of condensate in the suction line of blower.

3. It was concluded that the composting by negative aeration could be accomplished by either continuous or intermittent aeration method if the flow rate would be controlled efficiently and the condensate in suction line of blower could be removed effectively.

4. Ammonia emission rose up to the maximum value of 675ppm on the 3rd day for continuous aeration while 300ppm on the 9th day for intermittent aeration. The ammonia emission for intermittent aeration continued much longer periods.

5. The cumulative ammonia emission was 2151ppm during the 11 days of continuous aeration and 2695ppm during the 22 days of intermittent aeration.

ACKNOWLEDGEMENT

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