Problems of Pig Waste Disposal

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Introduction

Animal waste should be regarded as sludge rather than waste water. Therefore, before planning the disposal, it must be decided whether the waste is managed as a mixture of feces and urine (in a slurry condition) or as separate substances (solid feces and urinary waste water).

Although there is no established method of waste disposal applicable to livestock farmers of all kinds, there are several successful examples resulting from many trials.

The methods of waste disposal are also restricted naturally by 1) consideration of the animal population in the future, 2) size of farm area to which the waste is applicable as a manure, 3) kinds of soils, 4) topography of land, 5) climate, 6) water consumption and 7) distance from residential quarters.

The animal waste disposal aims at 1) reduction of the volume of waste, 2) stabilization of the organic substances of waste, 3) elimination of the malodor of waste and 4) protection of public hygiene. Furthermore, high efficiency of purification, low-cost for facilities and operation, and simple management which needs no special skill are strongly desired. Although these are difficult problems we must make every endeavor to solve them for the development of the livestock industry.

Characteristics of animal waste

Amount and component of animal excreta are variable depending upon digestibility and contents of protein and fiber. For example, amount of excreta of pigs of confinement rearing is said to be about 9% or 7–10% of the body weight. The major components of animal waste by animals are shown in Table 1. The figures can be used for rough estimates. According to the figures, excreta in terms of BOD (Biochemical oxygen demand)* per day is 3 to 15 g for fowl, 90 to 250 g for pig and 600 to 700 g for dairy cattle, and in terms of T-N per day is 1 to 2 g for fowl, 15 to 32 g for pig and 168 to 222 g for dairy cattle. Amount of phosphorus as P_2O_5 is 1 g, 11 g and 55 g respectively.

Rate of BOD to CODcr is 0.26 to 0.30 for fowl and 0.19 to 0.43 for pig while it is 0.08 to 0.23 for dairy cattle. This means that the biological treatment of the former two is easier than that of the third.

Table 1. Characteristics of animal wastes

Animal	Weight (lb)	Total solids (lb/day)	BOD (lb/day)	BOD/COD	Total nitrogen (lb/day)	P_2O_2 (lb/day)
Chicken	4～5	0.057～0.084	0.006～0.032	0.26～0.30	0.0030～0.0036	0.0026
Swine	100	0.50 ～ 0.97	0.20 ～0.56	0.19～0.45	0.032 ～0.07	0.025
Dairy cattle	1,000	6.8 ～10.4	1.32 ～1.53	0.08～0.23	0.37 ～0.49	0.12

* BOD: Biochemical Oxygen Demand
COD: Chemical Oxygen Demand
SS: Suspended Solid
DO: Dissolved Oxygen

On the other hand, results of experiment[1] using the metabolism crates with 20 pigs showed that BOD/CODcr of the excreta is 0.29 to 0.35, and the percentage of total solids ranges from 5.6 to 9.5 varying with different ratio of feedstuff to water. Content of organic matter in the total solids is about 83%. Contents of N, P, and K in the feces of pig are 0.9%, 0.4% and 0.4% respectively, with those in the urine are 0.9%, 0.1% and 0.2%.

In planning the pig waste disposal in Japan, the following figures are used: BOD is 180 g/head/day and SS is 700 g/head/day in the pig feces and BOD is 20 g and SS is 0 g in the pig urine. Assuming the amount of excreta as 3 kg of feces and 3 litre of urine, the BOD is 33,000 mg/l and and SS is 120,000 mg/l in the original excreta.

If 80% of feces are removed from the excreta, the BOD of urinary waste water would become to be 16,000 mg/l and SS to be 39,000 mg/l; consequently, the pollution potential would be reduced to a half.

Methods of animal waste disposal

Biological treatment is effective for such a substance as animal waste, which is easily decomposed biologically. The major methods of treatment presently used are as follows:

1) Returning to soils

This is a traditional method to use the waste as manure. Since chemical fertilizers are now widely utilized, the amount of animal excreta to be applied must be determined in consideration of its forms (compost, dried feces, liquid manure, etc.), maturity, components, property of soils and kinds of crop. For practicing this method, not only sufficient area of farm fields but also the compost depot and the reservoir tank are needed because the manuring time is different by crops.

In applying animal waste as manure, nitrogen content of the manure becomes a limiting factor and hence, crops of high nitrogen utilization are considered to be preferrable.

Table 2 shows the acreage required.

2) Anaerobic biological treatment

It is expected that 30 to 50% of organic carbon in animal waste can be decomposed under ideal conditions, resulting the liquefaction of organic matters. It is said that 50 to 75% of organic matters can be decomposed. As the final products of the decomposition of carbohydrate and protein in the anaerobic biological treatment, hydrogen sulfide, mercaptan, ammonia, methane and carbon-dioxide gas are produced. By the anaerobic biological treatment succeeded by aerobic biological treatment, 97% of organic matters can be decomposed under ideal conditions.

Although this method is suitable for the treatment of liquid waste of high concentration, it has disadvantages that the maintenance of a proper temperature and many days are needed. Therefore, this method can be used only in combination with aerobic biological treatments, manuring, or methane gas production.

3) Aerobic biological treatment

Organic carbon can be decomposed by organisms in waste water at the presence of free oxygen molecules or combined oxygen.

There are many method to keep the liquid waste of animals at an aerobic condition. Although many methods have been deviced to make oxygen diffused into liquid waste, any

Table 2. Land requirement for utilization of manures in an integrated land-livestock system

Size of operation	Minimum corn land requirement		
	N excreted	Crop utilization	Pollution control
10, 000 layers～365 days	5, 670 kg	100 acre	50 acre
1, 000 hogs ～175 days	5, 220	100	50
100 dairy ～365 days	6, 350	100	50

method that makes an easy movement of oxygen is effective. Some of these methods will be described.

(1) Lagoon, oxidation-pond and fish-pond

Oxygen is introduced into the liquid waste through the vast surface of waste water. Water in the depth of 1 to 2 feet under the surface is kept aerobic.

A lagoon is regarded as a mixture of water and waste water. A lagoon of about five feet in depth is basically aerobic when the load is appropriate. For example, a lagoon of one acre can dispose of the waste produced by not more than 50 pigs (about 300 kg of waste)[4]. This disposal efficiency comes to 0.0014 kg BOD/m³/day in terms of per water volume, and which corresponds to about 1/500 of the purification efficiency of the conventional activated sludge process. This method requires a vast area and, furthermore, is apt to be overloaded. Consequently, there are few examples of success by this method.

Fish ponds give the maximum production of fish with the application of about 20 ton/ha of fowl droppings (0.5 ton N/ha, 0.25 ton P_2O_5/ha), irrespective of differences of natural condition. It is generally considered that 0.3 to 0.5 ton N/ha is the critical value for the production of fish[6].

(2) Aerated lagoon

With the purpose of reducing the area of lagoon, oxygen is forced to diffuse into the liquid phase by aeration (air stirring, maching stirring, or spraying). It may be utilized for tertiary disposal.

(3) Oxidation ditch

This method is more advanced than the aerated lagoon or oxidation-pond and less advanced than the conventional activated sludge process. A characteristic of this method is the easiness in management. The upper limit of the loading may be 0.5 kg BOD/m³/day.

(4) Activated sludge process[7]

Although there are many modifications, more than 90% of BOD and SS of waste can be removed provided that the supply of oxygen is sufficient.

Results obtained at the experimental facilities of the Ministry of Agriculture and Forestry indicated that more than 90% removal of BOD and SS of waste could be obtained if the following conditions were kept; 0.5 to 1.5 kg BOD/m³/day of loading, 3,000 to 6,000 mg/l of MLSS concentration, more than 1 mg/l of DO concentration and 1,000 mg/l in the BOD concentration of waste applied. It is desirable, however, to keep the load capacity less than 1 kg BOD/m³/day to obtain always the effluent of good quality because the excess sludge would be increased according to the increase of the load.

A discontinuous activated sludge process has been examined to simplify this continuously running activated sludge process. The loading of this new process is reported to be 0.4 kg BOD/m³/day. A new purification process of high efficiency is now under study.

4) Drying process of dung

The labor-saving and economical drying process of dung is now being studied in a national scale to utilize it as manure or as feed.

Conclusion

For the future, studies on the disposal of animal waste should be developed on the basis of an effective utilization of organic matters, taking into consideration the problems of environmental pollution.

Urgent problems which require immediate solutions are as follows:

1. Livestock barn structure adapted to a separation of feces and urine.
2. Highly efficient fermentation techniques for the waste in slurry condition adaptable for manuring.
3. Efficient methods of dehydration, drying and compost-making of animal waste and excess sludge.
4. Highly effective purification process of urinary waste water.
5. Methods to produce feedstuff from the feces and excess sludge.
6. Methods to eliminate malodor.

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