DEVELOPMENT OF LOW COST COMPOSTING TOILET FOR DEVELOPING COUNTRIES

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The dry type of composting toilet is powerful tool to improve sanitation in developing countries. Current toilet is too expensive to install into developing country owing to strong material and convenient functions such as automatic mixing with a powerful motor, temperature control and large reaction container, while they requires huge amount of energy for the operation. In this study, the composting toilet with urine diverting toilet and hand mixing device was developed and performed to achieve low operation and production cost. As a result, the 50% of organic matter was biodegraded and the residue accumulated into the matrix. The moisture content increased at initial then became stable at 55%. Organic acids were generated in the matrix at initial, but no acids were detected after 2 weeks, however the pig manure contains the acids. Some inactivation process of pathogens was required, because E-coli and coliform count was higher than conventional composting toilet with heating device. The required force for mixing increased with operation progress, but it could be smaller than the force which young man could rotate by one hand owing to adoption of reducer. The loading force from the matrix was increased with increase of weight of mixed matrix and decrease of distance between screw blade and reactor wall. So that, more detailed investigation into the shape and size of screw should be required. The material cost in Japan was 220000 yen and over half was occupied by production of screw. Therefore, development of cheaper screw is one of the important issues.

1. Introduction

The dry composting toilet with sawdust matrix is powerful tool to improve sanitation in developing countries. This is also a key component of Onsite Wastewater Differentiable Treatment System[1)]. This tiolet takes much initial cost, and operation or energy cost for evaporating water of the wastes from the matrix[2,3)]. This cost retards installation of this system into the developing countries. The main reasons of the high initial cost are 1. adoption of expensive materials, 2. large size of the composting reactor and 3. many high-level functions, such as automatically mixing system of the matrix with powerful motor and heating system. Avoiding heating system also decreasing operation cost, however urine diverting toilet is required for reducing water load. Then, the objectives of this paper are to develop low cost composting toilet with hand mixing and to evaluate its operation performance.

2. Materials and methods

The aspect of the produced toilet is shown in Fig. 1. The composting reactor had PVC container, stainless screw from Seiwa Denko, a reducer and 60L of sawdust. The 600g in wet basis of pig faces was loaded into the reactor to represent usage by 4 member family[4)], then the matrix was mixed with 4 rotation of the screw. The total weight of the toilet, biodegradation rate of organic matter in the faces, concentration of organic acids, coliform counts and force for rotation of the screw at the handle were measured.

Fig. 1. Developed composting toilet

3. Results and discussion

Fig. 2 shows total weight of input faces, weight increase and moisture content of the matrix. The moisture content increases with input of faces then reaches to 55% of steady state. This is because the water evaporation rate increases with the moisture content, however the water load was constant. The accumulation increased with input of faces, but it was half of the total weight. This weight reduction rate was same level of another experiment with more mixing frequency, as shown in Fig.3. The concentration of organic acids in composting matrix is illustrated in Fig. 4. The acids detected in first 2 weeks, but they undetected after the time however the faces contain the organic acids as shown in Fig. 5. Therefore we can gather the organic matter in the faces was aerobically biodegraded to carbon dioxide.

Fig. 6 and 7 respectively show E-coli count and coliform count in the matrix. The level of each count was lower than the faces, but still higher than one in conventional composting toilet. So some additional treatment is required to reduce the level until changing the compost.

Required force for mixing at the handle is represented in Fig. 8. The force is increased with operation time, but it is still low level because of reducer. This system has a flexibility to choose suitable handle size and reducer. Fig.9 shows the relationship between the force for mixing and weight of the mixed matrix. The force increased with weight parabolically. When the clearance is wide, the trend becomes lower. But the large clearance makes avoid volume of the matrix which never mixed by screw. So, we need to find optimum clearance of other type of screw.

The cost of this toilet was about JPY 220,000, while 70% of it was for screw. So development of a cheaper screw can reduce the cost effectively. From the result of development of the composting toilet in Indonesia, the cost was estimated around Rp. 10,000,000 for producing in there as shown in Fig. 9. The equivalent of this cost in Japan is about JPY 100,000. The share of screw decreases to 30% owing to cheep screw. For more cost reduction, cheaper materials should be considered.

4. Conclusion

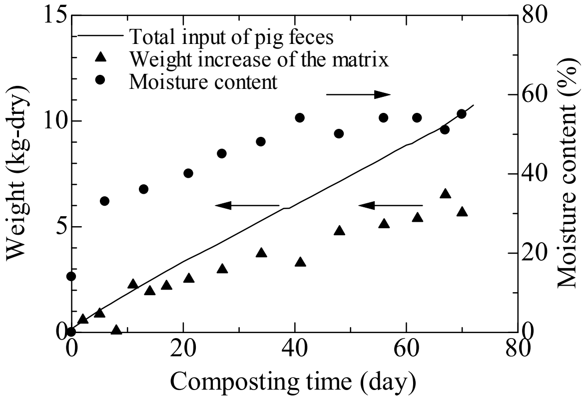

Fig.2. Variation of total faces, weight increase of the matrix and moisture content

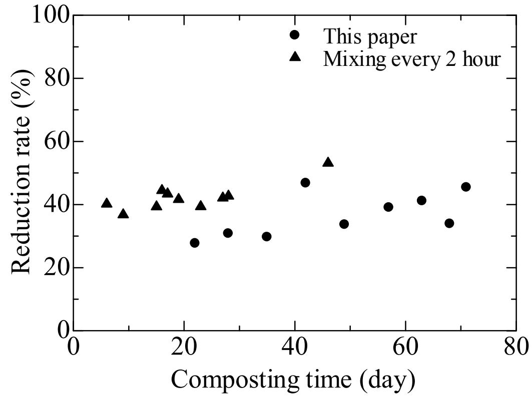

Fig. 3. Reduction rate of loaded faces

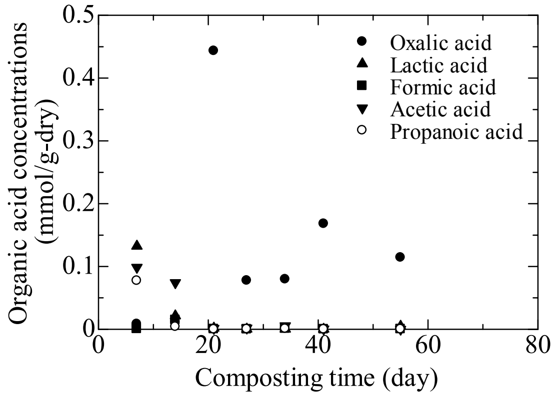

Fig. 4. Organic acids in the matrix

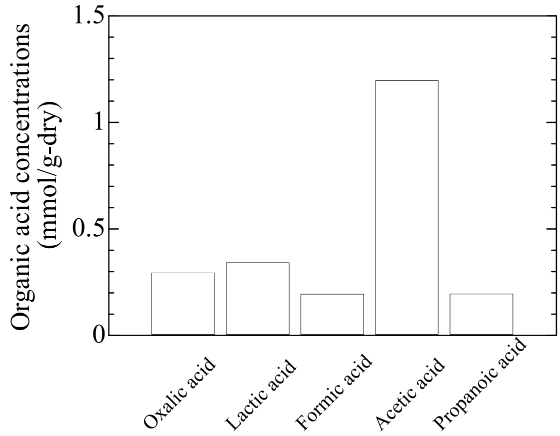

Fig. 5. Organic acids in pig faces

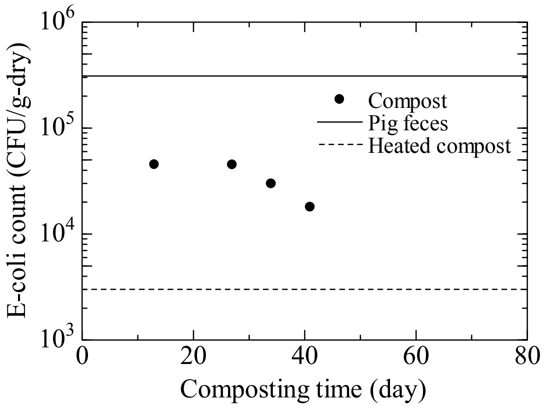

Fig. 6. E-coli count

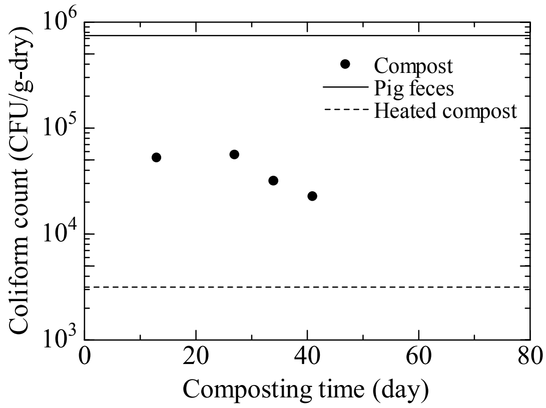

Fig. 7. Coliform count

The low cost composting toilet was successfully developed with low cost materials as PVC for container, limited functions as hand mixing and urine diverting toilet. As a result, the toilet showed same performance with current toilet. The weight of loaded faces aerobically biodegraded 50% because no organic acids detected after 2weeks and heat generation occurred in the matrix. The coliform count and e-coli count was still higher than the level of current toilet. The required force for mixing matrix kept low level for 2 month operation. The production cost was about JPY 220,000, while the screw occupied 70%. The estimation of the toilet in Indonesia was Rp. 10,000,000, but still expencive[5)].

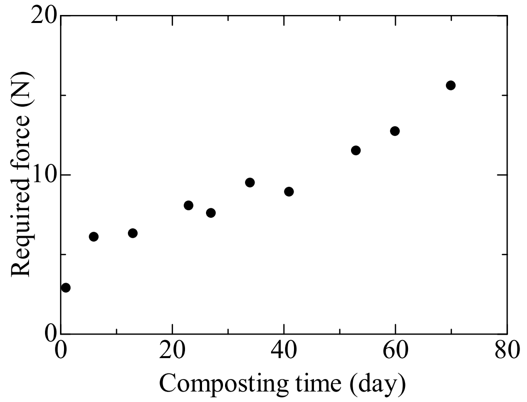

Fig. 8. Required force for mixing the matrix

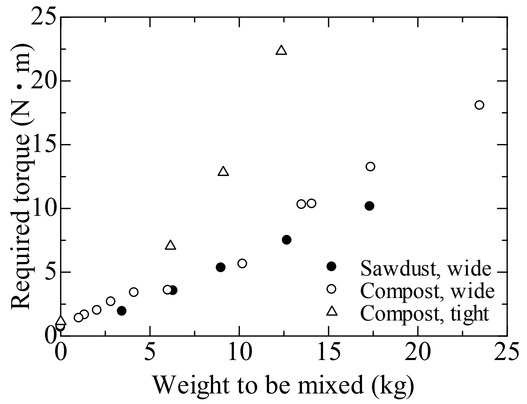

Fig. 9. Relationship between required force and weight to be mixed

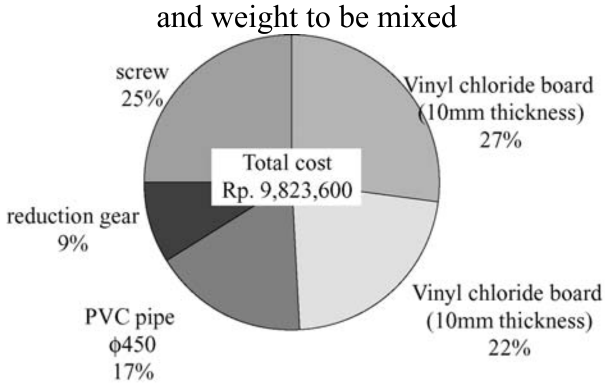

Fig. 10. Production cost

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