Aerobic Biodegradation of Toilet Wastes by Using Sawdust as a Matrix

北海道大学大学院工学研究科 環境衛生工学講座 水環境施設工学分野 López Zavala Miguel Ángel*、
Naoyuki Funamizu* and Takakuwa Tetsuo*

1. ONSITE WASTEWATER DIFFERENTIABLE TREATMENT SYSTEM.

The environmental and health principles supporting the management of onsite wastewater differentiable treatment system include: ecological sanitation, ecologically sustainable development, resources recycle (nutrients and water), water cycle management, total catchment's management, conservation of water resources, protection of public health and the prevention of public health risk (Lopez et al., submitted).

Figure 1 shows a hypothetical model for onsite wastewater differentiable treatment system. In this system, the separation of household wastewater into three types is essential. Thus, reduced-volume blackwater, higher- load and lower-load graywater are new concepts that are intended to introduce in this model. Here, the treatment of blackwater conceives a change in the traditional way of using the WC; in other words, the use of water in the WC is thought just to clean the toilet, not to transport the toilet wastes; this is a very important change that it is possible by using a bio-toilet (dry-toilet).

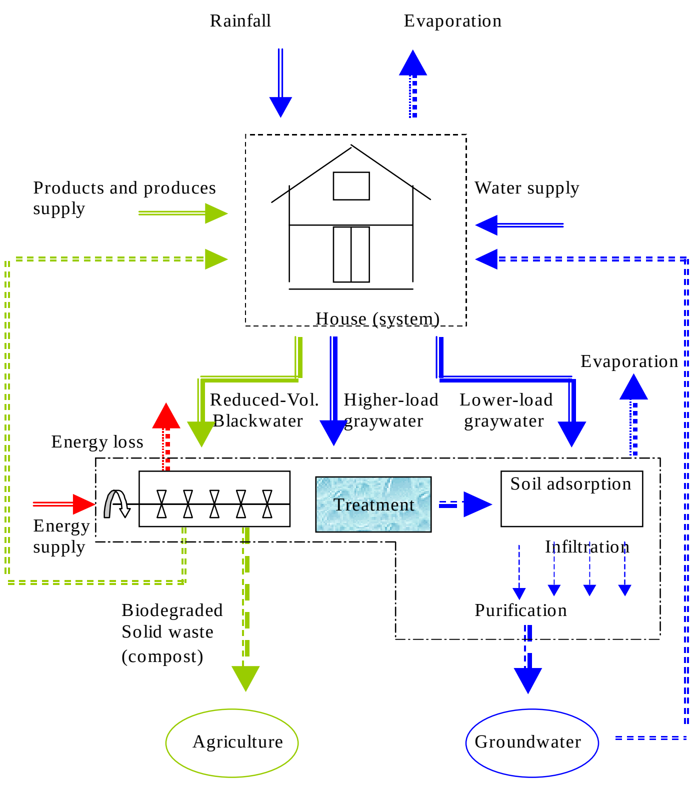

Figure 1. Hypothetical model for onsite wastewater differentiable treatment system.

2. AEROBIC BIODEGRADATION OF TOILET WASTES BY USING SAWDUST AS A MATRIX.

Batch tests for five different feces/sawdust ratios (F/S: 5, 10, 15, 20 and 25) were performed. Oxygen utilization rate (OUR) was monitored every 30 minutes in all trials; additionally, other parameters such as TS (total solids), VS (volatile solids), COD, T-N (total nitrogen), NH_3-N, NO_3-N, Cl, PO4-P, SO4, moisture content, EC (electrical conductivity), and pH of feces, sawdust and compost (biodegradation product) were measured for each trial.

3. RESULTS.

Pollution load of feces. There is a wide range of variability in the content of excrement from person to person, place to place. Factors include nutrition, climate, health, age and lifestyle. From the analysis of 7 feces samples taken during the performance of batch tests, it was found that feces are approximately constituted by 81% water and only 19% solids; from them, about 84% were VS. Values of 1.43 mg COD/mg feces, 56.2 mg T-N/g feces and 7.0 mg NH_3-N/g feces (dry basis) were also found. These average values are in accordance with those reported by the current literature.

Keywords: OWDTS, Aerobic Biodegradation of Toilet Wastes, Bio-toilet.

*060-8628 札幌市北区北 13 条西 8 丁目 Tel. and fax: (011) 706-6270。

Lopez Zavala M. A., Funamizu N. and Takakuwa T. (2000). Onsite wastewater differentiable treatment system: modeling approach. Hokkaido University. Department of Environmental Engineering. Sapporo, Japan.

OUR profiles. OUR profiles for each trial were plotted, it was found that the OUR peak was reached in all cases approximately 8 to 10 hours after the batch tests started. Before and after the OUR peak was reached, a rapid increase and decrease in OUR profiles were observed respectively. Stabilization of them started 4 to 5 days after the beginning of batch tests. COD reduction was found to be 89% of the accumulated OUR; it means, OUR may be employed to describe biokinetic characteristics of aerobic biodegradation of toilet wastes by using sawdust as a matrix; see Figure 2.

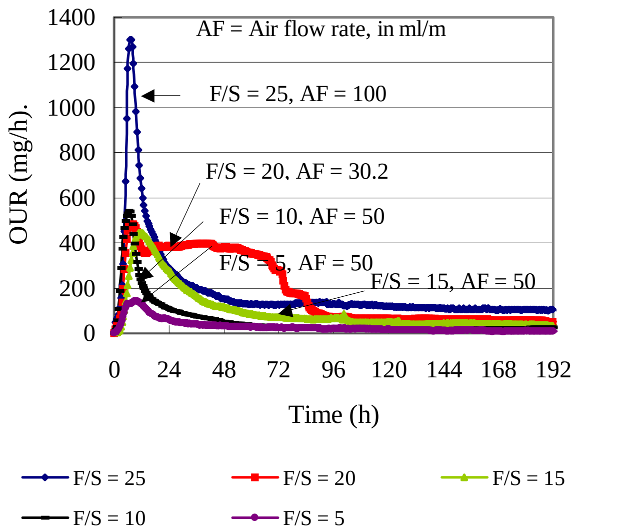

Figure 2. Respiration rate profiles (OUR) obtained for five different F/S ratios.

Biodegradation of organic matter. From batch tests the following was found: a) TS reduction increased linearly as the F/S increased and approximately 56% of feces, in terms of TS, was reduced in all organic loads (F/S ratios) evaluated; b) VS reduction also increased almost linearly as the F/S ratio increased; however, in this case the reduction of feces in terms of VS was approximately 70%; c) similarly to TS and VS, COD profile showed an increasing tendency as the F/S increased; however, redaction was about 75% respect to the COD of feces; see figure 3.

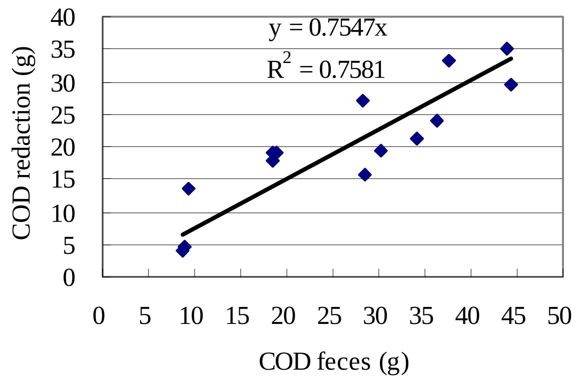

Figure 3. Effect of organic load on COD reduction.

Nitrogen. It was found that only ammonification process occurred under the conditions at which the experiment was performed. T-N reduction increased as F/S increased and T-N reduction of approximately 94% occurred. All T-N reductions in the bioreactor were equivalent to the NH_3-N released to the atmosphere. Despite fractions of nitrates were found in feces, sawdust and compost samples, their concentrations were so low to be considered as a sign of occurrence of other processes related to nitrogen, such as denitrification.

Characterization of feces for modeling purposes. From OUR profiles, COD determinations and by using procedures employed in characterization of raw wastewater, characterization of feces for modeling purposes was carried out; it was found that approximately 26% COD of feces was associated with easily biodegradable organic matter; 50% COD was slowly biodegradable organic matter and 24% COD was biologically inert material

4. CONCLUSIONS.

The Onsite Wastewater Differentiable Treatment System (OWDTS), seems to be a new approach with higher potential for improvement the traditional OWTS. The aerobic biodegradation of toilet wastes by using sawdust as a matrix is an important treatment process of the OWDTS.

Aerobic biodegradation rate of feces, by using sawdust as a matrix, in terms of COD, TS and VS reductions were approximately 75%, 56% and 70% respectively, irrespective of the organic load regarded. Therefore, organic load is not a limiting factor for aerobic biodegradation of feces at least in the practical F/S ratios evaluated. Accumulated OUR and COD determinations showed acceptable correlation, so that, OUR may be employed to describe biokinetic characteristics of aerobic biodegradation of toilet wastes by using sawdust as a matrix. T-N reduction during aerobic biodegradation of feces was approximately 94%. All T-N reductions in the bioreactor were equivalent to the NH_3-N released to the atmosphere.

Feces are approximately constituted by 81% water and 19% solids; from them, 84% are VS. Values of 1.43 mg COD/mg feces, 56.2 mg T-N/g feces and 7.0 mg NH_3-N/g feces (dry basis) were also found. Feces are characterized, for modeling purposes, as follows: 26% COD is associated with easily biodegradable organic matter; 50% COD is slowly biodegradable organic matter and 24% COD is biologically inert material.