Temperature Effect on Solubilization of Raw Garbage

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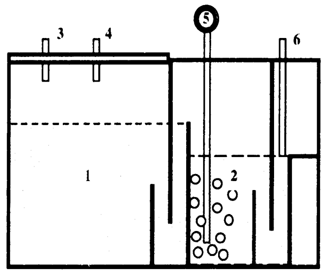
Introduction

Recently municipal solid wastes (MSW) are endlessly released out. MSW usually were incinerated or reclaimed in landfills. With the landfills reducing and some serious environmental consequences being increasingly caused, the studies on the reuse or recycle, the volume-reduction and the final harmless deposal of MSW gradually attract more attentions. Raw garbage is a noticeable solid waste, if combusted directly with other garbage, Dioxins may be produced. Kitchen is one of major sources of raw garbage, many scenarios have been put forward for kitchen raw garbage collection and treatment,and aspects of the environmental impact, the energy consumption and the economy have been considered. In this study, one small-scale raw garbage digester has been designed for its treatment, and the effects of temperature on the raw garbage solubilization was emphasized in this stage runs.

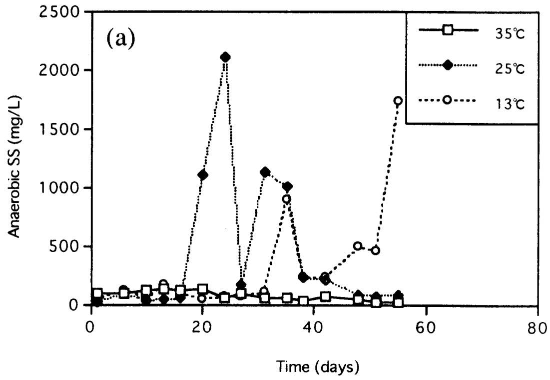
Materials and Methods

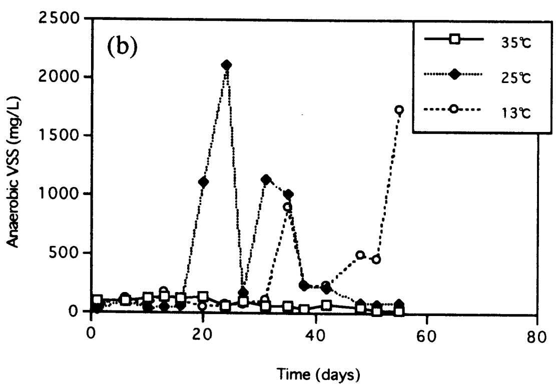
Here a synthesized raw garbage was prepared by scrapping raw garbage to diameter of 3mm and mixed with water by disposer, its composition (Weight percent) was vegetable 20%; fruit 30% and others 50%. $FeCl_2$, $CoCl_2$ and $NiCl_2$, were used as nutrients salts. The digester consists mainly of two connected units, one 5.6L anaerobic digestion chamber (AADC) externally isolated for the anaerobic digestion, one 2.8L aerobic digestion tank (ADT) (Fig.1).The influent substrate entered AADC at first with load rates of COD_{Cr}, T-N, T-P and tape water are 938mg・d^{-1}, 31.4 mg・d^{-1}, 12.4 mg・d^{-1} and 43 L・d^{-1}, respectively, and then overflowed into ADT, finally, effluents flow out. This device should be linked in the forepart of sewage system in future practical application. Effluent was sampled daily for the analyses of soluble COD_{Cr}, Total Nitrogen (T-N), Total Phosphorus (T-P), NH_4-N, $NO_{2,3}$-N, VSS and SS. Nutrient salts were loaded in rates of ($FeCl_2$) 120mg・d^{-1}, ($CoCl_2$) 12mg・d^{-1} and ($NiCl_2$) 12mg・d^{-1}. Batch tests have been carried out under temperatures of 13, 25 and 35℃. 13℃ is the average temperature of household underground septic tank in the winter of Japan. Methane ferment is mainly classified into thermophilic (55±2 ℃) and mesophilic (35±2℃) manners. Here 35℃ was selected as one



1. Anaerobic digestion chamber (5.6 L), 2. Aerobic digestion tank (2.8 L), 3. Gas outlet, 4. Substrate influent, 5. Air-blower pump, 6. Effluent

Fig. 1 Schematic diagram of raw garbage digester.





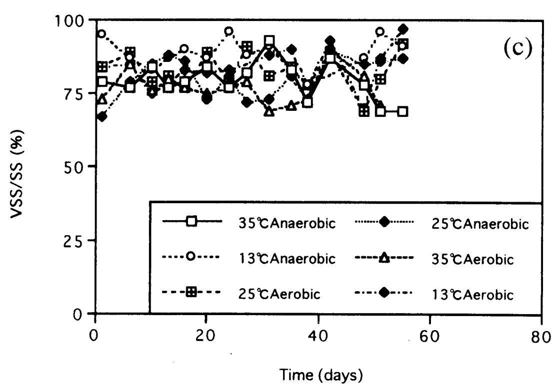


Fig.2. Changes of SS (a) and VSS (b) concentrations and VSS/SS ratio (c)

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temperature condition for methane ferment. The digester was started up with seed sludge obtained from a local wastewater treatment plant.

Result

We found that SS and VSS (Fig.2) in effluents from either anaerobic or aerobic units were low during whole running period, except those containing sludge at 25℃ and 13℃ anaerobic condition in which their SS and VSS concentrations showed short-period increases and decreases two weeks and one months later, respectively after the setup. Additionally, average VSS/SS ratios appreciably decreased with temperature increase either in anaerobic or aerobic effluents, even though most of them changed within the range of 0.70 to 0.90.

The final effluent COD_{Cr}, T-N and T-P (Fig.3, Fig.4 and Fig.5) after anaerobic treatment exhibited a similar trend with both VSS and SS. At 25℃, one concentration ups and downs of COD_{Cr}, T-N and T-P in effluents appeared 2 or 3 weeks later after the reactor setup. The same phenomenon also was observed at 13 and 35℃, but their emergencies came out latter and earlier respectively than that at 25℃. About 2 months later, all concentrations appear to reach a low and steady level.

All NH_4-N concentrations in (Fig.6) effluent after either anaerobic or aerobic digestion fell slowly to steady states about one month later after the setup of digestion. In the steady state, NH_4-N concentrations in anaerobic processed wastewaters at 35, 25 and 13℃ were 28.3, 21.6 and 0.3mg $\cdot$ L^{-1}, respectively. After the setup, all aerobic processed wastewater NH_4-N slowly decreased down to as low as 0.8 mg/L in average. In contrary, at 25 and 35 ℃ aerobic digestion processes, $NO_{2,3}$-N concentrations (Fig7) in effluents gradually increased.

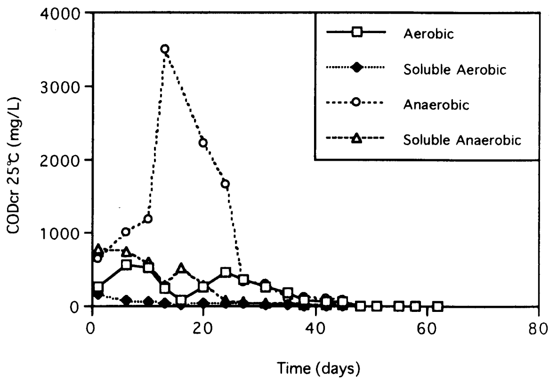

Fig.3. Changes of CODcr concentrations

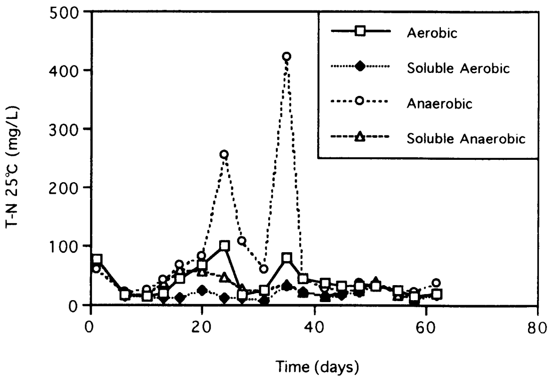

Fig.4. Changes of T-N concentrations

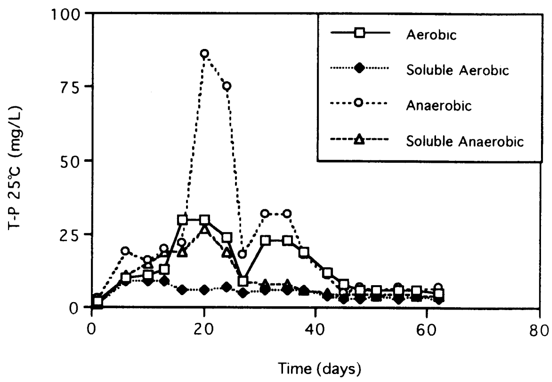

Fig.5. Changes of T-P concentrations

Summary

By measurements and analyses, we can conclude: 1. The solubilization of raw garbage at 35℃ is more remarkable than those at 25℃ and 13℃. 2. VSS removal can be promoted by raising digestion temperature. 3. The denitrification of soluble organic matters in raw garbage and the transform from $NO_{2,3}$-N to $NO_{2,3}$-N can easily be promoted only raising the digestion temperatures at least over 25℃. 4. The steady state of whole digestion can be rapidly reached by raising digestion temperature. Anyway, the temperature is an important factor affecting the raw garbage solubilization.

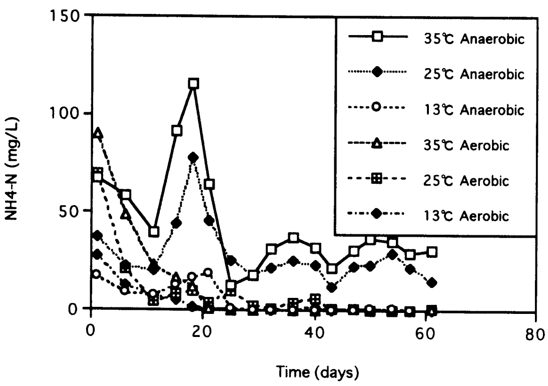

Fig.6. Changes of NH4-N concentrations

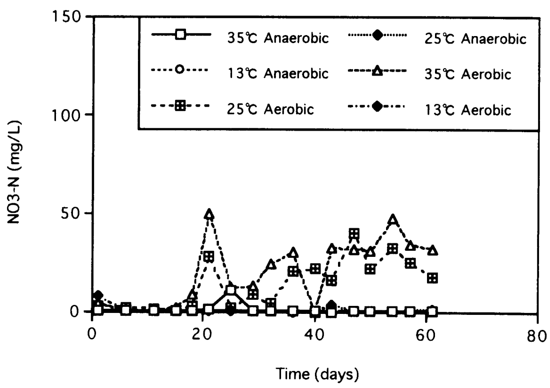

Fig.7. Changes of NO3,4-N concentrations