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EVALUATION OF KITCHEN GARBAGE TREATMENT BY ANAEROBIC/AEROBIC PROCESS COMBINED WITH DISPOSER SYSTEM

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A novel model for the kitchen garbage treatment, "crushing with disposer, anaerobic-aerobic degradation in digester, sewerage discharge", was evaluated in this study. The solubilization and degradation of crushed kitchen garbage were observed in anaerobic wastewater treatment at various temperatures (35°C, 25°C and 13°C) with different addition of nutrients. Both effluents and mass balances of anaerobic-aerobic kitchen garbage treatment were examined at various temperatures with nutrients being added. Experimental results and total cost analysis indicate that the kitchen garbage reduction, the operational safety and economy concerned with the proposed model are optimized at 25°C.

Key Words *: kitchen garbage, disposer, solubilization, anaerobic-aerobic process, digestion temperature, nutrients, total cost analysis*

1. INTRODUCTION

The occurrence of the garbage in daily life has increased sharply since the mid-1980s[1)]. In 1998, the total amount and the per capita per day of the household garbage in Japan were 53 Mt and 1,142 $g{\cdot}d^{-1}$, respectively. The industrial solid waste output also reached 415 $Mt{\cdot}y^{-1}$ (1997's value), and these industrial wastes were being treated at the rate of over 41% (169Mt). In comparison with industrial wastes, the garbage treatment and recycle remains at a low level, particularly in the case of the household garbage.

Household garbage, different from that produced in restaurants and factories, consists of various matters, including paper, glass, plastics and kitchen garbage. Kitchen garbage is the most notable solid waste at present. It accounts for 31 ~ 48% (w/w) of household garbage[2)] and has the following characteristics: (i) High moisture content, which inhibits the complete combustion. Due to the incomplete combustion at low temperature, some organic micropollutants such as polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) easily form[3), 4)], and accompanied with a large amount of energy consuming at drying stage. (ii) They are putrescible and are difficult to store, which means that the storage of the kitchen garbage easily gives rise to a foul smell and annoying insect, since main kitchen garbage compositions are organic matters. Hence, it has been suggested that the kitchen garbage should be treated apart from other combustible refuses. Done like this, the byproducts coming from the kitchen garbage treatment could be reused and recycled. Recently, a great deal improvement has been made on the treatment of organic wastes, the recycle and utilization of the residue, and biogases generated[5)-7)], but most of those achievements are mainly suitable for industry-scale applications.

The reasonable disposal of kitchen garbage becomes an important research topic at present, considering reduction efficiency, energy utilization and total cost.

Several models also have been put forward for the disposal of kitchen garbage. They include Model I: Collection, desiccation and incineration (directly or as RDF); Model II: Collection, degradation and methane recovery; Model III: Composting and farmland use; Model IV: Crushing with disposer and sewerage discharge[8)]. Comparatively, Model IV is a relatively concise procedure because it can avoid the daily strenuous garbage separation and collection. The garbage could be delivered to sewer systems right away as they are generated. However, the application of the disposer has been hindered due to some actual problems since it was developed in U.S.A. For example, direct discharge of crushed garbage may block up the sewer and cause a greater load on sewage treatment plants than usual: D-BOD, 1.6~1.7 times; SS, 1.3~1.4 times; T-N, 1.1~1.2 times and T-P, 1.3 times[9)]. Scientists recently have been trying to carry out the anaerobic-aerobic kitchen garbage pretreatment before the sewerage discharge[10)]. But the digestion temperature seems to be so high as to consume much energy. Effluents, which are to be discharged into the sewer, are excessively treated. Besides, due to the generation of methane, the operational safety cannot be disregarded.

In our study, kitchen garbage treatment by 25°C anaerobic and aerobic processes and the addition of nutrients is proposed.

Organic solid wastes are often recycled directly by thermophilic (55°C) and mesophilic (35°C) anaerobic and/or aerobic processes. Sasaki, H., *et al.*[11)] had ever examined the anaerobic fermentation of crushed kitchen garbage in 55°C wastewater. However, the digestion of organic wastes at low temperature was also well concerned. So far it has been examined on wastewater sludge[12)], synthetic substrate[13)], domestic sewage[14)], and etc., but the kitchen garbage treatment in wastewater, at 25°C and even low temperature, 13°C, has not been reported.

This study consists of anaerobic experiment, anaerobic-aerobic experiment, and total cost analysis. Anaerobic experiment was to study the effects of various temperatures (35°C, 25°C, and 13°C) and different additions of nutrients on the anaerobic treatment of the disposer-crushed kitchen garbage. The anaerobic-aerobic experiment was to examine the

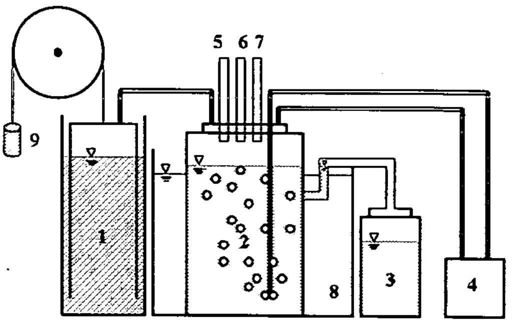

Fig.1 Schematic Diagram of Anaerobic Experimental Apparatus

1: Gas meter; 2: Anaerobic digestion chamber (working volume 1.2L); 3: Treated wastewater collector; 4: Air-circulating pump; 5: Outlet for gas sampling; 6: Inlet for tap water; 7: The inlet for substrate; 8: Water bath for temperature controlling; 9: counterweight.

effluents and C, N and P mass balances in one proposed system at various temperatures with nutrients being added, evaluating the actual performance and operational safety. With experimental results being referred, the economic benefits of kitchen garbage treatment at various temperatures were discussed by total cost analysis.

2. MATERIALS AND METHODS

(1) Experimental apparatus

Two sets of laboratory-scale apparatus were employed in experiments for different purposes.

a) Anaerobic digestion experimental apparatus

Fig.1 shows the schematic diagram of the anaerobic digestion system, composing of an anaerobic tank with an effective volume of 1.2 L, the gas-meter, and the gas-pump. A total of nine apparatuses with the same structure were employed for conditional experiments.

b) Anaerobic and aerobic continuous digestion system

The anaerobic and aerobic continuous digestion apparatus is designed as **Fig.2**, consisting of two linked parts, one anaerobic tank with an effective volume of 5.6 L, and one aerobic pond of 2.8 L. A total of three apparatuses with the same structure were manufactured.

(2) Synthesized garbage and preparation of the substrate

The composition of kitchen garbage may vary with different local conditions, as well as different seasons.

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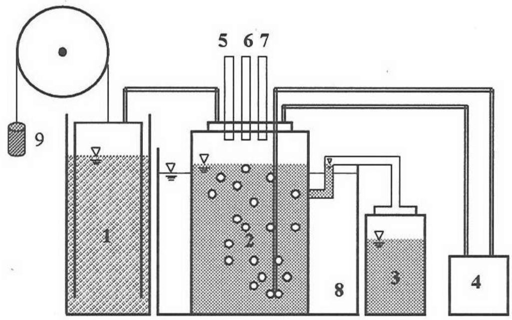

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Table 4 Anaerobic digestion experimental conditions

No.	1	2	3	4	5	6	7	8	9
Temperature (°C)		35			25			13	
The addition of nutrients*	A	B	C	A	B	C	A	B	C

*: A: $FeCl_2$ 0 + $NiCl_2$ 0 + $CoCl_2$ 0 ($mg{\cdot}L^{-1}{\cdot}d^{-1}$). B: $FeCl_2$ 20 + $NiCl_2$ 2 + $CoCl_2$ 2 ($mg{\cdot}L^{-1}{\cdot}d^{-1}$). C: $FeCl_2$ 100 + $NiCl_2$ 10 + $CoCl_2$ 10 ($mg{\cdot}L^{-1}{\cdot}d^{-1}$).

Table 5 Generation of biogas in case of no addition of nutrients ($mg\text{-}C{\cdot}d^{-1}{\cdot}unit^{-1}$)

App. No.	1	4	7
Aver. Production of biogas	3.6	0.6	0.1

Table 6 Effluent VSS and COD_{Cr} concentrations

App. No.	4	5	6
VSS ($mg{\cdot}L^{-1}$)	0.252 (0.117)	0.214 (0.094)	0.218 (0.048)
COD_{Cr} [SS contained] $mg{\cdot}day^{-1}{\cdot}unite^{-1}$	747 (151)	779 (174)	1040 (172)

(): Standard deviation.

were 1) to prevent excessive suspended solid discharge into the sewage; 2) to lessen the bacteria loss of reactor; and 3) to obtain COD_{Cr}, T-N and T-P concentrations of steady state effluents for estimating C, N and P mass balances in reactors. Simultaneously, nutrients were added at rates of $FeCl_2$: 20 $mg{\cdot}L^{-1}{\cdot}d^{-1}$, $CoCl_2$: 2 $mg{\cdot}L^{-1}{\cdot}d^{-1}$ and $NiCl_2$: 2 $mg{\cdot}L^{-1}{\cdot}d^{-1}$. It has been reported that nutrients were essential for microorganism activities. Adding nutrients (Fe, Co and Ni) was to make up the deficiency of nutrients in kitchen garbage[18]. The effluents after anaerobic and aerobic digestion treatments were sampled 2~3 times per week.

Three experiments were carried out at temperature 13, 25 and 35°C, respectively.

(4) Analytical Methods

All items were determined by U.S.A. Standard Methods[19]: COD_{Cr}: Acid Potassium Permanganate Method at 150°C; T-N and T-P, Persulfate digestion method; SS and VSS: Glass-fiber Filter Methods. Gas Chromatograph was used for gas analysis. Sludge activity tests were conducted with Japan Standard Methods[20].

3. RESULTS AND DISCUSSION

(1) Anaerobic digestion experiment

Biogas productions in anaerobic tanks with temperatures 13, 25 and 35°C, respectively, as evaluating indexes, have been observed. **Table 5** shows the results in the case of no addition of nutrients (for Apparatus No. 1, 4 and 7). The biogas production (expressed in Carbon) is estimated from $(P_{CH4}+P_{CO2})\times V_{Biogas}\times 12/22.4$. P_{CH4} and P_{CO2} are CH_4 and CO_2 contents (%), respectively. V_{Biogas} is total volume of the biogas daily produced, $mL{\cdot}d^{-1}$. It was found that the quantity of the biogas generated increases significantly with the temperature, especially from 25°C to 35°C. The same trends could be observed at the nutrient additions B and C. The biogas production is slightly higher at 25°C than at 13°C, but far lower than at 35°C.

For investigation of the effect of the addition of nutrients on the solubilization as well as the degradation of garbage, **Table 6** presents the average VSS and COD_{Cr} (SS contained) of effluents (from Apparatus No.4, 5 and 6) at 25°C. There is no obvious difference between VSS values. However, the effluent COD_{Cr} of App. No.6 is higher than that of App. No.5 and App. No.4 with significant differences (at 1% P level), and that of App. No.5 is also slightly higher than that of App. No.4 (although not significantly), i.e. the effluent COD_{Cr} concentration (containing SS) increases greatly with the addition of nutrients. Same results are obtained at both 13 and 35°C, respectively. Therefore it can be concluded that the solubilization of the garbage could be accelerated in the presence of nutrients.

It should be noted here, although the biogases were hardly generated at temperature 13°C, the soluble COD_{Cr} of effluents was higher than that at 25°C and especially 35°C at different degrees (statistical different, $P<0.05$). As can be found in **Table 7**. This demonstrates that the addition of nutrients could cause the solubilization of the garbage even at low temperature, while the degradation of soluble organic fractions could greatly reduce the soluble COD_{Cr} concentration of effluents at high temperature.

In addition, it can be seen from **Table 7** that the soluble T-N of effluents also increase with both the temperature [except from 25°C (No.5) to 35°C (No.2) in the case of Addition B] and the amount of nutrients added (except for that in the case of Addition B at 35°C), although the increased value by the addition of nutrients seems to have no obvious change at 13°C.

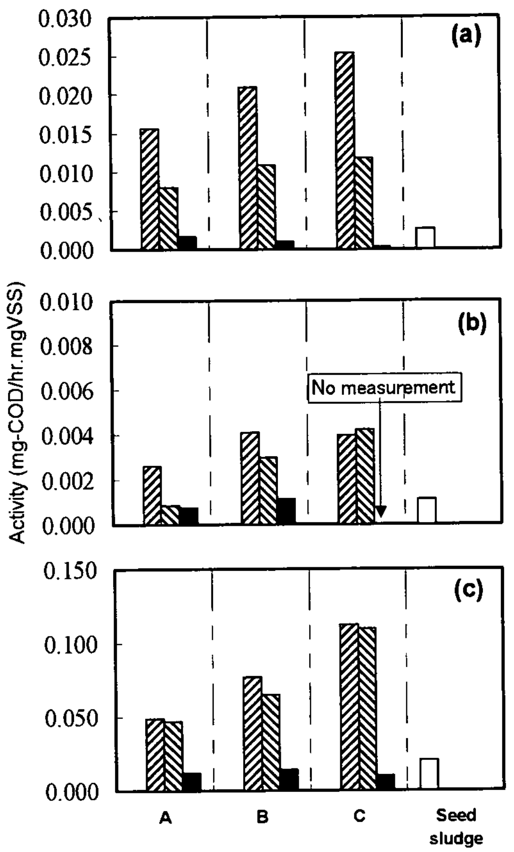

Fig.3 Sludge Activity (a) Hydrogen (b) HAc (c) Glucose as substrate.
□ Seed sludge ▨ 35°C ▧ 25°C ■ 13°C

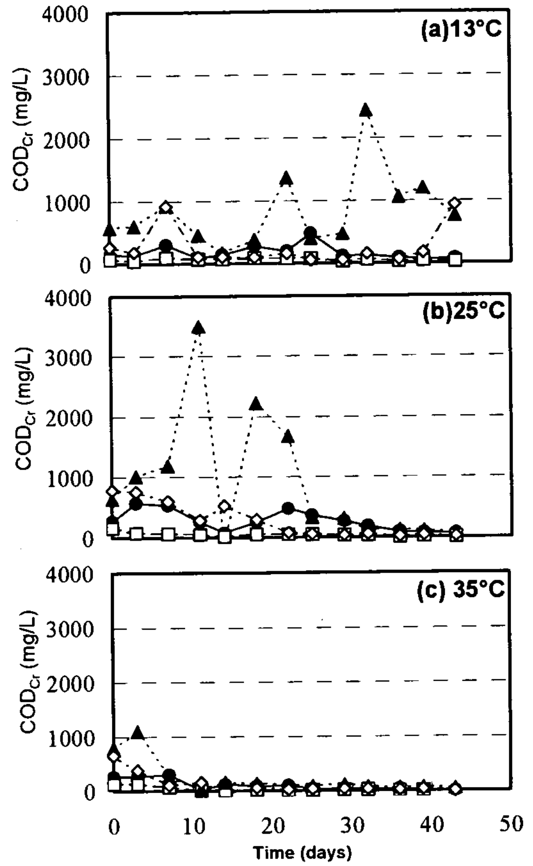

Fig.4 Effluent COD_{Cr} changes with elapsing time at 13, 25 and 35°C, respectively, HRT = 1.9 d.
● Aerobic (Soluble) □ Aerobic (SS)
▲ Anaerobic (Soluble) ◇ Anaerobic (SS)

The effluent soluble T-N may be proved to be significantly different at 5% P level. Therefore, the addition of nutrients and the increase in temperature can realize both solubilization and biodegradation of the organic N-containing fractions of the garbage.

All concentrations of the soluble T-P in effluents fluctuated irregularly at a low level for all three selected temperature systems. It is difficult to identify the relationship between the solubilization and the biodegradation of the garbage P-containing fractions with temperature and the addition of nutrients.

To study forward the sludge activities in anaerobic digestion systems, sludge activity tests were made by observing bacteria digestion rates of Acetic Acid (HAc), Glucose and Hydrogen. **Fig.3** shows the results of sludge activity as a function of COD_{Cr}. The activities of the sludge in effluents at both 35°C and 25°C were popularly higher than that of the seed digested sludge, but that at 13°C was lower than that of the seed digested sludge. As above, the sludge activity increases with the addition of nutrients at both 35°C and 25°C, except for HAc digestion bacteria. On the contrary, the sludge activities at 13°C are still lower than the activity of the seed digested sludge even if the nutrients were added.

(2) Anaerobic and aerobic continuous digestion

The short-term increases and decreases of COD_{Cr}, T-N and T-P concentrations in anaerobic effluents had been observed during the first month after the reactor start-up. **Fig.4** shows the changes of the effluent COD_{Cr} concentration with elapsing time. The increases and decreases of soluble COD_{Cr} concentrations of anaerobic effluents appeared around the 32nd, 12th and third day, respectively, indicating that the higher the digestion temperature was, the earlier this phenomenon appeared. Because it takes quite long time for the system set-up, the kitchen

Table 7 Average soluble COD_{Cr}, T-N and T-P in effluents, ($mg \cdot d^{-1}$)

	35°C			25°C			13°C		
App. No.	1	2	3	4	5	6	7	8	9
Soluble COD_{Cr}	360(114)	310(83)	460(148)	510(200)	430(92)	730(220)	530(43)	650(65)	720(131)
Soluble T-N	23(4)	18(2)	38(6)	17(8)	24(4)	32(4)	15(4)	13(1)	16(1)
Soluble T-P	18(2)	11(2)	13(2)	15(6)	14(3)	20(3)	10(2)	12(3)	20(2)

(): Standard Deviation.

Table 8 Average effluent COD_{Cr}, T-N, T-P, SS and VSS*

	Digestion Temperature (°C)	COD_{Cr} (mg·L^{-1})		T-N (mg·L^{-1})		T-P (mg·L^{-1})		SS (mg·L^{-1})	VSS (mg·L^{-1})	VSS /SS
		SS	Soluble	SS	Soluble	SS	Soluble			
Anaerobic effluents	35	154	44	88	75	12	7	138	101	69
	25	1220	357	82	37	15	8	638	532	90
	13	4087	946	230	44	27	12	2612	2418	94
Aerobic effluents	35	125	22	142	80	28	6	180	106	70
	25	789	61	101	13	20	3	972	825	87
	13	1314	103	115	23	17	5	1156	1006	88

*: From the day 105th to 196th since experiment start-up, HRT = 8.4 d (5.6 d for anaerobic tank).

garbage treatment at 13°C seems to be infeasible in practical application.

Table 8 shows the average effluent COD_{Cr}, T-N, T-P, SS and VSS from the day 105th to 196th since experiment start-up, respectively. The COD_{Cr}, VSS and SS concentrations of effluents, either anaerobic or aerobic, appreciably decrease with temperature. Furthermore, VSS/SS ratios also tend to drop.

Generally speaking, the main components of the kitchen garbage are organic matters, which will be transformed into the following three existing forms after the anaerobic and aerobic continuous process: (i) Dissolved organic matters, which will be discharged directly with domestic wastewater to the sewer. (ii) Biogases, CH_4 and CO_2, are formed from soluble organic fraction. (iii) Sludge, most of which accumulates in bioreactors, few of which is discharged with the wastewater. From the viewpoint of volume reduction (i.e. the reduction of solids in kitchen garbage, or the reduction of SS in effluents), we always hope that the kitchen garbage is transferred to soluble matters as much as possible. On the contrary, the high biogas production is not aimed at although the garbage volume-reduction is favored, because the existence of methane gas is quite dangerous to the practical utilization of such a system.

Table 9 gives the descriptions of Carbon, Nitrogen and Phosphorous mass balance, which were estimated for the effluents from the day 105th to 196th since experiment start-up. Those of organic carbon in effluents are conversed from COD_{Cr} by multiplied with 0.375.

At 35°C, 67.2% of the daily loading organic matter accumulated in reactors, 30.6% was released as

Table 9 Estimation of C, N and P mass balances*

		T	Organic C	T-N	T-P
Load rates, mg·d^{-1}			2119	150	29.3
Distribution, mg·d^{-1}	Discharge	35 °C	47	142	28
	Gasification		648	-	-
	Accumulation		1424	8	1.3
	Discharge	25 °C	296	101	20.0
	Gasification		274	-	-
	Accumulation		1549	49	9.3
	Discharge	13 °C	493	115	17.0
	Gasification		44	-	-
	Accumulation		1982	35	12.3

*: From the day 105th to 196th since experiment start-up, HRT = 8.4 d (5.6 d for anaerobic tank).

biogases, and only 2.2% was discharged out. The values at 25°C became 73.1%, 12.9% and 14.0%, respectively, and those at 13°C were 93.5%, 2.1% and 22.4%, respectively. The digestion temperature well affects the discharge of organic matters, biogas production and sludge accumulation. At 35°C, COD_{Cr}, T-N and T-P in effluents were treated to a level low enough for the sewage discharge, but the biogas was greatly released. At 13°C, although the biogas production was far little, the sludge accumulation gets easy, which may lead more frequent sludge cleaning than at 25°C and 35°C. It was found in this nearly six-month experiment that it took about 4 and more than 6 months for the anaerobic tank to be full of the sludge. For effective garbage volume reduction and the improvement of operational safety, the temperature 25°C is supposed to be a relatively appropriate temperature. The effluent was released at proper levels, while the biogas productivity dropped

Table 10 Total cost analysis on the household garbage treatment ($\times 10^3$ Yen)

		Detached house			Apartment house					
Number of families		1			20			50		
Digesting temperature (°C)		13	25	35	13	25	35	13	25	35
Disposer (0.55kW)	Price and installing	95	95	95	1,900	1,900	1,900	4,800	4,800	4,800
	Running, yr^{-1}	0.1	0.1	0.1	2.0	2.0	2.0	5.0	5.0	5.0
Plumbing	Price and installing	40	40	40	220	220	220	450	450	450
Tank	Price and installing	500	500	500	1,900	1,900	1,900	6,000	6,000	6,000
Temperature controller	Price and installing	0.0	30	30	0.0	70	70	0.0	70	70
	Running, yr^{-1}	0.0	18	70	0.0	79	260	0.0	79	260
Blower	Price and installing	30	30	30	70	70	70	220	220	220
	Running, yr^{-1}	5.1	5.1	5.1	23	23	23	23	23	23
Drainage pump	Price and installing	53	53	53	60	60	60	70	70	70
	Running, yr^{-1}	0.4	0.4	0.4	2.2	2.2	2.2	10	10	10
Maintenance yr^{-1}		20	20	20	120	120	120	320	320	320
Sludge cleaningyr^{-1}		80	40	20	400	200	100	800	400	100
Unknown cost: installing, chemicals, seed (microorganism), exchanging parts, yr^{-1}		20	20	20	200	200	200	250	250	250

greatly.

In one word, kitchen garbage may be treated appropriately at 25°C.

(3) Total cost analysis

Besides the treatment efficiency and operational safety, the total cost is also one noticeable aspect. Here, the total cost analysis of kitchen garbage treatment at different temperatures was made as follows. Temperature is one key, because the 35°C garbage treatment causes much energy consumption and biogas release; on another side, the digested sludge is subject to accumulate at 13°C, requiring much frequent cleaning-up (3-4 times·yr^{-1} in our study).

a) Description on the system operation

The proposed system consists mainly of the disposer, plumbing, the anaerobic and aerobic tanks, air blower, drainage pump, and temperature controller.

After start-up, the system enters a steady state. Kitchen garbage is crushed to the slurry state with the disposer, flows through the plumbing into the anaerobic tank and then aerobic tank, where the kitchen garbage is solubilized and degraded. Finally, the soluble fractions are drawn out to the sewer system and the solid residues are kept in the system.

b) Estimation of total cost

There are many facilities with similar purposes on sale now in Japan. For example, there are many styles of septic tanks or garbage digesters. But the application often causes high operation cost and energy consumption due to their extremely thorough processing abilities. With regard to the designed system discussed in this study, some estimated results have been listed in **Table 10**. The estimations were made at a total of three treatment temperatures, 13, 25 and 35°C, and two utilization conditions, which were both a detached house and two kinds of department buildings where 20 and 50 families stayed, respectively.

Prices of disposers on sale have been investigated from some of Japan's famous manufacturers such as Toto, Kyushu Matsushita and others. They were found mainly within the range from 40,000 to 150,000 Yen·unit^{-1}. Here an average value, 95,000 Yen·unit^{-1}, was chosen, in which the installing fee was included. It should be noted that this portion of fees must be paid only once within their own lifetimes. Some published reports[16] shows that one family usually uses the disposer about 3 times·d^{-1}, and 30 seconds for each use. Therefore, the total annual utilization period was estimated at 9 - 10 hrs. Supposing that the disposer power is 0.55 kW[21] and that 1 kWh is equal to 20 Yen (unit price of electricity), Annual Disposer Running Cost (ADRC) may be estimated as follows:

ADRC

$= 365\ (d) \times 30\ (s{\cdot}time^{-1}) \times 3\ (times{\cdot}d^{-1}) \times 20\ (Yen{\cdot}kWh^{-1}) \times 0.55\ (kW) / 3600$

$= 91.25\ (Yen) \approx 100\ (Yen)$

Table 11 Total cost at three treatment temperatures and different utilization scale (×1000Yen·family^{-1}·yr^{-1})

Number of families	1			20			50		
Lifetime (yr) \ T (°C).	13	25	35	13	25	35	13	25	35
8	215	197	229	63.1	57.5	61.7	56.9	50.7	48.4
12	185	165	198	54.5	48.8	53.0	47.3	41.0	38.7
20	161	140	173	47.7	41.8	46.0	39.7	33.3	31.0

ADRC would be not more than 100 Yen·unit^{-1}, which is almost negligible.

As for the plumbing, the cost in a detached house is generally higher than that in a department building, because the price of the system body or installing fee is divided among many families.

Prices of current septic tank products on sale have been researched to estimate the price of proposed treatment tank. Take septic tanks of D Corporation (Japan) for example, the tank price usually is at least 600,000 Yen for a family with less than 5 members; while for 7, 14, 25 and 547 consumers, the unit prices reach up to 770,000, 1,750,000, 2,000,000, 21,000,000 Yen, respectively, (all cited from Product Manual). Considering that the reactor designed in our study is simpler in the structure than the corresponding septic tank, 400,000, 1,500,000 and 5,000,000 Yen were used as prices of tanks corresponding to numbers of families 1, 20 and 50, respectively. As per the results listed in **Table 10**, certain amounts of installing fee also have been considered.

Since the temperature 13°C, as mentioned above[16], is accepted as the lowest temperature of the underground septic tank during the winter in Japan, therefore, no heater is needed for the temperature control. For the temperature controls at 25 and 35°C, the heaters must be equipped. Literature[13] shows that only running at intervals for a half day, one heater of 900W is able to keep the septic tank near 25°C, whether 20 or 50 families were served. Therefore, it was estimated that a heater of 1000W should run continuously to maintain the whole system at 35°C.

The parameters of both air blowers and drainage pumps were also obtained with reference to those of septic tanks concerned.

The maintenance and sludge cleaning used to be performed 4 times a year and once a year for the common septic tank, respectively. The anaerobic and aerobic experiment showed that it took about 4 and more than 6 months for 13°C and 25°C anaerobic digestion tanks to be full of the sludge. Therefore, it is suggested that the designed system should be cleaned once for 3, 6 and about 12 months when digestion

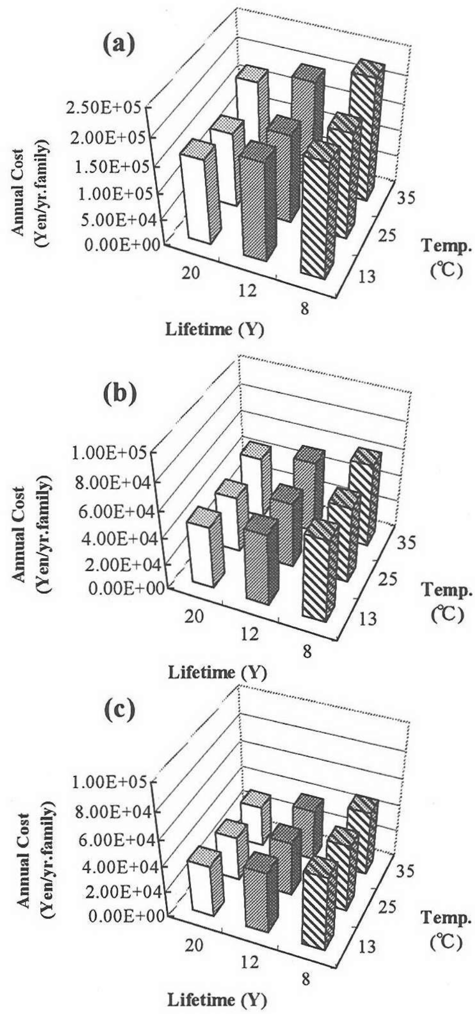

Fig.5 Annual total cost of the disposer system of the apartment building area with families: (a) 1; (b) 20; (c) 50, respectively (Yen·family^{-1}·yr^{-1})

temperatures were 13, 25 and 35°C, respectively.

c) Total cost analysis

The total costs concerned with kitchen garbage treatment by the disposer crushing, solubilization and sewerage discharge were analyzed. However it is impossible for all parts of the whole system to have the lifetimes of the same length, even for the same devices. Therefore, it is necessary to make some assumptions, and to some extent, considerable uncertainties of results are unavoidable.

The total initial expenditures of the designed system are distributed to corresponding lifetimes so as to analyze the total cost in a certain period. The annual fund investments needed are calculated at three temperatures and different numbers of families when the lifetimes of whole systems are projected to be 8, 12 and 20 yrs, respectively. In this case, all prices and installing fees except for the running fee are divided by the same lifetimes, and then added together. **Table 11** shows the results, from which **Fig.5** is obtained. Thus we can get the following conclusions: (i) The system with the long lifetime is likely to decrease annual total cost. Some parts should be used as long as possible in order to extend the lifetime of whole system; (ii) The most important conclusion is that the cost required at 25°C is lower than those at both 13°C and 35°C when the number of targeted families is no more than 20. This is because a high maintenance and sludge-cleaning fee are demanded at 13°C, and a large amount of energy (electricity) is consumed for the system operation at 35°C. Therefore, when the number of targeted families is limited, the temperature 25°C is believed to be the optimum temperature condition under which the kitchen garbage can also be treated at a low cost by disposer crushing, solubilization and sewerage discharge. The feasibility of kitchen garbage treatment at 25°C is also confirmed by the total cost analysis.

4. CONCLUSION

In short, with the addition of nutrients, the anaerobic-aerobic treatment of disposer-crushed kitchen garbage may be optimized at 25°C, keeping the relatively effective garbage reduction-volume, and improving the operational safety of household garbage treatment system.

The analysis also indicates that the total cost is lower at 25°C than those at both 13°C and 35°C, when the number of consumer is limited within a certain range.

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ディスポーザで粉砕した厨芥ごみの嫌気・好気消化法による処理の評価に関する研究

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本研究では「厨芥ごみをディスポーザで粉砕し，嫌気・好気消化法により分解処理をした後，下水道に放流する」ことについて評価を行った．まず，嫌気的条件下におけるディスポーザで粉砕した厨芥ごみの可溶化とその分解に関して，栄養塩添加の影響を調べた．さらに異なった設定温度条件（13，25，35℃）での可溶化と分解に関してその影響を調べた．次に栄養塩を添加し，粉砕した厨芥ごみを嫌気・好気消化法により処理する実験を同じく異なった設定温度条件で，それぞれ行った．この実験結果より物質収支を解析し，その結果から各温度における運転の総費用分析を行った．分析結果から，厨芥ごみの減容化特性，装置の運転操作の安全性，経済性の三つの面において25℃の運転温度が最適であることが示された．