Present Status of Biowaste Recycling in Japan

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1. Introduction

In recent years, global environmental problems have been closed up, and it is urgently required to develop the environmental protection technologies which will realize the low-loading society in the global scale region. In Japan, the amount of waste discharged has been rapidly increasing, since the latter half of 1980's. The percentage of recycling of general waste such as garbage is very small, comparing with that of industrial waste. Moreover, the treatment and disposal of sewage sludge of which percentage occupies approximately 50 % of industrial waste are the serious problems to be solved in, because a usable landfill is decreasing in each region. It is indispensable to develop the environmental protection technologies to bring the lowest impact to the environment.
In this paper, the present status of biowaste recycling in Japan are introduced, and the subjects and view of it are discussed.

2. Present status of biowaste

In Japan, biowaste is produced from the various kinds of origins, and the qualities are multifarious and seasonally changeable. Therefore, it is not easy to estimate the exact amount of production as in case of other kinds of wastes. The kinds of biowaste are over wide range, and agricultural waste, kitchen garbage, food industrial waste, stock waste and sewage sludge are among them. Table 1 shows the present status of the production of biowaste which were surveyed and estimated by the study group on biowaste recycling. According to the results, the amount of the production of biowaste in Japan is estimated to be about 200 million tons/year which corresponds to 60% of total wastes of general and industrial wastes including agriculture byproducts and sludge from night soil treatment.
It is especially difficult to estimate the amount of garbage, because the estimation method has not been established yet. Based on the table 1 on the necessity for food material by the Ministry of Agriculture, Forest and Fishery and the survey on the nutrition for the nation by the Ministry of Health and Welfare, the amount of garbage was estimated to be 18 million tons /year. On the other hand, it is estimated to be 20 million to/year, if the percentage of garbage in the general waste is assumed to be 40%. However, the percentage of garbage is remarkably variable and it may become the level of 20% in some cases. Therefore, the detailed survey should be conducted thereafter.
Garbage is discharged as a general waste and most of the garbage is incinerated to be disposed in landfill. Only 0.1% of it is composted today. In future, the amount of garbage and the residue of animals and plants from food industries will increase, if the Food Recycling Act will be enforced.

To evaluate the garbage as useful resource, the contents of the constituents of fertilizer were estimated to have 1320 thousand tons of nitrogen, 620 thousands tons of phosphorus and 850 thousands of potassium. Figure 1 shows the state of the production of garbage by regional groups. It depends on the region as biowaste is resulted from human activities. According to the above-mentioned survey, garbage from household and office in the three large city areas (Saitama, Chiba, Tokyo, Kanagawa, Aichi, Mie, Kyoto, Osaka, Hyogo) occupies 67% of total production. The amount of faces and urine of livestock in the three large city area occupies 18%, on the other hand, that in other cities occupies 82%. This shows the regionally uneven distribution of livestock waste. As shown in Table 2, organics containing in municipal wastewater, night soil, and agricultural waste are an important energy resource. Methane recovered from the above-mentioned organic wastes by methane fermentation corresponds to 9 million kl/year of crude petroleum. As about 200 million kl/year of crude petroleum is imported every year, the amount of energy recovery by methane fermentation corresponds to 4.5% of crude petroleum. Therefore, it will be hopeful to be the driving force of the substitute energy for oil

Table 1 Amount of production and component of main bio-wastes

($\times 10^4$ ton)

Bio-wastes	Kinds of wastes	Amount	Nitrogen	Phosphate	Potassium
Agriculture	Rice straw (1996)	1,094	6.57	2.19	10.94
	Wheat straw (1996)	78	0.31	0.16	0.78
	Chaff (1996)	232	1.39	0.46	1.16
	Subtotal	1,404	8.27	2.81	12.88
Stock farming	Cattle waste (1997)	9,430	74.90	27.40	51.90
	Stock residue (1995)	167	8.38	11.93	6.22
	Subtotal	9,597	83.28	39.33	58.12
Forestry	Bark (1996)	95	0.50	0.07	0.27
	Sawdust (1996)	50	0.08	0.02	0.07
	Chip of wood (1996)	402	0.60	0.12	0.56
	Subtotal	547	1.18	0.21	0.90
Food processing	Animals and plants residue (1993)	248	0.98	0.37	0.40
	Sludge (1993)	1,504	5.27	3.02	0.58
	Subtotal	1,752	6.25	3.39	0.98
Construction	Construction wood (1995)	632	0.95	0.19	0.88
Garbage	House hold and office (1995)	2,028	8.01	3.01	3.24
Grass and wood	Wood (1994)	247	1.87	0.47	0.91
Sludges	Sewage sludge (1996)	8,550	8.86	9.18	0.63
	Nightsoil (1995)	1,995	11.97	2.00	5.99
	Johkaso sludge (1995)	1,359	1.41	1.46	0.10
	Rural community sludge (1996)	32	0.03	0.03	0.00
	Subtotal	11,936	22.27	12.67	6.72
Total		28,143	132.08	62.08	84.63

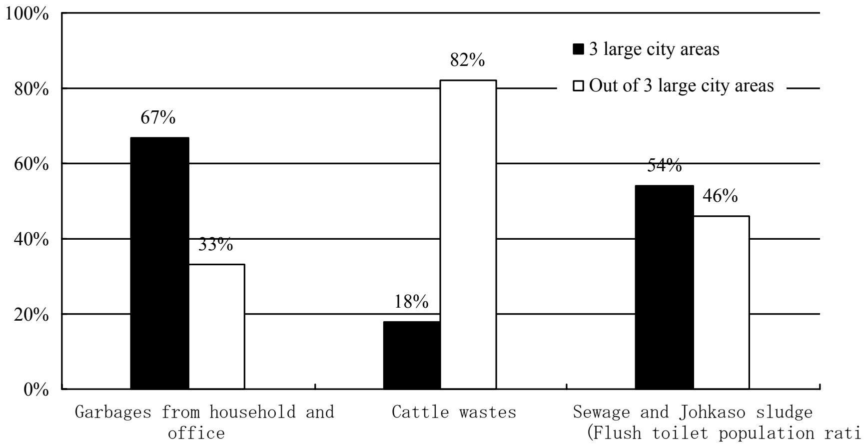

Fig.1 Production of bio-wastes by regional groups

3 large city areas：Saitama, Chiba, Tokyo, Kanagawa, Aichi, Mie, Kyoto, Osaka, Hyogo

Tble 2 Energy recovery by wastewater treatment (NEDO NEWS 1987)

Source of energy	Volume of wastewater	Potential of methane production (converted to oil kl/yer)
Sewage	21, 157 $\times 10^3 m^3$/day	5.8×10^5
Night soil	128 $\times 10^3 m^3$/day	3.5×10^5
Industrial wastewater	26,882 $\times 10^3 m^3$/day	7.3×10^6
Cattle wastewater	85 $\times 10^3 m^3$/day	7.7×10^5
Total	About 48,300 $\times 10^3 m^3$/day	9.0×10^6

Table 3 State of recycling of main bio-wastes

Kind of bio-wastes	Percentages to production （%）						
	Recycling					Others	Final disposal
	Agriculture use			Except agriculture	Total		
	Compost	Food	Others				
Rice straw	12	11	69	1	93	1	6
Chaff	22	0	43	1	66	7	27
Cattle waste	-	-	-	-	94	5	1
Stock residue	-	-	-	-	100	0	0
Bark	30	0	4	41	75	0	25
Sawdust	16	0	52	32	100	0	0
Wood chip	0	0	3	94	97	0	3
Animals and plants residue	-	-	-	-	39	52	9
Food processing sludge	-	-	-	-	4	89	7
Construction wood	0	0	0	37	37	2	61
Sewage sludge	8	0	5	17	30	3	67

Table 4 Present status of compost producing facility

	Facility	Number	Amount of production ($\times 10^3$ton)
Agriculture	Barnyard manure	2,537	1,280
Municipal wastes	Garbage composting (by local government)	39	-
	Food wastes processing	10	-
Wastewater sludge	Sewage sludge composting	42	43.8
	Rural community sewage sludge	8	-

3. Present status of biowaste recycling

(1) Composting

Table 3 shows the present status of biowaste recycling. Composting, recover of energy, feed processing, carbonization and melting for the production of construction material are given as the main procedures of biowaste recycling. Particularly, composting attained the high level of recycling technology, comparing with other technologies. The safety on pathogens and virus in compost is improved and its quality is stabilized through the methane fermentation process. Therefore, it has been the main treatment process of biowaste. The number of the companies for compost and the production of compost have been increasing year after year. It is reported that the number of the companies are 5,772 and the amount of compost produced is 3 million tons/year. The productions of bark and cow feces composts have been increased remarkably. The above-mentioned amount of compost was reported by the producers according to the Fertilizer Control Act. The amount of compost produced for the use of the household has not been grasped yet. Table 4 shows the results of the survey by local governments and the related groups. Regarding the actual condition of the circulation of compost, more than 50% of the total compost produced is utilized in the same region as the compost is produced and 20% of it is utilized in the other regions. The concentrations of heavy metals are obliged to be checked on the criteria for elution. In order to prevent the heavy metals from accumulating in the soil, the criteria for management was constituted, and the elution limits of cadmium, lead, arsenic and copper were also constituted by the Ministry of Environment.

(2) Melting of sewage sludge

Japan took the lead of developing the sewage sludge melting technology in the world. The Sewage Sludge Utilization Association already made the manual for the utilization of sewage sludge as the construction material in 1991. The measurement method on the elution of heavy metals contained in the melted materials has been improved and the new-type of melting furnace with gasification was developed by the joint work of Japan sewage Works Agency (JSWA) and the private company.

(3)Carbonization treatment

The content of carbon contained in the solid of sewage sludge is about 50% in case of high molecular coagulant sludge and it has the possibility to produce the carbonized material with good quality. JSWA developed the new technology to produce the charcoal from sewage sludge by the joint research with the private company. The fundamental study started in 1996 and the pilot plant of carbonization treatment with 3 tons/day has been operated since 1998. The carbonized sludge is added to sewage sludge as a coagulant aid and the effectiveness of it is confirmed on the decrease of moisture content of the sludge cakes dewatered by belt-press and screw-press filters, and centrifugal dehydrator.

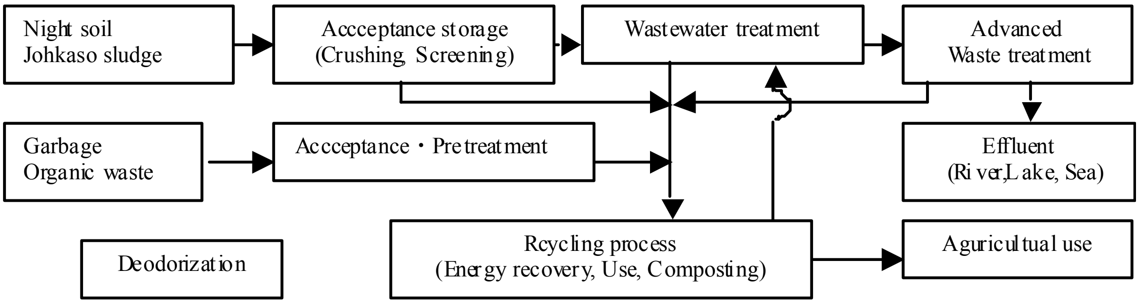

Fig.2 Sludge generation treatment center

(4) Sludge Regeneration Treatment Center

In recent years, the Ministry of Health and Welfare suggested the concept of “Sludge Regeneration Treatment Center Concept” as shown in Fig.2. Private companies introduced the methane fermentation process of biowaste from European countries and investigated methane fermentation of biowaste by pilot-plant experiments which were applied to the actual condition of biowaste in Japan. The number of actual facilities have been increased year by year in Japan.

4. The subjects on biowaste recycling

(1) Basic view

1) The necessity of the revolution of the nation’s consciousness for waste recycling

Generally speaking, the Japanese nation’s consciousness was not high in bearing the expense for the management of the large amount of waste and as the result, environmental pollution problems occurred to bring a tremendous amount of social cost for the counter plan after the fact. Therefore, it is important to have the view of agricultural economics that an appropriate cost should be sheared of the each step of production, recycling and disposal of the waste. Moreover, it is strongly desired that waste treatment works will be industrialized and the development of advanced waste treatment technology will be further developed , and the region for recycling will be more enlarged.

2) The ways of production, circulation and consumption of the present products made from waste should be reconsidered to promote the cooperation of each person in charge on biowaste recycling.

3) The construction of local system to enable biowaste to recycle

4) The introduction of recycling system based on the evaluation by life cycle assessment (LCA)

(2) The subjects in the promotion of biowaste recycling

Promoting to bear the expenses corresponding to the steps of manufacturing, marketing and consuming which are the source of discharge of waste, the investigation should be done on the construction of the system where the expense borne by the one who wrestles with biowaste recycling does not differ from that by the other who does not wrestle with recycling.

1) Quality and safety

The method of evaluation on the quality and safety of biowaste is not always satisfactory. The measurement method on epidemiological safety of pathogens and virus has not been established yet. Regarding heavy metals, the constitution of regulation must be based on the effects of the accumulation of heavy metals, because compost is fertilized in agriculture land for long years.

2) The investigation to make clear the reason why the individual recycling technology which was newly developed have not been widespread yet.
As an example, although biogas production technologies with high efficiency were developed, the utilization of biogas has not been prevailed yet in Japan.

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