THE CURRENT STATE AND FUTURE OF LANDFILL TECHNOLOGIES IN JAPAN

Masataka HANASHIMA
Fukuoka Research Center for Recycling Systems
Collaboration Center, Kitakyushu Science and Research Park, 2-1 Hibikino,
Wakamatsu-ku, Kitakyushu City 804-0135, Japan

1. TRANSITION OF MUNICIPAL SOLID WASTE MANAGEMENT

In an effort to revive the impoverished post-war Japanese economy, then Prime Minister H. Ikeda demonstrated an income-doubling program in 1960. With the increase of the national income, the amount of municipal solid waste also increased. "Consumption is a virtue" was a catchword in those days, and mass production and mass consumption started at this time. (See Fig. 1).

In 1963, the Emergency Establishment Act for Improvement of Living Environment Facilities was promulgated. In 1965, a guideline was issued to ensure that, subsequent to incineration of municipal solid waste, the residues should be subjected to landfill site in principal.

2. QUANTITY AND QUALITY OF GENERATED WASTE

The quantity of waste generated annually in Japan has shifted to a level slightly in excess of 450 million tons in recent years. It can be divided into about 50 million tons of municipal waste and about 400 million tons of industrial waste.

Fig. 2 shows the composition of municipal and industrial waste.

Fig. 3 shows the transition of the waste treatment method in the 1990s.

As can be observed in this figure, the municipal waste in Japan has come to be treated mainly by incineration since 1965, and the treatment by incineration reached a level of as high as 78 percent in 1998.

Fig. 4 shows the composition of the municipal waste to be subjected to final disposal, as a result. As illustrated, the amount of the incineration residue has increased with the lapse of time, and accounts for fifty percent at present. Increase of incineration amount has led us a big social problem in 1997, which brought "Dioxin Control Act" to the society.

For the industrial waste, in the meantime, there have been official statistics by the authorities since 1975. Starting from the level slightly lower than 240 million tons annually, the amount has been registering the levels above and below 240 million tons per year in the 1990s. (See Fig. 5).

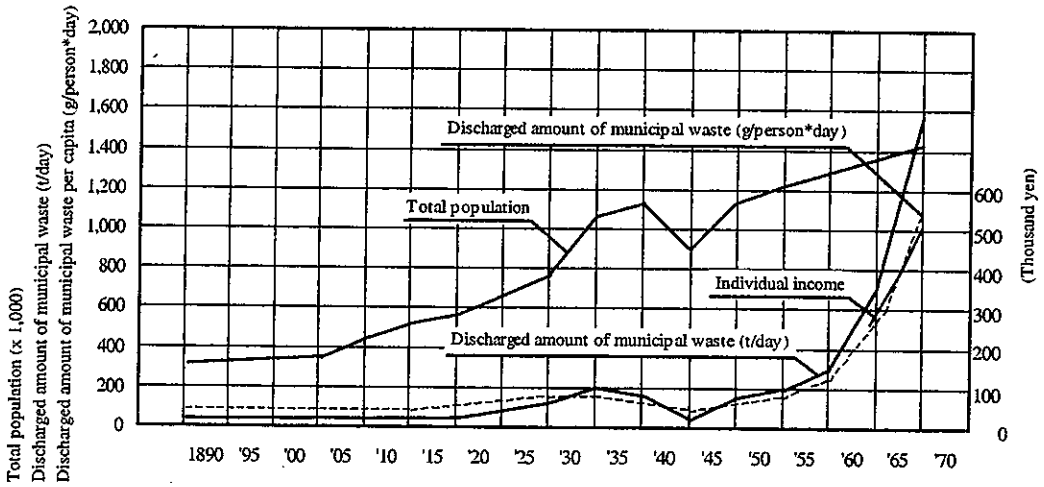


Fig. 1 Estimated amount of municipal solid waste generated in Kyoto city

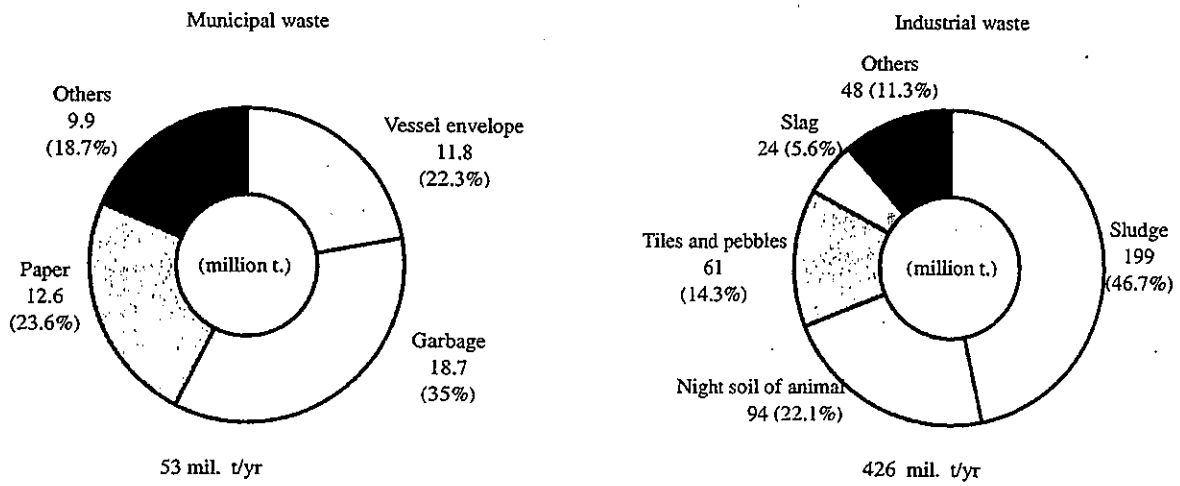


Fig.2 Composition of municipal waste and industrial waste in Japan

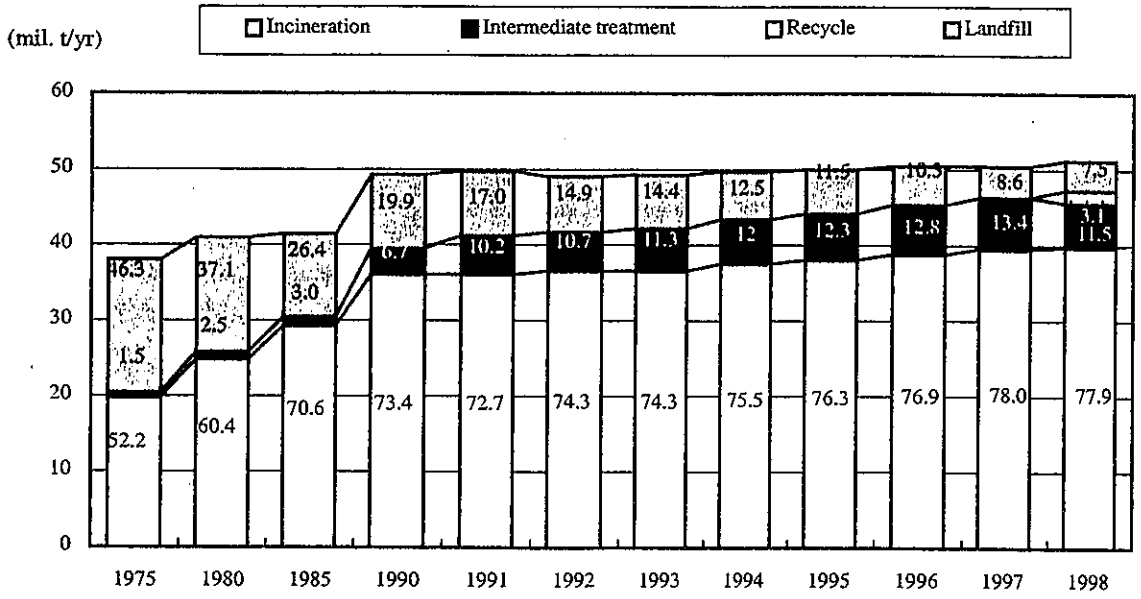


Fig.3 Transition of municipal solid waste treatment method in Japan

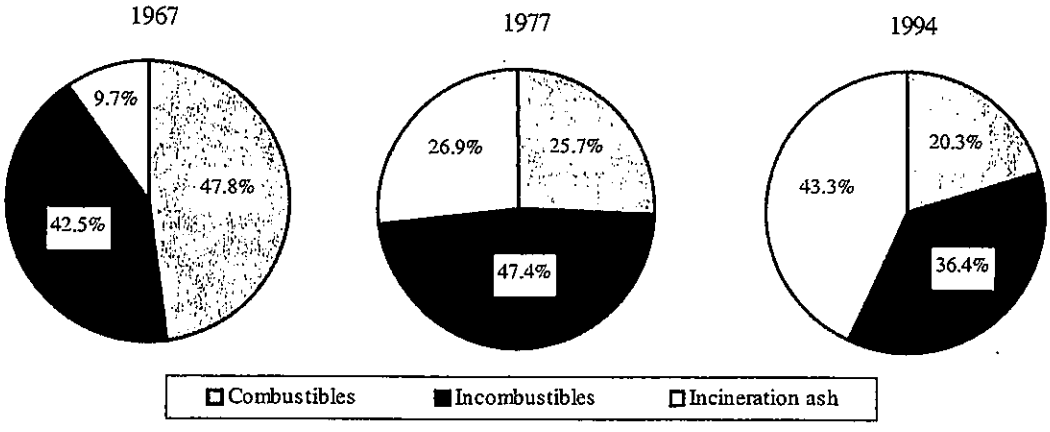
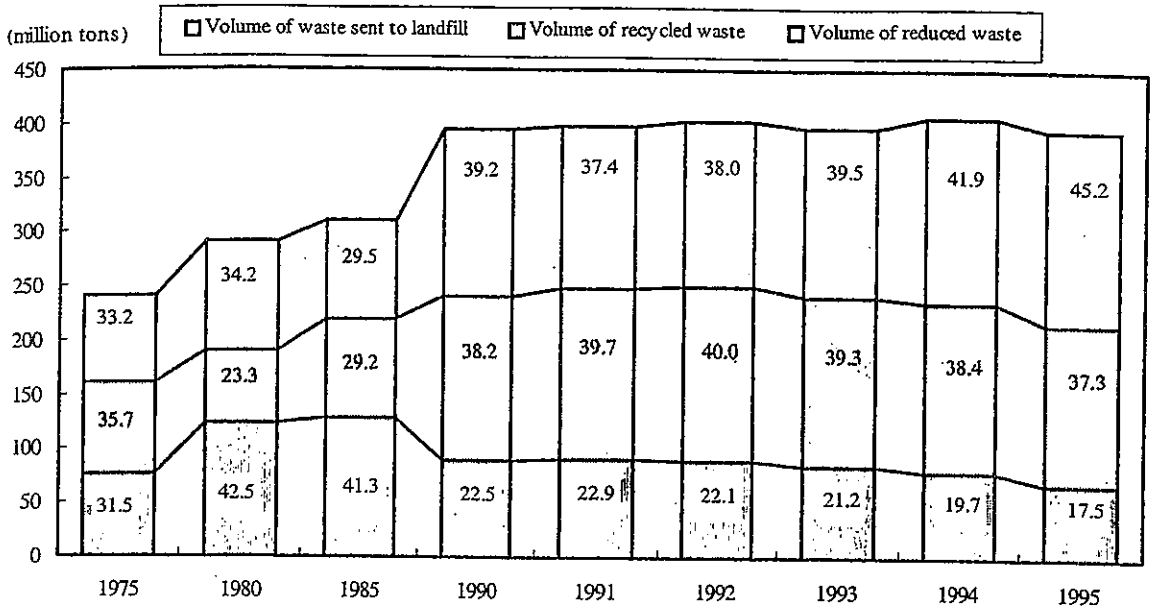


Fig.4 Transition of quality of landfilled solid waste incinerated residue in Japan



Figures in bar charts above are ratio of total waste

Fig.5 Amount of industrial waste reused as resources in Japan

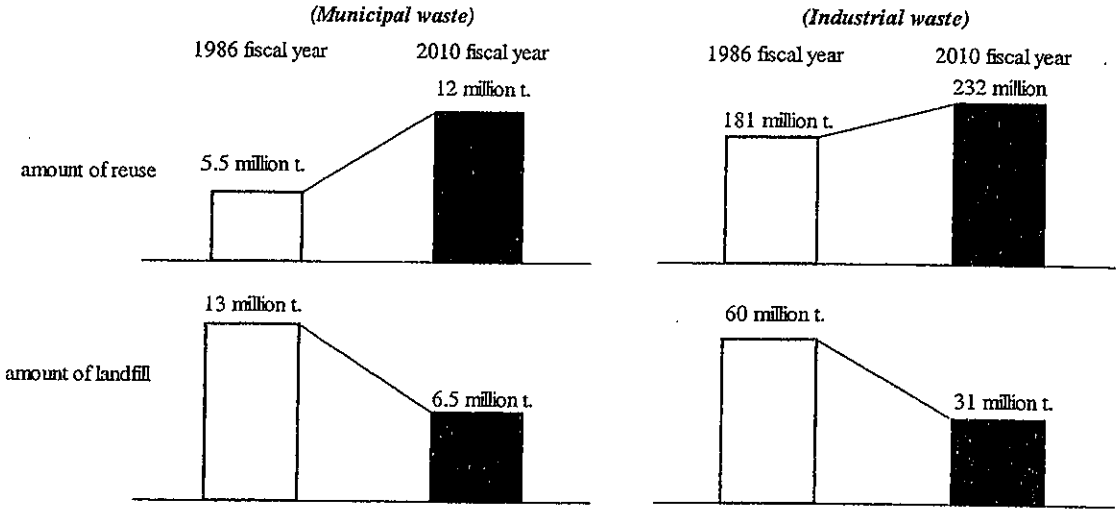


Fig.6 National target of waste reduction in Japan

It is noteworthy that there has been a decrease in the amount of waste subjected to final disposal due to the improvement of the function of intermediate treatment since 1995. The amount slightly below 90 million in the beginning of the 1990s has been reduced by about 20 percent. A 3R campaign (Reduce, Reuse and Recycle) was launched through the establishment of the Basic Act for Promotion of Recycling Community Formation promulgated in 2000 and Individual Acts related thereto. This will be certain to reduce the amount of waste, but it is not clear when waste can be reduced and what the amount of waste that can be reduced is.

According to the target in 2010 shown by the Government, the amount of municipal waste to be reused and recycled is 12 million tons annually, and the amount subjected to final disposal is 6.5 million tons annually, as shown in Fig. 6. The annual amount of industrial waste to be reused is 232 million tons, and the amount subjected to final disposal is 31 million tons annually.

In the Economic and Financial Advisory Council held in November 2001, a target was set up to ensure that the amount of solid waste to be landfilled should be cut down to one tenth by fiscal 2050, in an effort to achieve

a zero waste community. To be concrete, the amount of landfilled municipal and industrial waste registering 73 million tons in 1996 should be reduced to 7.3 million tons by fiscal 2050.

3. DIFFICULTIES IN THE CONSTRUCTION OF WASTE TREATMENT FACILITIES

Under the influence of the prevailing trend of encouraging consumption as a virtue, a great amount of waste was generated. Damages to the farm products caused by gas generated at the landfill site and poor management of the landfill site have given rise to mistrust of the nearby community people toward waste service companies, hence toward municipalities supervising such companies.

To put it more specifically, illegal dumping of industrial waste at Teshima in Kagawa Pref. has raised a big problem.

In fiscal 1998, 129 landfill sites for industrial waste were licensed, as shown in Fig. 7. This number was drastically reduced after the amendment of the Waste Disposal Law in 1997. As a result, only 26 sites were licensed in fiscal 1999.

The Japanese Environmental Sanitary Center conducted a survey and made the following report "The municipality questionnaire survey of today" shows that a predominantly greater percentage of the problem is related to influence of dioxins on human health and visual and psychological discomfort caused by them. As a result, compared with the poll of the community inhabitants conducted for the same item, it is conspicuous that the community inhabitants are concerned more about site selection procedure and consensus building procedure including method of information disclosure.

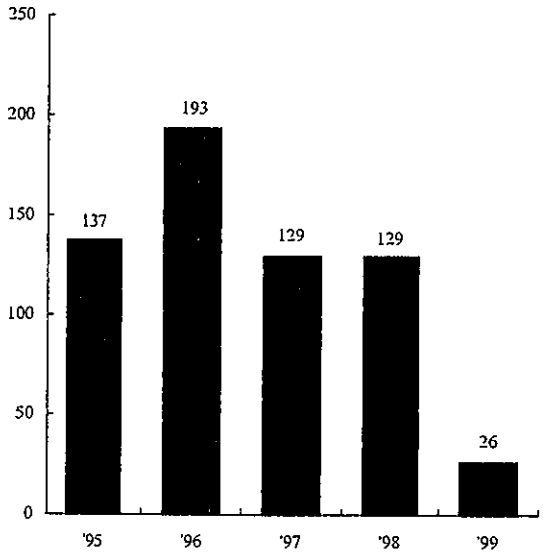


Fig.7 Number of newly licensed landfill sites in Japan

As discussed above, differences in views between municipalities and local inhabitants add further to the difficulties in construction of landfill sites.

4. TREND OF CONSTRUCTING WASTE TREATMENT FACILITIES

Japan has many landfill sites in valleys in mountainous districts, and these sites are often located in the upstream of the intake for drinking water. This has many campaigns of the inhabitants against construction of a landfill site. As a result, the landfill site tends to shift from the mountainous region without water source to the seaside.

Promotion of the adequate waste treatment requires development of unprecedented state-of-the-art technologies in order to solve various problems related to the difficulties of securing a landfill site, growing needs for recycling and advanced environmental protection measures including measures to protect against dioxins, etc.

Since waste disposal must be implemented over a wide area from now on, it was determined that each prefecture should carry out a wide-area municipal solid waste master plan by the end of fiscal 1998, and should lead the municipalities under the plan.

However, it is considered to be very difficult to depart from the principle of treatment within its own region on which each of the municipalities has been based so far, and to shift to a new principle of wide-area waste treatment.

For implementation of the public works where capital is invested, the PFI (Private Finance Initiative) is introduced in recent years. This is a next-generation business operation system intended to introduce the capital and know-how of the private sectors, to provide a more efficient and higher level of services and to ensure a balanced finance and growth of industry based on domestic demand.

As a first attempt for a landfill site management in Japan, private companies are invited to participate in the PFI for a landfill site to be launched by a city in Hokkaido in January 2002. In Hong Kong, a British firm has already embodied the PFI project.

5. TREND OF THE LANDFILL SITE

Since the Waste Disposal Law was formulated in 1970, it has been amended in 1991, 1997 and 2000. This was accompanied by formulation of more strict technological standards on a landfill site.

In the Japan Waste Management Association, attention

was paid to the importance of improvement of the landfill site, and the Commentary on the Guideline of Landfill sites was published in March 1989. It was utilized in the related fields extensively for more than ten years since that time. After that, the related laws and ordinances were amended, and it has become necessary to ensure an effective waste disposal in an advanced level and to promote quick introduction of new technologies. To meet this requirement, the Guideline of Landfill sites was renamed as the Guideline of Landfill site Performances in December 2000, and the Commentary was also renamed as the Planning and Designing Procedure for the Improvement of Landfill sites, thereby reflecting the spirit of the Guideline.

This Procedure covers the landfill site based on management system, and incorporates new items not found in the previous edition. These new items includes guidelines on the landfill site performances, procedures for placing an order for construction work of a landfill site, a bund for the construction of a landfill site (containing the description of PFI), seepage control technology and measures for protection against dioxins in the leachate treatment facilities, closed type facilities to be introduced as a new technology, new storage type disposal facilities using steel plates and a new system for accelerating stabilization by washing waste are also introduced.

(1) Semi-aerobic landfill (Fig. 8)

The average annual precipitation in Japan is 1,750mm. To avoid contamination of the area around the landfill site caused by leachate, an advanced level of leachate treatment facilities must be installed. This will increase the landfill site maintenance and control costs. It will also increase the costs for managing the completed landfill site.

To alleviate such burdens, a semi-aerobic landfill system invented in Japan is mainly introduced.

In this landfill type structure, the diameter of a leachate collection pipe is comparably wide, whereby air is allowed to flow into the upper portion of the pipe and leachate is permitted to flow through the lower portion. To assist the air to be penetrated to the waste layer and dispersed there, it is designed in a cairn stone structure with cobble stones laid one on top of another.

Basically, heat by biodegradation is used to produce thermal convection through a cairn structure and increased leachate collection section.
In Japan, the landfill sites are mainly composed of incinerated residue. Even such sites have an effect of assisting degradation of the unburnt organisms in incinerated residue or organic matters in crushed non-combustibles. They also have the effect of preventing hazardous gases from being produced, and maintaining the leachate collection function inside the landfill site. Because of these advantages, this structure is still used in Japan, which has humidity and much precipitation.

(2) Closed system landfill site

One of the landfill structures recently introduced in Japan is a closed system landfill site. This system has come to the fore as one of the measures in response to the movement against construction of a landfill site. In Japan, there are laws and ordinances prohibiting dumping of waste in a closed place such as an abandoned mine. To remove this ban, a closed system study association was formed in 1989.

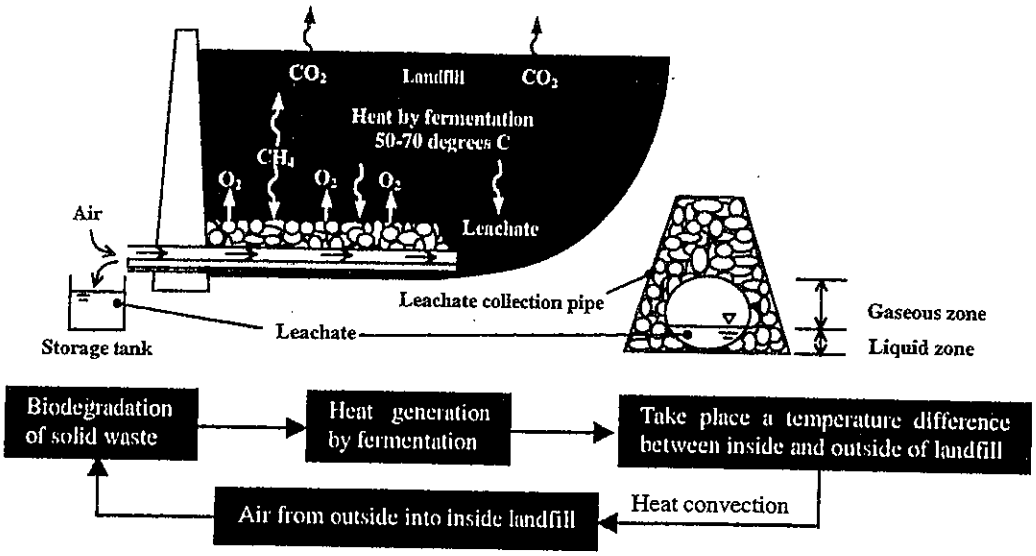


Fig.8 Illustration of semi-aerobic landfill system

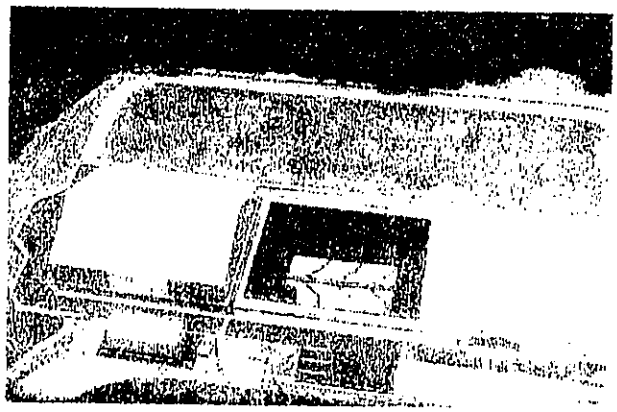


Fig.9-1 Closed landfill facility of movable type

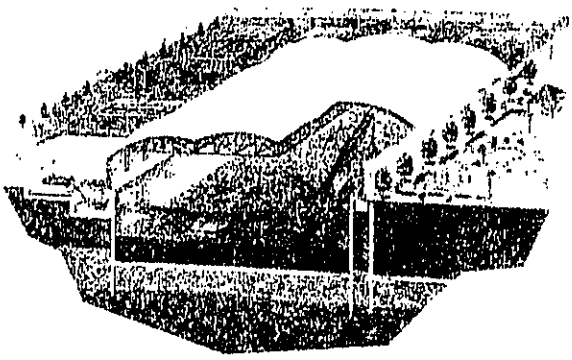


Fig.9-2 Closed landfill facility of tent type

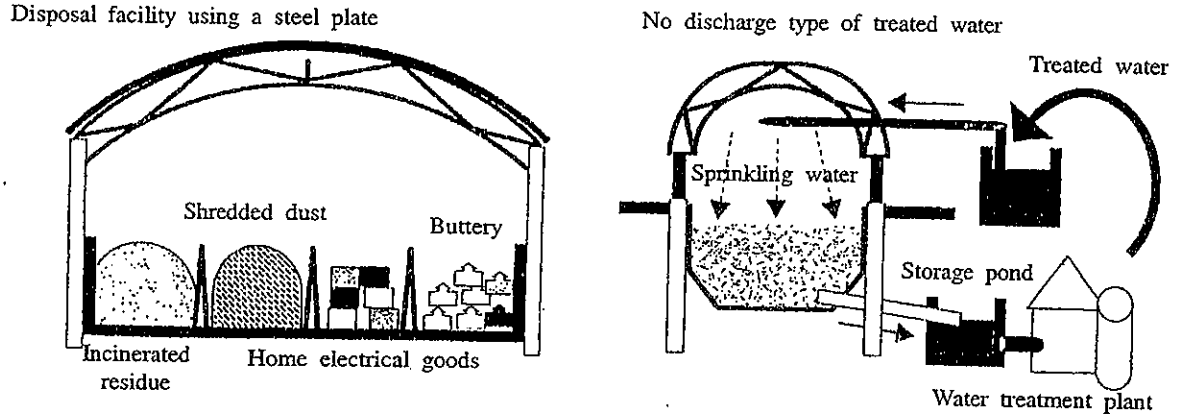


Fig.10 Stockyard disposal site using a steel plate

This system has the following advantages: (1) The appearance is improved and leachate management is facilitated by dumping waste in a closed space as shown in Fig. 9; (2) contamination in ground water likely to be caused in a landfill site can be eliminated; (3) the hazardous gas and offensive odor can be controlled; and (4) landfilling work can be performed even on a rainy or snowy day. On the other hand, it has disadvantages of possible explosion of dust and powder generated in a closed space, generation of gas and deterioration of working environment.
In addition, a higher construction cost is another disadvantage, which is being solved.

Since it is difficult for a Japanese local municipality to construct a disposal site, this system has come to be used in the construction of a small sized disposal site for disposal of only the waste in its own area. Publicly, local municipalities have introduced a landfill site of this type since 1998.

(3) Stockyard landfill site using a steel plate
In 1999, a study association was formed to create a landfill site using a steel plate.

A plastic sheet is used as a seepage control material at the current landfill site, and its breakdown has been taken up as creating a big social problem.
To solve this problem, a 9 to 12mm thick steel plate is used. This has the advantage of improving the strength of seepage control material and the degree of safety due to contamination of underground water or the like. The method of vertically driving a steel plate wall has the advantage of increasing the volume of the space than the conventional method of using earth.
Separation is possible by use of a partition wall, so the waste can be stored in a site in order to provide against subsequent recycling problems.
Since a steel plate is used, the service life as a disposal site can be defined. At present, its maximum service life is estimated at fifty years.

Another feature can be described as follows: Seismic disaster must be taken into account in Japan often visited by earthquake. Since a steel plate is used in the entire structure, the strength is easy to check and the earthquake-proof structure can be easily constructed. (See Fig. 10).
The following methods are considered to overcome the

problem of corrosion, the weakest point of this structure:
<1> Corrosion proofing by coating: Isolation of the steel surface from waste materials
<2> Corrosion proofing by electric means: Electric control of the progress of corrosion
<3> Corrosion proofing by coating plus electric means: Improvement of the effect of corrosion proofing by electric means

(4) Disposal site using waste washing method

In 2000, a WOW (Washing Out Waste) System Study Association was initiated to study the method of final waste disposal by intermediate treatment of waste in response to the changing social situations in Japan.

Since 1997 when discharge of a mount of estate started, foreign-owned companies have started to purchase the Japanese land. There is control by the Super Fund Law in the U.S.A. at the root of land purchase by western companies. If land contamination is found out subsequent to purchase of the land, a huge amount of burden is imposed on the previous landowners even if the land has not been contaminated by them. It has become necessary to evaluate land quality in addition to the extensible sense of value such as convenience or space of the land.

In this situation, washing waste, which is supposed to be one of the measures to construct a material recycling society, is expected to conserve a landfill site environment, to shorten stabilization of a landfill site and to enhance the land use effectively. Furthermore, washing waste could make reduction of loads on leachate treatment facilities, shortening a period from closure of caning in the waste to disuse as a landfill site and definition of the characteristics of the completed land site.

To put it more specifically:
<1> Dry washing: Separation of hazardous substances and useful matters by rubbing off the surface of incinerated residue (See Fig. 11).
<2> Wet washing: Washing off the deposited dissolvable matters by water-washing incinerated residue and other waste (See Fig. 12).

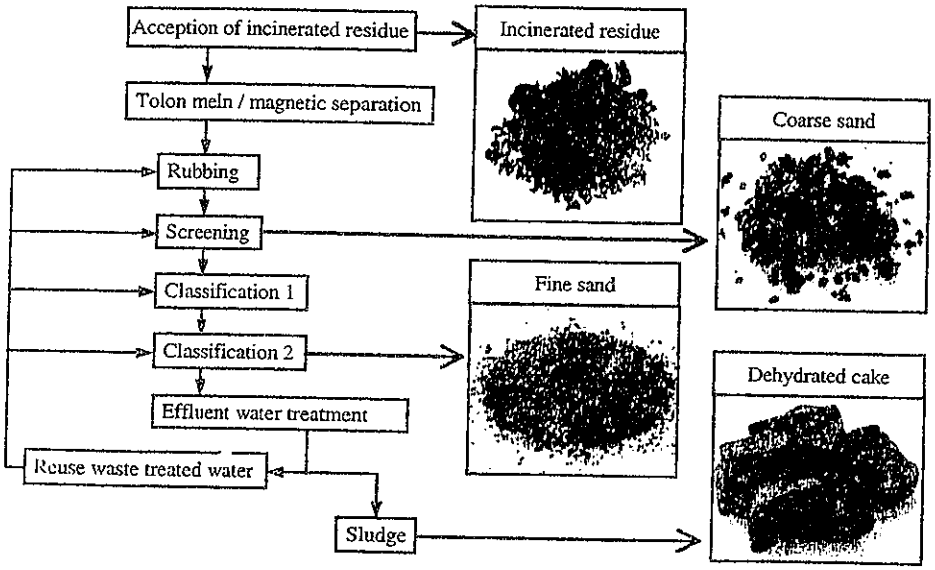


Fig.11 Dry solid rubbing treatment system

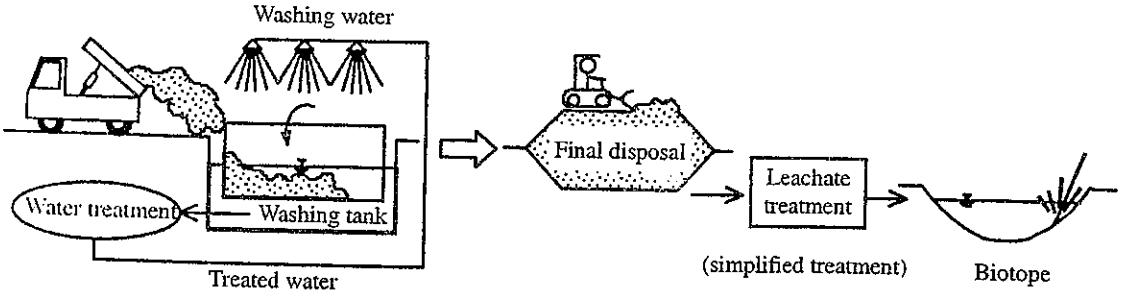


Fig.12 Concept of the WOW system

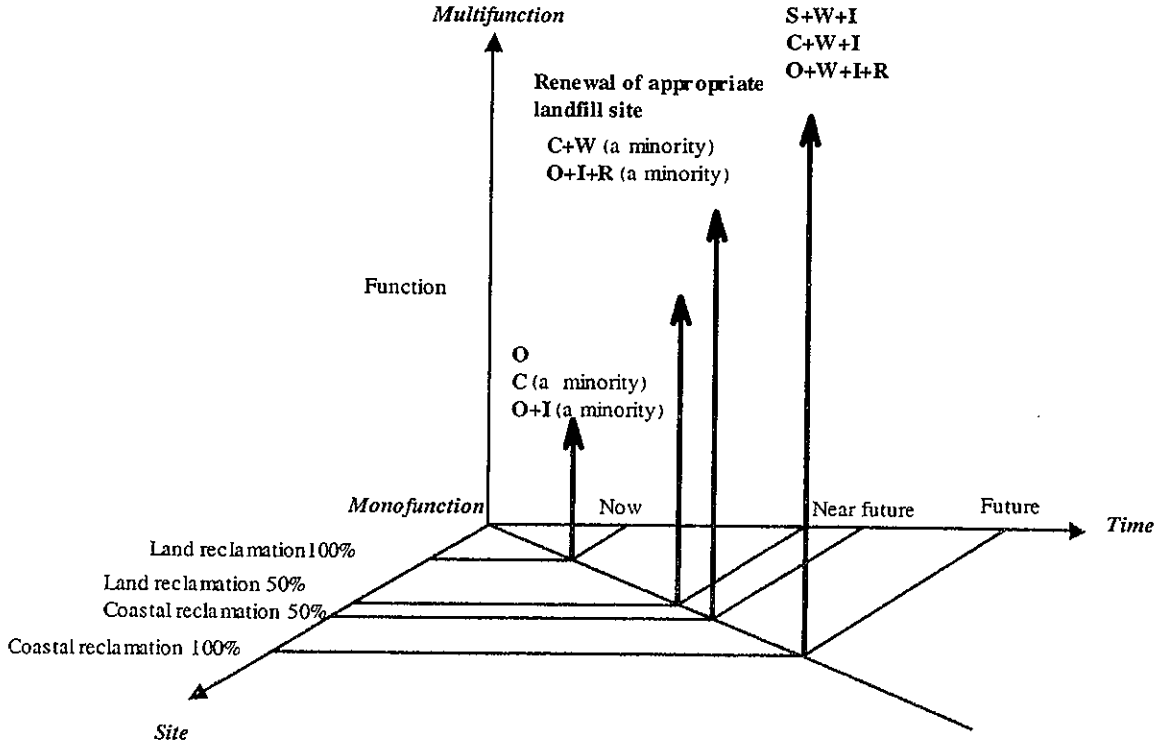


Fig. 13 Transition of landfill site

These steps are used to recycle the washed solids to create cement materials and construction materials. Salts leaching out by washing can be utilized as industrial refine salt, alkalis and acids. The washed completed landfill site has many advantages such as the possibility of earlier use of the land.

6. CONCLUSION

Fig. 13 provides a three dimensional illustration of the installation side and function of the landfill site based on various systems discussed above, showing their transition with respect to the current, near-future and future status.

The construction of an open or closed type landfill site will vary according to the location of each site and particular circumstances of each municipality. A storage type disposal site will be required with the progress of recycling. In response to the requirements by the local inhabitants, the inadequate landfill site will be renewed in increasing numbers of products.

We believe that presence of the adequate landfill site acceptable to the community people will provide a foundation for the effective progress of the recycling social system.

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