The Evolution of WTE Utilization - A Global Look
Asian Perspective - Waste Incineration and It's Value in Japan

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INTRODUCTION

Incineration carries significant weight in waste disposal in general. Seventy-five percent of the total quantity of municipal solid waste is incinerated. In the year 1994, there were a total of 1,854 incineration plants in Japan. Waste heat from MSW incineration is utilized for a power generation at most large-scale incineration plants.

In 1994, a total of 3,376 industrial waste incineration plants existed in Japan. They have been contributing much toward waste volume reduction, improvement of the quality of landfill materials through conversion of organic substances into inorganic substances which are more beneficial for landfill purposes, and conservation of resources by energy recovery.

But air pollution by exhaust substances -- especially dioxin -- from incineration plants pose a problem. This may place a big hurdle before future incineration plant projects. Small batch-type incineration furnaces are slowly dying out. Some municipalities will jointly construct a large incineration plant among themselves while others will consider introducing RDF producing plant, which is getting popular. More efforts will be made to melt and solidify the incineration residue, reduce the environmental load imposed by pollutants in the exhaust gas from now on.

GENERATION OF WASTE

Good health and comfortable life call for various foods, clothes and a house. All these essential items, however, are reduced to waste ultimately. Industrial waste is generated in a manufacturing process and in the distribution stage for a product. Waste is closely related to our health. In actuality, promotion and maintenance of health give rise to municipal solid waste and industrial waste.

Generated waste, if left as it is, gives out a bad odor and results in the breeding of noxious insects, which leads to a public hygiene problem highly detrimental to the human body. Thus presence of waste involves a risk to health. Waste is treated so as to make it into a state less harmful to the human body. Thus its disposal can contribute toward the enhancement of public hygiene and the preservation of the living environment. If it is improperly treated or disposed of, however, the waste or the treatment facility affects the environment with resultant physical harm and risk. Some measure to reduce this risk is therefore demanded. Thus health and waste are in complicated interrelation with each other.

The correlation between health and waste and that between waste disposal and physical risk are shown in Fig. 1. Probably dioxin is arousing the greatest concern now as a very dangerous byproduct of waste treatment. An exhaust gas is generated from incineration or some other intermediate process in a waste disposal system. Hazardous substances in such an exhaust gas are diffused into the air in large quantities, and they deteriorate the environment and adversely affect the human health -- that is, they are a serious threat to the human health. A leachate from a landfill site for incineration ash or the like contains hazardous chemical substances, which pollute underground water and surface water. These substances are taken into the bodies of various living things and condensed and may then be taken into human bodies also.

Breaking this circulation chain threatening human health is absolutely essential. Air pollution is controlled under the Air Pollution Control Law now, and water pollution under the Water Pollution Control Law. Soot, dust, nitrogen oxides, sulfur oxides and hydrogen chloride from waste incineration plants are under statutory control, but dioxin is still exempted from the regulation. Aside from dioxin, cadmium, mercury and some other possibly dangerous heavy metals are not under statutory control in Japan. But they are regulated under a law in some other countries.

WASTE DISPOSAL AND BASIC PRINCIPLE

The basic principle underlying waste disposal is shown in Fig. 2. Generation of waste is controlled at source by households and business enterprises, in which the waste originates. Recyclable components of such waste are separately discharged to facilitate recycling.

Municipalities and waste disposal agents, who dispose of waste, sort out useful components from the collected waste and put them in a recycling route. If recycling is not an appropriate action because of the technical difficulty involved in it, the environmental load, etc., volume reduction by incineration with every effort to take appropriate environment preservation action, and use of the energy derived from the incineration should be promoted. The ultimate residue is subjected to the proper final disposal.

The municipal waste disposal by municipalities and regional governments in Japan was initiated upon the promulgation of the "Dirt Removal Law" in 1990. Infectious diseases were rampant in Japan at that time, and it was therefore an important task to take effective measures against the generation of infectious insects and unsanitary water channels. Attention was directed to waste disposal from the standpoint of public hygiene action.

In 1954, after the end of World War II, the "Public Cleansing Law" was introduced to secure a hygienically sound living environment, followed by the "Waste Disposal and Public Cleansing Law" in 1970. These two constitute the main framework of the present waste management legislation. The "Waste Disposal and Public Cleansing Law had a widened regulatory coverage extended from municipal solid wastes to "industrial wastes" generated from industrial activities. Thus a complete legislative framework for environment conservation was established.

In the 20 years from the enactment of the original "Waste Disposal and Public Cleansing Law", the Japanese people's life style and economic structure have undergone drastic changes with their economic affluence in the background, with resultant quantitative growth and diversity in nature of wastes. Mass-production and mass-consumption in the human society have resulted in the depletion of forests, mineral resources, etc., the warming of the earth, acid rain, destruction of the ozone layer, sea pollution and other global environment problems. It has been realized that waste management holds the key to "sustainable growth".

Under the circumstances, the "Law for Promotion of Resource Recycling and Reuse" and the new "Waste Disposal and Public Cleansing Law" were enacted in Japan as basic statutory regulations regarding waste disposal and recycling in 1991. The "Law for Promotion of Resource Recycling and Reuse" aims at promoting recycling at the production, distribution, and consumption stages, having resources effectively used, suppressing generation of wastes and conserving environment.

Measures for waste reduction through waste discharge control, promotion of recycling, etc. were incorporated into the revised Waste Disposal and Public Cleansing Law. Furthermore, the Law for Promotion of Separate Collection and Recycling of Packaging Waste was enacted in June, 1995 and put into force in April, 1997.

As shown in Table 1, the earliest actions related to waste disposal were public hygiene measures including those for preventing contagious diseases. A shift was subsequently effected to environment hygiene measures to maintain urban functions and preserve living environment. Today waste disposal is quite significant for the purpose of global environment preservation.

WASTE DISPOSAL AT PRESENT

Disposal of Municipal Solid Waste

Japan is quite densely populated in comparison with other countries of the world, and its industries and population concentrate in cities. In its populous cities, waste generation density is high, but space resources are scarce. The difficulty in acquiring suitable land in such a city for a waste treatment or disposal site has been increasing every year. Pronounced difficulty in its acquisition is encountered in the case of a final disposal site which demands a very large space. In Japan, extra efforts have therefore been made to reduce generated waste by various intermediate treatments. Incineration, a process which can sharply reduce the volume of waste and is hygienic, is extensively adopted. In 1993,74.3% of the total quantity of waste discharged in that year was directly incinerated, 9.4% was separated and crushed, put in a high-speed composting process or otherwise treated, and 1.9% was processed in some other ways. Thus 85.6% of the discharged waste was subjected to some form of intermediate processing. The

quantity buried at landfill sites was reduced by the promotion of such intermediate processing from 15.3 million tons in 1992 to 14.96 million tons in 1993.

Fig. 3 is a diagram showing the entire disposal flow of a municipal waste. Besides domestic waste collected by the municipal authorities, bulky refuse is also discharged from house holds. In addition, some ordinary business waste from small businesses such as food left-over from restaurants in a town and twigs cut off by gardeners is brought directly to facilities run by the municipal authorities.

According to the results of the Ministry of Health and Welfare's survey in 1991, the quantities of waste disposed of at the municipal facilities throughout Japan add up to approx. 50 million tons. That is, approx. 1 kg of waste is generated per capita per day in Japan. Some waste from households or elsewhere, although it a very slight portion of the aggregate quantity, is subjected to "backyard disposal" -- kitchen refuse of a farmer's house used as a fertilizer in his field, combustible waste burnt at a backyard and so on.

Another part of the generated waste is retrieved through a private route such as one provided by a self-governing organ of a local community, as a substance of value instead of being discharged as unwanted stuff for collection by a municipality. This is called "group collection". Various unwanted items in a substantial quantity including old paper, cloth, metal and a glass bottle are retrieved in this way. While 2.2 million tons of waste collected by municipalities were recycled in 1993, 1.9 million tons were picked up by citizens' group collection. Thus a quantity virtually equal to that recycled by municipalities was collected through private-sector routes. The above group collection figure was based on municipalities' statistics, and a substantial additional quantity was presumably collected by resource retrieval agents and others. The voluntary private-sector activities contribute significantly to resource recovery. To encourage such voluntary recycling activities, some municipalities grant a subsidy based on the collected quantity, lend or furnish the tools and others necessary for the recovery activities, provide information for collection agents, made publicity effort directed to residents of the community and perform other actions.

To prolong the service lives of landfill sites, many municipalities incinerate the entire quantity of combustible waste in principle. The rest of the waste is separated into non-combustibles and waste which, if incinerated, may have an evil consequence and is therefore directly buried at a landfill site. Organic waste such as garbage is composted or fed to animals on trial. Composters used at households, a major source of garbage, play an important part in waste reduction. Waste paper, glass, metal, etc. are collected as recyclable items or separated waste. Part of such waste is further screened and recycled at recycling facilities, and bulky waste containing paper, glass, metal, etc. (large-size waste articles such as home electric appliances or furniture) is crushed, and different substances of value are sorted out and retrieved. A typical waste disposal system for minimization of the final-disposal quantity is illustrated in a diagram in Fig. 4 below.

Disposal of Industrial Waste

The industrial waste discharged is divided into three groups for recycling, intermediate treatment and final disposal, as shown in Fig. 5. Of approx. 403 million tons of industrial waste discharged, approx. 250 million tons (62%) were given an intermediate treatment, approx. 92 million tons (23%) were recycled, and approx. 61 million tons (15%) were sent directly to final disposal sites.

The approx. 250 million tons of industrial waste subjected to an intermediate treatment were dissipated to approx. 97 million tons, out of which approx. 69 million tons were recycled and 28 million tons were finally disposed of. Approx. 89 million tons (22% of that total quantity) were finally disposed of.

The ways of industrial waste disposal differ with waste categories, states at the time of discharge, etc. Most of ashes and the like is directly brought to final disposal sites. Items which cannot be recycled finally disposed of or are unsuitable for recycling or final disposal directly in the state in which they are discharged, are given some intermediate treatment. Waste oil, waste acid, waste alkali and other items in liquid state are given treatments such as separation of oil and water or neutralization, etc. Sludge (which is left after treatment of a waste liquid) is put through a dehydration or drying process or the like to reduce its moisture content. Waste oil, waste plastics and other organic industrial waste are incinerated or treated otherwise. Such intermediate treatments turn some industrial waste into dehydrated sludge, incineration residue or the like, reducing the weight or volume.

In April 1992, there are a total of 12,970 facilities for intermediate treatment and final disposal of industrial waste throughout Japan. (That figure, however, is the total number of facilities of stipulated scale or larger scale, in respect of which an official notification is required under Article 15 of the government law. There are supposedly many small facilities free of that obligation to notify.) Of these intermediate treatment and final disposal facilities, 10,440 are operated for intermediate treatment, and 2,530 for final disposal; thus intermediate treatment facilities account for 80% of the total number. The number of incineration plants is 3,376 as indicated in Table 2.

CONCLUSION

Most putrefactive (organic) substances in waste are turned into water and carbon dioxide by incineration and then diffused into the air, and non-putrefactive ash is left. It does not rot and is therefore sanitary. Its weight is only 1/6 of the weight of the original garbage, and its volume is 1/10 to 1/20 of the volume of the original garbage. Waste Disposal methods other than landfill are valued highly in Japan where a landfill site is extremely difficult to acquire. According to an estimate, the utility of a landfill site increases even tenfold to twentyfold if garbage is not directly buried there. Hence incineration is the primary waste disposal method in Japan now. Seventy-five percent of the municipal solid waste discharged throughout the country is incinerated. This is at a very high level as compared with the similar percentages in other countries of the world, and Japan leads the world in incineration technology. Japan's success in neutralizing the biohazard and organic toxity accomplished by incineration and in reducing the volume is highly evaluated.

A combustion exhaust gas is generated from a waste incineration process. As waste contains a variety of substances, the exhaust gas contains hydrogen chloride and other hazardous gases. Accordingly, an emission standard was established in respect of soot and dust, sulfur oxides, nitrogen oxides and hydrogen chloride under the Air Pollution Control Law. Various pollution preventive means were installed in waste incineration plants throughout Japan to reduce the adverse effect on the environment to meet the specified emission requirements. Many large-scale facilities and many facilities in an urban area adopted a very strict self-imposed standard higher than the emission standard under the Air Pollution Control Law since the operation of such plants may seriously affect the environment and residents.

The purposes of introduction of an incineration plant include the reduction of the waste volume to prolong the service lives of final disposal sites, the conversion of organic substances into inorganic substances for stabilization into a state fit for final disposal and the recovery of energy by utilizing the characteristics of the waste in its original state. The order of priority for these purposes and their relative weight may differ according to the place and the plant operating organization. Many of the municipality officials in charge, however, say that the prolongation of the incineration plant service life is the primary purpose.

The followings are some of the findings and conclusions.

1) The available practicable solutions to the waste problem are waste reduction at source, promotion of recycling, volume reduction by intermediate treatment and its proper final disposal.

2) Landfilling is an essential way of waste disposal, but it is extremely difficult to acquire the land for a landfill disposal site because of space availability and the concern about the environmental risk involved in such disposal.

3) Incineration is valued highly as a beneficial method of reducing the waste volume, stabilizing the substances to be buried and recovering energy.

4) Desirable municipal waste management in the future should feature the following:
   - Waste dischargers' best possible waste reduction efforts.
   - Recovery of newspapers, magazines, etc. by group retrieval or through other volunteer activity.

- Municipalities' recovery and recycling of recyclable items such as glass and metal. Crushing of bulky waste and recovery and recycling of metal. Incineration of the rest and combustible waste. Landfill disposal of the other items. In fact, the amount to be disposed of at landfill disposal sites can be minimized by this combination of processes.

5) Waste is composed of various substances, and reduction of the environmental risk from treatment and disposal facilities to zero in a strict sense would be impossible. Hence it is important to take safety ensuring measures with the locations of those facilities, waste inflow control, the seepage control function, the monitoring system, etc. all taken into consideration.

REFERENCES

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Waste Management in Japan 1996. Japan Waste Management Association.

Table 1. History of waste-related legislation

Year	Purpose	Law
1900	Public hygiene measure	Dirt Removal Law
1954	Living environment preservation	Public Cleansing Law
1970	Domestic environment preservation	Waste Disposal and Public Cleansing Law
1991	Global environment preservation	Revision of the Waste Disposal and Public Cleansing Law Law for Promotion of Resource Recycling and Rence
1995	Global environment preservation (Promotion of recycling of packaging waste)	Law for Promotion of Separate Collection and Recycling of Packaging Waste

Table 2. Numbers of incineration plants (in April, 1994).

	number
Plants for incinerating sludge	514
Plants for incinerating waste oil	522
Plants for incinerating waste plastics	2,122
Industrial waste incineration plants (excluding those mentioned above)	218
Total	3,376

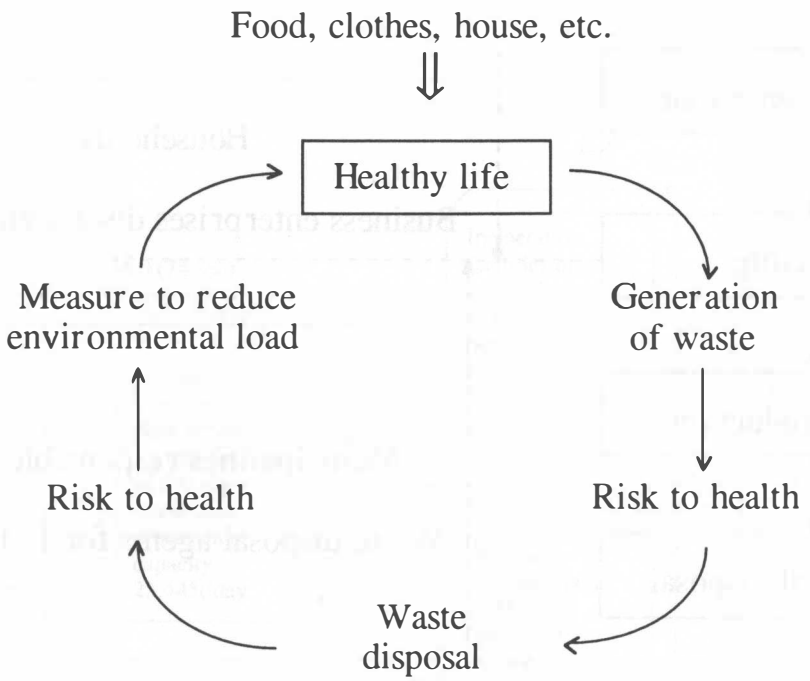

Figure 1. Interrelation Between Health and Waste and Interrelation Between Waste Disposal and Health.

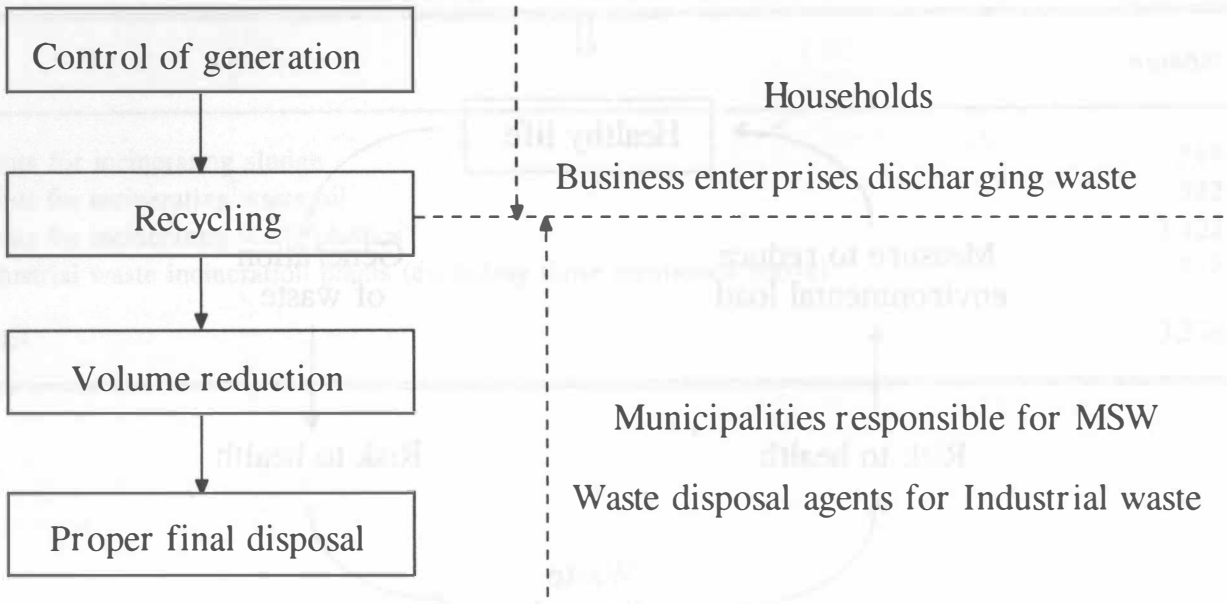

Figure 2. Basic Principle Underlying Waste Disposal.

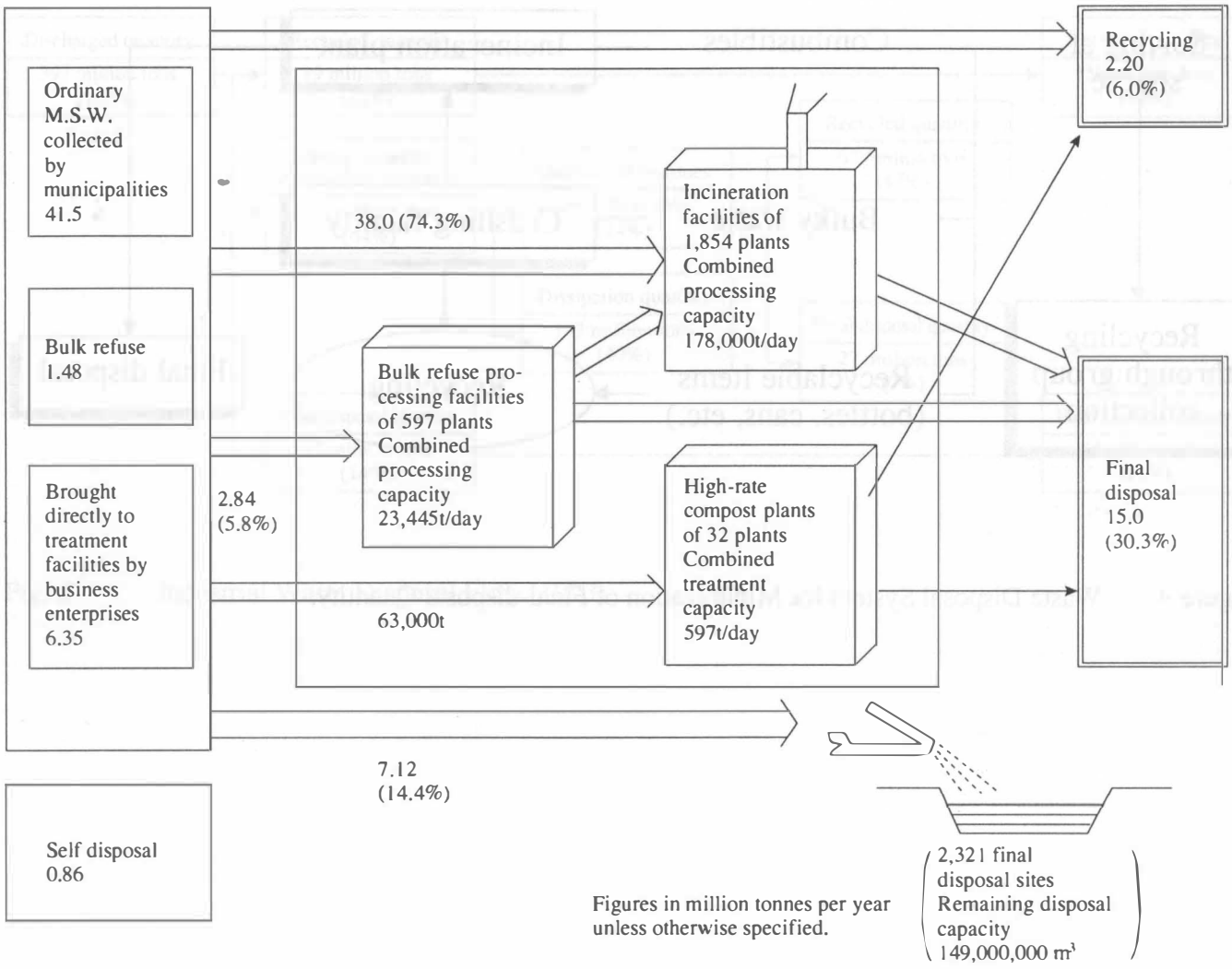

Figure 3. Waste Disposal Flow Diagram (1993).
Since: "Survey of Waste Disposal" by the Water Supply and Environmental Sanitation Department of the Ministry of Health and Welfare Japan.

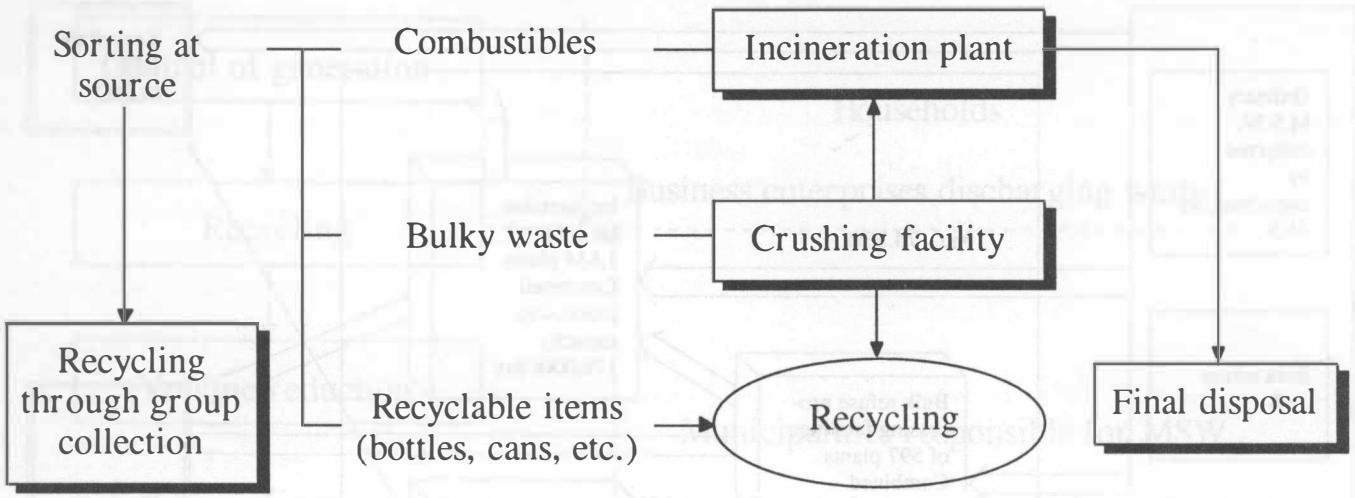

Figure 4. Waste Disposal System for Minimization of Final-disposal Quantity.

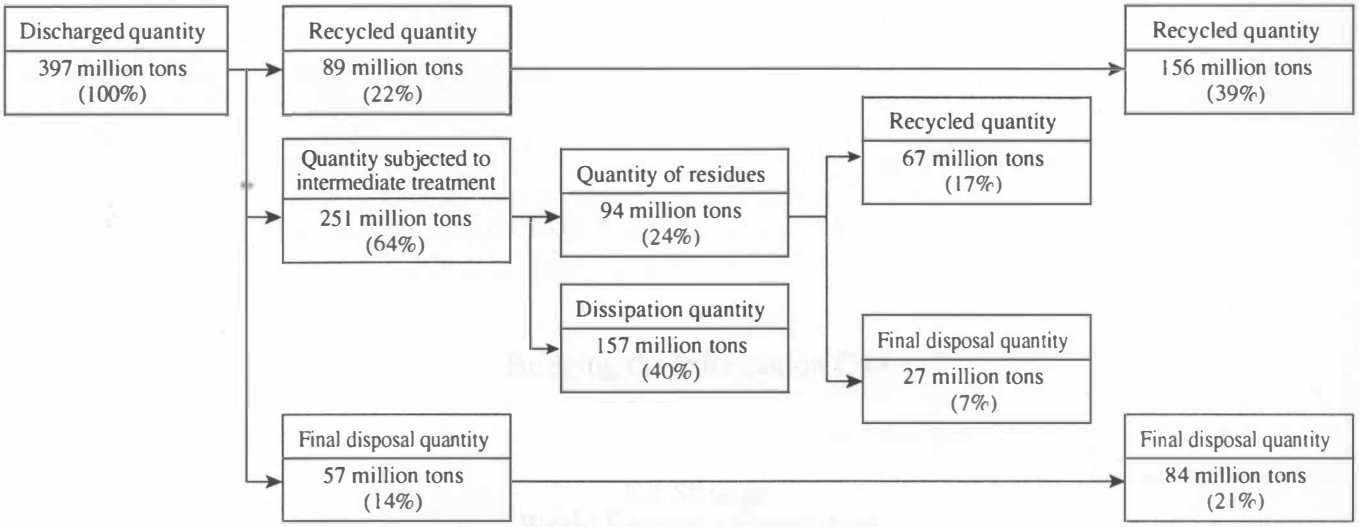

Fig. 5 Industrial Waste Disposal Flow (1993)