PROPOSAL OF CLOSED SYSTEM DISPOSAL FACILITIES FOR RESOURCE STORAGE

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ABSTRACT

One of idea of the next generation disposal facility is a complex facility, where not only the conventional function at landfills, but also a function of storage of unused resources, sorting recycable materials, or intermediate treatment are combined. The closed system disposal facility (CS) allows us to control quality of 'materials' within the facility in accordance with the required functions. In this study, we proposed a new application of a CS as a next generation facility. As regards the long-term storage function for the future, for instance, incinerated ashes of sewage sludge contain a lot of phosphorus, but it is difficult to recover phosphorus as a resource material due to its high recovery cost using present technology. It can therefore be thought to store incinerated ashes of sewage sludge as resources until cheap technology is developed. At the same time a humidity control system may be necessary to maintain water content in order to prevent the incinerated ashes of sewage sludge from solidifying. In addition, as regards the sorting function of resources, crushed incombustibles in general wastes include a lot of plastics. These crushed incombustibles and shredders are stored at a CS, and plastics are recovered at a sorting facility. The remains other than plastics will be eventually disposed of at the CS. Furthermore, as regards intermediate treatment function, incinerated ashes and fly ashes, which can be used as cement materials, will be temporarily stored at a CS, and the CS plays as a kind of treatment facility to extract heavy metals and chlorine at the same time. The energy necessary for operating the complex facility will be provided as heat and electricity from methane gas obtained by methane fermentation of organic wastes such as raw garbage and plant cuttings, etc.

INTRODUCTION

According to the White Paper on the Environment for the fiscal year 2002, Japan consumes 50% of the timbers, 24% of the metals, 25% of the crude oil, 27% of coals and 17% of the natural gas of total world consumption. As a result of the consumption of such a vast quantity of resources, an annual quantity of exhausted materials including wastes amounts to approximately 850 million tons. If this situation continues, it is obvious that the useful resources of the earth will dry up sooner or later. Because of this, we need to enhance resource saving and energy saving in a positive manner from the viewpoint of the prevention of drying-up of resources. In addition, we need to control the exhaustion of resources and convert wastes into resources. These are considered as important ways for alleviating and solving the global environmental issues. At the present time, wastes are eventually disposed of at a landfill. But, these disposed wastes include a lot of recoverable resource materials. It is necessary to control the quality of the "materials', using the function of storage of wastes, sorting function, intermediate treatment function, etc. in order to recover resource materials from wastes in the future. It is therefore considered that a closed system disposal facility (CS) could be applied to a facility for resource storage. Incinerated ashes of sewage sludge and, crushed incombustibles that include plastics et al., and bottom ashes and fly ashes that can be used as cement materials are candidates as resources. Several functions are required for conversion of wastes to resources in the CS. In this study, we investigated functions required for resource storage type CS, and proposed an new idea of the resource storage type CS.

ROLE OF CS

What is CS?

The concepts of a CS are "control" and "community". Control means that landfill wastes are stored safely, and their characteristics are monitored and converted to optimal quality for land use and recycling. The CS control quality of landfill waste in a closed space, as shown in Figure 1 (Ishii et al., 2003), without generating environmental pollution. The CS can prevent rainfall from infiltrating into waste layers and reduce the potential for groundwater pollution, which leads to safety of landfill sites.

Community, in the broad sense, means harmony with the local social setting through communication with residents, which can maintain reliance on landfill sites.

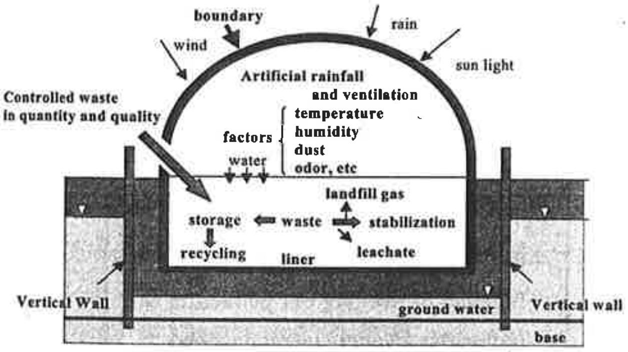

Figure 1 Schematic diagrams of CS

Storage function of CS

As mentioned above, the CS can control a disposed waste to meet objectives such as early stabilization with minimum environmental impacts. On the other hands, we can also see the disposed waste as resources in the future. For example, it is difficult to recycle wastes due to economical and technical conditions at the present time, but if these conditions are improved, the disposed waste will be able to be resources. In addition, if volume to be available for disposal of waste is lack, recyclable waste will be able to be dug out to collect resources, resulting to increasing the remaining volume for disposal. We can also convert the quality of the disposed wastes so that the quality of the waste is acceptable to recycling facilities. In addition, CS might be effective for countermeasures against neighboring environment such as dust and smell during digging the wastes.

The CS can play a role to control differences in the quantity and quality of recyclable wastes. The role is called the storage function of CS in this study.

EXAMPLE OF STORAGE IN CS

Incinerated ashes of sewage sludge

The quantity of phosphorous contained in incinerated ashes of sewage sludge in Japan corresponds to 15-30% (P_2O_5). The amount of sewage sludge generation amounts to 1,980 thousand tons-dry per annum, out of which 79% are treated at incineration plants, resulting in generation of 300-350 thousand tons of incinerated ashes. Therefore the quantity of P_2O_5 amounts to as much as 50 to 100 thousand tons per annum. Because phosphorous is well known to be one of exhaustible resources, phosphorous contained in the incinerated ashes expects to be used effectively. At the present time, although the recovery technology of phosphorous in water such as sewage water has been put into practice, the recovery technology of phosphorous from the incinerated ashes is currently under development. If the incinerated ashes of sewage sludge can be stored in a state applicable for a future recovery technology until the recovery technology of phosphorous is developed, the incinerated ashes will be expected to become a promising phosphorous resource.

The storage facilities for the incinerated ash of sewage sludge also require a function as a disposal facility, especially environmental protection. That is because that the storage of a vast quantity of incinerated ashes of sewage sludge may have an effect on the surrounding environment. Gases like methane and carbon dioxide are produced due to organic decomposition, and heavy metals may be eluted. The incinerated ashes must not be solidified nor mixed with other substances for their future use. Therefore, water content of the incinerated ashes is need to control to take out them easily at the time of using them, and to minimize an amount of soil for cover. The CS is one of the best storage facilities for these purposes (environmental protection and quality control) as shown in Figure 2.

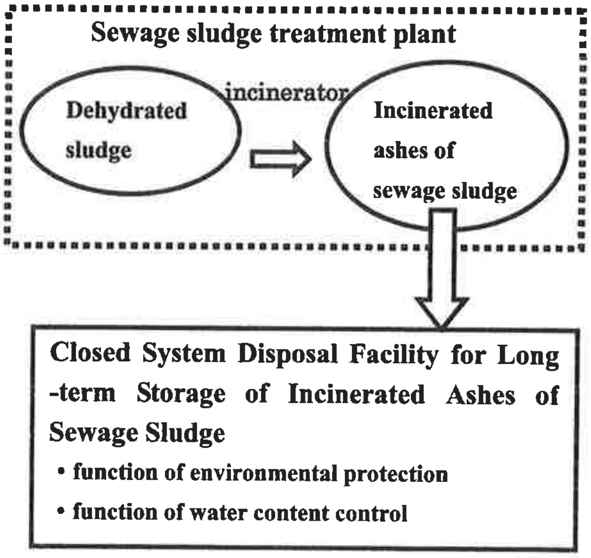

Figure 2 Idea of storage facility for incinerated ashes of sewage sludge

Recovery of plastics

The amount of waste plastics generation is 10,160 thousand tons every year in Japan, out of which 5,280 thousand tons are from general wastes, and 4,880 thousand tons of which are from industrial wastes. The 1,880 thousand tons of plastics in general wastes are used for generation of electricity, and 1,680 thousand tons of plastics are burned at municipal incineration plans (thermal recycling), the remaining 980 thousand tons is landfilled. On the other hand, the 1,920 thousand tons of plastics in industrial wastes is landfilled, 1,270 thousand tons is used for material recycling and 960 thousand tons is used for thermal recycling. Because various kinds of plastics are included in general wastes, the present usual use of them is limited to generation of electricity and thermal recycling. But plastics in industrial wastes include only a small amount of other substances. Material recycling is therefore estimated to be the main method of plastics in industrial wastes.

The method of making waste plastics resources is mainly divided into three methods, i.e. material recycling, chemical recycling and thermal recycling. An example of material recycling is to change PET bottles to various kinds of regenerated products such as fiber. An example of chemical recycling is to use as a replacement product for cokes as a blast furnace reducing agent. An example of thermal recycling is to use for heat supply and electric generation.

Crushed incombustibles in general wastes are mainly disposed of at landfills at the present. To recover plastics as resources from the incombustibles, one should consider a CS to be a temporary storage facility and set up a new facility for sorting plastics in the CS at the same time, as shown in Figure 3.

Because organic pollutants such as oils and other impurities such as sand and dirt, etc. are attached to the crushed incombustibles, it is necessary to wash out the pollutants and impurities as pretreatment. Water for washing is reused after water treatment. The pretreated incombustibles will be stored properly at CS.

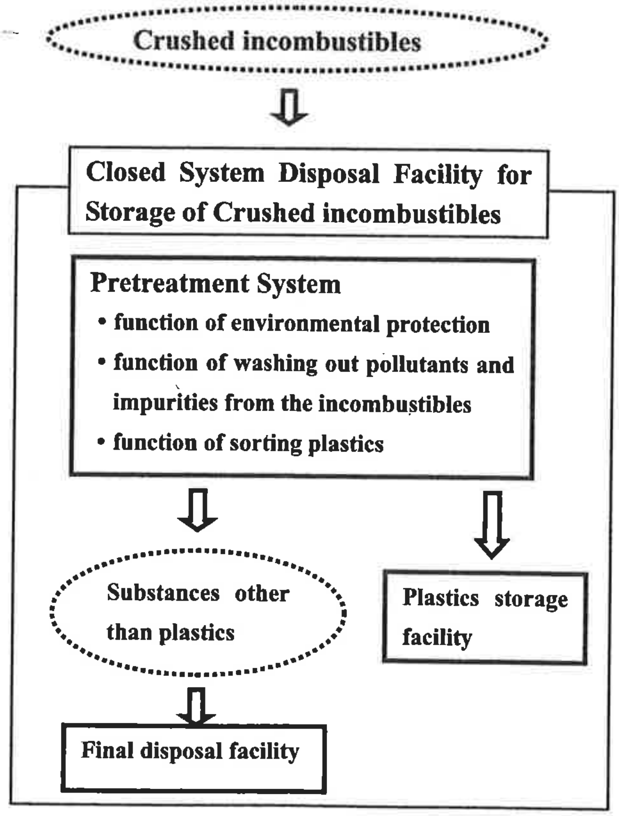

Figure 3 Idea of storage facility of plastics

Storage of bottom ashes and fly ashes

52,000 thousand tons of general wastes were generated in Japan in 2000, out of which 42,000 thousand tons of wastes were incinerated, and 5,700 thousand tons of their incinerated residues were landfilled. This amount corresponds to 54% of the total quantity of landfilled wastes. With regards to their recycling, the incinerated residues are melted or calcinated for construction materials. In addition, bottom ashes and fly ashes have started to be used as eco-cement materials in recent years. Eco-cement is produced by adding more than 500 kg of ashes to per 1 ton of cement products.

Incinerated residues are divided into bottom ashes and fly ashes, the proportions of which are 4 for bottom ashes and 1 for fly ashes. Because the incinerated residues usually contain a lot of the components of Portland cements, cement materials can be made by adding limestone to the bottom ashes or fly ashes. Nevertheless, removal of impurities is required for bottom ashes, and dechlorination treatment is required for fly ashes.

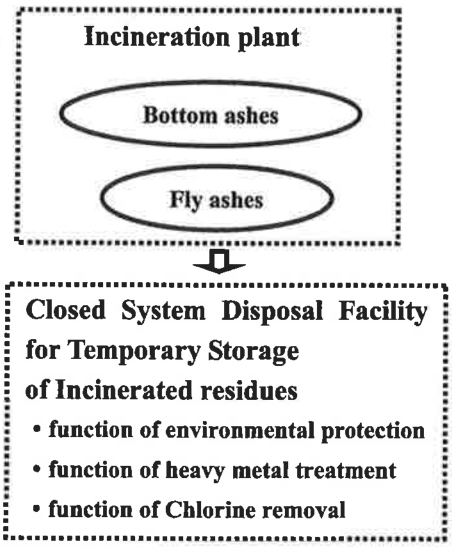

Figure 4 Idea of storage facility for incinerated residue

At the present state, according to the law in Japan, wastes that are not in conformity with the standards of the elution quantity of heavy metals must be landfilled in a strictly controlled landfill. In case of fly ashes, the elusion quantity of heavy metals exceeds the standard. They are therefore landfilled in a control-type landfill after cement solidifying or chelate treatment. In other words, because fly ashes as resources are mixed with other wastes in landfill site, it may require a treatment of further sorting out, when they are reused as resource materials in the future. For the purpose of making bottom ashes and fly ashes resource materials, as shown in Figure 4, they will be stored in a CS and a facility to remove heavy metals and salts contained in ashes will be set up at the same time side by side, which will play a role of the pretreatment facility for eco-cement production plant.

Heat and electricity supply facilities for resource recovery plants

19,400 thousand tons of food wastes consisting of general wastes and industrial wastes are generated in Japan every year, out of which 99.7% of them generated from general wastes, and 52% of those from industrial wastes are burned at incinerator plants. The remaining food wastes are recycled as composts, materials, etc., so the ratio of recycling resource materials can be said to be very low. Food wastes include a lot of water, but are rich in organic substance, and their use as a raw material for methane fermentation has been demonstrated. Generated methane gas can be used as a source of heat or as a fuel for electric co-generation by burning it. It is therefore expected to become an essential resource material that can be changed to heat and electric energy in the recycle-oriented society.

In addition, plant cuttings of street trees, etc., which are wastes in urban areas, are desired to be recycled as an organic resource material like food wastes. These organic matters can be used not only as raw materials for bio-gas but also as raw materials for composts and directly as fuels.

In general, wastes such as food wastes decompose easily, and are difficult to store. Accordingly, collected food wastes will promptly be used at a facility for methane fermentation or one for making composts. Generated heat and electricity can be supplied to other facilities for resource recovery. Figure 5 shows heat and electricity supply facilities where food wastes and plant cuttings are used.

PROPOSE OF COMPLEX FACILITIES FOR RESOURCE RECOVERY USING CS

CS has been considered as final disposal facilities. However, next general CS will be expected to have function as recovery facilities for resource materials. In this case, the role of a CS is expected to vary depending on resource material to be recovered as has been mentioned above. These facilities for resource recovery have not only a function as a just warehouse, but also functions of sorting out, washing, water content and

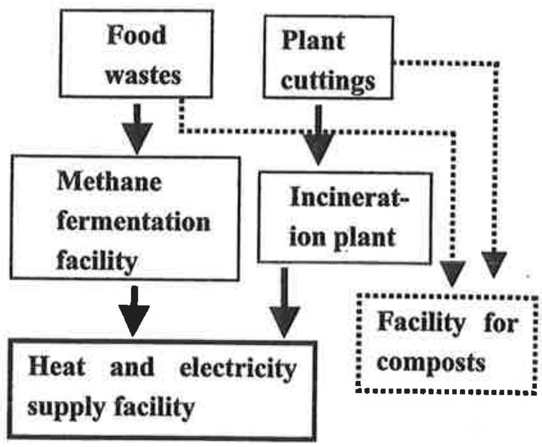

Figure 5 Heat and electricity supply facility

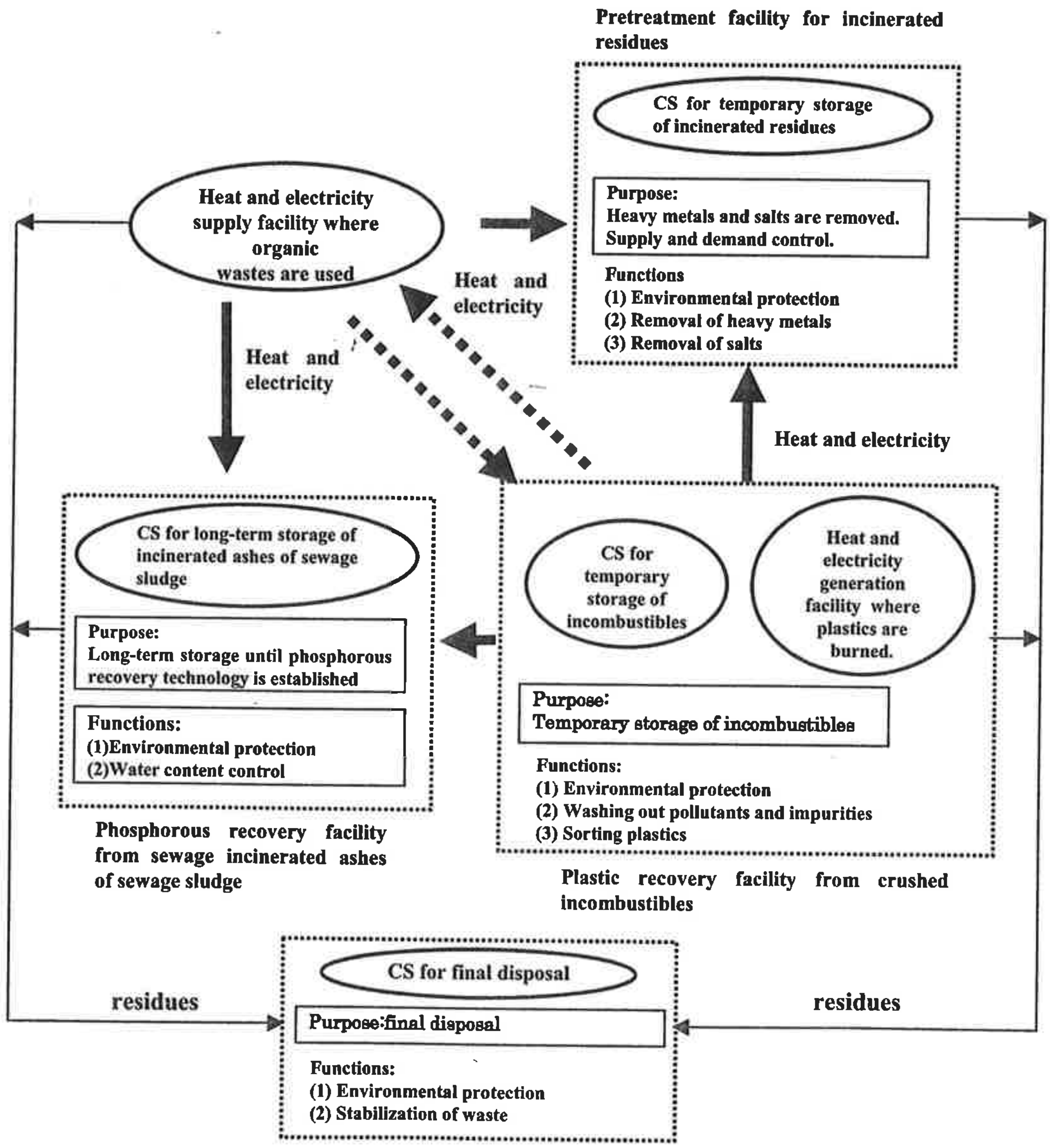

Figure 6 Proposal of complex facilities for resource storage and recovery based on CS

humidity control, distribution, and environmental protection.

To operate the facilities, heat and electric energy will be required. Because of this, an energy supply facility, where heat and electricity are generated with the use of organic wastes such as food wastes, plant cuttings, etc., can be constructed next to a resource recovery facility. Similarly, it is possible to supply heat and electric energy to a resource recovery facility by burning plastics. In this case, it is desirable to construct a plastic resources recovery facility and a resource recovery facility side by side. Figure 6 shows the one of images of complex facility with the several resource recovery facilities and the energy supply facility, based on CS.

FURTHER INVESTIGATIONS

In this study, a new application of closed system disposal facility as resource storage and recovery facilities was discussed and proposed. Now, we are conducting feasibility study on the next generation CS as resource storage and recovery facilities.

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