Solutions for Waste Recycling and Zero-Emission

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1. Introduction

As we enter the 21st century, we inherit responsibility for important worldwide issues such as environmental problems. In order to attain a sustainable civilization where the global societies will maintain their existence and their economies will continue to function, we must change our vantagepoint and course of thinking to solve the problems.

In this paper, a general overview of the present situation of environmental issues in Japan will be reported. Next, the main products and systems of Fuji Electric related to recycling, resource recovery and the zero-emission of waste will be also described.

2. Environmental Issues and the Present Situation in Japan

Among the various environmental issues on the global scale such as ozone depletion and acid rain, the most important issues are global warming and the disposal of waste and toxic chemical materials. Needless to say, there are also many other important issues.

2.1 Countermeasures for global warming

The Kyoto Protocol was adopted at the COP3 (Third Conference of Parties of the United Nations Framework Convention on Climate Change at Kyoto) held in December 1997, to deal with the problem of global warming. The target of reducing each country's green house gas emissions was adopted, and Japan committed to reduce its emissions by 6% compared to 1990 levels, during the 5 years between 2008 and 2013. The achievement of this target depends on the degree of reduction of CO_2 emission, the main component of green house gas. Therefore, means to achieve these goals are being promoted through governmental instruction, guidance and regulation including a nationwide energy conservation campaign.

As a measure to promote these activities, the so-called "Revised Energy Conservation Law" was enacted and a novel competition principle, the so-called "Top Runner Principle" was introduced as a new philosophy. New products must now be designed in consideration of energy conservation and recycling principles. In addition, the promotion of clean energy with less emission of CO_2 has been requested.

2.2 Waste issues

Wastes issues include the overflow of discharged waste in residential areas and the subsequent deterioration of residential environment condition. Japan is now in a critical situation. The final landfill sites for municipal waste and industrial waste will remain only for several more years, and therefore this is one of our most urgent issues. Furthermore, environment pollution due to the dioxins generated at incineration plants has become a reality, and in response our government has enacted regulations.

In order to find a solution to the waste issues, it is required for every company, every municipal and every local community to implement a "zero-emission policy" to bring the discharge of waste to zero without exemption. Such a zero-emission policy aims for a society in which no waste will be discharged over the life cycles of all productive operations, all service operations and all products. To that end, in the case of manufactured products as an example, strategies to "Reduce" (reduce waste generation), "Reuse" (reuse products and parts) and "Recycle" (resource recovery) shall be considered at each stage of design, manufacturing, distribution, consumption and disposal. This concept shall be realized not only within each company at the intra-company level, but also among companies at the inter-company level, at the local community level (an Eco-town plan, for example), and further on the global level. This concept is shown in Fig. 1.

2.3 Toxic chemical material issues

Toxic chemical material problems occurred frequently in the 1960s and 1970s as a result of "environmental pollution" in a specific area and due to a specific cause. However, because various types of chemical products have become common today, toxic chemical material issues have recently become broad issues not limited to a specific area and specific cause. The total quantity of toxic chemical material released or leaked into the environment by all the companies

Fig.1 New concept of recycling

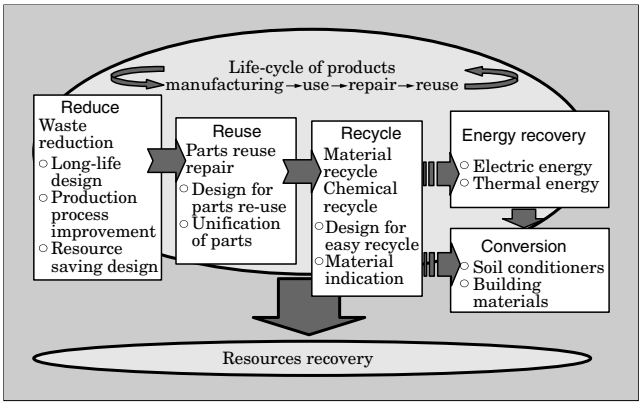
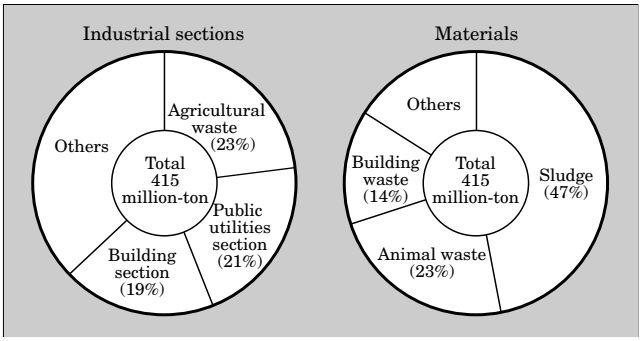


Fig.2 Industrial waste distribution in Japan



engaged in production and service operations, as well as by consumers, has created serious environmental issues. Many chemical substances are extremely toxic to the human body even in minute quantities, such as polychlorinated biphenyl or dioxins.

In order to cope with these issues, the "Law of Pollutant Release and Transfer Register" has been legislated and enacted from early this year. This law requires that the transfer and release of toxic chemical material must be registered and officially announced. Furthermore, the "environmental endocrine" problem is one of the toxic chemical material issues. It was learned recently that when this endocrine, even in extremely small quantities, affects a living organism for a specific period during the growth of that organism, normal hormone action is disrupted and the generative function and other functions are seriously affected. This is an important issue for which scientists shall endeavor to put forth a scientific explanation.

2.4 Present situation of waste discharge in Japan

The quantity of waste discharge in Japan is 50 million tons of "municipal waste" annually discharged from residences and offices, and 400 million tons of "industrial waste" annually discharged. These amounts have remained almost constant during the last 10 years.

The top three industries that produce industrial waste are construction, agriculture and public utilities. A breakdown by material type of industrial waste shows that sludge is ranked as the most prevalent type of waste, animal waste is ranked second and construction waste is ranked third.

Figure 2 shows the industrial waste distribution in Japan.

Recycling and resource recovery are indispensable future themes in Japan, in particular, drastic measures are needed to counter the tremendous amounts of industrial waste. On the other hand, recycling of the most voluminous containers and packages has become an issue in municipal waste.

2.5 Policies and regulations aiming for zero-emission

Various bills relating to environmental issues have been approved in the Diet of Japan in recent years.

A system of governmental laws aiming for a "society that recycles" and for zero-emission has being prepared through successive enactment of the "Dioxins Law", "Building Materials Waste Recycling Law", "Food Waste Recycling Law", "Containers and Packages Recycling Law", "Pollutant Release and Transfer Register Law", and "Home Electronics Recycling Law."

In addition, some cities have started planning locally to realize the concept of an "Eco-town", targeting resource recovery and the recycling of waste. Future developments can be expected.

3. Efforts of Fuji Electric to Provide Systems, Equipment and Services to Realize Zero-Emission

In order to realize the zero-emission society that aims to be without waste, Fuji Electric Group endeavors to incorporate the concept of zero-emission from all aspects.

The systems, equipment and services utilized for the treatment and resource recovery of discharged waste are provided in connection with the following fields in each phase of a product's life cycle:

(1) Waste collection, crushing, and size reduction system
(2) Waste separation system
(3) Waste resource recovery system
(4) Waste energy utilization system
(5) Clean energy system
(6) Waste management service system

3.1 Hot bind

In order to treat plastic waste, size reduction is required first due to the bulkiness and very small apparent specific gravity of the waste. The "Hot Bind" system reduces the waste size by the method of induced heating, rather than incineration, and enables the formation of cubes with side dimensions of 40, 50 or 70 cm. The bulky waste plastic is reduced in size by approximately 1/15 to 1/20. The cubic shape facilitates stacking; this is highly advantageous for the effective

use of space, since cubic blocks can be stacked in an orderly manner whether at a landfill site or temporary depot.

Figure 3 shows an example of the apparatus.

3.2 Ash melting system

This is an ash melting system in which the incinerated ash is reduction melted in an electric resistance reactor to make harmless materials. The ash is reproduced into harmless, high-purity and high-grade slug. Artificial sand with good quality suitable for building materials can be obtained through further thermal treatment. A demonstration test with 12 tons/day has already been performed.

Figure 4 shows general idea of this system.

3.3 Dry distillation system

In the case of treatment of waste containing plastic, because such waste may contain polyvinyl chloride, there is the possibility that dioxins may be generated if incinerated. However, this problem is solved by the dry distillation system (thermal decomposition without oxygen).

Through the dry distillation of waste containing plastic, the waste is separated into carbonaceous residue and decomposed gas. The decomposed gas can be converted into oil by re-cooling. Differing from the incineration, dioxins are not generated even in a chloride atmosphere because oxygen is not supplied; consequently, this is an environmental friendly system. The product of carbonaceous residue and distilled oil can be recycled effectively.

Fuji Electric developed the original induction heating system, instead of an oil burning system, as a heating source for dry distillation. Because the induction heating system can precisely control temperature, it has various merits such as clean heating, high efficiency of input energy and an optimal decomposition process corresponding to the type of waste plastic.

Fig.3 Waste plastics treatment system

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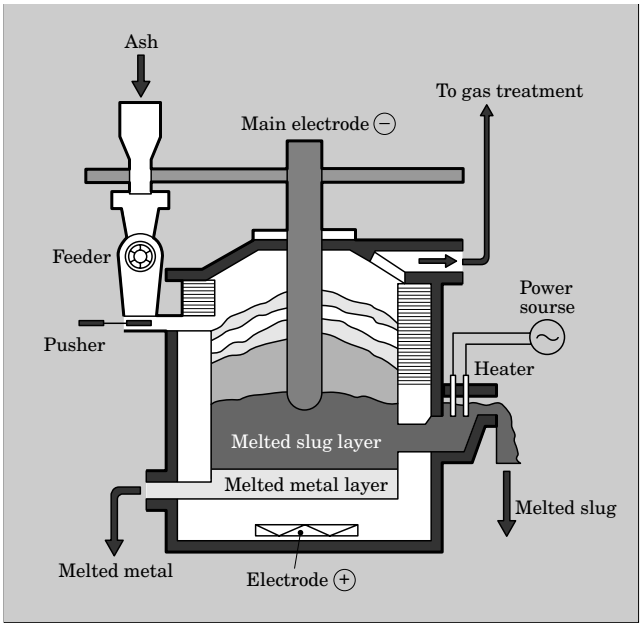
Fig.4 Ash melting system



3.4 Recycle plaza

Waste collected from residences and from the streets is processed with an intermediate treatment (crushing, separation) at the treatment plants and then recycled at so-called recycle plazas or recycle centers.

These plants are comprised of a crushing system, a glass bottle separation system, a steel and aluminum separation system and a plastic size reduction system.

Figure 5 is a photograph of a typical plant.

3.5 Final landfill site system

After the waste is recycled and treated intermediately, the final residues are deposited at a landfill site. At a final landfill site, the dirty water is treated into a suitable state as prescribed by environmental regulations through aeration, coagulating sedimentation, high-grade treatment with active carbon and/or sand filtering.

Figure 6 is a photograph of a typical system.

Fig.5 Recycle center

Fig.6 Landfill water treatment system

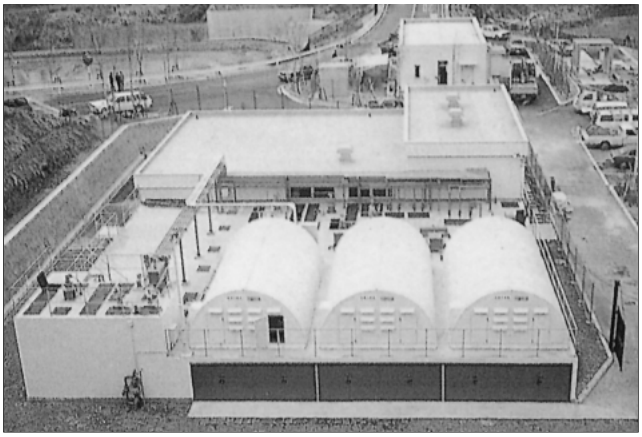


Fig.7 Fuel cell for biogas

3.6 Solid waste fuel (RDF) power generation system

RDF (refuse derived fuel) is solidified waste fuel and has enhanced transferability and storability characteristics. For this purpose, the municipal waste generated in each local area is processed into RDF; then the RDF collected from numerous bases over a wide area is concentrated at a single site, and burned. As such, this system makes possible a highly efficient system of power generation from waste.

3.7 Biogas power generation system

A biogas power generation system utilizes methane gas to generate electric power. The methane gas is generated by the anaerobic fermentation of organic waste such as raw organic waste and animal waste. The types of waste applicable to biogas power generation systems cover a wide range and include organic waste from residential and restaurant kitchens, food waste from food markets and factories, animal waste, agricultural waste, and sewage sludge. The available power generation systems are gas engines, gas turbines and fuel cells. Cogeneration is also possible.

Fuji Electric has demonstrated and is promoting practical applications of a 100kW-class power generation system equipped with phosphoric acid fuel cells that utilize fermented methane.

Figure 7 is a photograph of a typical system.

3.8 Management of waste through "SCM" system

It is possible to manage electronic manifest data by utilizing communication satellites and the global positioning system ("SCM" system). Through enabling the real-time monitoring of waste transportation routes, this system makes it possible to verify that waste is being treated legally and it facilitates management of car operation. Since this system communicates via satellites, all the land in Japan, including the mountainous areas, are included in the service area. This service is operating from a network center based in Tokyo.

4. Conclusion

In this paper, the present situation of environmental issues in Japan as well as the main products, main systems and services provided by Fuji Electric have been presented.

Last year (in the year of 2000), various bills related to environmental issues, including global warming and the waste problem, were approved in the Diet of Japan. Some of them have been enacted as of 2001. At the beginning of the 21st century, we are entering the real environmental age, and therefore the residents, companies, public utilities and government administrations must make every effort to cooperate in these efforts.