

The System of Waste Home Appliances Recycling in Taiwan

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The waste home appliances including television sets, refrigerators, washing machines and air conditioners have increasingly received environmental concerns in Taiwan. In light of the enforcement of Waste Disposal Act (WDA), the Taiwan Environmental Protection Administration (EPA) has certified 60 recycling/storage facilities and given permission for qualified companies to build six treatment plants around the island. Now the recycling and well treatment home appliances are estimated to be 3,342,369 units until May 31, 2001. This paper describes the present status of waste home appliance recycle and its treatment in Taiwan. The principle guidelines and policies regarding recycling, resource recovery and environmental concerns are presented.

Keyword : Waste, Home appliance, Recycling, Recovery, Reuse, Treatment, Environment

Introduction

EPA first announced on July 5, 1997 that "waste television sets, refrigerators, washers, air conditioners and heaters are ordinary wastes that are difficult to dispose of, treat and deteriorate after a long time" based on Paragraph 2 of Article 10.1 of the amended Waste Disposal Act (WDA, March 11, 1997). EPA established the "Foundation for Obsolete Appliance Recycling and Management" on December 29, 1997 in accordance with WDA. The Foundation was entrusted with using the recovery fund to lay down the groundwork related to the recycle of waste home appliances and actively plan for the future blueprint of the entire waste home appliance resource recycling, recovery and treatment system. The flow chart of the recycling system and resource recovery is shown in the Fig. 1 (1).

Later on, in response to a resolution by the Legislative Yuan, EPA founded the "Resource Recovery Fund Management Commission (RRFMC)" on July 1, 1998 (2). RRFMC included the previous commission to be in charge of the construction of the waste home appliance recycle/treatment system and the execution of disposal and treatment work.

According to Article 10.1 of WDA: Officially designated manufacturers, importers and sellers must pay a recycle/disposal/treatment fee as the resource recovery management fund based on the sales (import) amount and the rate approved by EPA. The recovery fund must be used to pay for the actual recycle/disposal/treatment costs, recycle subsidy and rebate and other purposes related to the works of recycling and resource recovery. Hence, on February 26, 1998, EPA first approved the rate for recycle/disposal/storage of waste home appliances, and started to collect the recovery fund from manufacturers, importers and seller on March 1, 1998. The currently approved rates and subsidies are listed in Table 1, Table 2 (1) and Table 3.

Present Status

The recycling and treatment of waste home appliances were first initiated by the government in 1998. The private sector also participated to construct a complete and smooth recycle/treatment system. The entire system can roughly be divided into the front-end part of recycling and the backend part of resource recovery/treatment. In light of the rapid increase in the amount of waste home appliances, recycling efforts were a must even before any treatment plant existed in the country. Thus, EPA has conducted the selection for recycling/storage sites three times since June 1998. As of now, there are a total of 60 recycling/storage sites all over Taiwan responsible for the recycle of four kinds of waste home appliances designated by the government. It is estimated that all recycling/storage sites have recycled and storage at least 3,342,369 units of waste home appliances until May 31, 2001 in the country.

According to a domestic survey (3), the maximum amount of waste home appliances generated every year is around 3 million units. The recycled/stored amount for the period between July 1998 and June 2000 are 1,826,504 units. After six treatment plants started the treatment and resource recovery processes, the amount of recycled and stored amount are over 1,515,865 units.

Process of Resource Recovery/Treatment

Resource recovery/treatment plant is the most important part in the resource recovery system of waste home appliances. To enable our future waste home appliance treatment plants to conform to treatment needs at home and meet environmental protection requirements, EPA conducted a series of workshops in 1998 regarding the guidelines for the construction of such resource recovery/treatment plants to include recommendations from

different interest groups. At present, five companies have invested six treatment plants. These companies come from three different backgrounds, including manufacturers, distributors and second hand shops, and all of them currently operate a waste home appliance recycling/storage site. Since no domestic companies have related experiences or technologies in such treatment, these companies all import major treatment technologies from Germany while studying characteristics of local home appliance products for improvement and localization of treatment technology.

At present, six plants have obtained the "Class-A Treatment Plant Permit" from EPA and officially had started operation after July 2000 to process large quantities of waste home appliances. The treatment capacity of all six plants together is estimated that the total amount of the four waste home appliances treated can reach over 3 million units annually. Besides, five plants have obtained the certificates of ISO14000 in 2001. In addition, another two companies have invested in the construction of two treatment plants and are applying for the "Class-A Treatment Plant Permit" from EPA now. In the near future, eight treatment plants will face the shortage of recycling amount of waste home appliances.

Domestic treatment plants of waste home appliances import the key treatment technologies from Germany. The preliminary planning of various plants focuses on the treatment of four large home appliances, refrigerators, TV sets, washers and air-conditioners. The objective is to properly recycle such restricted substances as coolant and PUR foaming agent in the refrigerator compressor, coolant in the air-conditioner compressor and fluorescent powder in waste TV sets. At the same time, valuable materials such as iron, copper and aluminum can be recovered and enter the reuse market.

The treatment of the four waste appliances can be roughly divided into the four stages of single unit weighing, manual dismantling and selection, granulation of main body and the selection and weighing after granulation, as described in the following (4) :

- (I) Treatment of waste TV set: First, the main body is dismantled and parts classified. Then the cone tube glass and panel glass of the CRT are separated, and the fluorescent powder on the panel glass is removed to recycle and reuse glass. All useful materials are recovered and classified after treatment.
- (II) Treatment of waste refrigerator: Recover CFCs and lubricants and remove the compressor. Granulate the refrigerator body in an enclosed condition and recover the PUR foaming agent in the foam material. All useful materials are recovered and classified after treatment.
- (III) Treatment of waste air-conditioner/heater: Recover coolant and lubricants and remove the compressor. Recover and classify all useful materials after treatment.
- (IV) Treatment flow of waste washer: Dismantle the washer to remove individual operation devices and parts. Then reduce the machine volume or granulate the machine to recover and classify all useful materials after treatment.

The Key Concerns to Prevent the Secondary Pollution

Taiwan government intends to raise the requirements on the environmental protection standards of waste home appliance treatment plants. Therefore, all interested businesses must file the construction permit application, test operation plan application and operation permit application with EPA. In the review process of the permit by EPA, the issues most often discussed among members of the review committee can be organized into the following points:

1. Certification of the software and hardware facilities of the treatment plant and its treatment capabilities.
2. Sampling plans for environmental monitoring and testing during the period of test operation, such as noise level, dust and air pollution.
3. Ratio of resource recovery after dismantling the four waste appliances.
4. Recovery of coolant, foaming agent and fluorescent powder.
5. Condition of CFC residuals in PUR and mineral oil.
6. Outsourcing treatment of hazardous enterprise waste.
7. Channels of waste disposal and feasibility of resource recovery.
8. Emergency action plans (including fire prevention and industrial safety).

Among the above issues, the recovery of coolant, PUR foaming agent and fluorescent powder and the resource recovery of wastes are the primary concerns. The coolant and PUR foaming agent in the compressor of waste refrigerators and waste air-conditioner are mostly CFCs. Thus, the recovery and treatment of such materials have a significant environmental impact on the destruction of the ozone layer and global warming effect. In terms of coolant in compressors, all plants recover and store the coolant and mineral oil from the compressor before dismantling and granulating waste refrigerators (or air-conditioners). As for PUR foaming agent, three plants use the most advanced liquid nitrogen super lower temperature condensing method used in Germany to recover the substance. The other plants use activated absorbed method for recovery. Regardless of CFC-R11, CFC-R12 or CFC-134a, the substances are all identified before recovery for classification and storage. The substances are later treated by CFCs regeneration/refining plant. Therefore, the capital invested by all plants for the recovery of CFCs tops that of all software and hardware facilities in the plant.

Currently, there are already mature technologies and treatment plants for processing waste printed circuit boards and waste electronic materials in Taiwan (7). There are still a number of materials to be treated as wastes after the treatment and resource recovery process of waste home appliances. For example, compressor and motor, CRT glass in TV sets, fluorescent powder, FRP shell and PUR in washers. Currently, there are already mature technologies for processing waste printed circuit boards and waste electronic materials. Compressors and motors are exported to a third country for treatment. As for CRT glass in TV sets, different CRT manufacturers use different glass ingredients, which are mixed together after recovery and difficult to reach the reuse standard required by manufacturers. Besides, the supply of recovered glass in the reuse market exceeds demand. Therefore, the search for a new resource recovery channel (e.g. glass decorations)

is the foremost task now for treatment plants. For fluorescent powder, the amount generated by waste TV sets is very limited. Besides, the recycle of materials that contain fluorescent powder, such as cathode ray tube, is not yet to hit the road. Thus, the scale is still too small to support the construction of a CRT recycle/treatment plant. Instead, the powder is solidified and dumped in sanitary landfills for now. The recycle of FRP shell of washers is facing the same problem of limited quantity as fluorescent powder. Before other objects containing FRP materials such as bathroom tubs and sinks are recycled, the limited quantity cannot reach the economic scale and support a FRP resource recovery/treatment plant. At present, FRP materials are either granulated and incinerated or dumped in sanitary landfills. PUR constitutes the largest quantity of wastes generated by treating each refrigerator unit. At present, treatment plants are actively studying methods for the resource recovery of PUR in the hope to reduce the cost of waste disposal. In addition to the above recycling/treatment work, the noise and dust problems generated during the granulation of appliance body and the selection and recovery afterwards also cause great concern. Labor safety and health training and the formulation and practice of emergency action plans are considered routine and essential work requirements.

Extended Producer Responsibility

In order to reduce the problems of shipment from north to south and competition among the recycling agents, treatment plants and un-environment sound dismantling agents, the six treatment plants has established a common recycling and treatment center (CRTC) to solve the above problems. After the CRTC started its function on March 1, 2001, the recycling rate of air conditioner is increasing from 3% to 15% and the recycling amount is above 30,000 units/week (Fig.2).

Areas needed to be Improve

1. In the near future, another two new treatment plants will join the system of recycling/treatment. In order to reduce the competition for waste home appliances, the goals of next stage include the addition of other items to be recycled through the legislation.
2. The establishment of a research center to develop new technologies is need for recovering materials from the current wastes. The R&D efforts may include the reuse of various CRT glass, fluorescent powder, FRP shell and PUR.
3. To reduce the cost of waste disposal, increase the resource recovery ratio, and lower the subsidies are always the major concerns.
4. The evaluation of recycling/treatment plants shows that several treatment plants need to be improved for the secondary pollution.

Conclusions

1. The current waste home appliance recycle/treatment system includes the participation by second hand shops,

manufacturers, distributors and sellers.

2. The six treatment plants have already in operation and have treated 3,342,369 units of waste refrigerators, TV sets, washers and air-conditioners until May 31, 2001.
3. Five treatment plants have the certificates of ISO14001 in 2001.
4. These construction experiences and lessons learned from technology development can be of assistance to other countries in the construction of treatment plants for waste home appliances.

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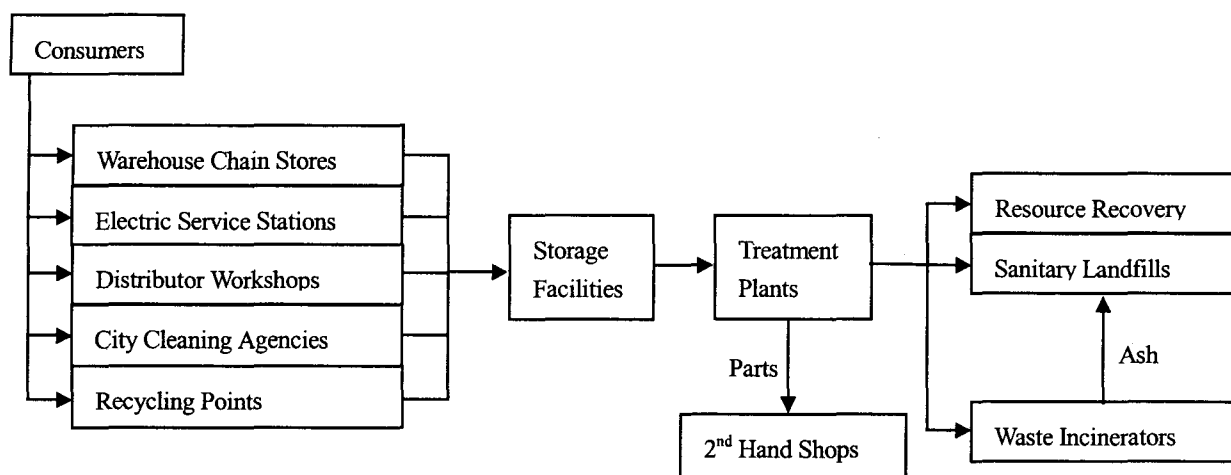


Fig. 1 The Flow Chart of the Recycling System and Resource Recovery

Table 1 Approved rates of the designated manufacturers, importers and sellers

Time & Item	TV set*		Refrigerator**		Washer	Air conditioner/heater
	Big size	Small size	Big size	Small size		
July 1,1998 ~ April 30,2000 (NT\$/unit)	245	119	427	157	272	174
May 1, 2000 ~ Present rate (NT\$/unit)	420	270	680	440	360	290

*TV set : Size based on 25"CRT. **Refrigerator: Size based on 250 liters.

Table 2 Approved subsidy for recycling/disposal/storage of waste home appliances

Time	Item	TV set	Washer	Refrigerator	Air conditioner/heater
April 1,1999 ∩ June 30,2000	Recycling subsidy (NT\$/unit)	65	85	150	160
	Recycling point management fee (NT\$/unit)	30	30	30	30
	Disposal/transport fee (NT\$/unit)	30	50	100	30
	Storage administration fee* (NT\$/unit)	20	20	20	20
	Storage fee (per month) (NT\$/unit)	10	19	28	10
July 1,2000 ∩ Present rate	Recycling subsidy (NT\$/unit)	85	105	170	230
	Disposal/transport fee (NT\$/unit)	30	50	100	30
	Treatment Plant Administration fee* (NT\$/unit)	20	20	20	20
	Recycling point management fee (NT\$/unit)	10	10	10	10

* rates for the storage administration fee became effective on 6/1/1999, while rates for other items became effective on 4/1/1999.

Table 3 Treatment subsidy and transport subsidy for treatment plants of waste home appliances

Component	Transport subsidy* (NT\$/unit)		Treatment subsidy (NT\$/unit)
	General area	Remote area	
TV set	25	37	330 ₍₁₎ /450 ₍₂₎
Refrigerator	65	97	410 ₍₁₎ /735 ₍₂₎
Washer	40	60	220 ₍₁₎ /415 ₍₂₎
Air conditioner/heater	25	37	145 ₍₁₎ /435 ₍₂₎

*Transport subsidy: Subsidy for the cost of transport from the storage/collection points to the treatment plants.

*Remote area: referring to the areas of Taitong and Hualien

(1) July 1, 2000 to December 31, 2000

(2) January 1, 2001 till present

Table 4 Estimated maximum amount of waste home appliances in the country [3]

Appliances	1995	1996	1997	1998
TV set	1,285,877	1,143,168	1,106,751	1,060,739
Air conditioner	1,444,655	1,289,718	1,346,038	1,224,123
Washer	630,217	610,890	559,697	540,241
Refrigerator	825,247	722,213	652,141	659,880

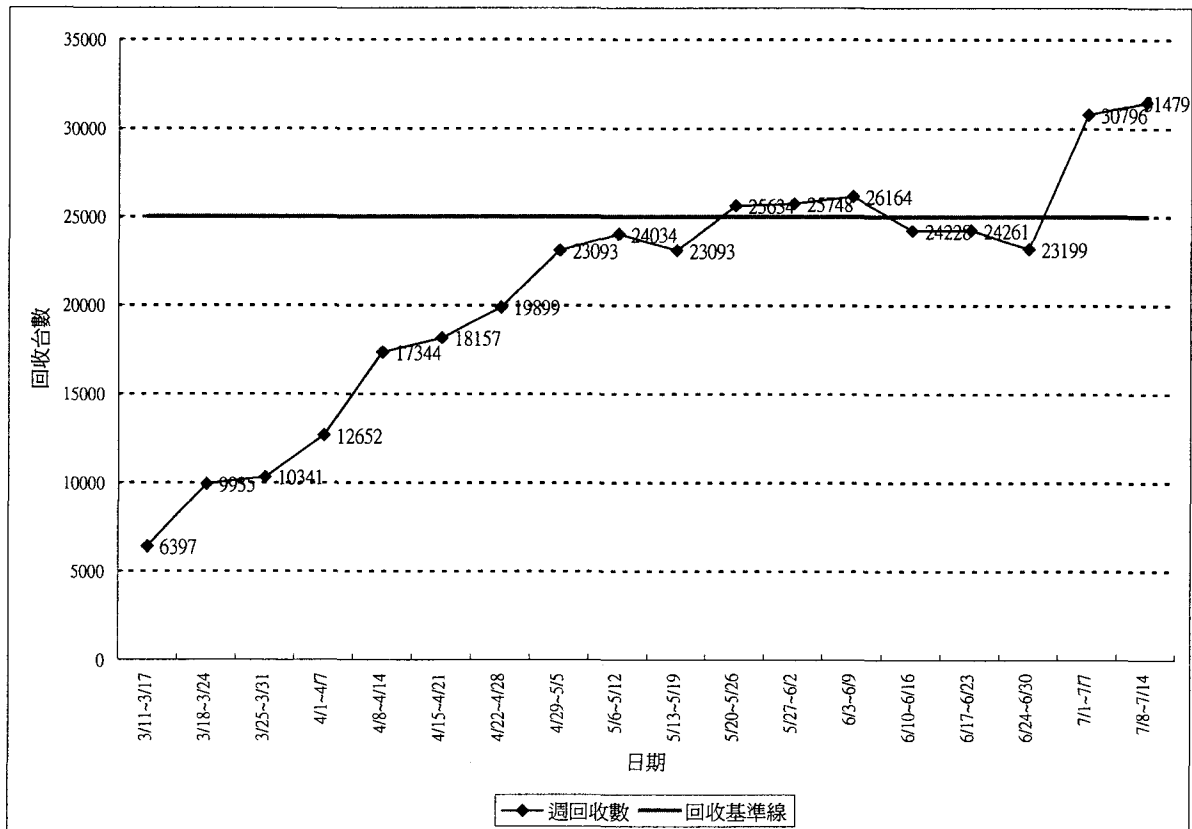


Fig. 2 The Recycling amount of Home Appliances in 2001