A-6.1 Research on Feasibility of Technologies for Control of Ozone Layer Depletion Materials

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Abstract Technologies for control of ozone layer depletion materials were estimated in detail by questionnaire, hearing, references and experiments for making clear on feasibility of them. The obtained results are summerized as follows:

(1) Good design of equipments for removal and recovery of chlorofluorocarbons (CFCs) from exhaust gas are economic and able to be applied also for removal and recovery of hydrochlorofluorocabons(HCFCs), hydrofluorocarbons(HFC) and other solvents.

(2)Followings are need for construction of recycling system of disused refrigerant.

1) High performance, low priced and small equipment to recover refrigerant from refrigerators.

2)Social recovery system

3) Legal fobid to release CFCs in air

(3) It is possible to destruct CFCs completely by good designed incinerate system under the selected conditions.

Key Words Chloroflruorocarbons(CFCs), Exhaust Gas, Refrigerant, Recovery, Destruction

1. Introduction

It was decided that the production of CFCs and HCFCs which cause destruction of the ozone layer should be stopped until 1996 A.D. and 2030 A.D., respectively. It become imporant to recover, recycle, reclaim and destruct of them.

2. Research Objectives

In this study, technologies for control of ozone layer depletion materials were investigated and estimated their problems and feasibility by questionnaire, hearing, references and experiments.

3. Research Methods

(1). Technologies for Removal and Recovery of CFCs in Exhaust Gas

① Six representative equipments for removal and recovery of CFCs by adsorption with activated carbon were evaluated technologically and economically.

Technical estimation items were as follows;

1) Utilization efficiency of activated carbon

2) Energy efficiency (blower, desorption, cooling)

Economic estimation items were as follows;

1) Initial cost (equipment cost, fit up cost)

2) Maintenance cost (operating cost, chemical cost, wastewater treatment cost, depreciation cost, interist cost, personnel cost, repair cost and fixed property tax)

② A high performance and economic equipment which use small granular carbon in fixed bed and have short cycle to desorb chlorocarbons was proposed. Adsorption capacity and recovery efficiencies of this equipment were calculated in case of application to ten chlorinated organic compounds such as 1,1,1-trichloroethane(MC), CFC113, HCFC123, HCFC141b, HCFC225ca, HCFC225cb, chloropicrin, dichloromethane, trichloroethylene and tetrachloroethylene.

(2) Technologies for Recovery of CFCs as Refrigerant

① Equipments for recovery and reclamation of refrigerants were investigated and classified by questionnaire, hearing and references.

② Total mentenance costs of the representative equipments were calculated and estimated.

③ Status of shifting to HCFC or HFC and recovery and recycling system for disused refrigerant were investigated by hearing and references in detail.

(3) Technologies for Destruction of CFCs

① CFC-12 was incinerated at a rotary-kiln system for industrial waste treatment.The exhaust gas from stack were analysed to make sure of complete destruction.

② Technologies for destruction of CFCs except incineration technologies were also investigated and estimated by hearing and references.

③ Stored amounts of CFCs for refrigerant and rigid polyurethane foam(PUF) and halons for fire extinguisher, which should be destructed, were roughly estimated on the date from hearing amd references.

④ Questionnaire what control, guide and counterplan to users and disposal companies and how many disposal plants in the district were answered by all the prefectures in Japan.

4. Results and Discussion

(1) Technologies for Removal and Recovery of CFCs in Exhaust Gas

① Table 1 shows six types of the equipments for removal and recovery of CFCs. The utilization efficiencies of the activated carbon in the equipments except No.2 were under 50% and should be improved. The energy efficiencies for blowers of the equipments except No.1 were estimated under 30% and slould be improved also. The energy efficiencies for desorption were much different depend on types of the equipment. The maintenance cost of almost the equipments which remove and recover CFC113 and MC from exhaust gas were lower than the commercial cost of these solvents. The spread of these equipments was expected.

Table 1 Six Types of Representative Equipments

No.	Bed type	Activated carbon type	Desorption method
1	Fixed type	Granular type	Direct steam heat
2	Fixed type	Honeycome type	Direct steam heat
3	Fixed type	Fibrous type	Direct steam heat
4	Fixed type	Granular type	Electric heat and vacuum
5	Fixed type	Honeycome type	Electric heat and vacuum
6	Fluidized type	Spherical type	Indirect steam heat

② The proposed equipment have large recovery efficiency for almost applied compounds. But, the compounds whose vapor pressure are large, HCFC123, HCFC141b, and dichloromethane, have small recovery efficiencies. For getting recovery over 90% of these compounds, cooling temperature must be let down to very low temperature.

(2) Technologies for Recovery of CFCs as Refrigerant

① The equipment for recovery and reclamation of refrigerant were classified as follows;

Use : Car air conditioner, Refrigerator, Centrifugal refrigerator

Recovering method : Compressor, Refrigerant, Vaper pump

Cooling method : Air, Heat exchanger, Water, Refrigerant

Adsorbent (for regeneration) : Synthetic zeolite, Silica gel, Synthetic zeolite + activated alumina

Oil seperator : By specific gravity, Distillation

Generally, the recovery efficiencies were over 90%, the electrical comsumptions were small as 0.2 to 0.8kW, the equipment costs were from 350 thousand to 2 million yen, the weights were from 40 to 370 kg. The recovery efficiencies were different from the equipments at low temperature.

') The refrigerant in car air conditioner was a little, such as about eight hundreds grams. Therefore, personnel cost per unit of recovery gravity for car air conditioner was very expensive. It need to recovery from some cars together for depressing the total maintenance cost.

③ HCFC 22 has been enclosed in all the room air conditioner. HFC134a was enclosed in air conditioner all kinds of car and some refrigerators since 1994 A.D..

(3) Technologies for Destruction of CFCs

① Table 2 shows the test data and the UNEP standards of the exhaust gas.

Table 2 The test data and the UNEP standards for exhaust gas

Items	Test data	UNEP standards[1)]
O_2(%)	>8	−
CO(12% O_2 conversion ppm)	30～100	<80
HCl(mg/Nm^3)	<2	<100
HF	0.2～1.6	<5
HBr/Br_2	−	<5
Particulate matter	<3	<50
PCDDs/PCDFs(ng-TEQ/Nm^3)	N.D.(<0.1)	<1.0
No volatile total organic halogenated carbons(mg-Cl/Nm^3)	N.D.(<0.2)	−
Ames mutagenicity(ug-2AA/Nm^3)	N.D.(<10)	−
Destruction efficiency(%)	>99.99	>99.99

Conditions; CFC12 feed rate: 3wt% of all the feed waste, Temperature in rotary kiln : 900℃, Residence time (rotary kiln and afterburner): 3 seconds.

The test data satisfied enough the UNEP standards except for CO. Since there was no relation between CO and PCDDs/PCDFs, it was not necessory to keep 80ppm of CO constantly in the case that safe was made sure by other methods. Further,the non volatile TOCl, the Ames mutagenicity and the volatile halogenated organic compounds were not detected. Safe and complete destruction of the CFC incineration were proved by this test.

② Technologies for destruction of CFCs must meet six terms as follows;

1) High destruction efficiency

2) Sufficient durability of facilities to corrosion by HCl and HF.

3) Certain treatment of exhaust gas, wastewater and sludge.
4) Not produce genotoxic substances
5) Cheap cost and simple operating
6) Use at many places.

The destruction technologies except incineration technologies were reported as follows; High frequency plasma destruction, detnation destruction, catalytic destruction, hydrothermal destruction, supercritical water destruction, UV photolysis, high energy radiation, molten metal destruction,electrochemical reduction, metaloxide reduction, arc plasma destruction, ultrasonic destruction and biological decomposition. However, these many methods have not been satisfied the above six terms and can not be used in near future.

③ Total stored amounts of CFCs were estimated to be 450,000 t and made up as follows;
CFC12 : 38,000 t for car air conditioner, 8,000 t for refrigerator, 9,000 t for commercial chiller and refrigerator
CFC11 : 10,000 t for centrifugal refrigerator , 150,000 t for rigid polyurethane foam (PUF)
Halon 1301, 1211 and 2402 : 23,000 t (as CFC 220,000 t) for fire extinguisher
HCFC22 : 100,000 t (as CFC 5,000 t) for room air conditioner
The stored amounts of CFCs for not only refrigerator but also car air conditioner, commercial chiller and refrigerator are large. Therfore, CFCs from car air conditioner, commercial chiller and refrigerator should be recovered and destructed positively. It is very difficult to correct the disused rigid PUF, but CFCs from the rigid PUF should be made effort to correct and destruction because of its large stored amounts.

④ All the prefectures do not execute technical guidance to disposal plants on incineration of halogenated organic compounds. Only 10% of the prefectures provide funds for building incineration systems and enforce lows on CFCs and hlogenated organic compounds.

5. References

1) UNEP : Report of Ad-hoc Technical Advisory Committee on ODS Destruction Technology.

6. Publications

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