United States
Environmental Protection
Agency

Air and Energy Engineering
Research Laboratory
Research Triangle Park NC 27711

Research and Development

EPA/600/S7-89/011 Dec. 1989

Project Summary

Technologies for CFC/Halon Destruction

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This report presents an overview of the current status of possible technologies used to destroy chlorofluorocarbons (CFCs) and halons, chemicals implicated in the destruction of the stratospheric ozone layer. The Montreal Protocol, an international treaty to control the production and consumption of these chemicals, allows countries to increase production by the volume of CFCs or halons destroyed, if the destruction technology has been approved by the Parties to the Protocol. The Parties have neither yet approved nor considered possible destruction technologies. This document is the first step in the United States' review of such technologies, and will serve as the basis for additional work in this area.

This report is based on publicly available articles and reports, and personal contacts with various individuals who are knowledgeable in the field. The summary of the key findings addressed the following areas:

- **The ability of the various technologies to effectively destroy CFCs;**
- **The environmental consequences of such destruction;**
- **The ability of current emission monitoring systems to verify that the CFCs have indeed been destroyed;**
- **The impacts of current regulations on CFC destruction; and**
- **The existence of any significant data gaps, along with recommendations of future required work to resolve any unanswered issues resulting from the data gaps.**

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The U.S. Environmental Protection Agency (EPA) requested an investigation into several areas related to chlorofluorocarbon (CFC) and halon destruction technologies:

- Currently and potentially available destruction technologies;
- Potential environmental or health effects posed by destruction byproducts; and
- Methods to monitor destruction efficiency.

This report documents the results of a limited scoping study based on publicly available articles and reports, and personal contacts with various individuals who are knowledgeable in the field.

Technologies to Destroy CFCs and Halons

Many technologies could potentially be used to destroy CFCs and halons. Most of these technologies are at a preliminary level of development for application to CFCs and halons. Only thermal incineration is currently available and demonstrated for CFC and halon destruction.

Other technologies have been proposed for destruction of CFCs and halons. Some of these technologies have been commercially used for destruction of other types of wastes, but they have not been demonstrated for CFCs and halons. Each of these promising technologies is discussed below.

- *Catalytic Incineration* is similar to thermal incineration, but the destruction is achieved at lower temperatures by use of a catalyst. The lower temperatures represent a potential savings in fuel costs, but the application to data, of catalytic incineration has been limited to destruction of hydrocarbons or chlorinated organics. If tests of chloride-resistant catalysts are successful with CFCs or halons, catalytic incineration could be commercially available in the near term (3 to 5 years).
- *Pyrolysis* is destruction using high temperatures, but without excess oxygen for direct combustion. This approach offers potential for reduced exhaust gas volume (resulting in smaller, less costly gas scrubbers), but has not been tested with CFCs or halons. If demonstration tests were initiated,, pyrolysis could be commercially available for CFCs or halons in the near term (3 to 5 years).
- *Active metals scrubbing* is a process which uses sodium, zinc, or aluminum metal to rapidly react with halogenated compounds. It has only been commercialized for destruction of PCB-containing wastes. Active metals scrubbing could be commercialized in the moderate term (5 to 10 years).
- *Chemical scrubbing* is a process that uses a highly alkaline reagent to destroy halogenated compounds. It has only been demonstrated on the bench-scale for PCB destruction. Chemical scrubbing would probably be a long term (10 to 15 years) commercial possibility.
- *Wet air oxidation* is a process that uses a moderate temperature aqueous stream with oxygen to destroy organic compounds. Limited test data show that CFC-113 can be destroyed by this process, but its use is limited to dilute aqueous wastes. The ultimate application of wet air oxidation is questionable because of the requirement for a dilute aqueous form, but it could probably be commercialized for some CFC or halon applications in the moderate term (5 to 10 years).
- *Supercritical water oxidation* is similar to wet air oxidation, but it operates at higher temperatures and pressures. The current application of supercritical water oxidation is limited to destruction of aqueous wastes containing chlorinated organics. It is possible that this technology could be commercialized for specialty CFC or halon streams in the moderate term (5 to 10 years).
- Corona discharge is a process that uses energized electrons from an ionized corona field to destroy many organics. It is currently a development project, but shows possibility for future development. The commercialization of corona discharge for destroying CFCs or halons is a long term (10 to 20 years) possibility.

Environmental Implications of CFC Destruction

Environmental concerns surrounding CFC and halon destruction include possible formation of potentially hazardous products of incomplete combustion (PICs), and acid and/or halogenated gas emissions. PIC formation, in general, is a poorly understood phenomenon, which is further complicated for CFC destruction systems since no data on PIC formation exist. Data from hazardous waste incinerators have indicated that PIC formation in a properly operated system is typically less than 1 ppm. At these low levels, the volumes of any PICs formed would be small. The overall toxicity, however, is an unresolved issue that requires additional data to resolve.

Thermal destruction of CFCs or halons also produces acid gases (HCl, HF, or HBr) and/or free halogen gases (Cl_2, F_2, or Br_2) when the halogen-containing parent compound is broken down in the incinerator. Both types of gases are hazards because of their toxicity and corrosivity, and will require scrubbing with either a water or caustic solution to react with the acid/halogen gases. These aqueous waste streams must be sent to wastewater treatment facilities before discharge. Large quantities of waste salts are generated. For each 1 lb (0.45 kg) of CFC-12 incinerated, neutralization of the acid gases produced results in the generation of roughly 1.5 lb (0.68 kg) of salts.

Monitoring Methods for CFC Destruction

To monitor destruction, record keeping procedures must be in place to track the quantities of CFC compounds in the waste fed to the incinerator, and then methods must be available to monitor the destruction efficiency achieved during incineration.

The basic tracking procedure now in use involves the preparation of a feed record and a certificate of destruction for each waste load that is incinerated. The feed record includes information on the weight and composition of the waste load. This information is gathered when the waste load is received by the incinerator facility. After the waste has been incinerated, the certificate of destruction is prepared to document that the waste was destroyed. This certificate is sent to the waste originator to complete the record keeping process.

Currently, continuous monitoring methods for measuring the destruction efficiency of CFCs and halons do not exist. Incinerators burning wastes that contain CFCs must comply with the Resource Conservation and Recovery Act (RCRA) performance standards. RCRA requires prelicense testing (trial burn) to ensure destruction efficiency and to define the range of operating parameters for which the unit would be in compliance.

Regulatory Impacts

Currently, the regulations that would have the most effect on CFC disposal operations are: (1) RCRA, which can affect the handling and processing of spent CFC wastes; and (2) the Clean Air Act, which affects the allowable emissions of acid gases. All regulatory provisions should be able to be met and thus should not create impediments to implementing a CFC destruction program.

Data Gaps and Research Needs

The four major areas of data gaps identified in this evaluation are: (1) PIC formation resulting from CFC destruction; (2) technical design data on CFC thermal destruction systems, particularly in the area of corrosion and materials of construction; (3) all aspects of halon destruction; and (4) availability of continuous CFC or halon monitors to verify destruction.

These data gaps can be addressed through short-term (2-5 years) research initiatives which would be focused on better characterizing thermal destruction systems to make data available for future developments. In addition to short-term research initiatives, a longer-term (5-15 years) research program should also be considered to promote the development of the most promising destruction technologies now in various stages of development.

☆U. S. GOVERNMENT PRINTING OFFICE: 1989/748-012/07190

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The complete report, entitled "Technologies for CFC/Halon Destruction," (Order No. PB 90-116 955/AS; Cost: $17.00, subject to change) will be available only from:

National Technical Information Service
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EPA/600/S7-89/011