A-6 Technologies for Decomposition of Chlorofluorocarbons

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Although ozone depleting substances (ODS) such as chlorofluorocarbons (CFCs), halons, and some chlorinated hydrocarbons will be phased out before the 21st century because of serious situation of the stratospheric ozone depletion on the Earth, there are large quantities of banked ODS in the world which should be decomposed urgently in the near future. Aiming at developing the technologies for decomposing CFCs, four promising methods of plasma, catalysis, incineration/thermal decomposition, and supercritical water were investigated in this project in the period of fiscal year 1990 to 1992.

(1) Decomposition of Chlorofluorocarbons by Inductively-Coupled r.f. Plasma

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Chlorofluorocarbons and chlorinated hydrocarbons were decomposed in the presence of water by a 15 kW and a 35 kW plasma reactors. Maximum rate of the decomposition is 8.1 kg of CCl_2F_2 per hour on 35 kW plasma. Detailed analyses of products indicate that disproportionation, dimerization, etc. take place at insufficient supply of water while the by-products disappear under normal conditions.

(2) Decomposition of Chlorofluorocarbons by Catalysis

National Institute for Resources and Environment
Kyushu University

Catalytic hydrolysis (National Institute for Resources and Environment) and oxidative decomposition (Kyushu University) were investigated. TiO_2-ZrO_2 and H-mordenite catalysts promote the hydrolysis of CFCs, carbon tetrachloride, and 1,1,1-trichloroethane at moderate temperatures. WO_3/Al_2O_3-ZrO_2 catalysts gives oxidative decomposition of C_2ClF_5 and CCl_2F_2. Life of catalysts, reaction mechanisms, and product analyses were also investigated.

(3) Incineration and Thermal Decomposition Methods

National Institute of Materials and Chemical Research
National Institute for Resources and Environment

For the pre-mixed incineration method, CFCs are perfectly destroyed if CFC/fuel feed ratio is kept within a certain value. This value can be extended by improving the design of the burner. For the thermal decomposition method, $C_2Cl_3F_3$ has completely been destroyed without producing any harmful by-products if temperature and residence time are appropriately controlled.

(4) Decomposition of CFCs by Supercritical Water

National Institute of Materials and Chemical Research

The hydrolysis of CFCs using supercritical water has been studied to establish the process in which CFCs are completely hydrolyzed and hydrogen halides produced are neutralized. The hydrolysis of CFCs is accelerated with the density. With the experiments in the flow reactor, more than 99% of CCl_3F can be decomposed in supercritical water at 380C and 30 MPa for the residence time of a few minutes. Addition of sodium hydroxide into supercritical water promotes the hydrolysis of CFCs and prevents the corrosion in the reactor.