A-2 Development and Evaluation of Countermeasure Technologies for the Stratospheric Ozone Depletion (Final Report)

Contact person Koichi Mizuno, General Research Counselor
National Institute for Resources and Environment
Agency of Industrial Science and Technology
Ministry of International Trade and Industry
16-3 Onogawa, Tsukuba, Ibaraki 305 Japan
Phone +81-298-58-8290, Fax +81-298-58-8291
E-mail k_mizuno@nire.go.jp

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Because the stratospheric ozone depletion becomes serious, human beings take action to phase out the ozone depleting substances (ODS) before the 21st century. In response to the phase-out, a variety of technological options are requested to develop destruction of ODS, recycling of ODS, manufacturing of the alternatives to ODS, human impact and environmental acceptability of the alternatives, and total assessment of these technologies.

A-2.1 Decomposition Technologies of Ozone Depleting Substances

ODS including CFCs, Halons, HCFCs and HFCs was destroyed by corona-discharge plasma, catalysis, pyrolysis, incineration, photolysis and supercritical water. The experimental research was studied on evaluation of reactor performance, detailed analyses of main- and by-products, accumulation of reaction parameters, elucidation of reaction mechanisms, promotional effects of additives and so forth.

A-2.2 Recovery and Emission Control of Fluorocarbons and Alternative Fluorocarbons by Adsorption

The two-component adsorption of fluorocarbons and water was investigated under microwave irradiation. The amount of fluorocarbon adsorption was found to increase with increased microwave power with no influence by adsorption temperature. In addition, activated carbons having excellent capacity of fluorocarbons were prepared by controlled gasification of char with carbon dioxide.

A-2.3 Development of Halon Replacements and Their Evaluation as Fire Extinguishers

Polyfluoroamines having a $(CF_3)_2N$-group and no bromine atoms showed good fire extinguishing ability and a potential of halon-1301 replacements. New fire suppression mechanism by CF_3-radical was proposed with the aid of computational chemistry of the action of CF_3 radical in fire, where CF_3 behaves catalytically as a radical scavenger for hydrogen and hydroxyl radicals in flame.

A-2.4 Human Impact of Halon Alternatives

Toxicity of 2H-heptafluoropropane, trifluoroiodomethane, perfluorotriethylamine, N,N-bis-(trifluoromethyl)-2H-tetra-fluoroethylamine, N,N-bis(trifluoromethyl)-2-bromotetrafluoroethyl-amine, and perfluoro-N-ethylpyrrolidine, and perfluorodimethylvinylamine. Neither prominent genotoxicity nor cytotoxicity was recognized in the all halon alternatives except for perfluorodimethylvinylamine. No cytotoxicity nor genotoxicity was found in pyrolysis products of 2H-heptafluoropropane, while those of perfluorotriethylamine showed weak cytotoxicity.

A-2.5 Environmental Acceptability of Alternatives to Ozone Depleting Substances

A-2.5.1 Fate of Halons and CFCs Substitutes Emitted into the Atmosphere

Based on absorption spectrum and reaction rate constants, the decay of $(C_2F_5)_3N$ by OH radical seems negligibly slow, while the decays of fluoroalcohols by OH were determined.

Because of the absence of near ultraviolet absorption of $(C_2F_5)_3N$, the molecule is expected to have an extremely long lifetime. The annual increase of HCFC-22 in the atmosphere has been observed by an ultra-sensitive detection, and it was compared with the 2-box model calculations. An ultra-sensitive measurement was developed for atmospheric concentration of HFC-142b.

A-2.5.2 Heterogeneous Chemical Reactions of Alternatives to ODS in the Atmosphere

Heterogeneous photolysis revealed that $(CF_3)_2NCF_2CF_3$ and $(CF_3)_2NCF=CF_2$ gave no appreciable degradation on solid particle, while $N(C_2F_5)_3$ had a possibility of its interaction with solid particles because of longer life time.

A-2.6 Studies on Total System for Recovery and Destruction of CFCs

Potential capacity for CFC destruction by 32 waste incinerators in Japan was estimated to be 20,000 tons/yr. The stack gases and waste water in CFC destruction by four incineration plants met the standards. Only two impingers, each containing water and diethylene glycol, were capable of trapping PCDDs/PCDFs in stack gas from CFC incineration. Non-volatile total halogen (NVTOX) may be useful as an index of toxic substances in the exhaust.