## A-7.1.3. Environmental Effects of Substitutes for CFCs

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**Abstract** The rate constant of the reaction between pentafluoropropanol (5FP) and OH radical was measured using a laser induced fluorescence technique, which is (8.8+- 1.1) x 10(-14) cc molecule/sec.
A rapid method of toxicity test *in vitro* for substitutes of CFCs was developed. For efficiency test of the method, cytotoxicity and cytogenotoxicity of benzene as a cancer initiator were measured. The results of the efficiency test suggest that the method is able to use for toxicity test of CFCs substitutes.

**Key Words** Substitutes for CFCs,OH radical, Laser-induced fluorescence, in vitro, Cytotoxicity.

### 1. Introduction

The criteria of excellent substitutes for CFCs among the chemicals which have similar chemical and physical properties to CFCs are, (1) short lifetime in the environment, (2) stability in the applied environment, (3) containing no chlorine or bromine atoms and (4) non-toxicity and non-toxic reaction products in the environment. Recently in Japan, several substitutes have been developed. However, the environment effects are not fully assessed.

### 2.Research Objective

In order to assess the environmental effects of the substitutes of CFCs, the following experiments have been required in this study. (1) Measurements of the reaction rate constants with OH radical, and the photolysis quantum yields in UV region. (2) Evaluation of the lifetimes in the environment and estimation of the secondary product concentrations. (3) Evaluation of toxicities of substitutes of CFCs and their reaction products. (4) Ozone depletion potential(ODP) and global warming

potential(GWP).
In the toxicity test for substitutes for CFCs, acute and chronic toxicities of the substitutes have been examined using experimental animals. However, these toxicity tests cost a great deal, and need a long-term. From these reasons, development of a rapid method of toxicity test *in vitro* for substitutes for CFCs has been required.

In this study, experiments to obtain the reaction rate constants of OH radical with substitutes for CFCs developed in Japan and the development of a rapid method of toxicity test *in vitro* for the substitutes were carried out.

## 3. Results and Discussion

### 1) Measurement of the rate constant of pentafluoropropanol as a CFCs substitute with OH radical

The development of the apparatus to measure the rate constant of the reaction of OH radical with pentafluoropropanol(5FP) developed in Japan was carried out. The indirect method was applied in which competitive reaction between the CFCs substitute and a compound with a known reaction rate constant was utilized. However, the obtained rate constant was rather unreliable because the absorption on the wall of the cell was found to affect the results considerably. Recently, we decided to measure the rate constants directly from the decay of OH radical due to the reactions with CFCs substitutes using the laser induced fluorescence technique. The apparatus was considerably modified because the wall effect should be large in case of the conventional flow type cells due to the eddy diffusion to the wall. Therefore, we stopped the flow when the reactions between CFCs substitutes and OH radical were carried out. In this case, diffusion was controlled by the molecular diffusion and the wall effect was efficiently suppressed. As the result, minimum measurable rate constant was estimated to be 10-16 cc molecule/sec.
The rate constant of the reaction between %FP and OH radical was measured with this apparatus, which is (8.8+-1.1)x10(-14)cc molecule/sec.

### 2) Development of a rapid method of toxicity test *in vitro* for CFCs substitutes

In the development of CFCs substitutes, Toxicity test is one of the most important tests. However, the toxicity tests cost a great deal, and need a long-term. In this study, we developed a rapid method of toxicity test *in vitro* for CFCs substitutes. In order to develop the method, we developed a exposure apparatus which consisted of compound gas generator, culture bottle, roller drum and incubator for cell culture. Fig.1 shows the roller drum and the rectangular culture bottle connected with the roller cap for exposure of gaseous compounds.
For an efficiency test of the exposure apparatus, gaseous benzene was used as a positive control. It is known that benzene is a cancer initiator and

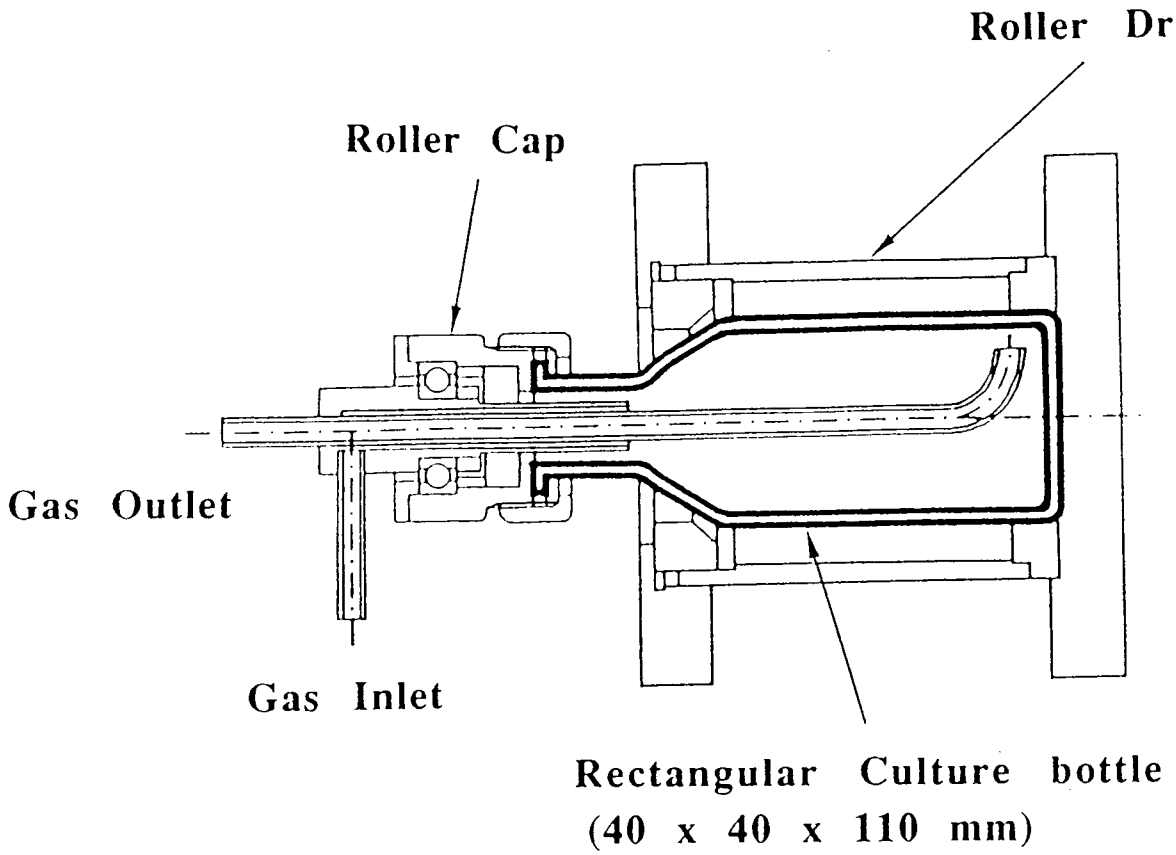


Figure 1. CFCs Substitutes Exposure Apparatus
The rectangular culture bottle connected with the roller cap for exposure of gaseous compounds, is settled the roller drum.

induces chromosome aberrations and sister-chromatid exchange(SCE) *in vivo* experiments. However, These cytogenotoxicity of gaseous benzene has not been demonstrated *in vitro*.

Gaseous benzene at the concentration of 1 to 8%, was exposure to cultured V-79 cells for 6 hr using the exposure apparatus. Before the exposure, P-450-containing fraction of rat liver(S-9) was added into the culture medium. After the exposure, the exposed cells were cultured in the fresh medium without S-9 for 24 hr. The toxicity of benzene was expressed as cell growth inhibition(cytotoxicity) and SCE(cytogeno-toxicity). Above the concentration of 4% gaseous benzene in air, dose dependent effects of cell growth inhibition and SCE were observed.

These results suggest the gaseous compounds exposure apparatus is able to use for toxicity test of CFCs substitutes.