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## **Joint Assessment of Commodity Chemicals No. 32**

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**Difluoromethane (HFC-32)**

**CAS No. 75-10-5**

May 1995

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| No. 30 | Joint Assessment of Commodity Chemicals, Methyl Methacrylate. CAS No. 80-62-6. In Press                         |
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# **Joint Assessment of Commodity Chemicals No. 32**

**Difluoromethane (HFC-32)**

**CAS No. 75-10-5**

May 1995

ISSN-0773-6339-32

## **ECETOC JACC Report No. 32**

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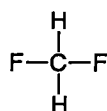
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## SECTION 2. IDENTITY, PHYSICAL AND CHEMICAL PROPERTIES, ANALYTICAL METHODS

### 2.1 IDENTITY

Chemical structure:



Chemical formula:  $\text{CH}_2\text{F}_2$

Common name: difluoromethane

Common synonyms: Fluorocarbon 32; HFC-32; R-32

CAS Registry Number: 75-10-5

EINECS Number: 200-839-4

Conversion factors: 1 ppm = 2.13 mg/m<sup>3</sup> at 25°C  
1 mg/l = 470 ppm at 25° C

### 2.2 PHYSICAL AND CHEMICAL PROPERTIES

Difluoromethane is a colourless, odourless gas flammable in air. Some chemical and physical properties are given in Table 1.

### 2.3 ANALYTICAL METHODS

Methods for difluoromethane analysis described by Parr-Dobrzanski (1993) are based on gas chromatography with flame ionisation detection.

## 4.2 ATMOSPHERIC LIFETIME<sup>1</sup>

The atmospheric degradation of difluoromethane will occur almost exclusively in the troposphere, being initiated by attack by naturally occurring hydroxyl radicals; reaction with other species, such as oxygen or chlorine atoms, is negligible even in the stratosphere, as is direct photolysis (Schmoltner *et al*, 1993). The overall atmospheric lifetime of difluoromethane is calculated to be 6 years (Schmoltner *et al*, 1993; IPCC, 1994).

## 4.3 OZONE DEPLETING POTENTIAL

Since difluoromethane contains neither chlorine nor bromine, it has no effect on stratospheric ozone.

## 4.4 GLOBAL WARMING POTENTIAL

Global Warming Potentials (GWPs) express the radiative forcing (increase in earthward infra-red radiation flux) due to emission of a unit mass of a given compound, divided by the radiative forcing due to emission of the same mass of a reference compound. The numerical values obtained depend not only on the reference gas adopted, but also on the time period after emission considered in the calculation (known as the "integration time horizon" or ITH).

Relative to trichlorofluoromethane (CFC-11), the GWP of difluoromethane is 0.13, for an infinite ITH. Relative to CO<sub>2</sub>, the GWP values for difluoromethane are 1,800, 580 and 180, for ITHs of 20, 100 and 500 years respectively (IPCC, 1994).

## 4.5 TROPOSPHERIC OZONE FORMATION

It has been demonstrated that many hydrochlorofluorocarbons and hydrofluorocarbons are too unreactive in the lower atmosphere to make any significant contribution to local urban tropospheric ozone formation, and the related "photochemical smog", near the emission sources (WMO, 1989a).

While difluoromethane was not considered explicitly in this analysis, the fact that its rate constant for reaction with hydroxyl radicals lies within the range of those of similar compounds examined,

<sup>1</sup> The "lifetime" is the time necessary for 63% degradation; it is equal to the "half-life" divided by ln2 (= 0.69)

leads to the conclusion that difluoromethane also has a negligible impact on urban ozone production.

#### 4.6 DEGRADATION MECHANISM AND PRODUCTS

By analogy with other hydrochlorofluorocarbons or hydrofluorocarbons for which detailed mechanistic studies exist (WMO, 1989b; WMO, 1991; Wallington *et al*, 1994), the appended atmospheric degradation scheme can be proposed for difluoromethane.

As stated above, breakdown of difluoromethane will occur almost exclusively in the troposphere and will be initiated essentially by the hydroxyl radical. It will proceed via various free-radical or short-lived molecular intermediates to give carbonyl fluoride ( $\text{COF}_2$ ). The latter is expected to be removed from the atmosphere, within a few days to a few weeks, by uptake into clouds, rain and the oceans, and then rapidly hydrolysed to  $\text{CO}_2$  and HF (AFEAS, 1992; Wallington *et al*, 1994).

Support for this mechanism is provided by experimental observations on the analogous chlorine-atom initiated oxidation of difluoromethane, in which  $\text{COF}_2$  is the sole carbon-containing product formed (Nielsen *et al*, 1992).

Although a peroxyxynitrate ( $\text{CHF}_2\text{O}_2\text{NO}_2$ ) and a hydroperoxide ( $\text{CHF}_2\text{O}_2\text{H}$ ) may be formed during the degradation of difluoromethane, they are not thought to play a significant role in its atmospheric chemistry, probably being rather short-lived intermediates (Wallington *et al*, 1994).

No information is available on biodegradation and possible bioaccumulation in the environment. Experimental studies demonstrate that difluoromethane is not readily biodegradable in the closed bottle test. A 3-5 % degradation was observed after 28 days (Tobeta, 1992).

#### 4.7 CONTRIBUTION OF DEGRADATION PRODUCTS TO ENVIRONMENTAL FLUORIDE AND TO THE ACIDITY OF RAINWATER

Assuming an atmospheric release and degradation rate of 30 kt difluoromethane per year (see above), 100 % conversion into  $\text{COF}_2$ , uniform scavenging of the latter into the global average rainfall of  $5 \times 10^{11}$  kt/y, followed by hydrolysis to  $\text{CO}_2$  and HF, leads to the conclusion that the levels of fluoride and acidity thus produced are low compared with those arising from existing sources:

## **SECTION 6.        EFFECTS ON ORGANISMS IN THE ENVIRONMENT**

No data are available on the effects of difluoromethane on organisms in the environment.

of the dose (calculated as the amount of fluorocarbon inhaled during the exposure) in both rats and mice. Of this 1% approximately half was exhaled as difluoromethane within one hour. The remaining radioactivity was excreted as exhaled carbon dioxide or in the urine and faeces, mostly within 24 hours of exposure. Carbon dioxide was a major metabolite accounting for 0.23% and 0.27% of the inhaled dose in rats and mice respectively. Urinary excretion accounted for 0.13% and 0.34% and faecal excretion 0.03% and 0.07% of the inhaled dose in rats and mice respectively. Analysis of a range of tissues at the end of the study showed a relatively uniform distribution of radioactivity with the highest concentration in the lungs, liver and kidney.

These authors also reported that, using unlabelled difluoromethane, there was no significant formation of carboxyhaemoglobin in rats and mice, indicating that metabolism of difluoromethane to carbon monoxide is not a significant metabolic pathway.

## **7.2 HUMAN**

No data exist for absorption, distribution, metabolic transformation or elimination of difluoromethane in man.

The potential teratogenic activity of difluoromethane was investigated using the modified Chernoff-Kavlock assay (Moxon, 1992). Groups of 10 pregnant female Alpk: APFSD Wistar strain derived rats were exposed to atmospheric concentrations of 0 (controls), 21,300 or 106,500 mg/m<sup>3</sup> (0, 10,000 or 50,000 ppm) difluoromethane for 6 h/d from days 7 to 16 of gestation. The animals were allowed to litter and the number, weight and viability of their offspring was assessed between days 1 and 5 *post partum*. Difluoromethane at either concentration had no effect on the females during gestation and had no effect on litter size at birth or pup survival to day 5. A slight reduction in pup weight gain at 106,500 mg/m<sup>3</sup> (50,000 ppm) was recorded. However according to the criteria for assessing the results of this assay, difluoromethane was potentially neither teratogenic nor foetotoxic at the concentrations tested.

Pregnant rats (Alpk:APfSD, Wistar derived) were exposed to concentrations of 0 (control), 10,650, 31,950 and 106,500 mg/m<sup>3</sup> (0, 5,000, 15,000 and 50,000 ppm) (Moxon, 1993) for 6 h/d difluoromethane. Exposures were on days 7-16 of gestation to groups of 24 animals. There was no change in maternal bodyweight gain. However a slight reduction in food consumption associated with exposure to 106,500 mg/m<sup>3</sup> (50,000 ppm) difluoromethane suggested a minimal effect on the dams. Overall there was no adverse effect on number, growth and survival of foetuses *in utero*. There was no increase from control values in the incidence of major defects in any treated group. An increase in the proportion of foetuses with minor external/visceral defects achieved statistical significance in the 106,500 mg/m<sup>3</sup> (50,000 ppm) group. These findings were of low incidence and were typical of the general minor changes seen in the presence of maternal toxicity. This slightly increased incidence of minor variants/defects compared to control is considered at most to indicate minimal foetotoxicity at 106,500 mg/m<sup>3</sup> (50,000 ppm) in the presence of minimal maternal toxicity.

Groups of 24 pregnant New Zeland white rabbits, were exposed to difluoromethane at concentrations of 0 (control), 10,650, 31,900 and 106,500 mg/m<sup>3</sup> (0, 5,000, 15,000 and 50,000 ppm) for 6h/d from day 6 to day 18 of gestation (Myers 1994). During days 8 to 10 of pregnancy there was a slight but statistically significant reduction of maternal bodyweight gain. Subsequent bodyweight gain was similar to control. There was no evidence of foetotoxicity. Numbers of malformations and skeletal and visceral anomalies were not statistically increased above control values in any exposed group.

In conclusion, difluoromethane was not teratogenic in the rat or rabbit at any exposure level. There was evidence of minimal maternal toxicity in both species, and minimal foetotoxicity in the rat at 106,500 mg/m<sup>3</sup> (50,000 ppm).

## **8.8 CARCINOGENICITY**

No data are available.

## **SECTION 9.        EFFECTS ON MAN**

There are no reports of adverse health effects due to difluoromethane.

WMO. 1989a. World Meteorological Association. Global Ozone Research and Monitoring Project, Report No. 20. Scientific Assessment of Stratospheric Ozone: 1989. Volume II, Appendix: AFEAS Report, chapter X, Impact on photochemical oxidants including tropospheric ozone.

WMO, 1989b. World Meteorological Association. Global Ozone Research and Monitoring Project, Report No. 20. Scientific Assessment of Stratospheric Ozone: 1989. Volume II, Appendix: AFEAS Report, chapter VI, Degradation mechanisms.

WMO, 1989c. World Meteorological Association. Global Ozone Research and Monitoring Project, Report No. 20. Scientific Assessment of Stratospheric Ozone: 1989. Volume II, Appendix: AFEAS Report, chapter XI, Natural sources.

WMO 1991. World Meteorological Association. Global Ozone Research and Monitoring Project, Report No. 25. Scientific Assessment of Ozone Depletion: 1991 p. 5.15-5.25.

Yaws CL, Yang HC, Hopper JR and Hansen KC. 1990. Organic chemicals: water solubility data. Chem Eng, July, 115-118.



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D-1995-3001-123