ECETOC

Joint Assessment of Commodity Chemicals No. 32

Difluoromethane (HFC-32)

CAS No. 75-10-5

May 1995

European Centre for Ecotoxicology
and Toxicology of Chemicals

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LIST OF ECETOC PUBLICATIONS (continued inside back cover)

MONOGRAPHS

No.	Title
No. 1	Good Laboratory Practice. Oct 79
No. 2	Contribution to Strategy for Identification and Control of Occupational Carcinogens. Sep 80
No. 2	Definition of a Mutagen, for 6th Amendment. Sep 80
No. 3	Risk Assessment of Occupational Chemical Carcinogens. Jan 82
No. 4	Hepatocarcinogenesis in Laboratory Rodents : Relevance for Man. Oct 82
No. 5	Identification and Assessment of the Effects of Chemicals on Reproduction and Development (Reproductive Toxicology). Dec 83
No. 6	Acute Toxicity Tests, $LD_{50}(LC_{50})$ Determinations and Alternatives. May 85
No. 7	Recommendations for the Harmonisation of International Guidelines for Toxicity Studies. Dec 85
No. 8	Structure-Activity Relationships in Toxicology and Ecotoxicology: An Assessment. Feb 86
No. 9	Assessment of Mutagenicity of Industrial and Plant Protection Chemicals. Jun 87
No. 10	Identification of Immunotoxic Effects of Chemicals and Assessment of their Relevance to Man. Aug 87
No. 11	Eye Irritation Testing. Jun 88
No. 12	Alternative Approaches for the Assessment of Reproductive Toxicity (with emphasis on embryotoxicity/teratogenicity). Nov 89
No. 13	DNA and Protein Adducts: Evaluation of their Use in exposure Monitoring and Risk Assessment. Oct 89
No. 14	Skin Sensitisation Testing. Mar 90
No. 15	Skin Irritation. Jul 90
No. 16	Mutation Research, Special Issue: Early Indicators of Non-Genotoxic Carcinogenesis. Jun 91
No. 17	Hepatic Peroxisome Proliferation. May 92
No. 18	Evaluation of the Neurotoxic Potential of Chemicals. Sep 92
No. 19	Respiratory Allergy. Aug 93
No. 20	Percutaneous Absorption. Aug 93
No. 21	Immunotoxicity: Hazard Identification and Risk Characterisation. Sep 94
No. 22	Evaluation of Chemicals for Oculotoxicity. Nov 94

JACC REPORTS

No.	Title
No. 1	Joint Assessment of Commodity Chemicals, Melamine. Feb 83
No. 2	Joint Assessment of Commodity Chemicals, 1,4-Dioxane. Feb 83
No. 3	Joint Assessment of Commodity Chemicals, Methyl Ethyl Ketone. Feb 83
No. 4	Joint Assessment of Commodity Chemicals, Methylene Chloride. Jan 84
No. 5	Joint Assessment of Commodity Chemicals, Vinylidene Chloride. Aug 85
No. 6	Joint Assessment of Commodity Chemicals, Xylenes. Jun 86
No. 7	Joint Assessment of Commodity Chemicals, Ethylbenzene. Aug 86
No. 8	Joint Assessment of Commodity Chemicals, Methyl Isobutyl Ketone. May 87
No. 9	Joint Assessment of Commodity Chemicals, Chlorodifluoromethane. Oct 89
No. 10	Joint Assessment of Commodity Chemicals, Isophorone. Sep 89
No. 11	Joint Assessment of Commodity Chemicals, (HFA-132b) 1,2-Dichloro-1,1-Difluoroethane. May 90
No. 12	Joint Assessment of Commodity Chemicals, (HFA-124) 1-Chloro-1,2,2,2-Tetrafluoroethane. May 90
No. 13	Joint Assessment of Commodity Chemicals, (HFA-123) 1,1-Dichloro-2,2,2-Trifluoroethane. May 90
No. 14	Joint Assessment of Commodity Chemicals, (HFA-133a) 1-Chloro-2,2,2-Trifluoromethane. Aug 90
No. 15	Joint Assessment of Commodity Chemicals, (HFA-141B) 1-Fluoro 1,1-Dichloroethane. Aug 90
No. 16	Joint Assessment of Commodity Chemicals, (HCFC-21) Dichlorofluoromethane. Aug 90
No. 17	Joint Assessment of Commodity Chemicals, (HFA-142b) 1-Chloro-1,1,Difluoroethane. Feb 91
No. 18	Joint Assessment of Commodity Chemicals, Vinylacetate. Feb 91
No. 19	Joint Assessment of Commodity Chemicals, Dicyclopentadiene. Jul 91
No. 20	Joint Assessment of Commodity Chemicals, Tris-/Bis-/Mono-(2-ethylhexyl)phosphate. May 92
No. 21	Joint Assessment of Commodity Chemicals, Tris-(2-butoxyethyl)-phosphate. Mar 92
No. 22	Joint Assessment of Commodity Chemicals, Hydrogen Peroxide. Jan 93
No. 23	Joint Assessment of Commodity Chemicals, Polycarboxylate Polymers as Used in Detergents. Nov 93
No. 24	Joint Assessment of Commodity Chemicals, (HFC-125) Pentafluoroethane. May 94
No. 25	Joint Assessment of Commodity Chemicals, (HCFC-124) 1-Chloro-1,2,2,2-Tetrafluoroethane. Jul 94
No. 26	Joint Assessment of Commodity Chemicals, Linear Polydimethylsiloxanes (viscosity 10-100,000 centisokes). Sep 94
No. 27	Joint Assessment of Commodity Chemicals, *n*-Butyl Acrylate. CAS No. 141-32-2. Aug 94
No. 28	Joint Assessment of Commodity Chemicals, Ethyl Acrylate. CAS No. 140-88-5. Sep 94
No. 29	Joint Assessment of Commodity Chemicals, 1,1-Dichloro-1-Fluoroethane (HCFC-141b) CAS No 1717-00-6. Feb 95
No. 30	Joint Assessment of Commodity Chemicals, Methyl Methacrylate. CAS No. 80-62-6. In Press
No. 31	Joint Assessment of Commodity Chemicals, 1,1,1,2-Tetrafluoroethane (HFC-134a) CAS No. 811-97-2. Feb 95
No. 32	Joint Assessment of Commodity Chemicals, Difluoromethane (HFC-32) CAS No. 75-10-5. May 95

Joint Assessment of Commodity Chemicals No. 32

Difluoromethane (HFC-32)

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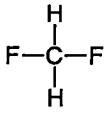
SECTION 2. IDENTITY, PHYSICAL AND CHEMICAL PROPERTIES, ANALYTICAL METHODS

2.1 IDENTITY

Chemical structure:



Chemical formula: CH_2F_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^3 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[1]

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_2, 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,

[1] 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 negligble 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 (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 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 COF_2 is the sole carbon-containing product formed (Nielsen *et al*, 1992).

Although a peroxynitrate ($CHF_2O_2NO_2$) and a hydroperoxide (CHF_2O_2H) 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 biodegrable 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 COF_2, uniform scavenging of the latter into the global average rainfall of 5×10^{11} kt/y, followed by hydrolysis to 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^3 (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^3 (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^3 (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^3 (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^3 (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 varients/defects compared to control is considered at most to indicate minimal foetotoxicity at 106,500 mg/m^3 (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^3 (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^3 (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.

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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.

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No. Title

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No. 2 The Mutagenic and Carcinogenic Potential of Formaldehyde. May 81
No. 3 Assessment of Test Methods for Photodegradation of Chemicals in the Environment. Aug 81
No. 4 The Toxicology of Ethylene Glycol Monoalkyl Ethers and its Relevance to Man. Jul 82
No. 5 Toxicity of Ethylene Oxide and its Relevance to Man. Sep 82
No. 6 Formaldehyde Toxicology: an Up-Dating of the ECETOC Technical reports 1 and 2. Sep 82
No. 7 Experimental Assessment of the Phototransformation of Chemicals in the Atmosphere. Sep 82
No. 8 Biodegradation Testing: An Assessment of the Present Status. Nov 83
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No. 10 Considerations Regarding the Extrapolation of Biological Data in Deriving Occupational Exposure Limits. Feb 84
No. 11 Ethylene Oxide Toxicology and its Relevance to Man : An Up-Dating of ECETOC Technical Report no.5. Mar 84
No. 12 The Phototransformation of Chemicals in Water : Results of a Ring-Test. Jun 84
No. 13 The EEC 6th Amendment : A Guide to Risk Evaluation for Effects on the Environment. Mar 84
No. 14 The EEC 6th Amendment : A Guide to Risk Evaluation for Effects on Human Health. Mar 94
No. 15 The Use of Physical-Chemical Properties in the 6th Amendment and their Required Precision, Accuracy and Limiting Values. Jun 84
No. 16 A review of Recent Literature on the Toxicology of Benzene. Dec 84
No. 17 The Toxicology of Glycol Ethers and its Relevance to Man : An Up-Dating of ECETOC Technical Report no.4. Apr 85
No. 18 Harmonisation of Ready Biodegradability Tests. Apr 85
No. 19 An Assessment of Occurrence and Effects of Dialkyl-o-Phthalates in the Environment. May 85
No. 20 Biodegradation Tests for Poorly-Soluble Compounds. Feb 86
No. 21 Guide to the Classification of Carcinogens, Mutagens and Teratogens Under the 6th Amendment. Feb 86
No. 22 Classification of Dangerous Substances and Pesticides in the EEC Directives. A Proposed Revision of Criteria for Inhalational Toxicity. 87
No. 23 Evaluation of the Toxicity of Substances to be Assessed for Biodegradability. Nov 86
No. 24 The EEC 6th Amendment : Prolonged Fish Toxicity Tests. Oct 86
No. 25 Evaluation of Fish Tainting. Jan 87
No. 26 The Assessment of Carcinogenic Hazard for Human Beings Exposed to Methylene Chloride. Jan 87
No. 27 Nitrate and Drinking Water. Jan 88
No. 28 Evaluation of Anaerobic Biodegradation. Jun 88
No. 29 Concentrations of Industrial Organic Chemicals Measured in the Environment: The Influence of Physico- Chemical Properties, Tonnage and Use Pattern. Jun 88
No. 30(5) Existing Chemicals : Literature Reviews and Evaluations. 94
No. 31 The Mutagenicity and Carcinogenicity of Vinyl Chloride : A Historical Review and Assessment. Jul 88
No. 32 Methylene Chloride (Dichloromethane) : Human Risk Assessment Using Experimental Animal Data. May 88
No. 33 Nickel and Nickel Compounds : Review of Toxicology and Epidemiology with Special Reference to Carcinogenesis. Feb 89
No. 34 Methylene Chloride (Dichloromethane) : An Overview of Experimental Work Investigating Species, Differences in Carcinogenicity and their Relevance to Man. Mar 89
No. 35 Fate, Behaviour and Toxicity of Organic Chemicals Associated with Sediments. Jan 90
No. 36 Biomonitoring of Industrial Effluents. Apr 90
No. 37 Tetrachloroethylene : Assessment of Human Carcinogenic Hazard. May 90
No. 38 A Guide to the Classification of Preparations Containing Carcinogens, Mutagens and Teratogens. Jul 90
No. 39 Hazard Assessment of Floating Chemicals After an Accidental Spill at Sea. Jul 90
No. 40 Hazard Assessment of Chemical Contaminents in Soil. Aug 90
No. 41 Human Exposure to N-Nitrosmaines, Their Effects and a Risk Assessment for n-Nitrosodiethanolamine in Personal Care Products. Aug 90
No. 42 Critical Evaluation of Methods for the Determination of N-Nitrosamines in Personal Care and Household Products. Feb 91
No. 43 Emergency Exposure Indices for Industrial Chemicals. Mar 91
No. 44 Biodegradation Kinetics. Sep 91
No. 45 Nickel, Cobalt and Chromium in Consumer Products: Allergic Contact Dermatitis. Mar 92
No. 46 EC 7th Amendment: Role of Mammalian Toxicokinetic and Metabolic Studies in the Toxicological Assessment of Industrial Chemicals. May 92
No. 47 EC 7th Amendment: 'Toxic to Reproduction' - Guidance on Classification. Aug 92
No. 48 Eye Irritation: Reference Chemicals Data Bank. Aug 92
No. 49 Exposure of Man to Dioxins: A Perspective on Industrial Waste Incineration. Sep 92
No. 50 Estimating the Environmental Concentrations of Chemicals Using Fate and Exposure Models. Nov 92
No. 51 Environmental Hazard Assessment of Substances. Jan 93
No. 52 Styrene Toxicology Investigations on the Potential for Carcinogenicity. Nov 92
No. 53 DHTDMAC: Aquatic and Terrestrial Hazard Assessment. CAS No. 61789-80-8. Feb 93
No. 54 Assessment of the Biodegradation of Chemicals in the Marine Environment. Aug 93
No. 55 Pulmonary Toxicity of Polyalkylene Glycols. (in preparation)
No. 56 Aquatic Toxicity Data Evaluation. Dec 93
No. 57 Polypropylene Production and Colorectal Cancer. Feb 94
No. 58 Assessment of Non-Occupational Exposure to Chemicals. May 94
No. 59 Testing For Worker Protection. May 94
No. 60 Trichloroethylene: Assessment of Human Carcinogenic Hazard. May 94
No. 61 Environmental Exposure Assessment. Sep 94
No. 62 Ammonia Emissions to Air in Western Europe. Jul 94

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