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on Existing Chemicals of
Environmental Relevance (BUA)

1,2-Dichloroethane

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(December 1994)



S. Hirzel

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GDCh Office:

Dr. H. Behret, GDCh, Frankfurt am Main

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S. Hirzel

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Dr. H. Behret
Gesellschaft Deutscher Chemiker
Postfach 90 04 40
D-60444 Frankfurt am Main

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Foreword

The German Chemicals Act (Chemikaliengesetz — ChemG) of 1980 stipulates that certain existing chemicals must be reported to the competent authority, if they exhibit properties which indicate that they may be hazardous, either alone or in combination with other substances.

In the summer of 1982, an Advisory Committee on Existing Chemicals of Environmental Relevance (BUA) was set up by the German Chemical Society (Gesellschaft Deutscher Chemiker — GDCh). It brings together representatives from the scientific community, the chemical industry and the governmental authorities. This Advisory Committee is responsible for elaborating appropriate solutions for substances of relevance for health and the environment on the basis of voluntary measures. It selects and examines existing chemicals from the aforementioned angles. The testing and evaluation are based on scientific criteria alone.

It was, therefore, necessary to develop priority setting procedures. In a first phase reports were only prepared for priority chemicals. Within the framework of a first priority setting procedure, chemicals were compiled from several priority lists and 135 chemicals were selected for detailed reports.

In a second priority setting procedure the survey of the German Chemical Industry Association (VCI) on all substances with a production volume of more than 10 tons per year was used as a starting list. Since this survey covered 4,600 chemicals, BUA decided to process the corresponding list in several stages. The first stage included approx. 1,050 substances with a production volume of more than 1,000 tons per year.

Detailed reports are drawn up on chemicals suspected of having a hazard potential and abridged reports on those presenting only a minor hazard potential, according to the current state of knowledge.

The detailed BUA reports take in both the published literature and data from industry. If data for the evaluation of the chemicals are not available, additional studies are recommended and the results are published as update to the reports. The reports serve as a basis for the instigation of administrative measures, when there are indications of risks to health or the environment.

Tübingen, May 1993

Ernst Bayer
Chairman of the Advisory Committee
on Existing Chemicals
of Environmental Relevance

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BUA Report on 1,2-Dichloroethane

Summary and conclusions

Ecological aspects

Occurrence and distribution among the compartments

In the Federal Republic of Germany 1,2-dichloroethane is produced by eight domestic producers, using the method of direct chlorination and oxychlorination.

In 1993 the production capacity for 6 of the 8 producers of 1,2-dichloroethane was 2,708,000 tons, and for 7 of the 8 firms the production quantity was 1,766,188 tons; 111,911 tons were exported and a total of 139,600 tons was imported.

In 1993 most of this (approx. 1.73 million tons) was further processed to vinyl chloride in the Federal Republic of Germany, and approx. 60,000 tons were further processed, mainly to 1,1,1-trichloroethane, trichloroethene, tetrachloroethene and tetrachloromethane, as well as to polyethylenamines and ion exchangers. 1,2-dichloroethane is only used in very small quantities as a solvent.

Until the 19th BImSchV (immission protection regulations) came into force on 25.07.1992, 1,2-dichloroethane was permitted for use as a scavenger in anti-knock agents for leaded motor vehicle fuels in the Federal Republic of Germany. Exemption allowances are, however, still in existence for the use of 112,518 tons scavenger-containing leaded super-grade petrol, which expire at the end of 1995 (1 l super-grade petrol contains 0.072 g 1,2-dichloroethane).

From the production and processing of 1,2-dichloroethane in 1993 in the Federal Republic of Germany a total quantity of approx. 150 tons was found to have entered the atmosphere after treatment of the exhaust air flow. Of this, 32 tons resulted from down-time of an exhaust gas combustion plant. The total quantity of 1,2-dichloroethane discharged into the sewage plants during production and processing in 1993 was approx. 2.5 tons (from 5 firms via prepurified waste water) and < 3.8 tons into the receiving stream. For 7 firms a total discharged quantity of 4.46 tons was calculated as the "worst case"; the discharge from 2 firms has to be added, for which quantifications are not submitted.

Owing to its physicochemical properties, the target compartment for 1,2-dichloroethane is the atmosphere.

1,2-dichloroethane is detectable in the atmosphere worldwide: between 1981 and 1985 concentrations between 0.152 to 0.173 μg 1,2-dichloroethane/ m^3 were measured in the northern hemisphere, and in the southern hemisphere between < 0.016 (detection limit) and 0.058 μg 1,2-dichloroethane/ m^3 .

The different distribution in the hemispheres is due to the main sources of emission in the northern hemisphere, such as 1,2-dichloroethane emission from motor vehicle traffic (as a scavenger for leaded fuels), from industry (production and processing plants) and waste landfills. From motor vehicle traffic, owing to the already mentioned exemption allowances, an emission of only 0.020 - 1.079 tons 1,2-dichloroethane is probable from combustion engines driven with scavenger-containing gasoline in the period from 1993 to 1995.

In cities of the Federal Republic of Germany with settled industry, for example Hamburg, the mean values determined at 12 different measuring points in 1986 were between 12.4 and 21.38 μg 1,2-dichloroethane/ m^3 . Peak values of up to 529 μg 1,2-dichloroethane/ m^3 were measured at one industrial location, and 1,560 μg 1,2-dichloroethane/ m^3 in the city area with high traffic density. On the other hand, in a rural district (near Ulm) a mean value of 0.075 μg 1,2-dichloroethane/ m^3 was measured, and in a forest (Geislinger Alb) 0.069 μg 1,2-dichloroethane/ m^3 .

In contrast to this, tests in the Netherlands in 1986 did not show such differences, since both in contaminated industrial cities and on the island of Terschelling mean values of between 0.206 and 1.233 μg 1,2-dichloroethane/ m^3 were measured.

In European cities maximum values of 57.5 μg 1,2-dichloroethane/ m^3 for Italy (1990), 7.9 for Switzerland (1982/83), 3.6 for Great Britain (1983) and 1.9 for Sweden (1978) are reported, resulting from motor vehicle traffic (road traffic, parking garage).

1,2-dichloroethane has also been detected in interior rooms. Up to 0.3 μg 1,2-dichloroethane/ m^3 air was measured in the interior room air in London (city centre) in December 1991, following a smog incident (fog during temperature inversion).

In the USA (6 different cities) 1,2-dichloroethane air concentrations in interior rooms of between 0.025 and 3.6 $\mu\text{g}/\text{m}^3$ (maximum value 69 $\mu\text{g}/\text{m}^3$ were measured in the years 1981 - 1984.

Short-term measurements at the working place during production and processing of 1,2-dichloroethane (the year when measurements were carried out is not indicated) in the Federal Republic of Germany resulted in mean values of between 28,300 (personal monitoring) and 39,000 μg 1,2-dichloroethane/ m^3 (area monitoring), whereby 80 % of the values for person-related measurements being between > 400 and < 2,000 $\mu\text{g}/\text{m}^3$ and for 66 % of the values the area measurements were in the same range. On the other hand, long-term measurements resulted in arithmetic mean values of 4,900 and 6,300 μg 1,2-dichloroethane/ m^3 respectively.

1,2-dichloroethane has also been detected in soil-spacial air and landfill gas. In the period from June 1986 to March 1987 soil-spacial air samples were taken at various sampling sites in a waste landfill at Bielefeld. 1,2-dichloroethane contents of 21 to 242 $\mu\text{g}/\text{m}^3$ were found, depending on the sampling position (positions with the highest pollution and less polluted areas of the waste landfill). Similar concentrations were found in the ground water; details of this are stated later.

Higher concentrations, in comparison with this, were measured in Southern Finland. In the spring and autumn of 1989 and 1990 mean values of between 200 and 950 μg 1,2-dichloroethane/ m^3 (maximum: 2,000 $\mu\text{g}/\text{m}^3$) were measured in gas samples taken from three closed down waste landfills with metal sludges and solvent wastes, and a mean value of 700 μg 1,2-dichloroethane/ m^3 (maximum: 1,600 $\mu\text{g}/\text{m}^3$) in a waste landfill still in operation.

1,2-dichloroethane can also be detected in surface natural waters. Thus the highest concentration in the Rhine was 8.5 μg 1,2-dichloroethane/l at Lobith in 1986, in 1987 the mean concentration was < 0.01 and in 1988 0.10 μg 1,2-dichloroethane/l; at Hagestein the mean concentration was < 0.1 μg 1,2-dichloroethane/l between 1988 and 1992 (highest concentration 1986: 4.4). In the Rhine tributaries (Sieg, Wupper, Erft and Ruhr) higher concentrations were detected; in 1987 5 μg 1,2-dichloroethane/l were found in random samples, and in 1988

6.3 µg 1,2-dichloroethane/l were measured in the Wupper. From 1988 to 1990 in the mouth of the Lippe the maximum 1,2-dichloroethane concentrations measured were < 5 µg 1,2-dichloroethane/l and 13.8 µg/l in 1991. In the Emscher 1,2-dichloroethane concentrations of 5.6 and 5.1 µg 1,2-dichloroethane/l were measured in 1988 and 1990, respectively.

In the Elbe at Schnackenburg, the maximum concentration of 1,2-dichloroethane was < 4 in 1988 and 8 µg 1,2-dichloroethane/l (random sample measurements) in 1990.

For the Ems, Leine and Weser the following maximum concentrations were reported: 12 µg 1,2-dichloroethane/l (1988: Leine), < 8 µg 1,2-dichloroethane/l (1990: Ems, Leine, Weser).

1,2-dichloroethane has also been detected in sea water (Netherlands): for the southern North Sea a mean concentration of 0.050 µg 1,2-dichloroethane/l (maximum: 0.647, minimum: 0.005 µg/l) was determined from August 1983 to July 1984.

In the IJsselmeer at Andijk < 2.00 µg 1,2-dichloroethane/l (monthly mean values) was determined from 1989 to 1992.

1,2-dichloroethane is also present in river sediment: on the basis of the water concentrations in sediment samples from the Rhine at Gorinchem (in the Netherlands - year of the tests not indicated) a concentration of 0.04 µg 1,2-dichloroethane/kg was calculated for the sediment.

In the U.S.A., 1,2-dichloroethane concentrations of below 0.5 µg/kg (wet weight) were detected in fresh water sediment samples from Los Angeles County in 1981, and of between < 0.1 and 0.1 µg 1,2-dichloroethane/kg (wet weight) were measured in salt water sediment samples from Lake Pontchartrain (located in deltaic plain of the Mississippi River) in 1980 and 1986, as well.

1,2-dichloroethane has also been detected in rain water: in September 1985 a 1,2-dichloroethane concentration of 0.01 µg 1,2-dichloroethane/l was measured. In 1983 a content of < 0.005 µg/l (detection limit) was determined in rain in the Netherlands.

In filtrate from banks of the Rhine, too, 0.35 µg 1,2-dichloroethane/l drinking water was found in the period from November 1975 to January 1976, while ozone treated (2 mg ozone/l) and filtered raw water contained 0.88 µg 1,2-dichloroethane/l. Unchlorinated drinking

water (sampling from the Rhine, exhausted activated carbon filter) contained 1.32 µg 1,2-dichloroethane/l. Actual data on drinking water are not available (1,2-dichloroethane is not listed in the drinking water regulations of 1990). From the Netherlands a maximum concentration of 0.06 µg 1,2-dichloroethane/l drinking water has been reported for the year 1981.

In 1981 in the U.S.A., 1,2-dichloroethane was found in drinking water samples from home as well as workplace at concentration levels of the detection limit of 0.02 µg/l or below.

The 1,2-dichloroethane concentration measured in drinking water samples from 5 Japanese cities ranged from 0.5 to 0.9 µg/l in 1977.

In Spain measurements carried out on the municipal water supply resulted in values of up to maximum 56.7 µg 1,2-dichloroethane/l between February and June 1987.

In leachate water of hazardous waste landfills, in waste water and in sewage sludge the presence of 1,2-dichloroethane can be detected: in 123 leachate water samples examined in Northrhine-Westphalia 1,2-dichloroethane was determined qualitatively in 99.2 % of the samples in 1987.

Although in the leachate water from 6 hazardous waste landfills (no information is given on the type of hazardous waste or the period in which the tests were carried out) concentrations of 1,2-dichloroethane of 40 - 830 µg/l were found, the 1,2-dichloroethane contents in leachate water samples from 5 domestic waste landfills were below the detection limit of 1.1 µg/l).

In the U.S.A., 1,2-dichloroethane concentrations up to a maximum level of 34,000 µg/l have been found in leachate water samples of landfills.

In 1980 to 1983 < 2 - 400 µg 1,2-dichloroethane/l were determined in the inflow, and < 2 - 74 µg 1,2-dichloroethane/l in the effluent of waste water from sewage plants in the Netherlands (mean elimination: 70 %).

In sewage sludges in the Federal Republic of Germany < 50 µg/kg dry matter were determined, both in municipal and in municipal/industrial waste water purification plants; in one industrial waste water purification plant a value of up to 2,700 µg 1,2-dichloroethane/kg dry matter was found.

For the year 1985, an average concentration of 25 µg 1,2-dichloroethane/kg sewage sludge (no further specification) has been reported for the U.S.A.

1,2-dichloroethane is mobile in the soil and can therefore enter the ground water. In Northrhine-Westphalia ≤ 0.2 µg 1,2-dichloroethane/l were measured in ground water samples between 1983 and 1986.

In ground water (loose sediment aquifer, original states of the German Federal Republic) in areas contaminated by closed and other waste landfills, a mean concentration of 107.3 and a maximum concentration of 210.0 µg 1,2-dichloroethane/l were measured (year of the tests not indicated).

In random soil samples (0 - 25 cm depth, soil not moved for a long time) no 1,2-dichloroethane was detected at 22 measuring points in Hamburg in 1984 (detection limit: 20 µg/kg).

Average values of 11,000 and $< 5,000$ µg/kg respectively were determined in soil samples (Netherlands) in the vicinity of houses and garages from May 1984 to November 1985. The soil concentration for a waste landfill was 30,000 µg 1,2-dichloroethane/kg.

As will be explained in more detail in the following subsection on accumulation, only weak bioaccumulation of 1,2-dichloroethane is to be expected. However, owing to its lipophilic properties, 1,2-dichloroethane has also been detected in human tissues obtained from autopsies. In the subcutaneous fatty tissue 30 µg 1,2-dichloroethane per kg wet weight were analysed, in the renal capsule fat 36 µg/kg, in the liver parenchyma 41 µg/kg, in the lung tissue 29 µg/kg and in the muscular tissue 22 µg.

In the U.S.A., 1,2-dichloroethane has been detected in the expired air of volunteers from New Jersey in concentrations of between 0.12 and 0.69 µg/m³ (mean values of repeated measurements during the period from July to December 1980).

In other biological material, too, 1,2-dichloroethane has been detected: in oysters (*Crassostrea virginica*) and other mussels (*Rangia cuniata*); from the outlet of Lake Pontchartrain, mouth of the Mississippi, Gulf of Mexico) 1.0 to 95 µg 1,2-dichloroethane/kg wet weight were detected in May/June 1980, and in 1986 between 1.0 and 1.5 µg/kg in unspecified mussels. In grass prawns (*Palaemonetes pugio*) 0.59 1,2-dichloroethane/kg was found and in toothed carps (*Fundulus spec.*) up to 3.2 mg/kg.

Off the coast of California < 0.3 µg 1,2-dichloroethane/kg wet weight was found in the liver of four fish species, as well as in the muscles of a crustacean species.

Accumulation of 1,2-dichloroethane in food has also been observed. Analysis of different foods gave highly variable contents of 1,2-dichloroethane. In bleached flour 6.1 and 6.5 µg 1,2-dichloroethane/kg were detected, and in whole grains 110 and 180 µg 1,2-dichloroethane/kg (no information on the origin of the samples). On the other hand, in a sample of British wheat (October 1978 to April 1979), a 1,2-dichloroethane concentration of 290,000 µg/kg was found. In spices from different producers (origin unknown) between 3,000 µg 1,2-dichloroethane/kg (celery) and 23,000 µg/kg (cloves) were found. In dairy products with fruit additives (Ice cream, yoghurt, curd, buttermilk) in the mean 1,2-dichloroethane concentrations of 0.8 µg/kg fresh weight (maximum: 3.5 µg/kg) were found.

Natural sources of 1,2-dichloroethane are unknown.

Degradability

Primary degradation of 1,2-dichloroethane (30 to > 90 % of the initial concentration) is only possible under favourable conditions (adaptation and methane enrichment, aerobic conditions, cometabolically through methanotrophic microorganisms). Adaptation is also necessary for those species which are well known for their degradative capacity (adaptation phase: 3 to 16 weeks). Reductive dehalogenation plays an important part in the metabolic process. Mineralisation of 1,2-dichloroethane was proved in one case (1.3 to 1.4 µg/g/day, required adaptation time up to 16 weeks). On the other hand under environmental conditions there is only a slight probability of mineralisation, owing to the long adaptation phase. Owing to the volatility of 1,2-dichloroethane and its rapidly diminishing concentration in water and soil as a result, adaptation in the environment or in sewage plants is improbable, and is only to be expected in highly contaminated locations or under laboratory conditions.

Hydrolytic degradation is not likely under conditions relevant to the environment. Experimentally determined half-life values of 6 years (at 25 °C, in the presence of buffer and sulphide) up to 310 years (15 °C) are available.

Indirect photochemical degradation in the troposphere is the most important degradation route for 1,2-dichloroethane. Half-life values of between 73 and 64 days at 23 and 24 °C have been calculated for the degradation of 1,2-dichloroethane through OH radicals. However, for a mean tropospheric temperature (- 8 °C) half-life values of 81.8 and 114.6 years have been determined.

Accumulation

Based on an experimentally determined n-octanol/water partition coefficient ($\log P_{ow}$) of 1.45 and calculated $\log P_{ow}$ values of 1.46 to 1.76, moderate bioaccumulation is to be expected. For 1,2-dichloroethane a bioconcentration factor (BCF) of 2 has been determined experimentally. According to this, 1,2-dichloroethane is distinguished by only a low bioaccumulation.

Because of its physicochemical properties and tests on soil sorption, no significant geoaccumulation is to be expected either. The K_{OC} values of 19 - 71 indicate very low soil sorption. One can expect a leachate-to-groundwater transport of 1,2-dichloroethane because of its high mobility in soil.

Based on the Henry constant (at 20 °C: experimentally $149 \text{ Pa} \cdot \text{m}^3 \cdot \text{mol}^{-1}$ calculated $111 \text{ Pa} \cdot \text{m}^3 \cdot \text{mol}^{-1}$) 1,2-dichloroethane is highly volatile from water, according to Thomas (1982).

On the other hand, observations on the whereabouts of 10 tons 1,2-dichloroethane, which entered the Rhine following a technical accident in June 1986, showed that the substance was still detectable (12 µg/l) after 4 days and at a distance of approx. 400 km (flow time: 66 hours).

Ecotoxic effect

1,2-dichloroethane has been examined in numerous studies, mainly in order to determine its acute effect on microorganisms (particularly bacteria), plant and animal aquatic organisms, higher plants, insects and earthworms. These tests are described below.

Because most of the studies do not specify nominal or effective concentrations, this is indicated only whenever explicit data about this are available. The main emphasis is in the representation of

ranges for the most sensitive species, in an ascending systematic classification. Attention is brought to extreme values if these occur.

For bacteria isolated from sewage sludge an IC_{50} of 29 mg 1,2-dichloroethane/l (ammonia utilisation) was determined with *Nitrosomonas*, for methanogenic bacteria an IC_{50} of 25 mg/l (gas production) and for aerobic heterotrophic bacteria an IC_{50} of 470 mg/l (oxygen consumption).

On *Photobacterium phosphoreum* an EC_{50} of 158 mg 1,2-dichloroethane/l was found after 5 minutes, and on *Photobacterium fischeri* an EC_{50} of 13 mg/l (2 minutes contact time).

An 8-day cell multiplication-inhibition test was carried out with the cyanobacterium (blue algae) *Microcystis aeruginosa*. A toxic limit concentration (TLC) of 105 mg 1,2-dichloroethane/l was determined. For *Pseudomonas putida* the toxic limit concentration (TLC) after 16 hours was 135 mg 1,2-dichloroethane/l. In the cell reproduction-inhibition test (18 hours) an EC_{10} of 40 mg/l (effective concentration) was found. In the cell reproduction-inhibition test with protozoa, toxic limit concentrations ranging from 943 mg/l (48 hours) to 1,127 mg/l (72 hours) were determined.

For the acute toxicity of 1,2-dichloroethane in tests with two types of green algae, EC_{50} values in the range of > 433 to > 1,000 mg 1,2-dichloroethane/l were found for a test period of 24 hours.

The toxic limit concentrations for 2 types of green algae were in the range of 710 to 1,005 mg 1,2-dichloroethane/l after 8 and 7 days respectively.

In an oxygen-production-inhibition test a 4-h EC_{50} value of 130 mg 1,2-dichloroethane/l was found for the green algae *Haematococcus pluvialis* with 1,2-dichloroethane.

For the inhibition of cell growth (test duration: 24 - 96 hours) and reduction of the chlorophyll a content of the halophilic silica algae *Skeletonema costatum*, the EC_{50} value was > 443 mg 1,2-dichloroethane/l. The NOEC (no-observed-effect concentration) was given as < 433 mg 1,2-dichloroethane/l.

For the monocellular marine silica algae *Phaeodactylum tricorutum* an EC_{50} value of 340 mg 1,2-dichloroethane/l sea water is given for the inhibition of ^{14}C assimilation.

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For the acute toxicity of 1,2-dichloroethane with four species of small crustaceans, LC₅₀ values ranging from 85 to 320 mg 1,2-dichloroethane/l have been reported (test duration: 24 - 96 hours). An NOEC of 75.1 mg 1,2-dichloroethane/l was given.

With regard to acute toxicity of water fleas (*Daphnia magna*), 24-h and 48-h EC₀ values of from 67 to 186 mg 1,2-dichloroethane/l are available, as well as EC₅₀ values in the range 383 to 600 mg 1,2-dichloroethane/l (test duration: 24 hours) and LC₅₀ values of 218 to 320 mg/l (test duration: 48 hours).

With regard to the chronic effect of 1,2-dichloroethane, water fleas (*Daphnia magna*) show an NOEC of 11 mg 1,2-dichloroethane/l in the 28- day reproduction test, and for growth an NOEC of 42 mg 1,2-dichloroethane/l. The LOEC (lowest-observed-effect concentration) for reproduction was 21 mg 1,2-dichloroethane/l and for growth 72 mg 1,2-dichloroethane/l (average effective concentrations).

For the acute toxicity of 1,2-dichloroethane with two fresh water fish species, LC₅₀ values in the range 1.8 to 406 mg 1,2-dichloroethane/l have been reported, with a test duration of 48 hours.

With five species of marine fish LC₅₀ values in the range 115 to > 600 mg 1,2-dichloroethane/l were found (test duration: 96 and 24 hours, respectively). The LC₀ values of 1.3 - 250 mg/l were given. The NOEC values were in the range 5 to 130 mg 1,2-dichloroethane/l.

In a 7-day extended fish toxicity test on 2 - 3 months old guppies (*Poecilia reticulata*), an LC₅₀ value of 106 mg 1,2-dichloroethane/l was found.

In a 32-day early-life-stage test (ELS test) on the fathead minnow (*Pimephales promelas*), MATC values (maximum acceptable toxicant concentration) related to wet weight of 29 to 59 mg 1,2-dichloroethane/l (effective concentrations) were estimated.

The survival of embryonal and larval stages of the northwestern salamander (*Ambystoma gracile*, 4 days posthatch) at an exposure of 2.58 mg 1,2-dichloroethane/l (effective concentration) was significantly reduced.

In the terrestrial field no investigations on chronic toxicity have been carried out, but results are available on acute effects. Concen-

trations of 40 to 80 mg 1,2-dichloroethane/l air caused moderate to severe damage (not specified in more detail) to iceberg lettuce (*Lactuca sativa var.*).

In concentrations of 40 to 160 mg/l air 1,2-dichloroethane was 100 % effective as an insecticide in an exposure test (24 °C) on the eggs, larvae and pupae of *Trichoplusia ni*.

For tests on the larvae of stone flies, e.g. *Pteronarcys californica*, a 96-h LC₅₀ value of > 100 mg/l test solution has been reported.

For mosquito larvae (*Aedes aegypti*) a 4-h LC₅₀ value of 0.12 % (v/v), corresponding to 1.5 g 1,2-dichloroethane/l test solution, was found.

A 2-day contact-filter paper test was carried out on *Eisenia fetida* (Lumbricidae family). A 48-h LC₅₀ value of 60 µg/cm² (taken up through the skin) was determined for 1,2-dichloroethane. No further data are available concerning skin alterations.

Toxicological aspects

1,2-dichloroethane is readily absorbed after inhalative uptake, from the intestinal tract, as well as percutaneously, and is then rapidly distributed throughout all the tissues. On the basis of its lipophilic properties, it accumulates mainly in tissue with a high fat content.

Absorbed 1,2-dichloroethane undergoes biotransformation mainly (48 – 86 %) via the oxidative route (catalysed by Cytochrom P-450) leading to metabolites which are excreted with the urine, and is rapidly eliminated. The main metabolites eliminated in this way are thiodiacetic acid (or its sulphoxide) and S-carboxymethylcysteine.

Exhalation takes place only to a small extent, whereby unchanged 1,2-dichloroethane is mainly exhaled, and only low metabolic rates for biotransformation to CO₂ have been found.

In humans a metabolic clearance of 88 % has been calculated, and a clearance value via the lungs of 12 %.

1,2-dichloroethane shows low acute toxicity, irrespective of the way it is administered. The LD₅₀ values following oral administration are between 413 and 911 mg/kg b.w. for mice, between 680 and 770 mg/kg b.w. for rats and 910 mg/kg b.w. for rabbits. After inhala-

tive exposure the values for acute toxicity (LC_{50}) are between 1,078 mg/m³ for mice (after a 6 hour exposure period) and 49,356 mg/m³ for rats (after a 0.53 hour exposure period).

At high dosages or concentrations, symptoms of poisoning are developed, both after acute and repeated exposure to 1,2-dichloroethane. Independent of the application route the intoxication profile is characterized by an initial depression of the central nervous system.

The predominant narcotic effect may be preceded by a stimulating phase.

Systemic effects following acute intoxication with high 1,2-dichloroethane dosages or concentrations (irrespective of the method of administration) include in particular a functional disturbance of and a damage to the liver (including fatty degeneration, parenchymatous degeneration or haemorrhagic necrosis), the kidneys (including congestion, haemorrhage, necrosis, interstitial oedema, dilatation of the renal tubules, fatty degeneration, degeneration of the tubular epithelium and hypertrophy of the tubular cells) and also the lungs (including congestion, oedema, haemorrhage, fluid in the pleural cavity or peritoneal cavity).

Symptoms of depression of the central nervous system included ataxia, somnolence, lateral position and finally anaesthesia.

Direct contact of 1,2-dichloroethane, both with the intact and damaged skin, causes slight and rapidly reversible irritation. Direct contact of 1,2-dichloroethane with the mucous membranes, as well as gaseous exposure, also causes transient irritation.

No results from animal experiments are available regarding a possible sensitizing effect of 1,2-dichloroethane.

Even after repeated inhalative uptake, 1,2-dichloroethane still shows only a moderately strong toxicity. A no-observed-effect level (NOEL) of 400 mg 1,2-dichloroethane/m³ can be deduced from inhalation studies on rats (after seven hours exposure per day for a maximum of 30 weeks).

From data obtained by a study on the toxicity of 1,2-dichloroethane after 13 weeks administration, carried out in the course of the National Toxicology Programme (NTP), the following no-effect levels (NEL) were determined: 120 mg/kg b.w./day for male and 150 mg/kg b.w./day for female F344/N rats, following administration by gavage

(in corn oil, on 5 days per week); 780 mg/kg b.w./day for male B6C3F1 mice (based on observed kidney damage) or 2,500 mg/kg b.w./day for female B6C3F1 mice (based on the determined mortality rates), following administration via drinking water. The main target organs after repeated inhalative exposure to high 1,2-dichloroethane concentrations are again the liver (cloudy swelling, congestion, haemorrhage, fatty degeneration and necrosis), kidneys (fatty degeneration and tubular dilatation, cloudy swelling, haemorrhage, urinary casts, degenerative and proliferative changes in the tubular epithelium and lipoid nephrosis) and the lungs (congestion, hyperaemia, haemorrhage, thrombosis and slight oedema) and additionally the heart (dilatation, fatty degeneration, necrosis, diffuse or focal myocarditis, auricular thrombosis and degeneration of the auricular myocardium) and the adrenal gland (lipoid nephrosis and calcification).

The observed symptoms of depression of the central nervous system after repeated inhalative uptake of 1,2-dichloroethane include apathy, ataxia, transient tremor, lateral position and finally coma.

In-vitro tests on mutagenicity, carried out with 1,2-dichloroethane in several test systems, both on prokaryotes and eukaryotes, produced mainly a positive result, which was intensified by metabolic activation. The findings of the Ames tests display 1,2-dichloroethane to be a substance which can cause base-pair substitution. Several in-vivo tests on *Drosophila melanogaster* (for detection of sex-linked recessive lethal mutations, mutations and recombinations in somatic cells as well as numerical anomalies of the sex chromosomes) and on mice (micronucleus test, spot test and tests to determine DNA damage in somatic cells) provided indication of 1,2-dichloroethane having mutagenic as well as gene and DNA damaging effect.

Although a DNA damaging effect of 1,2-dichloroethane metabolites of the oxidative metabolic pathway was found in in-vitro tests, in-vivo studies gave clear indications that the DNA damage is caused mainly by the glutathione-dependent metabolism. Referring to this context further results from in-vivo tests lead to the conclusion that probably the episulphonium ion of glutathione (assumed to be an intermediate of the glutathione-dependent metabolic pathway of 1,2-dichloroethane) has a key function in DNA damaging. Results from animal experiments also indicate that the genotoxic potential of 1,2-dichloroethane depends on the mode of administration, i.e. the

exposure-time profile. It is suspected that the (predominantly detoxifying) oxidative metabolism as the main pathway exhibits a saturation behaviour, and therefore biotransformation via the activating glutathione-dependent pathway is more intensive after reaching a high 1,2-dichloroethane level in the blood.

Long-term studies with technical 1,2-dichloroethane, carried out in the course of the NCI carcinogenicity bioassay programme, gave indications of a carcinogenic potential, following 78 weeks administration by stomach tube, both with B6C3F1 mice (adenocarcinoma of the mamma, alveolar/bronchiolar adenomas) and with Osborne-Mendel rats (adenocarcinoma of the mamma, as well as carcinoma of the acanthocytes of the forestomach and haemangiosarcoma in male animals).

The open dermal application of 1,2-dichloroethane (details of quality not specified) on Ha:ICR Swiss mice for a period of more than one year, up to the subchronic maximum tolerated dose, caused no formation of dermal papillomae, but there was a significantly higher incidence of lung tumours (benign papillomae, only).

On the other hand, gaseous 1,2-dichloroethane with a purity of 98.82 %, exhibited no carcinogenic potential following 1.5 years whole body exposure up to toxic concentrations, neither with the Swiss mouse nor the Sprague-Dawley rat. A short-term test on the A/St mouse, which was specially intended for investigating the incidence of lung tumours, also gave negative results, with i.p. injection up to the maximum tolerated dosage.

Available studies on toxicity of 1,2-dichloroethane to reproduction, involving peroral administration via drinking water with mice and via the feed or following inhalative uptake with rats gave neither indications of impairment of fertility nor of a fetotoxic, embryo toxic or teratogenic effect. However, parental toxic dosages/concentrations were not reached in these tests.

In tests on the CD-1 mouse, neither subacute administration of 1,2-dichloroethane by stomach tube, in doses of up to 10 % of the acute LD₅₀ value, nor subchronic uptake with drinking water, resulted in any impairment of the antibody-induced immune response or any cell-mediated delayed hypersensitivity to sheep erythrocytes. Subchronic exposure additionally caused no reduction in natural resistance.

In humans the course of acute intoxication by 1,2-dichloroethane, following oral and inhalative intake, is very similar: the primary intoxication profile is characterized by a prenarctic initial stage. Simultaneously with subsequent progress in depression of the central nervous system, gastroenteritic symptoms, as well as disturbances of the cardiovascular system and impairment of the respiration, occur. Intoxications with a fatal outcome are brought about from the influence of a therapy-resistant cardiovascular shock. Clinical examinations gave indications of dysfunction of liver and kidneys, as well as leucocytosis, and in addition, following oral intoxication, anaemia and coagulopathy. Autopsy findings following intoxications with a fatal outcome include severe irritation of the gastro-intestinal tract and a general haemorrhagic diathesis, which, apart from the gastro-intestinal tract, also affected the kidneys, lungs, brain, heart and urinary bladder. Furthermore additional damage to liver, kidneys, lungs, brain, spleen and myocardium were found.

The lowest of the lethal 1,2-dichloroethane dosages following peroral uptake, which have been documented in the literature, was approx. 19,000 mg/person (14 year old boy).

Available epidemiological studies on toxicity to reproduction or on carcinogenic risk in occupational exposed persons are not sufficient for unquestionable evaluation, since especially the type and the extent of exposure are not clearly specified in the particular examinations. It can be assumed that the particularly selected population was subjected to mixed exposure conditions.

Recommendations

Ecology

The available results on ecotoxicology and on environmental behaviour are considered to be sufficient for an evaluation of the environmental relevance.

Toxicology

With regard to the sensitizing effect of 1,2-dichloroethane, there is a gap in the data. However, all other endpoints of the toxicological profile of 1,2-dichloroethane have been examined, and are known. The main use of the substance is as starting material for the processing of various secondary products (particularly vinyl chloride). The substance has been placed by the German commission for the investigation of health hazards of chemicals in the work area into hazard group III A 2, i.e. it is classified as carcinogenic in animals, and has to be labelled with R-phrase 45 ("May cause cancer"). In view of this classification there are protective measures taken into account which make it appear unnecessary to carry out further animal experiments in order to close the gap in data mentioned above.