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GDCh-Advisory Committee
on Existing Chemicals of
Environmental Relevance (BUA)

o-Dichlorobenzene
(1,2-Dichlorobenzene)
BUA Report 53
(September 1990)



S. Hirzel

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of Environmental Relevance

Beratergremium für
Umweltrelevante Altstoffe (BUA)



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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 substance 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 updates 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 o-Dichlorobenzene

(1,2-Dichlorobenzene)

Summary and conclusions

Ecological aspects

Occurrence and distribution in the compartments

o-Dichlorobenzene is a chemical which is used in the Federal Republic of Germany chiefly (about 90 %) as an intermediate in the manufacture of plant protection products, pharmaceutical products and dyes, and to a lesser extent (about 10 %) as solvent. The volume of o-dichlorobenzene, which in the Federal Republic of Germany is manufactured as the main product and in part as a by-product during the production of chlorobenzene, amounted in 1989 to about 12 000 tonnes. About 2000 tonnes were exported; information on Imports is not available.

Discharge into the environment from industrial production, use and application takes place both via waste water and exhaust air. Due to its physico-chemical properties, transfer from water to the atmosphere and, vice versa, scavenging of gaseous o-dichlorobenzene by rain are possible. Discharge via waste water during production, use and application in the Federal Republic of Germany in 1989 amounted to less than 1.9 tonnes. Discharge via exhaust air has been estimated at about 14 tonnes for the same year.

In addition, non-quantifiable discharges into the environment take place by the metabolism of lindane, by biotic or abiotic degradation of higher chlorinated benzenes or by the burning of organic matter containing chlorine (see below).

o-Dichlorobenzene has repeatedly or regularly been found in the sea (North Sea, Mediterranean Sea) in coastal zones of estuaries of rivers (Rhine, Rhone) and near discharge zones of urban sewage, in lakes and rivers, in groundwater and drinking water and in rain as well.

As to occurrence in the Rhine River, an evident trend towards a reduction in contamination is discernible from the second half of the seventies to the end of the eighties. At Düsseldorf as sampling location selected for comparison and to comprise the essential discharges in the Rhine catchment area, concentrations ranging from 2 to 10 µg/l were still found in grab samples collected in the second half of the seventies. In 1982 to 1985, however, the 90-percentile value ranged from 1 to 0.6 µg/l and dropped to less than 0.5 µg/l from 1986 onward (except in February 1986 with a monthly mean value of 1.9 µg/l). In North America (USA, Canada) o-dichlorobenzene has been found in many cases in concentrations ranging from 0.003 to 25 µg/l and in some cases extending to as much as 6800 µg/l. The reason for the occurrence was in most cases contamination with landfill leachates of wells near disposal sites for chemical wastes, facilitated by the mobility of o-dichlorobenzene in soils, or because of improper chemical waste disposal.

Whereas concentrations in the atmosphere ranging from 0.9 to 46 µg/m³ were measured in about half of air samples collected in Bochum in 1978, mean values determined in Hamburg and Essen in 1987/88 amounted to 0.1 µg/m³. Individual values ranging from 0.07 to 0.18 µg/m³ are available only for the City of Essen. Concentrations ranging from not detectable (< 1 µg/m³) to 15 µg/m³ (98-percentile: 6.5 µg/m³) were found in Frankfurt/Main-Höchst in 1988. In the Netherlands in 1980 mean values of 0.37 µg/m³ and 0.18 µg/m³ were found in a heavily industrialised region and in one of the least polluted areas respectively. The concentrations also found in the ambient air of various cities and rural areas of the USA between 1978 and 1984 are comparable with those measured in Europe. In addition to discharge during industrial handling of o-dichlorobenzene, the burning of organic matter containing chlorine is one likely cause of occurrence in the atmosphere; it is not possible, however, to quantify this source, except for municipal waste incineration with an estimated o-dichlorobenzene output in the Federal Republic of Germany of 1.6 to 7.2 kg/yr. Concentrations ranging from 0.3 to 14 mg/m³

have been found in the air at the workplace of a dyestuff production plant in the Federal Republic of Germany when o-dichlorobenzene was used as a solvent.

o-Dichlorobenzene was found in sediments of the Rhine River in concentrations of up to 227 µg/kg (dry weight) and up to 54 µg/kg (dry weight) in 1982/83 and 1987/88 respectively. Concentration levels in sediments of the Great Lakes had values of up to 87 µg/kg and in those of the Pacific coast near discharge zones of urban sewage the maximum value was 800 µg/kg (dry weight). o-Dichlorobenzene can remain for decades in these sediments as adsorbate; it is desorbed, however, from resuspended sediments and is bioavailable to benthic organisms (worms, gastropods, starfish, midge fly larvae). Studies on occurrence in the geosphere give instances of contamination of soils on or near waste disposal sites; in such cases concentrations of up to 50 mg/kg have been found.

o-Dichlorobenzene has been detected qualitatively in various vegetable samples. Maximum concentrations (up to 210 µg/kg) have been found in corn oil. In some investigations the occurrence is attributed to the application of lindane, of which o-dichlorobenzene is one of several metabolites.

Studies performed in USA, Canada and Yugoslavia revealed the occurrence in fish and other aquatic organisms (up to 1200 µg/kg (lipid-based)), in beef meat (mean level: 1 µg/kg (meat) and 47.6 µg/kg (fat-based)) and in cows milk (mean level: 2.6 µg/kg (milk) and 81.25 µg/kg (fat-based)). Levels up to 20 µg/kg (fat-based) have been measured in human adipose tissue and up to 29 µg/kg (whole milk) and 890 µg/kg (milkfat) in mother's milk.

Degradability

In the upper layers of surface waters degradation of o-dichlorobenzene can take place on the one hand by indirect photolysis. On the other hand an aerobic biodegradation by adapted microorganisms is possible in the aquatic environment.' Biodegradation under anaerobic conditions could not be proved unambiguously. Degradation by hydrolysis under environmental conditions is unlikely to occur.

In the atmosphere, photodegradation takes place by reaction with photochemically produced OH radicals. The half-life is calculated from a measured rate constant to be 38 days.

Bioaccumulation

In view of the n-octanol/water partition coefficient ($\log P_{OW} = 3.34 - 3.75$), bioaccumulation is to be expected. Bioconcentration factors of up to 560 ($\log BCF 2.75$) on a wet-weight basis and 6600 ($\log BCF 3.82$) on mean fat level basis in fish and of 19 700 ($\log BCF 4.29$) on wet-weight basis in algae have been found experimentally.

Ecotoxicological effects

o-Dichlorobenzene at concentrations ≥ 15 mg/l causes growth inhibition or influences the dehydrogenase activity (inhibition or stimulation) of aerobic bacteria and is toxic to anaerobic bacteria. It does not exhibit distinct fungistatic or fungicidal activity.

The results of algal growth inhibition tests are inconsistent and strongly dependent on test species, growth medium and, as known from other studies of toxicity to aquatic organisms, on experimental design (open or closed System). In general, the lowest concentrations causing a

significant reduction in growth ranged from 3 to 100 mg/l, whereas in some tests (growth or photosynthesis inhibition) the no-observable-effect concentrations ranged from 0.4 to 0.9 mg/l. *o*-Dichlorobenzene at higher concentrations (740 to 5000 mg/l) is phytotoxic to higher plants.

The growth of protozoa is inhibited at concentrations ≥ 50 mg/l, whereas growth inhibition of marine phytoplankton already begins at a concentration > 7.6 mg/l and is complete at 13 mg/l.

For water fleas (*Daphnia magna*), the lowest 48-hr EC_0 value (immobilisation) has been determined as 0.36 mg/l in a closed system; the 24-hr EC_0 value in an open system amounted to 20 mg/l. In two reproduction studies no reproductive impairment or maternal toxicity was observed at concentrations of 0.37 mg/l and 0.63 mg/l; in the first test the 14-d EC_{50} value (fertility) amounted to 0.55 mg/l. For saltwater crustaceans, values of acute toxicity (96-hr LC_{50}) ranged from 2 to 10 mg/l. *o*-Dichlorobenzene is spermiotoxic and interferes with embryological development in the sea urchin. Exposure of fertilised eggs or sperm to *o*-dichlorobenzene at concentrations ≥ 0.15 mg/l causes developmental defects and inhibition of mitosis in the offspring.

For fish, values of acute toxicity (96-hr LC_{50}) have been determined in closed static systems or under dynamic (flow-through) conditions to range from to 10 mg/l, whereas in open systems or using aeration, tenfold higher values have been found. Following chronic exposure and in the prolonged toxicity test, the no-observable-effect concentration (NOEC) and the toxic concentration (14-d LC_{50}) were 2 mg/l and 5.8 mg/l respectively. For waterborne insect larvae following short-term exposure, LC_{50} values of about 4 mg/l to 50 mg/l have been determined. *o*-Dichlorobenzene does not exhibit distinct insecticidal effectiveness against terrestrial insects as shown by investigations of the behaviour of numerous species exposed to *o*-dichlorobenzene. Larvae are generally more sensitive than young animals.

In hen's embryos exhibiting a LD₅₀ value of 1070 mg/kg body weight, no teratogenic effect has been observed.

Toxicological Aspects

o-Dichlorobenzene is readily absorbed after oral or dermal application or inhalation exposure. In the organism it is chiefly oxidised to dichlorophenols, which, following conjugation, are excreted as glucuronides and sulfates. In addition, small amounts of mercapturic acid and phenols have been detected. Intermediately formed reactive metabolites covalently bind to liver proteins and may be involved in the induction of hepatotoxicity.

Following acute exposure to o-dichlorobenzene pathological changes in liver and kidneys prevail. In addition, increases in hepatic and urinary porphyrin and also in liver weight, and decreases in spleen and thymus weights have been observed after subchronic and chronic administration. Thymic lymphoid depletion has been found histopathologically in some cases.

Following oral administration of o-dichlorobenzene to rats and mice for two years there were no indications of a cancerogenic effect. o-Dichlorobenzene did also not show a tumour promoting effect.

o-Dichlorobenzene has been proved to be non-mutagenic. In the Ames test, HGPRT (hypoxanthine-guanine phosphoribosyl transferase) test and SLRL (sex-linked recessive lethal) test in *Drosophila*, whereas an increased revertant count in mouse lymphoma cells has been observed. In tests of chromosomal alterations, the induction of sister-chromatid exchanges *in vitro* and enhanced incidences of micronuclei have been reported. These findings, however, contrast with the negative results of two *in vitro* and two *in vivo* studies. o-Dichlorobenzene did not induce mitotic

recombinations in *Saccharomyces* and DNA repair in rat hepatocytes in the UDS (unscheduled DNA synthesis) test. The results of DNA repair studies in *E.coli* and *B.subtilis* are inconsistent.

Studies on reproductive toxicology resulted in maternal toxicity but no teratogenic effects.

Liquid o-dichlorobenzene is strongly irritating to human skin after topical application; its vapours also irritate the eyes and upper respiratory tract.

Following exposure to solvent mixtures containing o-dichlorobenzene of, in part, unknown composition, cases of lymphoid leukemia and anemia have been reported; the attribution of these findings to exposure to o-dichlorobenzene is uncertain. Nevertheless these case reports were the reason for performing the NTP cancerogenicity study, which did not give evidence of a cancerogenic effect.

Regular medical examination of workmen exposed to o-dichlorobenzene did not show any indications of organic injury or hematological changes.

Recommendations

Ecology

The available results of studies on ecotoxicology and environmental fate are regarded as sufficient for an evaluation of the environmental relevance.

Toxicology

The overwhelming majority of studies on mutagenicity of o-dichlorobenzene did not give evidence of genotoxic effects. The cancerogenicity studies on rats and mice conducted as part of the National Toxicology Program were unequivocally negative. Therefore a further clarification of the inconsistent mutagenicity results is not required. The sensitisation potential is still an open question. Since the substance, however, has for many years been handled in industrial operations and only one case of sensitisation has been reported, the experimental clarification of this effect is not necessary.