German Chemical Society
Gesellschaft Deutscher Chemiker

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

Diethylene glycol dimethyl ether

(Bis(2-methoxyethyl)-ether)
BUA Report 67
(December 1991)

S. Hirzel
Wissenschaftliche Verlagsgesellschaft 1993

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

Chairman:
Prof. Dr. E. Bayer, Institut für Organische Chemie der Universität Tübingen

Members:
Dr. G. Alfke, Mineralölwirtschaftsverband e. V., Hamburg
Prof. Dr. K. Ballschmiter, Abteilung Analytische Chemie und Umweltchemie der Universität Ulm
Dr. R. Bias, BASF AG, Emissionsüberwachung und Ökologie, Ludwigshafen a. Rh.
Dr. B. Broecker, HOECHST AG, Abteilung Umweltchemikalien/Verbrauchersicherheit, Frankfurt am Main
Prof. Dr. O. Fränzle, Geographisches Institut der Universität Kiel
Prof. Dr. F. H. Frimmel, DVGW-Forschungsstelle am Engler-Bunte-Institut der Universität Karlsruhe
Prof. Dr. H.-P. Gelbke, BASF AG, Toxikologie, Ludwigshafen a. Rh.
Prof. Dr. H. Greim, GSF - Institut für Toxikologie, Neuherberg (Vice Chairman)
Dr. H. Jungen, Deutsche Wissenschaftliche Gesellschaft für Erdöl, Erdgas und Kohle e. V., Hamburg
Dir. und Prof. Dr. D. Kayser, Bundesgesundheitsamt, Berlin
Prof. Dr. P. Müller, Institut für Biogeographie, Universität des Saarlandes, Saarbrücken
Dir. und Prof. Dr. E. Offhaus, Umweltbundesamt, Berlin
Dr. R. Ott, Deutsche Shell Chemie GmbH, Eschborn/Ts.
MinRat Prof. Dr. U. Schlottmann, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Bonn
Dr. N. Schön, BAYER AG, LE Umweltschutz/AWALU, Leverkusen
Vizepräsident Dr. A. Troge, Umweltbundesamt, Berlin

Guests:
Dr. K. H. Adlfinger, Initiative umweltrelevante Altstoffe, Frankfurt am Main
Prof. Dr. R. Kümmel, Technische Hochschule Leuna-Merseburg
Prof. Dr. Dr. W. Mücke, Institut für Toxikologie und Umwelthygiene der TU München
Dr. J. Oberhansberg, BG Chemie, Heidelberg

In collaboration with:
Priv.-Doz. Dr. J. Ahlers, Umweltbundesamt, Berlin
Frau Dr. A. Boehnke, Fraunhofer-Institut für Toxikologie und Aerosolforschung, Hannover
Frau Dipl.-Biol. K. Deilmann, HOECHST AG, Frankfurt am Main
Dr. S. Ettel, Institut für Organische Chemie der Universität Tübingen
Frau Dr. I. Mangelsdorf, GSF - Institut für Toxikologie, Neuherberg
Dr. H. Roß, Umweltbundesamt, Berlin
Frau Dr. H. Sterzl-Eckert, GSF - Institut für Toxikologie, Neuherberg
Dr. D. Vogel, Institut für Organische Chemie der Universität Tübingen
Frau Dipl.-Biol. L. Weis, Institut für Organische Chemie der Universität Tübingen
Dr. A. Wibbertmann, Fraunhofer-Institut für Toxikologie und Aerosolforschung, Hannover
Frau Dr. K. Widmann, Institut für Organische Chemie der Universität Tübingen
Frau Dr. K. Ziegler-Skylakakis, GSF - Institut für Toxikologie/Altstoffgruppe, Neuherberg

GDCh Office:
Dr. H. Behret, GDCh, Frankfurt am Main

Diethylene glycol dimethyl ether

(Bis(2-methoxyethyl)-ether)

BUA Report 67

(December 1991)

edited by the GDCh-Advisory Committee on Existing Chemicals of Environmental Relevance

Beratergremium für Umweltrelevante Altstoffe (BUA)

S. Hirzel

Wissenschaftliche Verlagsgesellschaft 1993

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

Translated by P. Karbe

Die Deutsche Bibliothek — CIP-Einheitsaufnahme

Diethylene glycol dimethyl ether : (Bis(2-methoxyethyl)-ether) /
GDCh Advisory Committee on Existing Chemicals of
Environmental Relevance (BUA) - (December 1991) - Stuttgart:
Hirzel ; Stuttgart : Wiss. Verl.-Ges., 1993
(BUA report; 67)

ISBN 3-7776-0557-3
NE: Gesellschaft Deutscher Chemiker / Beratergremium für
Umweltrelevante Altstoffe: BUA report

Printed in acid-free and low-chlorine paper.

Printing and binding: Druckhaus Beltz, Hemsbach
Printed in F.R. Germany

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

Contents

Summary and Conclusions ..... **IX**

Recommendations ..... **XIII**

Diethylene Glycol Dimethyl Ether
(Bis(2-methoxyethyl)-ether)

1.	**Chemistry of Diethylene Glycol Dimethyl Ether**	**1**
1.1.	Chemical Identity	1
1.2	Composition of the Technical Product	2
1.3	Chemical Properties	2
2.	**Physical Properties**	**4**
3.	**Analysis**	**9**
3.1	Determination in Air	9
3.2	Determination in Water	9
3.3	Determination in Soil, Sediment and Biological Material	11
3.4	Determination in Solvent Mixtures	11
4.	**Introduction into the Environment through Production, Processing, Application and Waste Disposal**	**13**
4.1	Production Methods	13
4.2	Manufacturers, Production Quantity, Export, Import, Total Consumption	14
4.3	Processing, Application, Consumption Quantity	15
4.3.1	Processing	15
4.3.2	Application	15
4.4	Introduction into the Atmosphere	18
4.4.1	Introduction through Production and Processing Exhaust	18
4.4.1.1	Introduction through Production	18
4.4.1.2	Introduction through Processing	18
4.4.2	Introduction through Application	18
4.5	Introduction into the Hydrosphere	18
4.5.1	Introduction through Production and Processing	18
4.5.1.1	Introduction through Production	18
4.5.1.2	Introduction through Processing	19
4.5.2	Introduction through Application	19
4.5.3	Introduction from Other Sources	19
4.6	Introduction into the Geo- and Biosphere	20
4.7	Introduction through Wastes and Their Treatment	20
4.8	Balance of Environmental Introduction	20
5.	**Environmental Occurrence**	**22**
5.1	Atmosphere	22
5.2	Hydrosphere	22
5.3	Geosphere	22
5.4	Biosphere	22
5.5	Natural Sources	22

6. Environmental Behavior 24
6.1 Transformation, Degradation arid Degradation Products 24
6.1.1 Biological Degradation 24
6.1.1.1 Aerobic Degradation 24
6.1.1.2 Anaerobic Degradation 24
6.1.2 Hydrolysis 25
6.1.3 Photolysis 25
6.1.3.1 Photolysis in the Atmosphere 25
6.1.3.2 Photolysis in the Hydrosphere 26
6.1.4 Possible Sewage—Treatment Measures 26
6.2 Accumulation 27
6.2.1 Bioaccumulation 27
6.2.2 Geoaccumulation 27
6.3 Distributional Behavior, Transport Processes within and between Environmental Compartments 27
6.3.1 Henry‘s Law Constant 27
6.3.2 n-Octanol/Water Partition Coefficient 28
6.3.3 Soil Sorption Coefficients 28
6.4 Environmental Fate 28

7. Ecotoxicity 30
7.1 Effects on Aquatic Organisms 30
7.1.1 Effects on Microorganisms 30
7.1.2 Effects on Plants 30
7.1.3 Effects on Invertebrates 30
7.1.4 Effects on Vertebrates 30
7.2 Effects an Terrestrial Organisms 31
7.2.1 Effects an Microorganisms 31
7.2.2 Effects an Plants 31
7.2.3 Effects on Invertebrates 32
7.2.4 Effects on Vertebrates 32
7.3 Effects on Ecosystems 33

8. Toxicity in Warm-Blooded Organisms 34
8.1 General Effects 34
8.2 Mode of Action 35
8.3 Metabolism, Toxicokinetics 35
8.4 Acute Toxicity 38
8.5 Skin and Mucous Membrane Tolerance 39
8.6 Sensitization 39
8.7 Subacute, Subchronic and Chronic Toxicity 41
8.8 Genotoxicity 41
8.9 Carcinogenicity 43
8.10 Reproduction Toxicity 43
8.10.1 Embryotoxic Effects 43
8.10.2 Fertility 46
8.11. Other Effects 46
8.12 Human Cases 46

9. Substance-Specific Regulations 47

10. Literature 51

BUA Report on Diethylene glycol dimethyl ether

(Bis(2-methoxyethyl)-ether)

Summary and conclusions

Ecological aspects

Production, Introduction, Occurrence and Distribution into Environmental Compartments

In 1990, about 400 tonnes of diethylene glycol dimethyl ether were produced in the Federal Republic of Germany. Exports amounted to about 200 tonnes. No import data are available.

About 25 % (≈ 50 tonnes) of the diethylene glycol dimethyl ether remaining in the Federal Republic of Germany were employed by the Hoechst AG factory in Hamburg as an inert solvent for water-soluble synthetic resins (employed mainly in the automobile industry). This application was discontinued in mid-1990. Approximately 75 % (≈ 150 tonnes) were sold to a large number of users in 1990.

During manufacturing in 1990, < 1 kg was emitted through exhaust air into the atmosphere and about 53 - 75 kg via the hydrosphere into the environment. The wastes which occurred (< 3 kg) were deposited according to regulations.

Due to its practically exclusive application as a solvent, the total quantity of diethylene glycol dimethyl ether produced and used presumably enters waste water, as well as exhaust air and solid wastes, all which need to be treated subsequently.

Without considering either possible imports or elimination processes one can therefore estimate that in 1990, a maximum entry of 200 tonnes through application could be expected. From its physicochemical properties, it can be assumed that the main entry occurs into the hydrosphere.

Data on the occurrence of diethylene glycol dimethyl ether in the atmosphere are not available. In the Netherlands, the substance was detectable in the Rhine at concentrations up to 5 µg/l between 1978 and 1985. In the USA, the substance was identified in a drinking water sample in 1974 and in France about 2 - 20 µg/l was detected in leachate from waste dumps in 1987.

According to the physicochemical properties, it is not expected to be transferred from water into the atmosphere.

Degradation

In the laboratory, the biological degradation of diethylene glycol dimethyl ether is difficult in the aquatic sphere under aerobic conditions. No data are available on the biological degradation under anaerobic conditions or in soil. Since available data show the substance to be nonvolatile in water, it is expected to remain in the hydrosphere. No hydrolysis occurs under environmental conditions.

In the atmosphere and hydrosphere, direct photolysis is expected to be slight at the most. The half-life time for the reaction of diethylene glycol dimethyl ether with OH radicals in the gas phase is 23 hours (experimental value) or 14 hours (empirically calculated value).

Accumulation

The log P_{OW} of -0.36 does not suggest any geoaccumulation or bioaccumulation. Experimental studies are not available. According to its physicochemical properties, diethylene glycol dimethyl ether may be considered to be mobile in soil. This, along with its difficult degradability, would indicate migration via leachate to the groundwater.

Ecotoxicological Effect

An EC_{10} of > 1000 mg/l was determined in the activated sludge respiration-inhibition test.
In a QSAR study with water fleas (*Daphnia magna*), a 96-hour LC_{50} of 5868 mg/l was calculated.
The 96-hour LC_{50} values for 3 different fish species, also calculated in a QSAR study, were 8569 mg/l 9845 mg/l and 10968 mg/l.
For the golden orfe (*Leuciscus idus*) the experimentally determined LC_0 (96 h) was ≥ 2000 mg/l.
A 48-hour LC_{50} of 8300 mg/l was found in tadpoles of the frog species *Rana brevipoda porosa*.
Diethylene glycol dimethyl ether had a fungistatic effect at 1 % vol. (9430 mg/l) and above; complete germ and growth inhibition occurred at 20 % vol. (188600 mg/l).
The eggs and larvae of fruit flies (*Dacus dorsalis* and *Ceratitis capitata*; 2 hour fumigation period) showed a 48-hour LD_{50} of > 98 g/m³.

Toxicological Aspect

Diethylene glycol dimethyl ether is absorbed rapidly after oral uptake. In the course of metabolism biotoxification occurs. The available experimental results indicate that methoxyacetic acid is the metabolite responsible for this. After oral administration the substance is excreted rapidly in the urine.

With oral uptake the substance has low toxicity. Signs of poisoning are superactivity, breathing disturbances and reduced body weight gains.

The substance is slightly irritating to skin and mucous membranes.

The target organs for male animals after repeated intake are the reproductive organs. Animal experiments have shown the following dose related effects: atrophy of the testis and epididymis, degenerative

changes in germinal cells, impaired spermiogenesis and sperm anomalies.

After inhalational exposure to high concentrations, male and female animals also exhibit bone marrow hypoplasias, impaired hematopoiesis, thymus and spleen atrophy and changed serum-enzyme activities. Most of the changes were reversible after the end of the experiment.

Most mutagenicity tests give no indication of a genotoxic effect. The dominant-lethal test (severely reduced fertility) indicates a mutagenic effect after exposure to high concentrations.

In reproduction toxicologic investigations in mice, rabbits and rats it was found that fetotoxic and teratogenic effects occur at non maternotoxic doses. At higher doses, diethylene glycol dimethyl ether has additionally a maternotoxic effect.

No data are available on human cases, the mechanism of action, the sensitizing effect or carcinogenicity.

Recommendations

Ecological Aspect

To further assess the toxic effects on aquatic organisms, the acute toxicity in Daphnia and damaging effects to algae should be determined.

Toxicological Aspect

Data are lacking on the sensitizing effect. However, since no sensitizing effect has been seen for the glycol ether group as a whole, it is - not necessary to test for sensitizing properties. The glycol ethers are also not suspected of being genotoxic to humans.

There has been no indication of carcinogenic properties, nor are they anticipated according to structure-effect considerations. Therefore no further toxicity tests are necessary.

However, random drinking water analyses should be carried out to clarify whether this substance, which is teratogenic in animal experiments, occurs in groundwater or processed drinking water in the Federal Republic of Germany.