NATIONAL INSTITUTE OF PUBLIC HEALTH AND ENVIRONMENTAL PROTECTION
BILTHOVEN, THE NETHERLANDS

Report no. 679101 008

DERIVATION OF MAXIMUM PERMISSIBLE CONCENTRATIONS FOR SEVERAL VOLATILE COMPOUNDS FOR WATER AND SOIL

E.J. van de Plassche, M.D. Polder and J.H. Canton

May 1993

76.

This research was carried out on behalf of the Directorate-General for Environmental Protection, Directorate for Chemicals, External Safety, and Radiation Protection, in the frame of the project 'Integrated environmental quality objectives for water, soil and air' (Quality objectives and risks, project no. 679101).

MAILING LIST

1-10	Directoraat Generaal Milieubeheer, Directie Stoffen, Veiligheid en Straling, afdeling Normstelling, d.t.v. prof. dr. C.J. van Leeuwen
11	DG Milieubeheer ir. M.E.E. Enthoven
12	plv. DG Milieubeheer dr. ir. B.C.J. Zoeteman
13	plv. DG Milieubeheer mr. G.J.R. Wolters
14	Directoraat Generaal Milieubeheer, Directie Stoffen, Veiligheid en Straling, afdeling Stoffen t.a.v. ir. M. Bovenkerk
15 - 22	Projectgroep IWINS d.t.v. drs. C.A.J. Denneman
23 - 31	Onderzoeksbegeleidingsgroep INS d.t.v. dr. J.H.M. de Bruijn
32 - 38	Projectgroep INS d.t.v. drs. E. van de Plassche
39	Gezondheidsraad
40	Technische Commissie Bodembescherming
41	Coördinatiecommissie Uitvoering Wet Verontreiniging Oppervlaktewateren
42	Raad van de Waterstaat
43	Centrale Raad voor de Milieuhygiëne
44	drs. C. v.d. Guchte, RIZA
45	drs. M.A. Beek, RIZA
46	drs. C.A.M. van Helmond, Adviesbureau BKH
47	M.C.Th. Scholten, Instituut voor Milieuwetenschappen, TNO Den Helder
48	dr. ir. C.A.M. van Gestel, Vrije Universiteit Amsterdam
49	dr. J.L.M. Hermens, RITOX
50	dr. H.J.M. Verhaar, RITOX
51	drs. A.E.G. Tonneijck, Instituut voor Plantenziektenkundig Onderzoek
52	P. Douben, Department of the Environment, Engeland
53	Depot van Nederlandse publikaties en Nederlandse bibliografie
54	Directie RIVM
55	Sectordirecteur Stoffen en Risico's, dr. ir. G. de Mik
56	Sectordirecteur Milieuonderzoek, prof. dr. ir. C. van den Akker
57	Hoofd Adviescentrum Toxicologie, mw. drs. A.G.A.C. Knaap
58	Hoofd Laboratorium voor Ecotoxicologie, prof. dr. H.A.M. de Kruijf
59	Waarnemend hoofd Laboratorium voor Toxicologie, dr. H. Könemann
60	dr. W. Slooff
61	ir. C.J. Roghair
62	Ir. M.A. Vaal
63	dr. ir. J. Notenboom
64	dr. P. van Beelen
65 - 67	Auteurs
68	Bureau Projecten- en rapportregistratie
69	Hoofd Bureau Voorlichting en Public Relations, drs. J.A. Lijdsman
70 - 71	Bibliotheek RIVM
72 - 85	Reserve exemplaren

PREFACE

This report contains results of research carried out in the framework of the project 'Setting integrated environmental quality objectives'. The results have been discussed in the 'Setting integrated environmental quality objectives advisory group'. Members thereof are C.W.M. Bodar (Dutch Health Council), J.H.M. de Bruijn (Ministry of Housing, Physical Planning and the Environment), J.H. Canton (National Institute of Public Health and Environmental Protection), C.A.J. Denneman (Ministry of Housing, Physical Planning and the Environment), J.W. Everts (Ministry of Transport, Public Works and Water Management; Tidal Waters Division), M.P.M. Janssen (National Institute of Public Health and Environmental Protection), P. Leeuwangh (Winand Staring Centre for Integrated Land, Soil and Water Research), W. Ma (Institute for Forestry and Nature Research), E.J. van de Plassche (National Institute of Public Health and Environmental Protection), P.B.M. Stortelder (Ministry of Transport, Public Works and Water Management; Institute for Inland Water Management and Waste Water Treatment), J. Struijs (National Institute of Public Health and Environmental Protection), M. Vossen (Ministry of Transport, Public Works and Water Management; Institute for Inland Water Management and Waste Water Treatment), and J. van Wensem (Technical Soil Protection Committee).

ACKNOWLEDGEMENTS

Hereby we express our gratitude to R. Posthumus for carrying out the on-line literature search and to M.A. Vaal and C.A.M. van Gestel for scientific advice on the evaluation of toxicity data. H. Verhaar from RITOX is thanked for figure 3.

CONTENTS

SUMMARY

In this report Maximum Permissible Concentrations (MPC's) for water, sediment and soil were derived for 46 volatile organic compounds in frame of the project 'Volatile compounds'. This project is part of another one called 'Setting integrated environmental quality objectives'.
Because most of the 46 compounds are acting by narcosis the QSAR (Quantitative Structure-Activity Relationships) approach from Van Leeuwen et al. (1992) is used in order to derive MPC's for water. This appoach uses NOEC values obtained by application of QSAR's for minimum toxicity for 19 different organisms. These NOEC values are used as input data for the extrapolation method of Aldenberg and Slob to calculate a MPC.
The QSAR approach differs from the one used in other projects. In the more traditional approach only experimentally obtained NOEC or L(E)C50 values are used as input data for extrapolation methods. These NOEC and L(E)C50 values are usually obtained by literature search. Therefore both approaches were applied and compared for a sub-set of the 46 compounds mentioned above. Toxicity data for fresh- and saltwater organisms were gathered from literature. MPC's values were calculated based on these data and compared with the ones using the QSAR approach. From this comparison it could be concluded that the MPC's for water calculated with both approaches were in good agreement. Therefore it is proposed to use the QSAR approach in order to derive MPC's for water because the MPC is then based on toxicity data for many organisms.
Because acrylonitril, 2-chloro-1,3-butadiene, 3-chloropropene, 1,3- and 2,3-dichloropropene and ethylene oxide cannot be classified as inert chemicals the QSAR approach could not be used for these 6 compounds. Therefore the MPC's were based on toxicity data obtained by an extensive literature search. For 2-chloro-1,3-butadiene no MPC for water could be derived because no toxicity data were available. For acrylonitril, dichloropropene and ethylene oxide no chronic data were present, while for 3-chloropropene only chronic data were found for less sensitive species. The MPC for 3-chloropropene was therefore based on acute data using the modified EPA method. It can be argued therefore that the MPC's for these 5 compounds is a conservative estimation: if more toxicity data become available the MPC will probably increase.

Toxicity data for soil organisms were gathered from literature. Due to scarcity of data only for 11 compounds a MPC for soil could be derived. In all cases the modified EPA method had to be applied. No toxicity data were available for benthic organisms exposed via contaminated sediment.

SAMENVATTING

In dit rapport zijn in het kader van het project 'Vluchtige Stoffen' op basis van ecotoxicologische gegevens Maximaal Toelaatbare Risiconivo's (MTR's) voor water en bodem afgeleid voor 46 vluchtige organische verbindingen. Dit project maakt onderdeel uit van het project Integrale Normstelling Stoffen (INS).
Omdat voor bijna al deze stoffen kan worden aangenomen dat ze een a-specifieke narcotiserende werking hebben, is voor het afleiden van de MTR voor water gebruikt gemaakt van de QSAR (Quantitatieve Structuur-Activiteits Relaties). Hierbij worden voor 19 verschillende organismen NOEC waarden berekend m.b.v. QSAR's voor minimumtoxiciteit. Deze NOEC waarden worden vervolgens als input data gebruikt voor toepassing van de extrapolatiemethode van Aldenberg en Slob waarmee de MTR wordt berekend.
Deze benadering wijkt af van degene die in de andere projecten van INS gehanteerd wordt. Hierin worden namelijk alleen experimentele L(E)C50 of NOEC waarden gebruikt als input gegevens voor extrapolatiemethoden waarmee de MTR voor water berekend wordt. Daarom zijn voor een aantal stoffen van de bovengenoemde 46 beide benaderingen toegepast en de resultaten met elkaar vergeleken. Aangezien de MTR's berekend met de twee verschillende benaderingen goed met elkaar in overeenstemming waren is voorgesteld om voor alle vluchtige stoffen met een narcotiserende werking de MTR's voor water te hanteren berekend met de QSAR benadering. Deze MTR's zijn namelijk gebaseerd op gegevens voor veel organismen.
Voor 6 stoffen, namelijk acrylonitril, 2-chloor-1,3-butadiëne, 3-chloorpropeen, 1,3- en 2,3-dichloorpropeen en ethyleen oxide, kon de QSAR benadering niet worden toegepast gezien hun specifieke werking. Voor deze stoffen is de MTR voor water dan ook gebaseerd op toxiciteitsdata verkregen uit literatuuronderzoek. Voor 2-chloor-1,3-butadiëne kon geen MTR voor water worden afgeleid omdat geen toxiciteitsgegevens beschikbaar waren. Voor de andere 5 stoffen is de MTR berekend door toepassing van de EPA methode op acute toxiciteitsgegevens. Voor acrylonitril, 1,3- en 2,3-dichloorpropeen en ethyleen oxide zijn geen chronische gegevens gevonden, terwijl voor 3-chloorpropeen alleen chronische gegevens van relatief ongevoelige organismen beschikbaar waren. Gesteld kan worden dat de MTR voor water voor deze 5 stoffen een conservatieve schatting is: indien meer gegevens beschikbaar komen zal de MTR waarschijnlijk hoger worden.

Voor het afleiden van een MTR voor de bodem zijn toxiciteitsgegevens verzameld voor alle 46 stoffen. Omdat zeer weinig gegevens gevonden werden kon slechts voor 11 stoffen een MTR berekend worden. In alle gevallen is deze MTR berekend met de EPA methode. Er waren geen toxiciteitsgegevens beschikbaar voor benthische organismen blootgesteld via gecontamineerd sediment.

1. INTRODUCTION

In 1989 the project 'Setting integrated environmental quality objectives' started. Aim of the project is to derive these objectives for air, water, sediment and soil for a great number of compounds. The method used in this project consists in general of determining Maximum Permissible Concentrations (MPC's) for different compartments followed by harmonization of these MPC's using the equilibrium partitioning method. [1, 2] MPC's are calculated using extrapolation methods, which use results from single species toxicity tests as input data. In the projects 'MILBOWA' and 'Exotic Metals' no MPC's were derived for the compartment air. [2, 3] The present report is concerned with the next project called 'Volatile Compounds'. In this project an attempt will be made to derive also integrated environmental quality objectives for air. These objectives will be aimed at the protection of man as well as the environment. Therefore the following had to be done:

- derivation of MPC's for air, water, sediment and soil based on (eco)toxicological data,
- derivation of partitioning coefficients in order to apply the equilibrium partitioning method,
- development of a model for harmonization of MPC's.

The derivation of MPC's in air is described in Rademaker et al. (1993). [4] In the present report MPC's for water, soil and sediment are calculated based on ecotoxicological data. Secondary poisoning is not taken into account although it is recognized that some of the compounds can bioaccumulate, e.g. penta- and hexachlorobenzene. The risk for bioaccumulation will however be subject of another report in which all compounds from the project 'Setting environmental quality objectives' that have a potential for secondary poisoning will be dealt with. The derivation of partition coefficients and the model for harmonization, called INS-BOX, will be discussed in an integration report of the project 'Volatile Compounds'. Values derived there can be used to set up limit and target values.

The project 'Volatile Compounds' consists of 46 substances. It has been shown that many of these chemicals have a non-specific mode of action (see f.i. Könemann, 1981). [5] Hence, according to the classification scheme of Verhaar et al. (1992) such type of chemicals can be classified as 'inert chemicals' and their expected effect concentration can be calculated on the basis of their octanol/water partition coefficient using Quantitative Structure-Activity Relationships (QSARs). [6] Van Leeuwen and co-workers derived QSARs for non-specific toxicity for 19 different types of organisms. These QSARs were used to generate a data-set of 19 NOEC (No Observed Effect Concentration) values for every individual organism. Subsequently this dataset was used as input for the extrapolation method (a.o. the one according to Aldenberg and Slob) in order to derive MPC values for water. [7] In this report, the approach from Van Leeuwen et al. (1992), further called the QSAR-approach, is applied for those chemicals of the 46 mentioned above that can be classified as 'inert chemicals'. In order to validate the application of this QSAR-approach for derivation of MPCs the results of this method are compared for a subset of the 46 chemicals with the more traditional method for deriving MPC's. In the tradional method experimental data from toxicity tests with the chemical itself are selected and these data are used for extrapolation to MPC values.

For derivation of MPC's for soil and sediment the QSAR approach cannot be used because almost no QSAR's are available for terrestrial organisms. Therefore toxicity data for soil and sediment dwelling organisms exposed via contamined soil or sediment are gathered for all compounds. In the integration report of the project 'Volatile Compounds' these MPC values based on toxicity data will be compared to MPC's calculated using the equilibrium partitioning method. [1, 2]

2. METHODOLOGY

2.1. Introduction

In order to derive MPC's for water several activities had to be performed. First it was decided which chemicals could be classified as inert based on the classification scheme of Verhaar and Hermens. This selection is carried out in paragraph 2.2. For chemicals which could not be classified as inert the traditional approach for deriving MPC's is followed. For these compounds aquatic toxicity data were gathered from literature. This was also carried out for a sub-set of 27 chemicals for which results from the QSAR approach were compared with the traditional one. In paragraph 2.3 the derivation of toxicity data and the applied quality criteria are described. In paragraph 2.4 the different approaches to derive a MPC are given: the QSAR approach on the one hand and the modified EPA method and the method according to Aldenberg and Slob, both being extrapolation methods used in the traditional approach, on the other hand.

2.2. Selected compounds

The substances of the project 'Volatile compounds' are presented in table 2.1 together with some physico-chemical data. For most compounds these data have been taken from Van Leeuwen et al. (1992). [7] The octanol-water partition coefficients (K_{ow} values) values selected by Van Leeuwen et al. (1992) are experimentally obtained by the slow-stirring method if such values were available. In all other cases preference was given to the so called 'LogP*-values' from the THOR database over calculated values using the ClogP-method from the Pomona Medchem programme. [7] Acrylonitrile, 2-chloro-1,3-butadiene (or chloroprene), dichloroethene, vinylchloride (or chloroethene), ethylene, ethylene oxide (or epoxyethane), ethylbenzene, 3-chloropropene, dichloropropene, 2-monochlorotoluene and styrene (or phenylethene) were not selected by Van Leeuwen et al. (1992). For these compounds data on molecular weight were taken from physico-chemical handbooks and reviews. K_{ow} values were gathered in the same way as in Van Leeuwen et al. (1992).

The QSAR approach can only be applied for chemicals that act by narcosis. [7] In order to determine which compounds from table 2.1 can be considered as chemicals acting by narcosis a classification scheme presented by Verhaar and Hermens (1991) was used. [6] They defined structural requirements for four classes of compounds:

1. Inert chemicals: chemicals that are not reactive under normal physiological conditions and do not interact with specific receptors in an organism. The mode of action of these compounds can be classified as narcosis and the toxicity displayed is the so called 'baseline' or minimum toxicity.
2. Less inert chemicals: chemicals that are not reactive under normal physiological conditions and that do not interact with specific receptors in an organism, but are slightly more toxic than the minimum toxicity. The mode of action of these compounds can be classified as 'polar narcosis'.
3. Reactive chemicals: chemicals that, under normal physiological conditions react nonspecifically with certain chemical structures commonly found in biomolecules, or chemicals that are metabolized into (more) toxic (reactive or specifically acting) species (bioactivation).
4. Specifically acting chemicals: chemicals that exhibit toxicity due to specific interaction with certain receptor molecules.

Table 2.1. Compounds selected with molecular weight (MW) and log K_{ow}

Compound	molecular weight (gram)	log K_{ow}
acrylonitril	53.06	0.25
benzene	78.11	2.19
2-chloro-1,3-butadiene	88.50	2.16[a]
3-chloropropene	76.50	1.45[a]
1,2-dichlorobenzene	147.01	3.43
1,3-dichlorobenzene	147.01	3.53
1,4-dichlorobenzene	147.01	3.44
1,1-dichloroethane	98.95	1.79
1,2-dichloroethane	98.95	1.48
1,1-dichloroethene	96.94	1.86
1,2-dichloroethene	96.94	1.86
dichloromethane	84.93	1.25
1,2-dichloropropane	112.98	1.99
1,3-dichloropropane	112.98	2.00
1,3-dichloropropene	110.97	1.76[a]
2,3-dichloropropene	110.97	2.04[a]
ethylbenzene	106.16	3.15
ethylene	28.05	1.13
ethylene oxide	44.05	-0.30
hexachlorobenzene	284.80	5.73
hexachloroethane	236.72	4.14
monochlorobenzene	112.57	2.90
2-monochlorotoluene	126.58	3.32[a]
3-monochlorotoluene	126.58	3.28
4-monochlorotoluene	126.58	3.33
pentachlorobenzene	250.32	5.18
pentachloroethane	202.28	3.63
styrene	104.16	2.95
1,2,3,4-tetrachlorobenzene	215.88	4.64
1,2,3,5-tetrachlorobenzene	215.88	4.66
1,2,4,5-tetrachlorobenzene	215.88	4.60
1,1,2,2-tetrachloroethane	167.84	2.39
tetrachloroethene	165.83	3.40
tetrachloromethane	153.82	2.83
toluene	92.13	2.79
1,2,3-trichlorobenzene	181.43	4.14
1,2,4-trichlorobenzene	181.43	4.05
1,3,5-trichlorobenzene	181.43	4.19
1,1,1-trichloroethane	133.41	2.49
1,1,2-trichloroethane	133.39	1.89
trichloroethene	131.40	2.42
trichloromethane	119.39	1.97
vinylchloride	62.50	1.52[a]
2-xylene	106.16	3.12
3-xylene	106.16	3.20
4-xylene	106.16	3.15

[a] calculated value (C log P)

Most compounds presented in table 2.1 belong to the class of inert chemicals. Only acrylonitril, 2-chloro-1,3-butadiene, 3-chloropropene, 1,3- and 2,3-dichloropropene and ethylene oxide belong to another class of compounds: they are reactive chemicals. For reactive chemicals the QSAR approach cannot be used. MPC's for water were therefore derived using experimental toxicity data gathered by literature search (traditional approach).

For comparison of MPC values for water derived by the QSAR approach and MPC's calculated according to the traditional approach the following compounds were selected: chlorobenzenes, ethylbenzene, trichloromethane, 1,2-dichloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, tetrachloroethene, 1,2-dichloropropane, xylene (or dimethylbenzene), styrene and monochlorotoluene. This means that for these 27 compounds toxicity data for the aquatic environment were collected from literature (for saltwater as well as freshwater organisms). This was done also for compounds that were not classified as inert chemicals.

Terrestrial toxicity data (for sediment dwelling organisms exposed via contaminated sediment and soil organisms) were collected for all compounds except the chlorobenzenes.

2.3. Derivation of toxicity data

2.3.1. Literature sources

Several sources were used for the collection of single species toxicity data:
- literature present at the Toxicology Advisory Center of the National Institute of Public Health and Environmental Protection.
- on-line search carried out in TOXLINE, AQUIRE and BIOSIS. On-line search was performed either updating from the publication of the most recent reliable review, or over a longer period when no reliable review was available. The retrieved references that seemed relevant were collected and evaluated. An overview of the reviews used as a basis for on-line search is given in Appendix I.
- retrospective literature search using public literature and reviews as a basis.

For chlorobenzenes no literature search for toxicity data for freshwater and soil organisms was carried out because a recent review is available from Hesse et al. (1991). [8]

2.3.2. Parameters

For environmental effect assessment principally only those parameters are taken into account that exclusively affect species on the level of population. [9] In general the parameter in acute studies is mortality. In (semi)chronic studies next to mortality parameters like growth and reproduction are studied. Also other parameters are studied however, such as behaviour or histopathological effects. Results of such studies were used only if the parameter was considered ecologically relevant, e.g. immobility in tests with daphnids, lying on the bottom of the test-vessel in experiments with fish or histopathological effects on reproductive organs. The parameter acidification as a result of the assimilation of added glucose in a test with Pseudomonas was not considered ecologically relevant, so test results were not used for the derivation of MPC values. [10]

2.3.3. Selection of aquatic toxicity data: quality criteria

First of all a study had to meet several requirements with respect to experimental design. Most of these requirements are stated in test-guidelines like the ones of the Organisation for Economic Co-operation and Development (OECD).
Due to the volatile properties of the evaluated compounds special attention was paid to the way test concentrations were maintained in water. In many studies it was reported how the problem of evaporation was dealt with, while in other studies no special precautions were taken or were not reported. Therefore two selections were made for tests carried out with aquatic organisms:
Data set I: Toxicity data from studies which meet the reliability criteria according to OECD guidelines, without further selection on special precautions for concentration maintenance.
Data set II: From the studies selected in data set I a stringent selection was made based on maintenance of the test concentrations.
The following type of studies were included in data set II:
- flow-through, static and semi-static studies in which measured concentrations were reported,
- static and semi-static studies in which the test vessels were closed properly and the concentrations were not measured,
- static and semi-static studies where the testcontainers were not closed, no analysis of test concentrations was carried out (or nothing was reported thereof), if these studies reported results that were lower than results found in other studies with the same compound and test organism carried out according to the two criteria mentioned above.

When results from flow-through studies with measured concentrations were obtained from a reliable review, the original literature was not collected. For all other test situations the original literature was studied.

Two studies are presented here as examples:
In a study of Alexander et al. (1978) a comparison was made between the flow-through and static method in a toxicity test with fathead minnow (*Pimephales promelas*) with four volatile compounds [11]. The test containers in the static test were covered with plastic film for the first 24 hours. LC50, 96 hours values of the flow-through test, reported as measured concentrations, were between 50 and 86% of the values of the static tests which were based on nominal concentrations.
Smith et al. (1991) compared LC50 values for American flagfish (*Jordanella floridae*) from a semi-static test with daily renewal of the test medium and a flow-through system. [12] In the semi-static test no analysis was carried out contrary to the flow-through test. No data were reported about the covering or closing of the testcontainers. The LC50, 96 hours values in the flow-through system were between 35 and 51% of the ones from the semi-static test.
A summary of the results of both studies is presented in table 2.2. From these studies it can be concluded that possible volatilisation of these compounds during the tests does not lead to a considerable underestimation of toxicity. No increase of the ratio between the continuous flow and static or semi-static LC50 with increasing Henry coefficient was found.

Table 2.2. Comparison between different test-systems: data from studies of Alexander et al. (1978) and Smith et al. (1991). LC50 (96 hour) values for fish are presented in mg/l (S: static; SS: semi-static; CF: continous flow).

Compound	Henry coeff.	$LC50_{CF}$	$LC50_{S\ or\ SS}$	$LC50_{CF}/LC50_{S\ or\ SS}$
1,1,2-trichloroethane[a]	0.04	45.1	89.1	0.51
dichloromethane[b]	0.09	193	310	0.62
trichloroethene[b]	0.35	40.7	66.8	0.61
trichloroethene[a]		28.3	63.1	0.45
tetrachloroethene[b]	0.86	18.4	21.4	0.86
tetrachloroethene[a]		8.4	24	0.35
1,1,1-trichloroethane[b]	0.98	52.8	105	0.50

[a] data from Smith et al. (1991) for *Jordanella floridae*
[b] data from Alexander et al. (1978) for *Pimephales promelas*

The two data sets were not available for the chlorobenzenes. For these compounds data were collected from a recent review by Hesse et al. (1991) as stated before in paragraph 2.3.1. [8] They also developed criteria with respect to concentration maintenance, which were applied for those chlorobenzenes which were considered as highly volatile, i.e. the mono-, di-, and trichlorobenzenes. Tests with these compounds were considered acceptable if:

1. a closed system or a continuous flow system was used,
2. toxicant concentrations were analyzed during the test.

Because of this data presented in Hesse et al. (1991) were considered as a stringent selection similar to data set II. Results of tests in which these criteria are not fulfilled were not presented in Hesse et al. (1991). Therefore no data set is available for chlorobenzenes disregarding criteria with respect to volatility of the compound (data set I).

2.3.4. Recalculation of aquatic toxicity data

Van Helmond (1992) gathered toxicity data for marine organisms for all substances. [13] He made the same selections as described in paragraph 2.3.3. leading to two different data sets. However, he also used another approach to derive toxicity data considering the volatile properties of the selected compounds: if sufficient information was available presented L(E)C50 or NOEC values were recalculated. The following situations were distinguished:

1. if three or more measured concentrations during the exposure time were available the average concentration was calculated,
2. if the nominal or measured initial concentration (C_0) and final measured concentration (C_t) were available a half-life of the substance was calculated assuming first order kinetics. With this half-life the concentration after half the exposure time was calculated. This concentration was regarded as the best estimation of the real exposure concentration.
3. if the initial nominal concentration and the L(E)C50 or NOEC (based on nominal concentrations) were available the concentration at half the exposure time was regarded as the best approximation of the real exposure concentration. This concentration was calculated using an estimated half-life of 5, 15,

25 or 50 hours. The choice of these half-lives depended on a combination of test conditions used in the experiment (in particular sealing, aeration and temperature) and an indication of half-lives from literature (for details see Van Helmond (1992)).

2.3.5. Selection of toxicity data: soil organisms

A study had to meet several requirements with respect to experimental design. Test-guidelines of the OECD were used as a basis, although only a few of such guidelines are present for terrestrial organisms. All results from experiments with soil organisms were converted to a standard soil, which is a soil with a clay and organic matter content of 25 and 10%, respectively. For organic compounds this normalisation is based only on the organic matter content of the soil. This means that test results are corrected according to the following formula [9]:

$$\text{NOEC or L(E)C50}_{ss} = \text{NOEC or L(E)C50}_{exp} * f_{om}\ (ss)\ /\ f_{om}\ (exp) \qquad (1)$$

ss = standard soil,
exp = data from experiment,
f_{om} (ss) = fraction organic matter in standard soil, i.e. 10%,
f_{om} (exp) = fraction organic matter in soil from experiment.

2.3.6. Procedures for deriving L(E)C50 values

In principle a distinct concentration-effect relationship had to be present. In most cases however, raw data were not presented in literature. Yet, in general these studies were considered reliable because acute studies have been carried out already for a long time and have been standardized to a great extent, especially in aquatic ecotoxicology. If only raw data were available the L(E)C50 was calculated according to the method of Spearman and Karber. [14]

2.3.7. Procedures for deriving NOEC values

Several procedures were used for deriving NOEC values depending on whether statistical methods have been used or not:

- if the NOEC value was based on a statistical method these results were used: the highest concentration tested not differing from the control at $P < 0.05$ is regarded as the NOEC,
- if no statistical method was applied or could be used in principle the highest concentration showing less than 10% effect was considered as the NOEC. There had to be a distinct concentration-effect relationship however.
- if there were not enough NOEC values available to apply refined effect assessment (see paragraph 2.4.2) or when there was a LOEC (Lowest Observed Effect Concentration) which was lower than the available reliable NOEC value(s) the following procedures were applied [15]:
    1) LOEC >10 to 20% effect: NOEC = LOEC/2,
    2) LOEC ≥20% effect and a distinct concentration-effect relationship: the EC10 was calculated or extrapolated and regarded as the NOEC,

3) LOEC ≥20% with no distinct concentration-effects relationship:

a) LOEC 20 to 50% effect: NOEC = LOEC/3,

b) LOEC ≥50% effect: NOEC = LOEC/10.

In aquatic ecotoxicology several other toxicological criteria are used. These were dealt with in the following way:

- 'Toxische Grenzkonzentration' (TGK) or Toxic Threshold of Bringmann and Kühn. [16] The TGK is defined by Bringmann and Kühn as the concentration at which 3-5% inhibition occurs (the limit of 3 or 5% depends on the organism tested) and is calculated by a graphic method. The NOEC was calculated as TGK/2.
- Maximum Acceptable Toxicant Concentration (MATC): if the MATC was presented as a range of 2 values the lowest value was used as the NOEC. If the MATC was presented as one value the NOEC was calculated as MATC/2.

2.4. Derivation of Maximum Permissible Concentrations

In the Netherlands two extrapolation methods are used for deriving environmental quality objectives:

1. preliminary effect assessment: modified EPA method; if only acute or chronic NOEC values for only algae, crustaceans and fish are available this method is applied,
2. refined effect assessment: Modification 0 of the method of van Straalen and Denneman as developed by Aldenberg and Slob; this method is applied if 4 or more NOEC values are available for different taxonomic groups.

These methods are described in detail in Slooff (1992) and Aldenberg and Slob (1991) [9, 17]. A short description of both methods is given in paragraphs 2.4.1 and 2.4.2. In addition the QSAR approach is shortly described in paragraph 2.4.3 (a detailed explanation is given in Van Leeuwen et al. (1992)). In figure 1 the three methods for calculating a MPC for water are presented schematically.

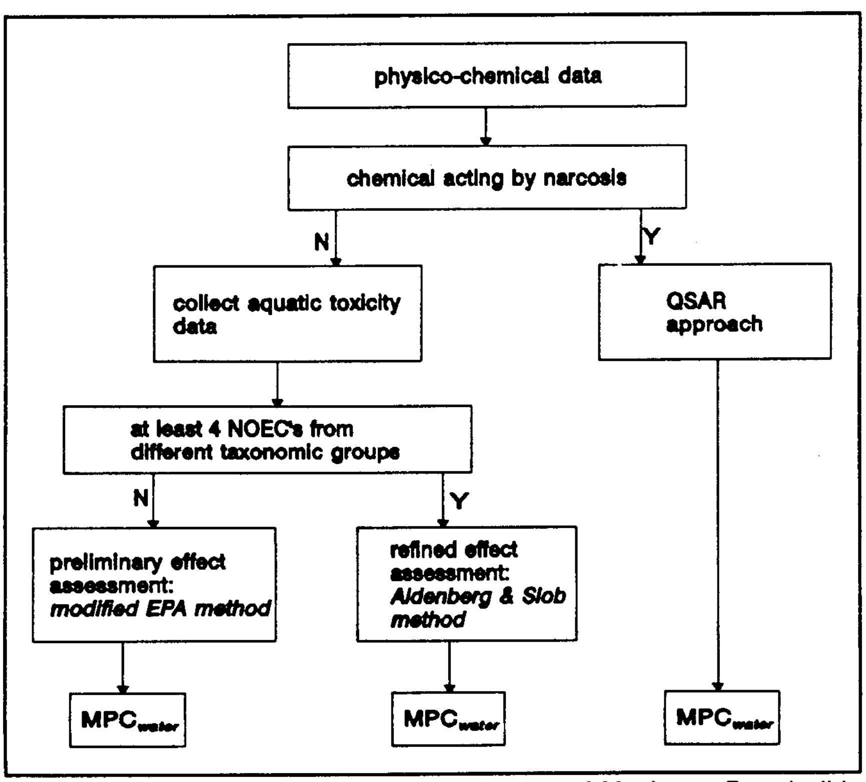

Figure 1. Schematic presentation of derivation of Maximum Permissible Concentrations for water.

2.4.1. Modified EPA method

In the modified EPA method assessment factors are applied to toxicity data. The size of this factor depends on the number and kind of toxicity data. In tables 2.3 and 2.4 the method is summarized for aquatic and terrestrial ecosystems, respectively. Because this method lacks scientific basis the outcome is called an indicative MPC. In contrast with the former EPA method, the modified method weights chronic as well as acute toxicity data over the species according to the method described in paragraph 2.4.2. for Aldenberg and Slob. In addition also acute to chronic ratios are used to derive NOEC values. These ratios are applied only within one taxonomical group.

Table 2.3. Modified EPA method for aquatic ecosystems

available information	assessment factor
lowest acute L(E)C50-value or QSAR estimate for acute toxicity	1,000
lowest acute L(E)C50-value or QSAR estimate for acute toxicity for minimal algae/crustaceans/fish	100
lowest NOEC-value or QSAR estimate for chronic toxicity	10*
lowest NOEC-value or QSAR estimate for chronic toxicity for minimal algae/crustaceans/fish	10

* this value is subsequently compared to the extrapolated value based on acute L(E)C50 toxicity values. The lowest one is selected

Table 2.4. Modified EPA method for terrestrial ecosystems

available information	assessment factor
lowest acute L(E)C50-value or QSAR estimate for acute toxicity	1,000
lowest acute L(E)C50-value or QSAR estimate for minimal three representatives of microbe-mediated processes, earthworms or arthropods and plants	100
lowest NOEC-value or QSAR estimate for chronic toxicity	10*
lowest NOEC-value or QSAR estimate for chronic toxicity for minimal three representatives of microbe-mediated processes, earthworms or arthropods and plants	10

* this value is subsequently compared to the extrapolated value based on acute L(E)C50 toxicity values. The lowest one is selected

2.4.2. Method of Aldenberg and Slob

The method of Aldenberg and Slob (a modification of the method of Van Straalen and Denneman) calculates a Hazardous Concentration (HC*p*) defined as the concentration at which p% of the species in the community may be adversely affected. [16, 18] The decision on what is an acceptable value for p% is not a matter of science, but a political compromise. Anticipating on political discussions, a protection level for the ecosystem is assumed as follows: ecosystems are supposed to be protected if 95% of the species is protected, which means that in the ecosystem the NOEC can be exceeded for 5% of the species. This 95% protection level or HC_5 can be calculated with a 50% and 95% confidence level. In the Netherlands the former value is called the MPC. [9] To indicate the uncertainty in the estimation of the MPC the 95% protection level with both 50 and 95% confidence is calculated.

The Aldenberg and Slob method uses the lowest NOEC per species as input data and is applied when at least 4 NOEC values for different taxonomic groups[1] are available. NOEC values used as input data for the extrapolation methods are evaluated as follows [9]:

- if for a single species several NOEC values are derived for different effect parameters the lowest is selected,
- if for a single species several NOEC values are derived for the same effect parameter a geometric mean is calculated.

The method of Aldenberg and Slob assumes that the NOEC values used for calculation fit the log-logistic distribution. For checking this assumption the data available are tested statistically with the so called empirical distribution function (EDF): Kolmogorov-Smirnov D*sqrt(n) test. [19] The significance level (1, 2.5, 5, or 10%) is presented at which the test rejects the distribution as being log-logistic. Only if the NOEC values are not log-logistically distributed at a significance level of 1% and there are no reasons for leaving out outliers the modified EPA method is applied also. The lowest value is considered as the MPC.

2.4.3. QSAR approach

The QSAR approach is presented schematically in figure 2.

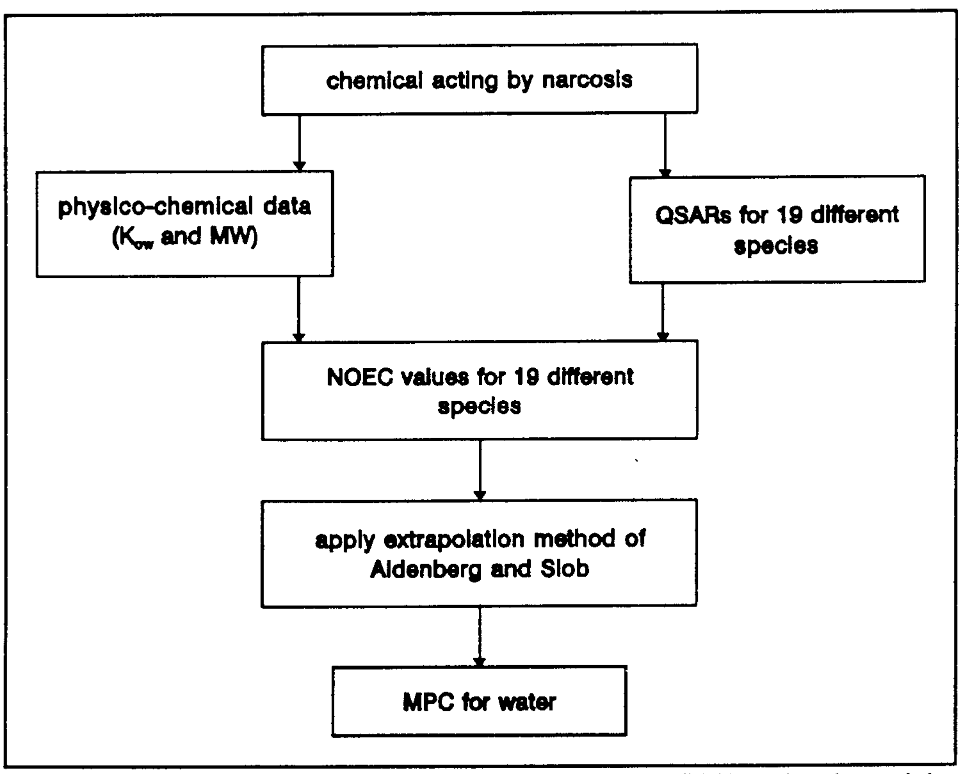

Figure 2. Schematic presentation of the QSAR approach (MW: molecular weight; K_{ow}: octanol-water partition coefficient).

---

[1] Species belong to a different 'taxonomic group' if they differ in ecological function, anatomic design, route of exposure etc. [9] At the moment no definite answer can be given to the question which taxonomic groups should be distinguished. In the future information from a project of the National Institute of Public Health and Environmental Protection on quantitative species sensitivity relationships (QSSR's) may provide a basis for the solution of this problem. [28]

Principle of the approach is that with 19 QSAR's a set of 19 NOEC values for different organisms is obtained. This data set is used as input for the extrapolation method of Aldenberg and Slob (see paragraph 2.4.2). Using this extrapolation method a MPC for water is calculated. The approach can only be used for chemicals that act by narcosis because the QSAR's used are valid only for such chemicals. QSAR's used by Van Leeuwen et al. (1992) are presented in table 2.5. [7] QSAR's are expressed as log NOEC = a log K_{ow} + b. Van Leeuwen et al. (1992) obtained QSAR's from literature and applied acute-chronic ratio's to transform QSAR's for acute effects or chronic lethal effects into QSAR's for chronic sublethal effects. For criteria for selection of QSAR's from literature see Van Leeuwen et al. [7]
An advantage of the QSAR approach is that data for more species are present than are usually available if only toxicity data obtained by literature are used. Van Leeuwen et al. (1992) selected 19 QSAR's comprising species of different trophic levels and taxonomic groups. QSARs were selected for a number of representative species, based on their ecological function (trophic level), morphological structure and route of exposure. [7]
In figure 3 the 19 QSARs from table 2.5 and the HC_5 values calculated with the method of Aldenberg and Slob are depicted. The 95% protection level calculated with 50% confidence (HC_5 50%) as well as the 95% protection level calculated with 95% confidence (HC_5 95%) is given. The former value is equal to the MPC, the latter is the one calculated by Van Leeuwen and co-workers.

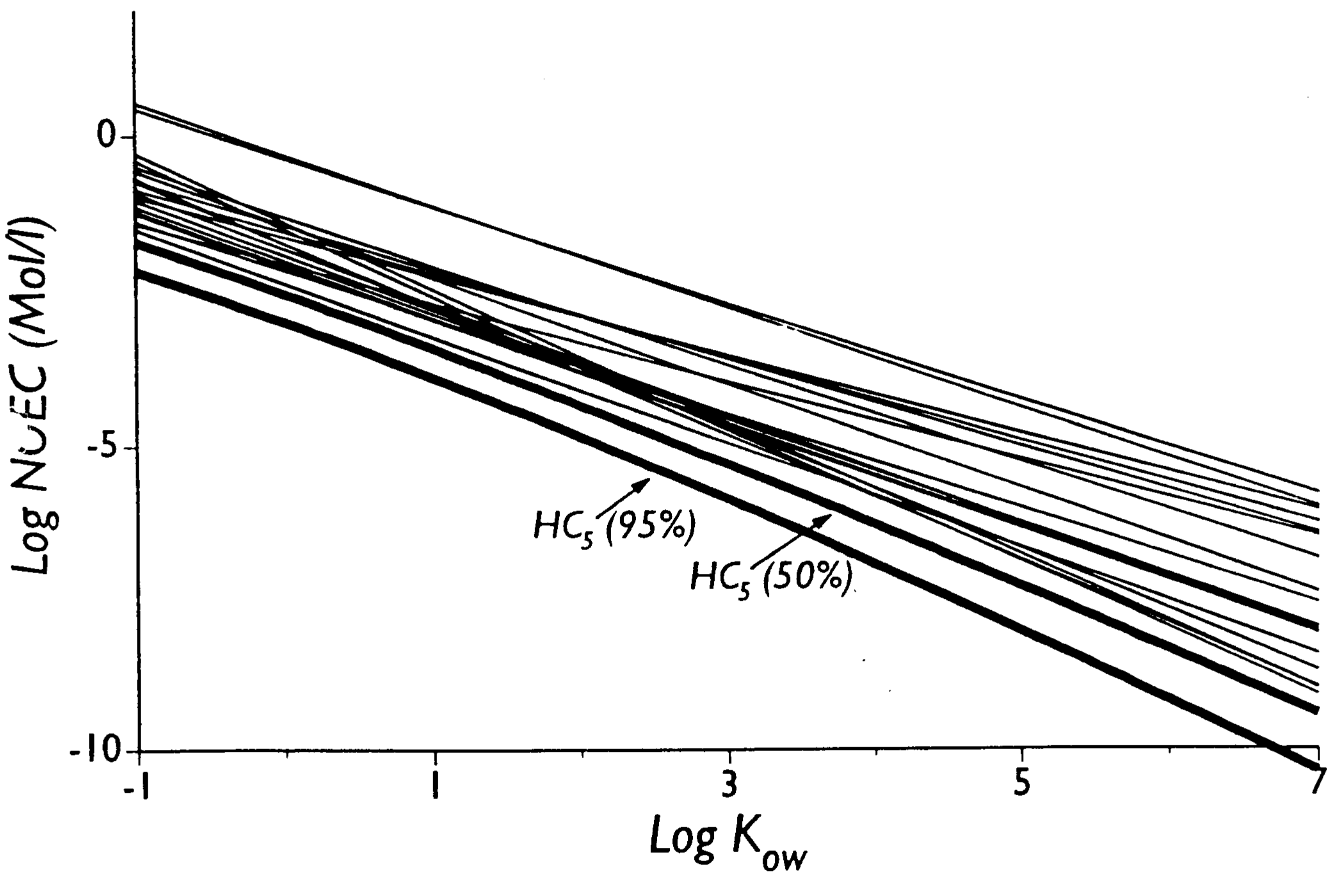

Figure 3. QSARs from table 2.5 (thin lines), together with HC_5 50% (or MPC) and HC_5 95% (thick lines) calculated according to the method of Aldenberg and Slob.

Table 2.5. QSAR's used by Van Leeuwen et al. (1992) [7]

Species	QSAR (NOEC expressed as mol/l)
Bacteria	
Clostridium botulinum	log NOEC = -0.82 log K_{ow} - 0.29
Bacillus subtilis	log NOEC = -0.64 log K_{ow} - 2.03
Pseudomonas putida	log NOEC = -0.64 log K_{ow} - 1.60
Photobacterium phosphorum	log NOEC = -0.68 log K_{ow} - 1.52
Algae	
Skeletonema costacum	log NOEC = -0.72 log K_{ow} - 1.42
Scenedesmus subspicatus	log NOEC = -0.86 log K_{ow} - 1.41
Selenastrum capricornutum	log NOEC = -1.00 log K_{ow} - 1.71
Fungi	
Saccharomyces cerevisiae	log NOEC = -0.78 log K_{ow} - 0.35
Protozoans	
Tetrahymena pyriformis	log NOEC = -0.80 log K_{ow} - 1.28
Coelenterates	
Hydra oligactis	log NOEC = -0.86 log K_{ow} - 2.05
Molluscs	
Lymnaea stagnalis	log NOEC = -0.86 log K_{ow} - 2.08
Arthropods	
Nitocra spinipes	log NOEC = -0.78 log K_{ow} - 2.14
Daphnia magna	log NOEC = -1.04 log K_{ow} - 1.70
Aedes aegypti	log NOEC = -1.09 log K_{ow} - 1.36
Culex pipiens	log NOEC = -0.86 log K_{ow} - 1.98
Fish	
Pimephales promelas/ Brachydanio rerio	log NOEC = -0.87 log K_{ow} - 2.35
Amphibia	
Ambystoma mexicanum	log NOEC = -0.88 log K_{ow} - 1.89
Rana temporaria	log NOEC = -1.09 log K_{ow} - 1.47
Xenopus laevis	log NOEC = -0.90 log K_{ow} - 1.79

3. SELECTION OF TOXICITY DATA

3.1. Data availability for aquatic organisms

The toxicity data obtained by literature search are presented in Appendix 2 and 3 for freshwater and saltwater organisms, respectively. As stated in paragraph 2.3.1 toxicity data for chlorobenzenes for freshwater organisms were taken from Hesse et al. (1991) [8]

For freshwater organisms acute as well as chronic toxicity data were available for almost all compounds. Only for 2-chloro-1,3-butadiene and 3-monochlorotoluene no toxicity data were found, while for acrylonitril, 1,3-dichloropropene and ethylene oxide no chronic data were available. For marine organisms chronic data were very scarce: only for 11 out of 35 compounds such data were available. For 2-chloro-1,3-butadiene and 3-chloropropene no toxicity data for marine organisms were found.

As stated in paragraph 2.3.3. the following selections were made from the toxicity data for freshwater as well as saltwater aquatic organisms:

Data set I: studies that meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance.

Data set II: stringent selection from the studies selected in data set I based on maintenance of the test concentrations.

If stringent criteria with respect to volatility of the test compound were used many studies had to be rejected as illustrated in table 3.1: in almost 50 percent of the tests evaluated no adequate measures were taken to prevent volatilisation of the test compound. Also the scarcity of chronic data for marine organisms is illustrated clearly in this table.

Table 3.1. Number of L(E)C50 or NOEC values from data set I and II

compound	freshwater organisms				saltwater organisms			
	acute		chronic		acute		chronic	
	I	II	I	II	I	II	I	II
acrylonitril	11	2	0	0	2	0	0	0
2-chloro-1,3-butadiene	0	0	0	0	0	0	0	0
3-chloropropene	6	2	5	1	0	0	0	0
1,2-dichloroethane	12	4	9	4	7	2	1	1
1,2-dichloropropane	6	3	1	1	4	1	0	0
1,3-dichloropropene	2	2	0	0	4	0	0	0
ethylbenzene	15	8	5	2	6	4	0	0
ethylene oxide	2	0	0	0	1	0	0	0
2-monochlorotoluene	1	0	4	2	2	0	0	0
3-monochlorotoluene	0	0	0	0	1	0	0	0
4-monochlorotoluene	1	1	3	3	1	0	0	0
styrene	9	4	3	1	2	0	0	0
tetrachloroethene	10	5	2	2	3	1	0	0
1,1,1-trichloroethane	9	6	6	4	1	0	0	0
1,1,2-trichloroethane	11	10	7	5	13	13	3	3
tricloroethene	25	11	5	2	7	4	1	1
trichloromethane	16	13	6	4	0	0	1	0
2-xylene	22	16	3	2	5	4	0	0
3-xylene	15	9	2	2	4	4	0	0
4-xylene	17	11	2	2	3	3	0	0
total	190	107	63	37	66	36	5	4

3.2. Data availability for terrestrial organisms

The toxicity data obtained by literature search are presented in Appendix 4. As stated in paragraph 2.3.1 toxicity data for chlorobenzenes were taken from Hesse et al. (1991) [8]
No toxicity data were available for sediment dwelling organisms exposed via contaminated sediment. For soil organisms only for 1,2-dichloropropane, tetrachloroethylene and toluene some reliable toxicity data were present. Hesse et al. (1991) found toxicity data for 1,4-dichlorobenzene, all tri- and tetrachlorobenzenes, and pentachlorobenzene. For most chlorobenzenes acute as well as chronic data were available, although in almost all cases from only one taxonomic group. Plants appear to be sensitive to some chlorobenzenes, e.g. 1,2,3-trichlorobenzene and 1,2,3,5-tetrachlorobenzene. [8]

3.3. Recalculation of aquatic toxicity data

Toxicity data for saltwater organisms were recalculated by Van Helmond as described in paragraph 2.3.4. These recalculated data are also presented in Appendix 3. Recalculation leads to much lower L(E)C50 and NOEC values. In order to evaluate these recalculated toxicity data MPC values were calculated using 'original' and recalculated data. All MPC's were calculated using the modified EPA method as presented in paragraph 2.4.1.

Table 3.2. MPC values ($\mu g/l$) using 'original' and recalculated toxicity data for saltwater organisms

Compound	MPC ($\mu g/l$) saltwater	MPC ($\mu g/l$) recalculated data	MPC (saltwater)/ MPC (recalculated)
acrylonitril	25	2	13
benzene	18	1	18
1,2-dichlorobenzene	73	<0.001	>73,000
1,3-dichlorobenzene	78	0.01	7,800
1,4-dichlorobenzene	74	0.01	7,400
1,2-dichloroethane	94	0.2	470
dichloromethane	33	0.4	83
1,2-dichloropropane	50	0.3	170
1,3-dichloropropane	87	0.1	870
1,3-dichloropropene	8	0.02	400
ethylbenzene	0.49	0.04	1.2
ethylene oxide	745	27	28
hexachloroethane	2.4	0.003	800
monochlorobenzene	10	0.001	10,000
2-monochlorotoluene	7.8	4	2.0
3-monochlorotoluene	25	3	8.3
4-monochlorotoluene	15	2	7.5
pentachlorobenzene	0.46	0.001	460
pentachloroethane	116	0.1	1,200
styrene	9.1	0.01	910
1,2,3,5-tetrachlorobenzene	3.7	0.005	740

Compound	MPC (μg/l) 'original' data	MPC (μg/l) recalculated data	MPC ('original')/ MPC (recalculated)
1,2,4,5-tetrachlorobenzene	0.8	0.001	800
1,1,2,2-tetrachloroethane	12	0.02	600
tetrachloroethene	3.5	0.006	580
tetrachloromethane	50	0.2	250
toluene	43	2	22
1,2,3-trichlorobenzene	2.4	2.4	1
1,2,4-trichlorobenzene	0.54	0.003	180
1,3,5-trichlorobenzene	100	4	25
1,1,1-trichloroethane	71	0.1	710
1,1,2-trichloroethane	300	300	1
trichloroethene	80	50	1.6
trichloromethane	21,600	4,100	5.3
2-xylene	1.3	0.01	130
3-xylene	3.7	3.7	1
4-xylene	2.0	2.0	1

From this table it can be concluded that the MPC's based on recalculated data are always much lower than the ones based on the original data. For most compounds the difference is more than a factor 100. MPC's based on recalculated data often lead to values in the range of 1-10 ng/l. Considering the fact that most compounds act non-specifically it can be concluded that using recalculated data leads to unrealistically low MPC values. Van de Meent et al. (1990) e.g. calculated MPC values varying from 4.3 ng/l to 750 ng/l for pesticides like atrazin, lindane, azinphos-methyl, diazinon, malathion, parathion-ethyl and dieldrin; compounds which are considered to be more toxic than the ones presented in table 3.2. due to their specific mode of action. Hence the recalculated data will not be used for the derivation of the MPC for water.

3.4. Comparison of sensitivity of fresh and saltwater organisms

No clear answer can be given yet to the question whether marine and freshwater organisms differ in sensitivity to xenobiotics. Jonkers and Everts (1992) state that a general trend is not distinguishable although it is seldom the case that substances are equally toxic in fresh and saltwater. [20] Van de Plassche et al. (1992) compared the sensitivity of salt and freshwater organisms for nine trace metals on the level of taxonomic groups. It was concluded that there was no difference in sensitivity. Therefore combined data sets were used by Van de Plassche et al. (1992) to derive MPC's for water.
It was not possible to carry out an extensive comparison on the level of taxonomic groups like in Van de Plassche et al. (1992) due to the scarcity of marine toxicity data. The compounds for which this could be done based on chronic toxicity data are presented in table 3.3.

Table 3.3 Comparison of sensitivity of freshwater and saltwater organisms on the level of taxonomic groups.

compound	taxonomic group	NOEC (mg/l) freshwater	saltwater
tetrachlorobenzene	fish	0.16[1]	0.09
1,1,2-trichloroethane	crustaceans	22[2]	10
	fish	23[3]	3
trichloromethane	algae	180[4]	220

1 data taken from Hesse et al. (1991); value presented is geometric mean of 0.25 and 0.1 mg/l for *Pimephales promelas* and *Brachydanio rerio*, respectively
2 geometric mean of 26 and 18 mg/l for *Daphnia magna*
3 geometric mean of 18 and 29 mg/l for *Jordanella floridae*
4 geometric mean of 93, 550, and 110 mg/l for *Microcystis aeruginosa*, *Scenedesmus quadricauda* and *Scenedesmus subspicatus*, respectively

Based on these data no conclusions can be dwawn with respect to differences in sensitivity between salt and freshwater organisms. Therefore MPC's were derived based on toxicity data for freshwater and marine organisms. In Appendix 5 the data used for extrapolation are presented. Toxicity data from data set I are used, i.e. studies which meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance (see paragraph 2.2.2.). Results are presented in table 3.4.

Table 3.4. Comparison of MPC's (in μg/l) for fresh and saltwater organisms based on data set I.

compound	MPC (μg/l) freshwater	MPC (μg/l) saltwater	MPC (freshwater)/ MPC (saltwater)
acrylontril	7.6[1]	25[1]	0.30
1,2-dichloroethane	8.5	94[1]	0.09
1,2-dichloropropane	45[1]	50[1]	0.9
1,3-dichloropropene	6.1[1]	8[1]	0.76
ethylbenzene	260	0.49[1]	530
ethylene oxide	84	745	0.11
2-monochlorotoluene	75	7.8[1]	9.6
4-monochlorotoluene	3.6[1]	15[1]	0.24
styrene	230[1]	9.1[1]	25
tetrachloroethene	4.9[1]	3.5[1]	1.4
1,1,1-trichloroethane	500	71[1]	7.0
1,1,2-trichloroethane	3,600	300[1]	12
trichloroethene	2,200	80[1]	28
trichloromethane	5,600	22,000[1]	0.26
2-xylene	23[1]	1.3[1]	18
3-xylene	49[1]	3.7[1]	13
4-xylene	26[1]	2.0[1]	13

1 indicative MPC calculated using the modified EPA method; the other MPC's are calculated using the method of Aldenberg and Slob

As can be seen from this table the quotient of both MPC's varies from 0.09 to 530. If only MPC's calculated with the same extrapolation method are compared the quotient varies from 0.11 to 25 with a geometric mean of 2.0, i.e. the MPC for saltwater organisms is a geometric mean factor of 2.0 lower than the one for freshwater organisms. It should be stated that for freshwater organisms much more toxicity data were available then for marine organisms which often leads to the use of lower assessment factors in the modified EPA method. Based on these data it cannot be concluded that saltwater organisms are more sensitive to these compounds than freshwater organisms. Therefore the data sets for salt and freshwater organisms for calculating MPC's for water were combined (see chapter 5).

3.5. Selection of aquatic toxicity data based on special precautions based on concentration maintenance

As stated in paragraph 2.3.3 a selection was made into data set I and II with respect to concentration maintenance due to volatile properties of the test-compounds. In table 3.5 MPC values for water are calculated using both data sets based on toxicity data for fresh as well as saltwater organisms.

Table 3.5. MPC values (μg/l) based on data set I and II.

compound	MPC (mg/l) data set I[1]	MPC (mg/l) data set II[2]	MPC (data set I)/ MPC (data set II)
acrylonitril	0.0076[3]	0.0093[3]	**0.82**
3-chloropropene	0.72 (24[4,5])	0.00034[3]	2,100
1,3-dichloropropene	0.008[3]	0.006[3]	**0.75**
ethylene oxide	0.084[3]	-	-
1,2-dichloroethane	11 (8.5)	4.3 (83)	**2.6**
1,2-dichloropropane	0.45[3]	0.045[3]	**10**
ethylbenzene	0.26 (460)	0.0049[3]	53
2-monochlorotoluene	0.075 (2700)	0.021[3]	3.6
3-monochlorotoluene	0.025[3]	-	-
4-monochlorotoluene	0.0036[3]	0.0036[3]	**1**
styrene	0.091[3]	0.023[3]	**4.0**
tetrachloroethene	0.0035[3]	0.0049[3]	**0.71**
1,1,1-trichloroethane	0.5 (310)	0.08[3]	6.3
1,1,2-trichloroethane	2.2 (7.6)	2.8 (5.1)	**0.79**
trichloroethene	2.6 (314)	0.13[3]	20
trichloromethane	8.2 (18)	0.18[3]	46
2-xylene	0.013[3]	0.013[3]	**1**
3-xylene	0.037[3]	0.037[3]	**1**
4-xylene	0.020[3]	0.020[3]	**1**

1 data set I: studies which meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance
2 data set II: stringent selection from the studies selected in data set I based on maintenance of the test concentrations
3 indicative MPC calculated using the modified EPA method
4 value between brackets: ratio between $MPC_{50\%\ confidence}$ and $MPC_{95\%\ confidence}$ calculated with the method of Aldenberg and Slob
5 distribution of NOEC values is rejected as being log-logistic at a significance level of 1%
6 if the MPC values are calculated with the same extrapolation method the ratio is printed bold

The method of Aldenberg and Slob, which needs at least 4 chronic NOEC's for different taxonomic groups as input data, could be applied for 8 compounds using data set I, but only for 2 compounds using data set II. For almost all compounds the MPC using data set I is higher than the one using data set II. The ratio between these MPC's varies between 0.71 and 2,100 with a geometric mean ratio of 4.4. It is more accurate, however to compare only MPC's derived with the same extrapolation method. MPC values calculated using the modified EPA method will in most cases be lower than the ones using the method of Aldenberg and Slob. Emans et al. (1992) applied both methods to 18 compounds. The geometric mean values calculated with the method of Aldenberg and Slob were a factor 9.3 higher than the ones calculated with the modified EPA method. [21] If, for the volatile compounds, only MPC values calculated with the same extrapolation method are taken into account the geometric mean ratio between the MPC's based on data set I and II is reduced from 4.4 to 1.5 with a range of 0.71-10 for 11 instead of 17 compounds. For 9 of these 11 compounds the MPC is calulated with the modified EPA method using acute toxicity data. Based on these small differences between the results based on data set I and II it was decided to use data set I for the further calculations, i.e. the derivation of MPC's for chemicals that do not act by narcosis (see paragraph 4.1) and the comparison of the traditional and QSAR approach (see paragraph 4.2).

4. MAXIMUM PERMISSIBLE CONCENTRATIONS FOR WATER

4.1. MPC's for water for chemicals with a specific mode of action

MPC's were calculated based on toxicity data for fresh and saltwater organisms as presented in appendix 2 and 3. Results are presented in table 4.1.

Table 4.1. MPC's for water for chemicals with a specific mode of action using data from literature search (based on toxicity data for fresh and saltwater organisms) together with the lowest acute L(E)C50 and chronic NOEC (all in mg/l).

compound	MPC (mg/l)	lowest NOEC (mg/l)	lowest L(E)C50 (mg/l)
acrylonitril	0.0076[1]	-	7.6
3-chloropropene	0.0034[1,2]	3.2	0.34
1,3-dichloropropene	0.008[1]	-	0.8
ethylene oxide	0.084[1]	-	84

1 indicative MPC calculated using the modified EPA method
2 an assessment factor of 100 is used although no acute toxicity data are available for algae, crustaceans and fish. Chronic data were present, however for bacteria, algae and protozoans

For 2-chloro-1,3-butadiene and 2,3-dichloropropene no toxicity data were available for the aquatic environment. No MPC's for water could therefore be derived for these compounds. Comparing the MPC's with the lowest NOEC and LC50 available the following can be concluded:

- the MPC for 3-chloropropene is calculated with the modified EPA method although 4 chronic NOEC values were available which means that the method of Aldenberg and Slob could be applied. The MPC value calculated with the method of Aldenberg and Slob would be 0.72 mg/l. The distribution of NOEC values is however rejected as being log-logistically distributed at a significance level of 1%. Therefore the method should not be applied (see paragraph 2.4.2.).
  Besides, this MPC of 0.72 mg/l is higher than the lowest LC50 available, being 0.34 mg/l for *Xenopis laevis*. Also, based on a comparison between acute and chronic data it could be concluded however that chronic values were present for insensitive organisms only, i.e. lower organisms: bacteria, algae and protozoans. It is known that these lower organisms are less sensitive for most organic compounds than higher organisms like fish and crustaceans.
- for acrylonitril, 1,3-dichloropropene and ethylene oxide no conclusions can be drawn because no chronic toxicity data were available for these compounds.

4.2. MPC's for water for chemicals acting by narcosis

MPC's for water were derived using the traditional and the QSAR approach for those compounds for which toxicity data for freshwater as well as saltwater organisms were searched for. Results are presented in table 4.2. together with the lowest L(E)C50 and NOEC value.

Table 4.2. Comparison of MPC's for water using the QSAR approach with MPC's using data from literature search (based on toxicity data for fresh and saltwater organisms) together with the lowest acute L(E)C50 and chronic NOEC (all in mg/l).

compound	MPC (mg/l) traditional approach	MPC (mg/l) QSAR approach	MPC (QSAR)/ MPC (trad. approach)	lowest NOEC (mg/l)	lowest L(E)C50 (mg/l)
1,2-dichlorobenzene	0.012[1,2]	0.27 (4.1)	23[4]	0.34	1.23
1,3-dichlorobenzene	0.033[1]	0.21 (4.1)	6.4	0.68	3.27
1,4-dichlorobenzene	0.030[1]	0.26 (4.1)	8.7	0.304	7.4
1,2-dichloroethane	11 (8.5[3])	14 (3.1)	**1.3**	11	1.8
1,2-dichloropropane	0.45[1]	5.3 (3.3)	12	6	45
ethylbenzene	0.26 (460)	0.37 (3.9)	**1.4**	1	0.49
hexachlorobenzene	0.00018[1]	0.0024 (6.3)	13	0.0018	0.030
monochlorobenzene	0.0066[1]	0.69 (3.6)	110	0.32	0.66
2-monochlorotoluene	0.075 (2700)	0.30 (4.1)	4	0.21	7.8
3-monochlorotoluene	0.025[1]	0.33 (4.0)	13	-	25
4-monochlorotoluene	0.0036[1]	0.30(4.0)	83	0.32	3.6
pentachlorobenzene	0.0025[1]	0.0075 (5.7)	3	0.035	0.25
styrene	0.091[1]	0.57 (3.8)	6.3	34	9.1
1,2,3,4-tetrachlorobenzene	0.0025[1]	0.023 (5.7)	9.2	0.025	0.34
1,2,3,5-tetrachlorobenzene	0.0158[1]	0.022 (5.1)	1.4	0.18	1.58
1,2,4,5-tetrachlorobenzene	0.015[1]	0.026 (5.1)	1.7	0.09	0.8
tetrachloroethene	0.0035[1]	0.33 (4.1)	94	0.51	3.5
1,2,3-trichlorobenzene	0.004[1]	0.064 (4.7)	16	0.040	0.35
1,2,4-trichlorobenzene	0.019[1]	0.079 (4.6)	4.2	0.19	0.54
1,3,5-trichlorobenzene	0.0049[1]	0.057 (4.7)	12	0.26	0.49
1,1,1-trichloroethane	0.5 (310)	2.1 (3.5)	**4.2**	1.3	8
1,1,2-trichloroethane	2.2 (7.6)	7.9 (3.2)	**3.6**	3.0	40
trichloroethene	2.6 (31)	2.4 (3.5)	**0.92**	5.8	7.8
trichloromethane	8.2 (18)	5.9 (3.3)	**0.72**	9.7	18
2-xylene	0.013[1]	0.40 (3.8)	31	1	1
3-xylene	0.037[1]	0.33 (3.9)	8.9	0.7	3.7
4-xylene	0.020[1]	0.40 (4.2)	20	0.9	2.0

1 indicative MPC calculated using the modified EPA method

2 Slooff et al. (1991) also calculated overall MPC's of 30, 20, 10, 5, 2.5, and 0.2 μg/l for monochloro-, dichloro-, trichloro-, tetra-, penta, and hexachlorobenzene(s), respectively. [22]

3 between brackets: ratio between $MPC_{50\% \text{ confidence}}$ and $MPC_{95\% \text{ confidence}}$ calculated with the method of Aldenberg and Slob

4 If the MPC values are calculated with the same extrapolation method the ratio is printed bold

Using the traditional approach the method of Aldenberg and Slob could be applied for 7 out of 27 compounds. For almost all compounds the distribution of NOEC values was not rejected by the Kolomogorov-Smirnov test as being log-logistic. Only for 1,2-dichloroethane this was the case, but only for a significance level of 5 and 10%. This means that, according to the procedure described in paragraph 2.4.2., the method of Aldenberg and Slob can be applied.
It has to be stated that Van Leeuwen et al. (1992) also calculated MPC values for many of these compounds. [7] Values presented in table 4.2 differ, however from the ones calculated by Van Leeuwen et al. (1992) because in the present report 95% protection levels with a 50% confidence level are calculated with the method of Aldenberg and Slob (see paragraph 2.3.2.), while Van Leeuwen et al. (1992) calculated 95% protection levels with a 95% confidence level. Calculation of the latter leads to lower values (see figure 3). In figure 4 the MPC values calculated with the QSAR approach are compared with the lowest NOEC value as presented in table 5.2: the lowest NOEC values are presented as cubes, while the relation between log K_{ow} and the MPC is depicted as a line.

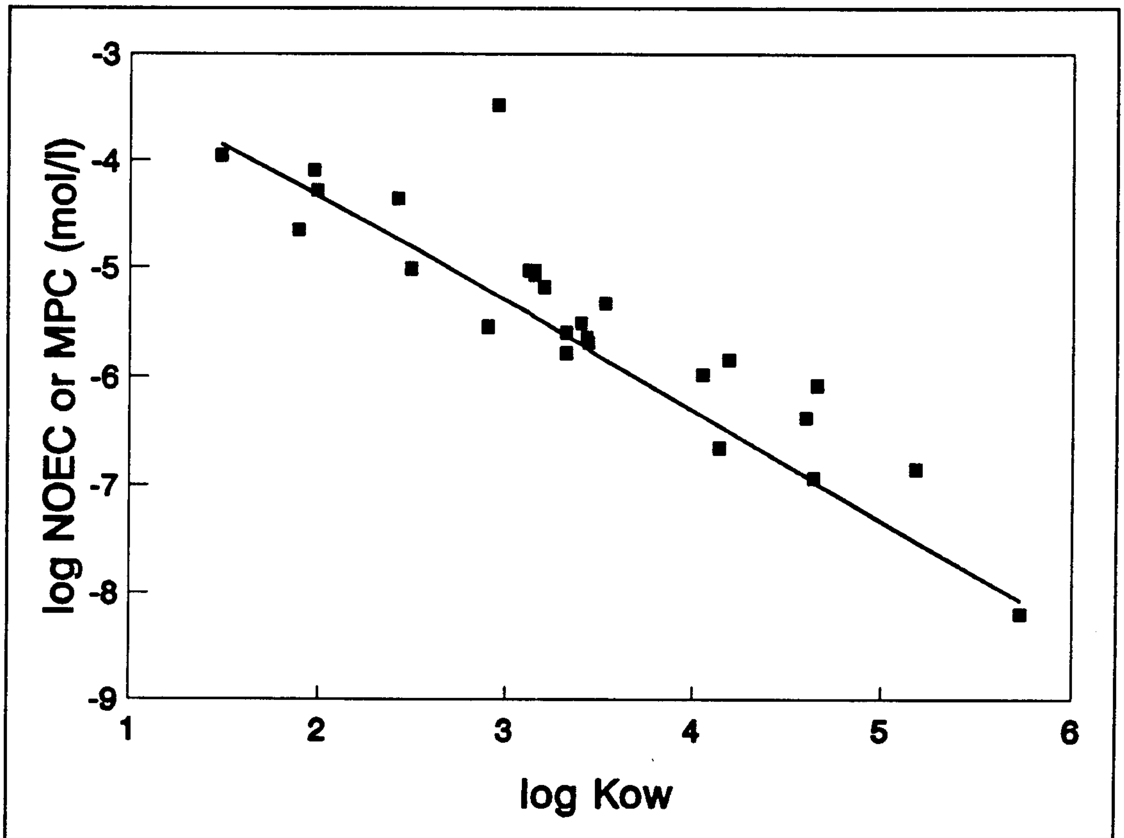

Figure 4. Relation between log K_{ow} and MPC for water calculated with the QSAR approach (presented as a line) and log K_{ow} and the lowest NOEC from literature (presented as cubes).

For most compounds the MPC's are comparable to the lowest NOEC values within approximately one order of magnitude. This can be regarded as an indication that it is allowed to use the QSAR approach to determine MPC values. The opposite should be argued if the lowest NOEC was systematically lower than the MPC. It should be noted that results presented here differ from the ones given in Van Leeuwen et al. (1992). They calculated a mean assessment factor, i.e. the ratio between the calculated 95% protection levels and the lowest estimate of toxicity using QSAR's, of circa 10. [7] The difference is

caused by the different confidence levels used in the Aldenberg and Slob method. As already stated the 95% confidence level leads to lower values. If a 50% confidence level is used the probability increases that the MPC is higher than the lowest NOEC from the data set.
Ratio's between MPC's using the QSAR approach and MPC's based on the traditional approach varied from 0.72 to 94 (geometric mean: 6.8). This reflects, however the scarcity in toxicity data causing the application of high assessment factors in the modified EPA method. If the same extrapolation method is used, i.e. the method of Aldenberg and Slob, difference between both MPC's is small: a factor 0.72-4.2 (based on 6 compounds). Based on these data it can be concluded that application of both approaches leads to comparable MPC's for water.

In table 4.3 MPC's for water are calculated for the other substances from the project 'Volatile Compounds' using the QSAR approach. For these compounds only toxicity data for marine organisms were searched for so a MPC could be calculated using the traditional approach, but based on saltwater toxicity data only. For 1,1-dichloroethane, 1,1- and 1,2-dichloroethene, ethylene and vinylchloride, however no toxicity data for saltwater organisms were found. This means that only a MPC using the QSAR approach can be calculated for these compounds.
If the traditional approach was used in all cases the modified EPA method as described in paragraph 2.4.1. had to be applied. Therefore these values should be regarded as indicative MPC's, also because they are based on saltwater toxicity data only. The large differences between MPC's based on the traditional and the QSAR approach are for most compounds caused by the high assessment factors used in the modified EPA method.

Table 4.3. Comparison of MPC's for water (in mg/l) using the QSAR approach with MPC using the traditional approach and ratios between these MPC's.

compound	MPC (mg/l) saltwater	MPC (mg/l) QSAR	MPC (QSAR)/ MPC (saltwater)	lowest NOEC (mg/l)	LC50 (mg/l)
benzene	0.018[1]	2.4	130	0.18	10
dichloromethane	0.33[1]	20	6,100	-	330
1,1-dichloroethane	-[2]	7.3			
1,1-dichloroethene	-[2]	3.4			
1,2-dichloroethene	-[2]	6.1			
1,3-dichloropropane	0.087[1]	5.2	60	-	87
ethylene	-[2]	8.5			
hexachloroethane	0.0024[1]	0.083	35	-	2.4
pentachloroethane	0.12[1]	0.23	1.9	10	116
1,1,2,2-tetrachloroethane	0.012[1]	3.3	280	-	12
tetrachloromethane	0.050[1]	1.1	22	-	50
toluene	0.043[1]	0.73	17	3.2	4.3
vinylchloride	-[2]	8.2			

1 indicative MPC calculated using the modified EPA method
2 no toxicity data for saltwater organisms available

5. MAXIMUM PERMISSIBLE CONCENTRATIONS FOR SOIL AND SEDIMENT

For sediment dwelling organisms no toxicity data were found so no MPC's can be derived. The MPC's for soil based on toxicity data presented in appendix 4 and for chlorobenzenes in Hesse et al. (1991) are given in table 5.1. Because only for these compounds toxicity data were present for soil organisms no MPC's could be calculated for other substances from table 2.1. All MPC's are based on the modified EPA method as presented in paragraph 2.4.1. These MPC's should therefore be considered as indicative values.

Table 5.1. MPC values for soil and the lowest chronic NOEC and acute L(E)C50 value available (all in mg/kg dry weight). All values have been converted to a standard soil with 10% organic matter.

compound	MPC[1] (mg/kg)	lowest NOEC (mg/kg)	lowest L(E)C50 (mg/kg)
1,4-dichlorobenzene	0.4	50	390
1,2-dichloropropane	4.2	-	4,240
pentachlorobenzene	0.3	50	280
1,2,3,4-tetrachlorobenzene	0.2	50	160
1,2,3,5-tetrachlorobenzene	0.007	-	7
1,2,4,5-tetrachlorobenzene	0.01	-	10
tetrachloroethene	0.16	-	155
toluene	1.4	14	>140
1,2,3-trichlorobenzene	0.005	5	5
1,2,4-trichlorobenzene	0.1	50	127
1,3,5-trichlorobenzene	0.6	50	615

[1] all MPC's are indicative MPC's because the modified EPA method is used

For all compounds, except for toluene, an assessment factor of 1,000 has been applied, caused by the scarcity of toxicity data. Hesse et al. (1991) state that for the chlorobenzenes the available data do not show an increase in toxicity with an increasing degree of chlorination. This can be explained by differences in bioavailability or a possible specific toxicity of tri- and tetrachlorobenzenes towards plants. It is known that toxicity and bioaccumulation (and therefore bioavailability) of organic compounds in soil are dependent on the concentration in soil solution. [23] MPC's for the different isomers for tetra- and trichlorobenzene differ greatly. This is caused by differences in sensitivity in toxicity to plants for the respective isomers, which were consistent in exposure via soil and nutrient solution. Hulzebos et al. attributed these differences partly to the number of unsubstituted free vicinal carbon atoms. [24] For this reason Hesse et al. (1991) give a range of 0.01 to 1 mg/kg as an indicative MPC for individual chlorobenzenes in a standard soil. [8]
MPC's for soil and sediment can be calculated using MPC's for aquatic organisms by application of the equilibrium partitioning method. [1, 2] Results thereof will be published in the integration report of the project 'Volatile Compounds'.

6. DISCUSSION

6.1 Data availability

For sediment dwelling organisms no tests were found at all for organisms exposed via contaminated sediment. For soil organisms only for 11 out of 35 compounds toxicity data were available. For most compounds this scarcity of data was expected because contamination of sediment or soil will probably not occur due to their volatile properties.
Much more toxicity data were available for aquatic organisms. For 16 out of 19 compounds for which toxicity data for freshwater organisms were searched for chronic data were found. For marine organisms chronic data were scarce. Only for 11 out of 35 compounds such data were present. Enough toxicity data for fresh and saltwater organisms were available, however to compare the QSAR approach and the one based on extensive literature search.

6.2 Criteria for data selection with respect to concentration maintenance in aquatic toxicity tests

The studies with aquatic organisms collected from the literature search were selected in two ways to obtain toxicity data like acute L(E)C50's and chronic NOEC's (see paragraph 2.3.3.):
Data set I: Toxicity data from studies which meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance.
Data set II: From the studies selected in data set I a stringent selection was made based on maintenance of the test concentrations.
As stated in chapter 3 almost 50% of the data from data set I had to be rejected. Because of this the method of Aldenberg and Slob, which needs at least 4 chronic NOEC's for different taxonomic groups as input data, could be applied for 8 compounds using data set I, but only for 2 compounds using data set II. MPC values based on data set I and II were in good agreement if only MPC's calculated with the same extrapolation method were taken into account: the geometric mean ratio between the MPC's based on data set I and II decreased from 4.4 to 1.5 for 11 compounds.
It is remarkable that the difference between the MPC's using data set I or II calculated with the same extrapolation method is only a geometric mean factor of 1.5. It can be concluded that taking no adequate measures to prevent volatilisation of the test compound doesn't lead to an important underestimation of toxicity. One explanation might be that the test compound doesn't disappear that fast from the test vessel because of the small evaporation surface area. Another one might be that adverse effects caused by these compounds appear rapid, i.e. within 24 hours: for compounds with low K_{ow} values a rapid equilibrium between the internal concentration in the organism and the concentration in water can be expected.

6.3 Comparison of QSAR approach and the one using data from literature search

For 27 substances from the project 'Volatile compounds' the QSAR approach was compared with the traditional one based on gathering of toxicity data from literature. MPC values and ratio's between both MPC's have been presented in table 4.2. Based on this comparison of MPC values it was concluded that both MPC's were comparable. It is therefore proposed to use the MPC's calculated with the QSAR approach. This approach is based on data for 19 species, which is more than the number of toxicity data usually being available in the more traditional approach and being a cross-section of an aquatic ecosystem. For many compounds effects assessment is therefore raised from the preliminary to the refined stage.

It should be stated that the same toxicity data are used for the derivation of MPC's based on literature search in the present report as have been used by Van Leeuwen et al. (1992) for the calculation of QSAR's presented in table 2.5. Toxicity data used for the calculation of 11 out of 19 QSAR's presented in table 2.5 are presented also in Appendix 2. Species of these QSAR's were *Pseudomonas putida*, *Photobacterium phosphoreum*, *Scenedesmus subspicatus*, *Selenastrum capricornutum*, *Hydra oligactis*, *Lymnaea stagnalis*, *Daphnia magna*, *Aedes aegypti*, *Culex pipiens*, *Brachydanio rerio*, *Ambystoma maxicanum* and *Xenopus laevis*. For all compounds, however also other toxicity data were available. First of all data were found for organisms for which no QSAR's were present, e.g. for blue algae (*Microcystis aeruginosa*) and protozoans (*Chilomonas paramecium* and *Entosiphon sulcatum*). Also more data were found for species for which QSAR's were present: e.g. for *Daphnia magna* two additional chronic studies were found in which several compounds were tested.

6.4 Comparison of MPC's for water and results from field studies

For some compounds results from (semi-)field studies were available. The results of these studies can be compared with the MPC values using the traditional or QSAR approach:

- Emans et al. (1992) compared NOEC values derived from field studies with results from extrapolation methods, a.o. the method of Aldenberg and Slob. [21] They report a NOEC for the most sensitive species tested in the experiment, called the multiple species NOEC (or MS NOEC), for 1,2,4-trichlorobenzene and trichloroethene. It has to be stated that both experiments, 1,2,4-trichlorobenzene by Lay et al. (1985) and trichloroethene by Lay et al. (1984), were considered as less reliable by Emans et al. (1992). [24, 25]
  For trichlorethene a MS NOEC of 2.5 mg/l was derived from an effect concentration by application of an uncertainty factor. This value is in good agreement with the MPC's presented in table 4.2 of 2.6, and 2.4 mg/l using the traditional and QSAR approach, respectively. For 1,2,4-trichlorobenzene a MS NOEC of 0.022-0.057 mg/l was derived by Emans et al. (1992). Also this value is in good agreement with the MPC's of 0.019 and 0.079 mg/l, based on the tradtional and QSAR approach, respectively.
- Merlin et al. (1992) tested dichloromethane in a micro- and mesocosm. [26]
  Microcosms contained plants (*Elodea canadensis* and *Lemna minor*), algae (*Scenedesmus subspicatus*) and two snails (*Physa sp.*). Two concentrations were tested, i.e. 0.5 and 1.0 g/l for 21 days. Snails were the most sensitive: both died on the second day post-dosing at 0.5 g/l.
  The species diversity in the mesocosms was large, a.o. snails, macrophytes and fish (*Coregonus lavaretus*). Test concentrations for two replicates were 156 and 137 mg/l. Several assays were carried out: e.g. plankton and periphyton, embryotoxicity effects on snails (number and viability of eggs), fish survival, bacterial analysis, cellulolytic bacterial activity, photosynthesis and respiration, carbon fixation and chlorophyll a. No adverse effects were detected in both replicates during the test, which lasted 90 days. Dichloromethane disappeared rapidly from the water phase: DT50 values of 1.15 and 2.76 days were calculated for the first 4 and 14 days, respectively.
  From these field tests it can be concluded that the MS NOEC lies between 156 and 500 mg/l. The MPC derived using the QSAR approach is 20 mg/l. Considering the rapid volatilisation of dichloromethane in the micro- and mesocosms these values compare reasonably well.

7. CONCLUSIONS

In the present report MPC's for water and soil were derived for 46 compounds. In order to derive MPC's for water two methods were used:

- the traditional approach in which only experimentally obtained NOEC or L(E)C50 values are used as input data for extrapolation methods. NOEC and L(E)C50 values were obtained by an extensive literature search for toxicity data for freshwater and saltwater organisms.
- the QSAR approach from Van Leeuwen et al. (1992) which uses NOEC values obtained by application of QSAR's for 19 different organisms as input data for extrapolation methods. This method can only be applied for chemicals that act by narcosis

Most compounds could be classified as inert chemicals. For 27 compounds MPC's calculated with the traditional and QSAR approach were compared. As these MPC's were in good agreement and because the QSAR approach uses toxicity data for at least 19 different organisms it is proposed to use the QSAR approach for these chemicals.

Because acrylonitril, 2-chloro-1,3-butadiene, 3-chloropropene, 1,3- and 2,3-dichloropropene and ethylene oxide cannot be classified as inert chemicals the QSAR approach could not be used for these compounds. MPC's for water for these compounds are therefore based on toxicity data gathered by literature search. For 2-chloro-1,3-butadiene no MPC could be derived because no toxicity data are available. For 3-chloropropene a MPC of 3.4 μg/l is proposed based on the modified EPA method although 4 NOEC values are available. Yet, the method of Aldenberg and Slob was not applied because the distribution of NOEC values was not log-logistic and the NOEC values are derived from tests with insensitive organisms, based on a comparison of acute and chronic data. Therefore, chronic tests should be carried out with higher organisms like fish, crustaceans or amphibians. For acrylonitril, 1,3- and 2,3-dichloropropene and ethylene oxide no chronic data were found at all. This means that also for these compounds chronic tests should become available. MPC values for these compounds, including 3-chloropropene, would then probably increase.

In table 7.1 the proposed MPC's for water are presented for all substances from the project 'Volatile Compounds'. For chlorobenzenes, monochlorotoluene and xylene also overall MPC's are calculated as the mean of MPC's for the respective isomers.

Slooff et al. (1991) also derived MPC's for chlorobenzenes using the modified EPA method as presented in table 2.3. The values presented in table 7.1 based on the QSAR approach are preferred, however because of the advantages of this approach as stated already.

No MPC's for sediment could be calculated as no toxicity data for sediment dwelling organisms exposed via contaminated sediment were present. Only for 11 compounds MPC's for soil could be calculated. As toxicity data for soil organisms were very scarce all MPC's were calculated using the modified EPA method and should therefore be regarded as indicative values. For all compounds, except toluene, an assessment factor of 1,000 was applied on the lowest L(E)C50 value available.

Table 7.1. Proposed Maximum Permissible Concentrations for water (mg/l) and soil (mg/kg)

Compound	MPC for water (mg/l) QSAR approach	traditional approach	MPC for soil (mg/kg)
acrylonitril		0.0076[1]	-[2]
benzene	2.4		-[2]
2-chloro-1,3-butadiene		-[2]	-[2]
3-chloropropene		0.0034[1]	-[2]
1,2-dichlorobenzene	0.27[3]		-[2]
1,3-dichlorobenzene	0.21		-[2]
1,4-dichlorobenzene	0.26		0.4[1]
1,1-dichloroethane	7.3		-[2]
1,2-dichloroethane	14		-[2]
1,1-dichloroethene	3.4		-[2]
1,2-dichloroethene	6.1		-[2]
dichloromethane	20		-[2]
1,2-dichloropropane	5.3		4.2[1]
1,3-dichloropropane	5.2		-[2]
1,3-dichloropropene		0.008[1]	-[2]
2,3-dichloropropene		0.008[4]	-[2]
ethylbenzene	0.37		-[2]
ethylene	8.5		-[2]
ethylene oxide		0.084[1]	-[2]
hexachlorobenzene	0.0024		-[2]
hexachloroethane	0.083		-[2]
monochlorobenzene	0.69		-[2]
2-monochlorotoluene	0.30[5]		-[2]
3-monochlorotoluene	0.33		-[2]
4-monochlorotoluene	0.30		-[2]
pentachlorobenzene	0.0075		0.3[1]
pentachloroethane	0.23		-[2]
styrene	0.57		-[2]
1,2,3,4-tetrachlorobenzene	0.023[6]		0.2[1,7]
1,2,3,5-tetrachlorobenzene	0.022		0.007[1]
1,2,4,5-tetrachlorobenzene	0.026		0.01[1]
1,1,2,2-tetrachloroethane	3.3		-[2]
tetrachloroethene	0.33		0.16[1]
tetrachloromethane	1.1		-[2]
toluene	0.73		1.4[1]
1,2,3-trichlorobenzene	0.064[8]		0.005[1,9]
1,2,4-trichlorobenzene	0.079		0.1[1]
1,3,5-trichlorobenzene	0.057		0.6[1]
1,1,1-trichloroethane	2.1		-[2]
1,1,2-trichloroethane	7.9		-[2]
trichloroethene	2.4		-[2]
trichloromethane	5.9		-[2]
vinylchloride	8.2		-[2]
2-xylene	0.40[10]		-[2]
3-xylene	0.33		-[2]
4-xylene	0.40		-[2]

1 indicative MPC based on the modified EPA method
2 no MPC can be calculated because no toxicity data are available
3 overall MPC for dichlorobenzenes: 0.25 mg/l
4 value calculated for 1,3-dichloropropene
5 overall MPC for monochlorotoluenes: 0.31 mg/l
6 overall MPC for tetrachlorobenzenes: 0.024 mg/l
7 overall MPC for tetrachlorobenzenes: 0.072 mg/kg
8 overall MPC for trichlorobenzenes: 0.067 mg/l
9 overall MPC for trichlorobenzenes: 0.24 mg/kg
10 overall MPC for xylenes: 0.38 mg/l

8. REFERENCES

1. Van der Kooij, L.A., Van de Meent, D., Van Leeuwen, C.J. and Bruggeman, W.A. (1991). Deriving quality criteria for water and sediment from the results of aquatic toxicity tests and product standards: Application of the equilibrium partitioning method. Wat. Res. **25**, 679-705.

2. Van de Meent, D., Aldenberg, T., Canton, J.H., Van Gestel, C.A.M. and Slooff, W. (1990). Desire for levels. Background study for the policy document "Setting environmental quality standards for water and soil". RIVM report No. 670101 002.

3. Van de Plassche, E.J. and De Bruijn, J.H.M. (1992). Towards integrated environmental quality objectives for surface water, ground water, sediment and soil for nine trace metals: an integration report. RIVM report. No. 679101 005.

4. Rademaker, B.C., Guinée, E.P. and Van de Plassche, E.J. (1993). The derivation of preliminary maximum permissible concentrations of volatile compounds in air. RIVM report No. 679101 009.

5. Könemann, H. (1981). Quantitative structure-activity relationships in fish toxicity studies. part 1: Relationship for 50 industrial pollutants. Toxicology **19**, 209-221.

6. Verhaar, H.J.M., and Hermens, J.L.M. (1991). Quantitative structure-activity relationships of environmental pollutants: an outline for application within hazard assessment of new and existing chemicals. RITOX, Utrecht.

7. Van Leeuwen, C.J., Van der Zandt, P.T.J., Aldenberg, T., Verhaar, H.J.M., and Hermens, J.L.M. (1992). Application of QSARs, extrapolation and equilibrium partitioning in aquatic effects assessment. I. Narcotic industrial pollutants. Environ. Toxicol. Chem. **11**, 267-282.

8. Hesse, J.M. et al. (1991) Appendix to report no. 710401 005. Integrated criteria document chlorobenzenes: effects. RIVM report.

9. Slooff, W., et al. (1992). RIVM guidance document. Ecotoxicological effect assessment: deriving Maximum Tolerable Concentrations (MTC) from single-species toxicity data. RIVM report No. 719102 018.

10. Bringmann, G., und Kühn, R. (1959). Vergleichende wasser-toxikologische Untersuchungen an Bakterien, Algen und Kleinkrebsen. Gesundheits-Ingenieur **80**, (4), 115-120.

11. Alexander, H.C., McCarty, W.M., and Bartlett, E.A. (1978). Toxicity of perchloroethylene, 1,1,1-trichloroethane, and methylene chloride to fathead minnows. Bull. Environ. Contam. Toxicol., **20**, 344-352.

12. Smith, A.D., Bharath, A., Mallard, C., Orr, D., Smith, K., Sutton, J.A., Vukmanich, J., McCarty, L.S., and Ozburn, G.W. (1991). The acute and chronic toxicity of ten chlorinated organic compounds to the American flagfish (*Jordanella floridae*). Arch. Environ. Contam. Toxicol., **20**, 94-102.

13. Van Helmond, C.A.M. (1992). Acute and chronic toxicity data of some volatile substances to marine organisms. BKH Consulting Engineers.

14. Hamilton, M.A., Russo, R.C., and Thurston, R.V. (1977). Trimmed Spearman-Karber method of estimating median lethal concentrations in toxicity bioassays. Environ. Sci. Technol. **11**, 714-719 (correction: 1978, **12**, 417).

15. Van de Plassche, E.J., Polder, M.D., and Canton, J.H. (1992). Maximum permissible concentrations for water, sediment and soil derived from toxicity data for nine trce metals. RIVM report No. 679101 002.

16. Bringmann, G. und Kühn, R. (1977). Grenzwerte der Schadwirkung wassergefährdender Stoffe gegen Bakterien (*Pseudomonas putida*) und Grünalgen (*Scenedesmus quadricauda*) im Zellvermehrungstest. Z. f. Wasser- und Abwasserforschung **10**, (5), 161-166.

17. Aldenberg, T. and Slob, W. (1993) Confidence limits for hazardous concentrations based on logistically distributed NOEC toxicity data. Ecotox. Environ. Saf. **25**, 48-63.

18. Van Straalen, N.M., and Denneman, C.A.J. (1989). Ecotoxicological evaluation of soil quality criteria. Ecotox. Environ. Saf. **18**, 241-251.

19. D'Agostino, R.B. and Stephens, M.A. (1986). Goodness-of-fit techniques. M. Dekker Inc. New York.

20. Jonkers, D.A., and Everts, J.W. (1992). Seaworthy. Derivation of micropollutant risk levels for the North Sea and Wadden Sea. Publikatiereeks gebiedsgericht beleid. Zoetermeer.

21. Emans, H.J.B., Van de Plassche, E.J., and Canton, J.H. (accepted). Validation of some extrapolation methods for effects assessment. Environ. Toxicol. Chem.

22. Slooff, W., Bremmer, H.J., Hesse, J.M., and Matthijsen, A.J.C.M. (1991). Integrated criteria document chlorobenzenes. RIVM report No. 71040 015.

23. Van Gestel, C.A.M., and Ma, Wei-chun (1988). Toxicity and bioaccumulation of chlorophenols in earthworms, in relation to bioavailability in soil. Ecotox. Environ. Saf. **15**, 289-297.

24. Hulzebos, E.M., Adema, D.M.M., Dirven-van Breemen, E.M., Henzen, L., Van Dis, W.A., Herbold, H.A., Hoekstra, J.A., Baerselman, R., and Van Gestel, C.A.M. (1993). Phytotoxicity studies with *Lactuva sativa* in soil and nutrient solution. Environ. Toxicol. Chem.

25. Lay, J.P., Schauerte, W., and Klein, W. (1984). Effects of trichloroethylene on the population dynamics of phyto- and zooplankton in compartments of a natural pond. Environ. Pollut. Ser. A Ecol. Biol. **33**, 75-91.

26. Lay, J.P., Schauerte, W., Klein, W., and Korte, F. (1985). Long-term effects of 1,2,4-trichlorobenzene on freshwater plankton in an outdoor-model-ecosystem. Bull. Environ. Contam. Toxicol. **34**, 761-769.

27. Merlin, G., Thiebaud, H., Blake, G., Sembiring, S., and Alary, J. (1992). Mesocosms' and microcosms' utilization for ecotoxicity evaluation of dichloromethane, a chlorinated solvent. Chemosphere **24**, (1), 37-50.

28. Hoekstra, J.A., Vaal, M.A., and Notenboom, J. (1992). Sensitivity patterns of aquatic species to toxicants: a pilot study. RIVM report No. 719102 016.

Appendix 1. Literature search profiles for the collection of ecotoxicological data

compound	freshwater		saltwater		terrestrial	
	review	on-line	review	on-line	review	on-line
acrylonitril	14	1983	14	1983	14	1983
benzene			15	1990	8	1988
2-chloro-1,3-butadiene			16	1985	-	1980
3-chloropropene	3	1980	17	1983	-	1980
1,2-dichlorobenzene	7	-	18	1990	7	-
1,3-dichlorobenzene	7	-	18	1990	7	-
1,4-dichlorobenzene	7	-	18	1990	7	-
1,1-dichloroethane			19	1990	11	1986
1,2-dichloroethane	2	-	19	1990	-	1980
1,1-dichloroethene			-	1970	-	1980
1,2-dichloroethene			-	1970	-	1980
dichloromethane			20	1990	9	1987
1,2-dichloropropane	4	1979	21	1981	8	1988
1,3-dichloropropane			-	1970	-	1980
1,3-dichloropropene	4	1979	22	1990	8	1988
2,3-dichloropropene			22	1990	-	1980
ethylbenzene	1	1985	23	1990	-	1980
ethylene			-	1970	-	1980
ethylene oxide	24	1986	24	1986	24	1986
hexachlorobenzene	7	-	18	1990	7	-
hexachloroethane			-	1970	-	1980
monochlorobenzene	7	-	18	1990	7	-
2-monochlorotoluene	-	1970	25	1985	-	1980
3-monochlorotoluene	-	1970	25	1985	-	1980
4-monochlorotoluene	-	1970	25	1985	-	1980
pentachlorobenzene	7	-	18	1990	-	1980
pentachloroethane			-	1970	-	1980
styrene	6	1985	6	1985	6	1985
1,2,3,4-tetrachlorobenzene	7	-	18	1990	7	-
1,2,3,5-tetrachlorobenzene	7	-	18	1990	7	-
1,2,4,5-tetrachlorobenzene	7	-	18	1990	7	-
1,1,2,2-tetrachloroethane			26	1982	-	1980
tetrachloroethene	2	-	27	1990	8	1988
tetrachloromethane			28	1986	-	1980
toluene			29	1986	8	1988
1,2,3-trichlorobenzene	7	-	18	1990	7	-
1,2,4-trichlorobenzene	7	-	18	1990	7	-
1,3,5-trichlorobenzene	7	-	18	1990	7	-
1,1,1-trichloroethane	2	-	30	1990	-	1980
1,1,2-trichloroethane	-	1970	30	1990	-	1980
trichloroethene	2	-	31	1990	13	1984
trichloromethane	2	-	32	1986	10	1985
vinylchloride			33	1990	12	1984
2-xylene	5	1985	34	1985	-	1980
3-xylene	5	1985	34	1985	-	1980
4-xylene	5	1985	34	1985	-	1980

1 Task Force on Water Quality Guidelines of the Canadian Council of Resource and Environment Ministers (1987). Canadian water quality guidelines.
2 Bund/Länder-Arbeitskreis (1990). Qualitätsziele (BLAK QZ).
3 Internal RIVM review (1979).
4 EPA (1980). Ambient water quality criteria for dichloropropane and dichloropropene. US-EPA 440/5-80-043.
5 ECETOC (1986). Joint assessment of commodity chemicals no. 6: xylenes.
6 Van Apeldoorn, M.E., van der Heijden, C.A., van Leeuwen, F.X.R., Huldy, H.J., Besemer, A.C., Lanting, R.W., Jol, A., Heijna-Merkus, E., Bergshoeff, G., Venselaar, J., van der Most, P.F.J., de Vrijer, F., van der Plaat, J., Knaap, A.G.A.C., Huygen, C., Duiser J.A. and de Jong, P. (1986). Criteriadocument styreen. RIVM report No. 738513 003.
7 Hesse, J.M. et al. (1991) Appendix to report no. 710401 005. Integrated criteria document chlorobenzenes: effects. RIVM report
8 Denneman, C.A.J., van Gestel, C.A.M. (1990). Bodemverontreiniging en bodemecosystemen: voorstel voor C-(toetsings)waarden op basis van ecotoxicologische risico's. RIVM report No. 72501 001 (in Dutch).
9 Van Apeldoorn, M.E., Vermeire, T., van der Heijden, C.A., van Gestel, C.A.M., Heijna-Merkus, E., Knaap, A.G.A.C. and Krajnc, E.I. (1988). Appendix to Report nr. 758473 009 Integrated criteria document dichloromethane: Effects.
10 Gerlofsma, A., van der Heijden, C.A., Heijna-Merkus, E., Janssen, P.J.C.M., Knaap, A.G.A.C., van Leeuwen, F.X.R., Maas, R.J.M., Mennes, W.C., Ros, J.P.M., Bergshoeff, G., Besemer, A.C., Duiser, J.A., Huldy, H.J., Huijgen, C., de Jong, P., Lanting, R.W., van der Heijden, P.F.J., Most, E. and de Vrijer, F. (1986). Criteriadocument chloroform. Publikatiereeks Lucht No. 54.
11 IPCS (1987). Environmental health criteria 62, 1,1-dichloroethane. WHO, Genève.
12 Besemer, A.C., Hollander, J.C.T., Huldy, H.J., Laurier, M.B.H.M., Maas, R.J.M., and Mulder, H.C.M. (1984). Criteriadocument vinylchloride. Publikatiereeks Lucht No. 34.
13 IPCS (1985). Environmental health criteria 50, trichloroethene. WHO, Genève.
14 Besemer, A.C., Van Esch, G.J., Hollander, J.C.T., Huldy, H.J., Laurier, M.B.H.M., and Maas, R.J.M. (1984). Criteriadocument acrylonitril. Publikatiereeks Lucht No. 29.
15 EC Working Document: benzene (1991).
16 EC Working Document: 2-chloro-1,3-butadiene (1986).
17 EC Working Document: chloropropene (1983).
18 IPCS (1991). Environmental health criteria 128, chlorobenzenes, WHO, Genève.
19 EC Working Document: dichloroethane (1991).
20 EC Working Document: dichloromethane (1991).
21 EC Working Document: 1,2-dichloropropane (1982).
22 EC Working Document: dichloropropene (1991).
23 EC Working Document: ethylbenzene (1991).
24 Van Esch, G.J., van der Heijden, C.A., Heijna-Merkus, E., Knaap, A.G.A.C., Van Leeuwen, F.X.R., van der Plaat, J., Vermeire, T., Bergshoeff, G., Besemer, A.C., Duiser, J.A., Huldy, H.J., Huijgen, C., de Jong, P., Lanting, R.W., van der Most, P.F.J., and de Vrijer, F. (1986). Criteriadocument ethyleenoxide. Publikatiereeks Lucht No. 55.
25 EC Working Document: monochlorotoluene (1986).
26 EC Working Document: 1,1,2,2-tetrachloroethane (1983).
27 EC Working Document: tetrachloroethene (1991).
28 Gerlofsma, A., Heijna-Merkus, E., Huiskamp, R., Janssen, P.J.C.M., Knaap, A.G.A.C., Maas, R.J.M.,

Mennes, W.C., Ros, J.P.M., Speijers, G.J.A., Bergshoeff, G., Besemer, A.C., Duiser, J.A., Huldy, H.J., Huijgen, C., de Jong, P., Lanting, R.W., van der Most, P.F.J., and de Vrijer, F. (1986). Criteriadocument tetrachloormethaan. Publikatiereeks Lucht No. 58.

29 Slooff, W., and Blokzijl, P.J. (eds.) (1988). Integrated criteria document toluene. RIVM report No. 758473 010.

30 EC Working Document: trichloroethane (1991).

31 EC Working Document: trichloroethene (1991).

32 Gerlofsma, A., van der Heijden, C.A., Heijna-Merkus, E., Janssen, P.J.C.M., Knaap, A.G.A.C., van Leeuwen, F.X.R., Maas, R.J.M., Mennes, W.C., Ros, J.P.M., Bergshoeff, G., Besemer, A.C., Duiser, J.A., Huldy, H.J., Huijgen, C., de Jong, P., Lanting, R.W., van der Heijden, P.F.J., Most, E., de Vrijer, F. (1986). Criteriadocument chloroform. Publikatiereeks Lucht No. 54.

33 EC Working Document: chloroethene (1991).

34 EC Working Document: xylene (1986).

Appendix 2. Toxicity data for freshwater organisms

In this appendix toxicity data for freshwater organisms are presented in three different tables:
- table 2.1: acute data: L(E)C50 values,
- table 2.2: chronic data: NOEC values,
- table 2.3: data from deviating tests.

In tables 2.1 and 2.2 the data used for data set II (stringent selection with respect to maintenance of test concentration from tests carried out according to OECD guidelines) are printed bold.

Legenda:

A	+ Test substance analysed in test solution - Test substance not analysed in solution or : no data
test type	S: static; R: renewal; F: continuous flow c : closed system; d: daily
test water	a.m.: artificial medium; d.n.w.: dechlorinated natural water; DSW: dutch standard water; d.t.w.: dechlorinated tap water; d.w.: distilled water; n.w.: natural water; r.g.w.: reconstituted ground water with addition of some salts; r.n.w.: deionized reconstituted natural water; s.w.: double distilled water with 20 mg NaCl/l; tap: tap water
exp. time	exposure time: h: hour(s); d: day(s); w: week(s) m: months; min: minute(s)
> and ≥	value indicated is highest concentration used in the test
< and ≤	value indicated is lowest concentration used in the test
α	given value based on measured concentration

Content:

Acute toxicity (table 2.1):

Table 2.1.1 Acute toxicity of acrylonitrile to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
crustaceans										
Daphnia magna, < 24 h	-	S	≥80%	nw	7.4-9.4	160-186	48 h	LC50[a]	7.6	LeBlanc, 1980
	-	S	-	nw	7-8.2	90-180	48 h	EC50[b]	11	Randall & Knopp, 1908
fish										
Brachydanio rerio	-	S	>99%	-	7.2-7.8	-	96 h	LC50	25	Wellens, 1982
Lepomis macrochirus, 0.9 g, 3.7 cm	-	S	-	tap	-	31	96 h	LC50	24	Bailey et al., 1985
0.9 g, 3.7 cm	+	F	-	tap	-	31	96 h	LC50	**9.3**	Bailey et al., 1985
0.32-1.2 g	-	S	≥80%	nw	6.7-7.8	32-48	96 h	LC50	10	Buccafusco et al, 1981
2 g, 4.5 cm	-	S	-	-	7.4	20	96 h	LC50	12	Henderson et al., 1961
Pimephales promelas, 1.5 g, 6.5 cm	-	S	-	-	8.2	380	96 h	LC50	14	Henderson et al., 1961
	-	S	-	-	7.4	20	96 h	LC50	18	Henderson et al., 1961
	-	F	-	-	7.4	20	96 h	LC50	**10**	Henderson et al., 1961
Poecilia reticulata, 0.1 g, 2.5 cm	-	S	-	-	7.4	20	96 h	LC50	34	Henderson et al., 1961

a not clear if test vessels were closed
b immobility

Table 2.1.2 Acute toxicity of 3-chloropropene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
fish										
Carassius auratus, 2.3-4.3 g	+	S	-	tap	6-8	250	24 h	LC50[a]	**10**	Bridié et al., 1979
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	21	Pickering et al., 1966
Lebistes reticulatus 0.1-0.2g	-	S		a.m	7.5	soft	96 h	LC50	51	Pickering et al., 1966
Lepomis macrchirus, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	42	Pickering et al., 1966
Pimephales promelas, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	20	Pickering et al., 1966
amphibians										
Xenopus laevis, 3-4 w larvae	-	Sc	>98%	DSW	8-8.4	200	48 h	LC50	**0.34**	De Zwart & Slooff, 1987

a concentrations are determined before and after each test; which conc is presented was not mentioned by the author

Table 2.1.3 Acute toxicity of 1,2-dichloroethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
bacteria										
Photobacterium phosphoreum	-	S	>99%	s.w.	6.3-7.8	0	15 min	EC50[a]	**1100**	Hermens et al., 1985
Spirochaeta aurantia	-	S	-	a.m.	7	-	30 min	EC50[b]	840	Pill et al., 1991
green algae										
Haematococcus pluvialis	-	S					4 h	EC50[c]	130	Knie et al., 1983
crustaceans										
Daphnia magna, ≤24 h	+	Sc	95-99%	n.w.	7.1-7.7	44.7	48 h	EC50[d]	**160** α	Richter et al., 1983
≤24 h	-	S	≥80%	r.n.w	6.7-8.1	66-78	48 h	LC50[e]	220	LeBlanc, 1980
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[f]	540	Bringmann & Kühn, 1982
	-	S					48 h	EC50[f]	600	Knie et al., 1983
fish										
Leuciscus idus	-	S					96 h	LC50	1.8	Knie et al., 1983
Lepomis macrochirus	-	S	-	n.w.	7.6-7.9	55	96 h	LC50[g]	550	Dawson et al., 1975/77
0.32-1.2g	-	Sc	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	430	Buccafusco et al., 1981
Pimephales promelas, 31 d	+	F	99%	n.w.	7.4	44.8	96 h	LC50	**140** α	Brooke et al., 1985
30-35 d	+	F	-	n.w.	6.7-7.6	45.1	96 h	LC50	**120** α	Walbridge et al., 1983

a inhibition of bioluminescence
b growth
c O_2 production
d complete immobilisation; conc is average of initial and measured final conc.
e not clear if testvessels were closed
f immobility
g 1,1- or 1,2-dichloroethane unknown; mild aeration after the first 24 h; only 4 testconc's

Table 2.1.4 Acute toxicity of 1,2-dichloropropane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l	Reference
crustaceans										
Daphnia magna, <2 d	+	Sc	-	DSW	8-8.4	100	48 h	EC50[a]	**45**	Hermens et al., 1984
≤24 h	-	S	≥80%	r.n.w	7.4-9.4	160-186	48 h	LC50[b]	52	LeBlanc, 1980
fish										
Lepomis macrochirus	-	S	-	n.w.	7.6-7.9	55	96 h	LC50[c]	320	Dawson et al., 1975/77
0.32-1.2g	-	S	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	280	Buccafusco et al., 1981
Pimephales promelas, 31 d	+	F	99%	n.w.	7.5	45	96 h	LC50	**130** «	Brooke et al., 1985
30-35 d	+	F	-	n.w.	6.7-7.6	45.1	96 h	LC50	**140** «	Walbridge et al., 1983

a immobility; measured conc at least 70% of nominal, which is given
b not clear if testvessels were closed
c mild aeration after the first 24 h, only 3 testconc's

Table 2.1.5 Acute toxicity of 1,3-dichloropropene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l	Reference
crustaceans										
Daphnia magna, ≤24 hr	-	S	≥80%	r.n.w	7.4-9.4	160-186	48 h	LC50[a]	6.2	LeBlanc, 1980
fish										
Lepomis macrochirus 0.32-1.2g	-	Sc	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	**6.1**	Buccafusco et al., 1981

a not clear if testvessels were closed

Table 2.1.6 Acute toxicity of ethylbenzene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l		Reference
green algae											
Chlamydomonas angulosa	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**51**		Hutchinson et al., 1980
Chlorella vulgaris	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**63**		Hutchinson et al., 1980
Selenastrum capricornutum	+	Sc	-	-	-	-	72 h	EC50[b]	**4.6**	«	Galassi et al., 1988
crustaceans											
Daphnia magna, ≤24 h	+	Sc	-	-	-	-	24 h	EC50[c]	**2.2**	«	Galassi et al., 1988
≤24 h	-	S	≥80%	r.n.w	6.7-8.1	66-78	48 h	LC50[d]	75		LeBlanc, 1980
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[e]	180		Bringmann & Kühn, 1982
4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[e]	**2.1**		Abernethy et al., 1986
fish											
Carassius auratus, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	94		Pickering et al., 1966
Lebistes reticulatus 0.1-0.2g	-	S		a.m	7.5	soft	96 h	LC50	97		Pickering et al., 1966
Lepomis macrchirus, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	32		Pickering et al., 1966
0.32-1.2g	-	S	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	150		Buccafusco et al., 1981
Pimephales promelas, 1-2 g	-	S		a.m	8.2	hard	96 h	LC50	42		Pickering et al., 1966
Pimephales promelas, 34 d	-	F	99%	n.w.	7.4	45.6	96 h	LC50	**12**	«	Brooke et al., 1985
Poecilia reticulata	+	Rc	-	-	-	-	96 h	LC50[f]	**9.6**	«	Galassi et al., 1988
Salmo gairdneri	+	Rc	-	-	-	-	96 h	LC50[f]	**4.2**	«	Galassi et al., 1988

a $^{14}CO_2$ uptake
b biomass; test according to OECD guidelines 1981
c immobility; test according to OECD guidelines 1981
d not clear if testvessels were closed
e immobility
f renewal at 48 h; test according to OECD guidelines 1981

Table 2.1.7 Acute toxicity of ethylene oxide to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l	Reference
crustaceans										
Daphnia magna	-	S	-	tap	-	-	48 h	LC50	210	Conway, 1983
fish										
Pimephales promelas	-	S	-	tap	-	-	96 h	LC50	84	Conway, 1983

Table 2.1.8 Acute toxicity of 2-monochlorotoluene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
crustaceans										
Daphnia magna, <24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[a]	40	Bringmann & Kühn, 1982

a immobility

Table 2.1.9 Acute toxicity of 4-monochlorotoluene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
crustaceans										
Daphnia magna, <2 d	+	Sc	-	DSW	8-8.4	100	48 h	EC50[a]	**3.6**	Hermens et al., 1984

a immobility; measured conc at least 70% of nominal

Table 2.1.10 Acute toxicity of styrene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
crustaceans										
Daphnia magna, ≤24 hr	-	S	≥80%	r.n.w	7.4-9.4	160-186	48 h	LC50[a]	23	LeBlanc, 1980
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[b]	180	Bringmann & Kühn, 1982
fish										
Carassius auratus, 2.3-4.3 g	+	S	-	tap	6-8	250	24 h	LC50[c]	**26**	Bridié et al., 1979
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	65	Pickering et al., 1966
Lebistes reticulatus 0.1-0.2g	-	S		a.m	7.5	soft	96 h	LC50	75	Pickering et al., 1966
Lepomis macrchirus, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	25	Pickering et al., 1966
Leuciscus idus melanotus	-	S	-	tap	7-8	255	48 h	LC50[d]	**17**	Juhnke &Lüdemann, 1978
								LC50[e]	**66**	Juhnke &Lüdemann, 1978
Pimephales promelas, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	46	Pickering et al., 1966

a not clear if testvessels were closed or not
b immobility
c concentrations are determined before and after each test; which conc is presented was not mentioned by the author
d Juhnke
e Lüdemann

Table 2.1.11 Acute toxicity of tetrachloroethene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
crustaceans											
Daphnia magna, ≤24 h	+	Sc	95-99%	n.w.	7.1-7.7	44.7	48 h	EC50[a]	**8.5**	*	Richter et al., 1983
≤24 h	-	S	≥80%	r.n.w	6.7-8.1	66-78	48 h	LC50[b]	18		LeBlanc, 1980
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[c]	150		Bringmann & Kühn, 1982
Moina macrocopa, 5 d	-	S	-	a.m.	-	-	3 h	LC50	63		Yoshioka et al., 1986
fish											
Jordanella floridae, 2-4 m	+	F	-	d.n.w	6.6-7.3	46-50	96 h	LC50	**8.4**	*	Smith et al., 1991
Lepomis macrochirus 0.32-1.2g	-	S	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	13		Buccafusco et al., 1981
Oryzias latipes	-	S	-	a.m.	-	80	48 h	LC50	40		Yoshioka et al., 1986
Pimephales promelas, 31 d	+	F	99%	n.w.	7.3-7.7	42-45	96 h	LC50	**17**	*	Brooke et al., 1985
Pimephales promelas, adult	+	F	-	d.n.w	7.8-8.0	68	96 h	LC50	**18**	*	Alexander et al., 1978
Salmo gairdneri	+	F	-	n.w.	7.1	47	96 h	LC50	**4.9**	*	Shubat et al., 1982

a complete immobilisation; conc is average of initial and measured final conc.
b not clear if testvessels were closed
c immobility

Table 2.1.12 Acute toxicity of 1,1,1-trichloroethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
green algae											
Chlamydomonas angulosa	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**280**		Hutchinson et al., 1980
Chlorella vulgaris	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**150**		Hutchinson et al., 1980
bacteria											
Photobacterium phosphoreum	-	S	>99%	s.w.	6.3-7.8	0	15 min	EC50[b]	**8**		Hermens et al., 1985
Spirochaeta aurantia	-	S	-	a.m.	7	-	30 min	EC50[c]	410		Pill et al., 1991
crustaceans											
Daphnia magna, 4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[d]	**58**		Abernethy et al., 1986
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[e]	2400		Bringmann & Kühn, 1982
fish											
Lepomis macrochirus 0.32-1.2g	-	S	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	72		Buccafusco et al., 1981
Pimephales promelas, 31 d	+	F	99%	n.w.	7.7-8.0	43.8-46.4	96 h	LC50[f]	**48**	*	Brooke et al., 1985
Pimephales promelas, adult	+	F	-	d.n.w	7.8-8.0	68	96 h	LC50	**53**	*	Alexander et al., 1978

a $^{14}CO_2$ uptake
b inhibition of bioluminescence
c growth
d immobility
e immobility; unknown if 1,1,1-TCA or 1,1,2-TCA was tested
f average of 2 tests: 52.9 and 42.3

Table 2.1.13 Acute toxicity of 1,1,2-trichloroethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l		Reference
green algae											
Chlorella pyrenoidosa	+	SRF	≥98%	a.m.	±8	-	96 h	EC50[a]	**170**		Adema & Vink, 1981
molluscs											
Dreissena polymorpha, adult	+	SRF	≥98%	-	±8	hard	96 h	LC50[a]	**320**		Adema & Vink, 1981
Lymnaea stagnalis, young eggs	+	SRF	≥98%	-	±8	hard	96 h	LC50[a]	**170**		Adema & Vink, 1981
crustaceans											
Daphnia magna, ≤24 h	+	Sc	95-99%	n.w.	7.1-7.7	44.7	48 h	EC50[b]	**81**	«	Richter et al., 1983
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[c]	2400		Bringmann & Kühn, 1982
≤24 h	-	S	≥80%	r.n.w	7.4-9.4	160-186	48 h	LC50[d]	18		LeBlanc, 1980
≤24 h, 7 d	+	Sc	-	a.m.	7.9	100	48 h	LC50	**43**	«	Adema, 1978
fish											
Jordanella floridae, 2-4 m	+	F	-	d.n.w	6.6-7.3	46-50	96 h	LC50	**45**	«	Smith et al., 1991
Lepomis macrochirus 0.32-1.2g	-	Sc	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	**40**		Buccafusco et al., 1981
Pimephales promelas, 31 d	+	F	98%	n.w.	7.5	45.2	96 h	LC50	**82**	«	Brooke et al., 1985
Poecilia reticulata, young	+	SRF	≥98%	-	±8	hard	24 h	LC50[a]	**72**		Adema & Vink, 1981

a Chlorella: E = growth; only the averaged result of static, renewal and flow-through tests is given by the authors; measured conc's at least 70% of nominal conc's; NB: for Poecilia the 7 d LC50 is 70 mg/l

b complete immobilisation; conc is average of initial and measured final conc.

c immobility; unknown if 1,1,1-TCA or 1,1,2-TCA was tested

d not clear if testvessels were closed

Table 2.1.14 Acute toxicity of trichloroethene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
bacteria											
Photobacterium phosphoreum	-	S	>99%	s.w.	6.3-7.8	0	15 min	EC50[a]	**190**		Hermens et al., 1985
crustaceans											
Daphnia cucullata, 10-12 d	-	Sc	≥98%	a.m.	7.9	100	48 h	LC50	**57**		Canton & Adema, 1978
Daphnia magna, 4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[b]	**7.8**		Abernethy et al., 1986
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[b]	1300		Bringmann & Kühn, 1982
≤24 h	-	Sc	≥98%	a.m.	7.9	100	48 h	LC50	**65**		Canton & Adema, 1978
<2 d	+	Sc	-	DSW	8-8.4	100	48 h	EC50[c]	**21**		Hermens et al., 1984
≤24 h	-	S	≥80%	r.n.w	7.4-9.4	160-186	48 h	LC50	18		LeBlanc, 1980
Daphnia pulex, ≤24 h	-	Sc	≥98%	a.m.	7.9	100	48 h	LC50	**45**		Canton & Adema, 1978
Moina macrocopa, 5 d	-	S	-	a.m.	-	-	3 h	LC50	200		Yoshioka et al., 1986
insects											
Aedes aegypti, 3 instar	-	S	>98%	DSW			48 h	LC50	48		Slooff et al., 1983
Culex pipiens, 3 instar	-	S	>98%	DSW			48 h	LC50	55		Slooff et al., 1983
coelenterates											
Hydra oligactis, budless	-	S	>98%	DSW			48 h	LC50	75		Slooff et al., 1983
molluscs											
Lymnaea stagnalis, 3-4 w	-	S	>98%	DSW			48 h	LC50	56		Slooff et al., 1983
fish											
Brachydanio rerio	-	F	-	d.t.w	8	170	48 h	LC50	**60**		Slooff, 1979
Jordanella floridae, 2-4 m	+	F	-	d.n.w	6.6-7.3	46-50	96 h	LC50	**28**	*	Smith et al., 1991
Lepomis macrochirus 0.32-1.2g	-	Sc	≥80%	n.w.	6.7-7.8	32-48	96 h	LC50	45		Buccafusco et al., 1981
Oryzias latipes	-	S	-	a.m.	-	80	48 h	LC50	79		Yoshioka et al., 1986
4-5 w	-	S	>98%	DSW			48 h	LC50	270		Slooff et al., 1983
Pimephales promelas, adult	+	F	-	d.n.w	7.8-8.0	68	96 h	LC50	**41**	*	Alexander et al., 1978
31 d	+	F	98%	n.w.	7.45	45	96 h	LC50	**44**	*	Brooke et al., 1985
30-35 d	+	F	-	n.w.	6.7-7.6	45.1	96 h	LC50	**45**	*	Walbridge et al., 1983
3-4 w	-	S	>98%	DSW			48 h	LC50	47		Slooff et al., 1983
Salmo gairdneri, 5-8 w	-	S	>98%	tap			48 h	LC50	42		Slooff et al., 1983
amphibians											
Ambystoma mexicanum, 3-4 w after hatch	-	S	-	DSW	8-8.4	200	48 h	LC50	48		Slooff et al., 1980
Xenopus laevis, 3-4 w after hatch	-	S	-	DSW	8-8.4	200	48 h	LC50	45		Slooff et al., 1980

a inhibition of bioluminescence
b immobility
c immobility; measured conc at least 70% of nominal conc, which is given

Table 2.1.15 Acute toxicity of trichloromethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
green algae											
Chlamydomonas angulosa	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**380**		Hutchinson et al., 1980
Chlorella vulgaris	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**410**		Hutchinson et al., 1980
Haematococcus pluvialis	-	S					4 h	EC10[b]	440		Knie et al., 1983
crustaceans											
Daphnia magna, ≤24 h	-	S	≥80%	r.n.w	7.4-9.4	160-186	48 h	LC50[c]	29		LeBlanc, 1980
4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[d]	**79**		Abernethy et al., 1986
	-	S					48 h	EC50[d]	290		Knie et al., 1983
fish											
Brachydanio rerio	-	F	-	d.t.w	8	170	48 h	LC50	**100**		Slooff, 1979
Cyprinus carpio, eggs	+	S	-	n.w.	-	-	3-5 d	LC50[e]	**97**		Criteriadocument, 1986
Ictalurus punctatus	+	F	-	n.w.	-	-	96 h	LC50	**75**	α	Criteriadocument, 1986
Lepomis macrochirus	+	F	-	n.w.	-	-	96 h	LC50	**18**	α	Criteriadocument, 1986
Leuciscus idus	-	S					96 h	LC50	92		Knie et al., 1983
Micropterus salmoides	+	F	-	n.w.	-	-	96 h	LC50	**51**	α	Criteriadocument, 1986
Pimephales promelas, 10-15 d	-	Sc	>98%	n.w.	7.2-8.5	96-125	96 h	LC50	**130**		Mayes et al., 1983
30-35 d	-	Sc	>98%	n.w.	7.2-8.5	96-125	96 h	LC50	**170**		Mayes et al., 1983
60-100 d	-	Sc	>98%	n.w.	7.2-8.5	96-125	96 h	LC50	**100**		Mayes et al., 1983
Salmo gairdneri	+	F	-	n.w.	-	-	96 h	LC50	**18**	α	Criteriadocument, 1986

a $^{14}CO_2$ uptake
b O_2 production
c not clear if testessels were closed
d immobility
e exposure time: until hatching = 3-5 days

Table 2.1.16 Acute toxicity of 2-xylene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
bacteria											
Photobacterium phosphoreum	-	S	>99%	s.w.	6.3-7.8	0	15 min	EC50[a]	**9.2**		Hermens et al., 1985
green algae											
Selenastrum capricornutum	+	Sc	-	-	-	-	72 h	EC50[b]	**4.7**	«	Galassi et al., 1988
crustaceans											
Daphnia magna	+	Sc	-	-	-	-	24 h	EC50[c]	**1**	«	Galassi et al., 1988
≤24 h	+	F	-	n.w.	6.8-7.8	41-48	48 h	EC50[d]	**3.8**	«	Holcombe et al., 1987
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[e,f]	170		Bringmann & Kühn, 1982
4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[e]	**3.2**		Abernethy et al., 1986
insects											
Aedes aegypti, 4 instar	-	S					24 h	LC50[i]	1.6		Berry & Brammer, 1977
fish											
Brachydanio rerio	-	F	-	d.t.w	8	170	48 h	LC50[f]	**20**		Slooff, 1979
Carassius auratus, 2.3-4.3 g	+	S	-	tap	6-8	250	24 h	LC50[g]	**13**		Bridié et al., 1979
2.5 g	+	F	-	n.w.	6.8-7.8	41-48	96 h	LC50[d]	**16**	«	Holcombe et al., 1987
adult	+	F	>98%	d.t.w	6.7-7.3	80	96 h	LC50[f]	**17**	«	Brenniman et al., 1976
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	37		Pickering et al., 1966
Catostomus commersoni, 2.4 g	+	F	-	n.w.	6.8-7.8	41-48	96 h	LC50[d]	**16**	«	Holcombe et al., 1987
Lebistes reticulatus 0.1-0.2g	-	S		a.m	7.5	soft	96 h	LC50	35		Pickering et al., 1966
Lepomis macrochirus, 1.1 g	+	F	-	n.w.	6.8-7.8	41-48	96 h	LC50[d]	**16**	«	Holcombe et al., 1987
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	21		Pickering et al., 1966
Pimephales promelas, 0.3 g	+	F	-	n.w.	6.8-7.8	41-48	96 h	LC50[d]	**16**	«	Holcombe et al., 1987
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	27		Pickering et al., 1966
Poecilia reticulata	+	Rc	-	-	-	-	96 h	LC50[h]	**12**	«	Galassi et al., 1988
Salmo gairdneri	+	Rc	-	-	-	-	96 h	LC50[h]	**7.6**	«	Galassi et al., 1988
13.1 g	+	F	-	n.w.	6.8-7.8	41-48	96 h	LC50[d]	**8.1**	«	Holcombe et al., 1987
amphibians											
Xenopus laevis, 3-4 w larvae	-	Sc	>98%	DSW	8-8.4	200	48 h	LC50	**73**		De Zwart & Slooff, 1987

a inhibition of bioluminescence
b biomass; test according to OECD guidelines 1981
c immobility; test according to OECD guidelines 1981
d Daphnia: E = immobility; simultaneous multiple species test: each species in a seperate compartment in exposure tank
e immobility
f 2-, 3- or 4- unknown
g concentrations are determined before and after each test; which conc is presented was not mentioned by the author
h renewal at 48 h; test according to OECD guidelines 1981
i mixture of 2-, 3- and 4-xylene

Table 2.1.17 Acute toxicity of 3-xylene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite- rion	Result mg/l	Reference
green algae										
Selenastrum capricornutum	+	Sc	-	-	-	-	72 h	EC50[a]	**4.9** α	Galassi et al., 1988
crustaceans										
Daphnia magna	+	Sc	-	-	-	-	24 h	EC50[b]	**4.7** α	Galassi et al., 1988
4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[c]	**9.6**	Abernethy et al., 1986
<2 d	+	Sc	-	DSW	8-8.4	100	48 h	EC50[d]	**14**	Hermens et al., 1984
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[c,e]	170	Bringmann & Kühn, 1982
insects										
Aedes aegypti, 4 instar	-	S					24 h	LC50[i]	1.6	Berry & Brammer, 1977
fish										
Brachydanio rerio	-	F	-	d.t.w	8	170	48 h	LC50[e]	**20**	Slooff, 1979
Carassius auratus, 2.3-4.3 g	+	S	-	tap	6-8	250	24 h	LC50[f]	**16**	Bridié et al., 1979
adult	+	F	>98%	d.t.w	6.7-7.3	80	96 h	LC50[e]	**17** α	Brenniman et al., 1976
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	37	Pickering et al., 1966
Lebistes reticulatus 0.1-0.2g	-	S		a.m	7.5	soft	96 h	LC50	35	Pickering et al., 1966
Lepomis macrchirus, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	21	Pickering et al., 1966
Pimephales promelas, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	27	Pickering et al., 1966
Poecilia reticulata	+	Rc	-	-	-	-	96 h	LC50[g]	**13** α	Galassi et al., 1988
Salmo gairdneri	+	Rc	-	-	-	-	96 h	LC50[g]	**8.4** α	Galassi et al., 1988

a biomass; test according to OECD guidelines 1981
b immobility; test according to OECD guidelines 1981
c immobility
d immobility; measured conc at least 70% of nominal, which is given
e 2-, 3- or 4- unknown
f concentrations are determined before and after each test; which conc is presented was not mentioned by the author
g renewal at 48 h; test according to OECD guidelines 1981
i mixture of 2-, 3- and 4-xylene

Table 2.1.18 Acute toxicity of 4-xylene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l	Reference
green algae										
Chlamydomonas angulosa	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**46**	Hutchinson et al., 1980
Chlorella vulgaris	-	Sc	-	a.m.	6.5	-	3 h	EC50[a]	**110**	Hutchinson et al., 1980
Selenastrum capricornutum	+	Sc	-	-	-	-	72 h	EC50[b]	**3.2** *	Galassi et al., 1988
crustaceans										
Daphnia magna	+	Sc	-	-	-	-	24 h	EC50[c]	**3.6** *	Galassi et al., 1988
4-6 d	-	Sc	≥97%	d.w.	6-7	-	48 h	EC50[c]	**8.5**	Abernethy et al., 1986
<24 h	-	S	-	a.m.	7.8-8.2	-	24 h	EC50[c,d]	170	Bringmann & Kühn, 1982
insects										
Aedes aegypti, 4 instar	-	S					24 h	LC50[f]	1.6	Berry & Brammer, 1977
fish										
Brachydanio rerio	-	F	-	d.t.w	8	170	48 h	LC50[d]	**20**	Slooff, 1979
Carassius auratus, 2.3-4.3 g	+	S	-	tap	6-8	250	24 h	LC50	**18**	Bridié et al., 1979
adult	+	F	>98%	d.t.w	6.7-7.3	80	96 h	LC50[d]	**17** *	Brenniman et al., 1976
1-2 g	-	S		a.m	7.5	soft	96 h	LC50	37	Pickering et al., 1966
Lebistes reticulatus 0.1-0.2g	-	S		a.m	7.5	soft	96 h	LC50	35	Pickering et al., 1966
Lepomis macrchirus, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	21	Pickering et al., 1966
Pimephales promelas, 1-2 g	-	S		a.m	7.5	soft	96 h	LC50	27	Pickering et al., 1966
34 d	+	F	99%	n.w.	7.4	45.1	96 h	LC50	**8.9** *	Brooke et al., 1985
Poecilia reticulata	+	Rc	-	-	-	-	96 h	LC50[e]	**8.8** *	Galassi et al., 1988
Salmo gairdneri	+	Rc	-	-	-	-	96 h	LC50[e]	**2.6** *	Galassi et al., 1988

a $^{14}CO_2$ uptake
b biomass; test according to OECD guidelines 1981
c immobility
d 2-, 3- or 4- unknown
e renewal at 48 h; test according to OECD guidelines 1981
f mixture of 2-, 3- and 4-xylene

Table 2.2.1 Chronic toxicity of 3-chloropropene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	**58**	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	4.1	Bringmann & Kühn, 1978
green algae										
Scenedesmus quadricauda	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	3.2	Bringmann & Kühn, 1978
protozoans										
Chilomonas paramecium	-	S	-	a.m.	6.9	-	48 h	NOEC[a]	4.3	Bringmann & Kühn, 1980b
Enthosiphon sulcatum	-	S	-	a.m.	6.9	76.5	72 h	NOEC[a]	4.2	Bringmann & Kühn, 1980

a growth; NOEC calculated as TGK/2

Table 2.2.2 Chronic toxicity of 1,2-dichloroethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	**68**	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	53	Bringmann & Kühn, 1978
green algae										
Scenedesmus quadricauda	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	360	Bringmann & Kühn, 1978
protozoans										
Chilomonas paramecium	-	S	-	a.m.	6.9	-	48 h	NOEC[a]	470	Bringmann & Kühn, 1980b
Enthosiphon sulcatum	-	S	-	a.m.	6.9	76.5	72 h	NOEC[a]	560	Bringmann & Kühn, 1980
Uronema parduczi	-	S	-	a.m.	6.9	-	20 h	NOEC[a]	530	Bringmann & Kühn, 1980a
crustaceans										
Daphnia magna, ≤24 h	+	Rc	95-99%	n.w.	6.6-7.9	44.7	28 d	NOEC[b]	**11** «	Richter et al., 1983
	+	Rc	95-99%	n.w.	6.6-7.9	44.7	28 d	NOEC[c]	**42** «	Richter et al., 1983
fish										
Pimephales promelas, just fert. eggs	+	F	98-99%	n.w.	7.4	45	32 d	NOEC[d]	**29** «	Benoit et al., 1982

a growth; NOEC calculated as TGK/2
b reproduction; renewal three times a week; conc is mean of measured new (at renewal) and old (just before renewal) values, during 28 d.
c lenght; see b
d growth (as weight)

Table 2.2.3 Chronic toxicity of 1,2-dichloropropane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
fish											
Pimephales promelas, 2-8 h	+	F	98-99%	n.w.	7.4	45	32 d	NOEC[a]	6	«	Benoit et al., 1982
ELS-test, eggs	+	F	98-99%	n.w.	7.4	45	32 d	NOEC[b]	11	«	Benoit et al., 1982

a growth (as weight)
b mortality

Table 2.2.4 Chronic toxicity of ethylbenzene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l		Reference
bacteria											
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	6		Bringmann & Kühn, 1980
blue algae											
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	17		Bringmann & Kühn, 1978
green algae											
Selenastrum capricornutum	+	Sc	-	a.m	7	-	8 d	NOEC[b]	1	«	Herman et al., 1990
protozoans											
Chilomonas paramecium	-	S	-	a.m.	6.9	-	48 h	NOEC[a]	470		Bringmann & Kühn, 1980b
Enthosiphon sulcatum	-	S	-	a.m.	6.9	76.5	72 h	NOEC[a]	70		Bringmann & Kühn, 1980

a growth; NOEC calculated as TGK/2
b growth

Table 2.2.5 Chronic toxicity of 2-monochlorotoluene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	**8**	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	16	Bringmann & Kühn, 1978
green algae										
Scenedesmus subspicatus	-	S	-	a.m.	7.7-9.3	-	48 h	NOEC[c]	29	Kühn & Pattard, 1990
crustaceans										
Daphnia magna, ≤24 h	+	Rc	-	a.m.	7.0-8.2	-	21 d	NOEC[b]	**0.21** «	Kühn et al., 1989

a growth; NOEC calculated as TGK/2
b reproduction rate and appearance of first offspring; NOEC is mean of lowest measured and nominal concentration; renewal on mo-we-fr
c biomass; NOEC calculated as TGK/2

Table 2.2.6 Chronic toxicity of 4-monochlorotoluene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Criterion	Result mg/l	Reference
crustaceans										
Daphnia magna, ≤24 h	+	Rc	-	DSW	8-8.4	100	21 d	NOEC[a]	**0.32**	De Wolf et al., 1988
≤24 h	+	Rc	-	DSW	8-8.4	100	21 d	NOEC[b]	**0.57**	De Wolf et al., 1988
<24 h	+	Rc	-	DSW	8-8.4	100	16 d	NOEC[b]	**0.32**	Hermens et al., 1984
fish										
Brachydanio rerio, 24 h eggs	+	R	99%	r.g.w	7.4-8.4	210	28 d	NOEC[c]	**1.9** «	Van Leeuwen et al., 1990

a growth; renewal 3 times a week; average measured conc ± 80% of nominal; NOEC given as nominal concentration
b reproduction; see c
c growth (as length) and hatch; renewal 3 times a week; conc's measured just before and after renewal: mean actual conc is given (60% of nominal)

Table 2.2.7 Chronic toxicity of styrene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	**36**	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	34	Bringmann & Kühn, 1978
protozans										
Uronema parduczi	-	S	-	a.m.	6.9	-	20 h	NOEC[a]	93	Bringmann & Kühn, 1980a

a growth; NOEC calculated as TGK/2

Table 2.2.8 Chronic toxicity of tetrachloroethene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
crustaceans										
Daphnia magna	+	Rc	95-99%	n.w.	6.6-7.9	44.7	28 d	NOEC[a]	**0.51** «	Richter et al., 1983
fish										
Jordanella floridae <24 h egg	+	F	-	d.n.w	6.6-7.3	46-50	15 d	NOEC[b]	**2** «	Smith et al., 1991
7 d fry	+	F	-	d.n.w	6.6-7.3	46-50	28 d	NOEC[b]	**2.3** «	Smith et al., 1991

a reproduction and length; renewal three times a week; concentration is mean of measured new (at renewal) and old (just before renewal) values.
b mortality

Table 2.2.9 Chronic toxicity of 1,1,1-trichloroethane to freshwater organisms

Organism	A	Test-type	Test sub. purity	Test-water	pH	Hardness mg $CaCO_3$/l	Exp.-time	Crite-rion	Result mg/l		Reference
bacteria											
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	47		Bringmann & Kühn, 1980
blue algae											
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	180		Bringmann & Kühn, 1978
green algae											
Scenedesmus quadricauda	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	220		Bringmann & Kühn, 1978
crustaceans											
Daphnia magna, ≤24 h	+	Rc	96%	a.m.	7.6-8.8	187	17 d	NOEC[b]	1.3	α	Thompson et al., 1989
≤24 h	+	Rc	-	a.m.	-	200	21 d	NOEC[c]	7.9	α	De Wolf et al., 1986
fish											
Cyprinus carpio, 0.79 g	+	F	96%	-	7.6-8.1	64-74	14 d	NOEC[d]	7.7	α	Thompson et al., 1989

a growth; NOEC calculated as TGK/2; 1,1,1- or 1,1,2- not recorded
b both reproduction and mortality; renewal every 2 days; conc is mean of measured new (at renewal) and old (just before renewal) values
c growth; measured conc 56% of nominal, NOEC is mean of measured and nominal conc; renewal three times a week
d weight

Table 2.2.10 Chronic toxicity of 1,1,2-trichloroethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite- rion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	**47**	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	180	Bringmann & Kühn, 1978
green algae										
Scenedesmus quadricauda	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	220	Bringmann & Kühn, 1978
molluscs										
Lymnaea stagnalis, young eggs	+	SRF	≥98%	-	±8	hard	16 d	NOEC[b]	**10**	Adema & Vink, 1981
crustaceans										
Daphnia magna, ≤24 h	+	Rc	95-99%	n.w.	6.6-7.9	44.7	28 d	NOEC[c]	**26** *	Richter et al., 1983
	+	Rc	95-99%	n.w.	6.6-7.9	44.7	28 d	NOEC[d]	**13** *	Richter et al., 1983
	+	Rc	-	a.m.	7.9	100	21 d	NOEC[e]	**18** *	Adema, 1978
	+	Rc	-	a.m.	7.9	100	21 d	NOEC[f]	**32** *	Adema, 1978
fish										
Jordanella floridae <24 h egg	+	F	-	d.n.w	6.6-7.3	46-50	15 d	NOEC[g]	**18** *	Smith et al., 1991
7 d fry	+	F	-	d.n.w	6.6-7.3	46-50	28 d	NOEC[g]	**29** *	Smith et al., 1991

a growth; NOEC calculated as TGK/2; 1,1,1- or 1,1,2- not recorded
b hatching and morphology; only the averaged result of static, renewal and flow-through tests is given by the authors; measured conc's at least 70% of nominal conc's
c reproduction; renewal three times a week; conc is mean of measured new (at renewal) and old (just before renewal) values
d length; see b
e reproduction; pH and oxygen measured, but not given; vessels 1 l and daily renewal, or 2.5 l and renewal three times a week
f mortality; see e
g mortality

Table 2.2.11 Chronic toxicity of trichloroethene to freshwater organisms

organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite- rion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	33	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	32	Bringmann & Kühn, 1978
green algae										
Selenastrum capricornutum	-	S	>98%	a.m.		220	96 h	NOEC[b]	180	Slooff et al, 1983
protozoans										
Enthosiphon sulcatum	-	S	-	a.m.	6.9	76.5	72 h	NOEC[a]	600	Bringmann & Kühn, 1980
fish										
Jordanella floridae <24 h egg	+	F	-	d.n.w	6.6-7.3	46-50	15 d	NOEC[c]	5.8 α	Smith et al., 1991
7 d fry	+	F	-	d.n.w	6.6-7.3	46-50	28 d	NOEC[c]	11 α	Smith et al., 1991

a growth; NOEC calculated as TGK/2
b growth
c mortality

Table 2.2.12 Chronic toxicity of trichloromethane to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
bacteria										
Pseudomonas putida	-	Sc	-	a.m.	7	76.5	16 h	NOEC[a]	**63**	Bringmann & Kühn, 1980
blue algae										
Microcystis aeruginosa	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	93	Bringmann & Kühn, 1978
green algae										
Scenedesmus quadricauda	-	S	-	a.m.	7	59.5	8 d	NOEC[a]	550	Bringmann & Kühn, 1978
Scenedesmus subspicatus	-	Sc	-	a.m.	7.7-9.3	-	48 h	NOEC[b]	**110**	Kühn & Pattard, 1990
crustaceans										
Daphnia magna, ≤24 h	+	Rc	-	DSW	8-8.4	100	21 d	NOEC[c]	**15**	De Wolf et al., 1988
≤24 h	+	Rc	-	a.m.	7.0-8.2	-	21 d	NOEC[d]	**9.7**	Kühn et al., 1989

a growth; NOEC calculated as TGK/2
b biomass; NOEC calculated as TGK/2
c reproduction; average measured conc ± 120% of nominal; NOEC given as nominal conc; renewal 3 times a week
d P-mortality, reproduction rate and appearance of first offspring; renewal three times a week; given NOEC-value is the mean of lowest measured and nominal concentration

Table 2.2.13 Chronic toxicity of 2-xylene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
green algae										
Chlorella vulgaris	-	S		a.m.			24 h	NOEC[a]	<25	Kauss et al., 1975
Selenastrum capricornutum	-	Sc		a.m.	7		[illegible]	NOEC[a]	[illegible]	[illegible] et al., [illegible]
protozoans										
Tetrahymena elliotti	-	Sc	99%	a.m.	-	-	24 h	NOEC[b]	**9**	Rogerson et al., 1983

a growth
b mortality; NOEC calculated from data as Toxicity Treshold/2; ($NOEC_{reprod}$<TT<$LOEC_{mort}$); toxicity curve very steep

Table 2.2.14 Chronic toxicity of 3-xylene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
green algae										
Selenastrum capricornutum	+	Sc	-	a.m	7	-	8 d	NOEC[a]	**0.7** α	Herman et al., 1990
protozoans										
Tetrahymena elliotti	-	Sc	99%	a.m.	-	-	24 h	NOEC[b]	**28**	Rogerson et al., 1983

a growth
b mortality; NOEC calculated from data as Toxicity Treshold/2; ($NOEC_{reprod}$<TT<$LOEC_{mort}$); toxicity curve very steep

Table 2.2.15 Chronic toxicity of 4-xylene to freshwater organisms

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
green algae										
Selenastrum capricornutum	+	Sc	-	a.m	7	-	8 d	NOEC[a]	**0.9** α	Herman et al., 1990
protozoans										
Tetrahymena elliotti	-	Sc	98.5%	a.m.	-	-	24 h	NOEC[b]	**9**	Rogerson et al., 1983

a growth
b mortality; NOEC calculated from data as Toxicity Treshold/2; ($NOEC_{reprod}$<TT<$LOEC_{mort}$); toxicity curve very steep

Table 2.3 Toxicity to freshwater organisms: values from deviating tests

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite- rion	Result mg/l	Reference
acrylonitrile										
fish										
Brachydanio rerio	-	Fc	-	tap	7.8-8.2	180	48 h	LC50	15	Slooff, 1979
Leuciscus idus melanotus	-	S	-	-	-	-	48 h	LC50	13	(Juhnke &) Lüdemann, 1978
	-	S	-	-	-	-	48 h	LC50	28	Juhnke (& Lüdemann), 1978
Oryzias latipes, 0.2 g, 2 cm	-	S	>99%	dw	-	-	48 h	LC50	32	Tonogai et al., 1982
Pimephales promelas, 1.5 g, 6.5 cm	-	F	-	-	7.4	20	30 d	LC50	2.6	Henderson et al., 1961
3-chloropropene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	>99%	a.m.	-	25	14 d	LC50	1.2	Hermens, 1983
1,2-dichloropropane										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	120	Könemann, 1981
dichloropropene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	>75%	a.m.	-	25	14 d	LC50	0.51	Hermens, 1983
1,2-dichloroethane										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	110	Könemann, 1981
ethylene oxide										
fish										
Carassius auratus, 3.3 g, 6.2 g	-	S	-	tap	7.8	280	24 h	LC50	90	Bridie et al., 1979
2-, 3-, and 4-monochlorotoluene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50[b]	18	Könemann, 1981

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
1,1,1-trichloroethane										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	130	Könemann, 1981
1,1,2-trichloroethane										
molluscs										
Dreissena polymorpha, adult	+	SRF	≥98%	-	±8	hard	14 d	LC50[a]	140	Adema & Vink, 1981
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	94	Könemann, 1981
young	+	SRF	≥98%	-	±8	hard	7 d	LC50[a]	70	Adema & Vink, 1981
trichloroethene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	55	Könemann, 1981
tetrachloroethene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	18	Könemann, 1981
trichloromethane										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	14 d	LC50	100	Könemann, 1981
amphibians										
Hyla crucifer, eggs, 2-6 h	+	F	-	a.m.	7.6	107	7 d	LC50	0.3	Birge et al., 1980
Rana pipiens, eggs, 0.5 h	+	F	-	a.m.	7.6	107	9 d	LC50	4.2	Birge et al., 1980
Rana palustris eggs, 2-6 h	+	F	-	a.m.	7.6	107	8 d	LC50	21	Birge et al., 1980
Bufo fowleri, eggs, 2-6 h	+	F	-	a.m.	7.6	107	7 d	LC50	35	Birge et al., 1980

Organism	A	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result mg/l	Reference
2-xylene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	35	Könemann, 1981
3-xylene										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	14 d	LC50	38	Könemann, 1981
4-xylene										
fish										
Poecilia reticulata, 2-3 m	-	Rdc	-	a.m.	-	25	7 d	LC50	35	Könemann, 1981
	-	Rdc	-	a.m.	-	25	14 d	LC50[c]	5.9	Könemann, 1979

a only the averaged result of static, renewal and flow-through tests is given by the authors; measured conc's at least 70% of nominal conc's
b 3-monochlorotoluene
c 4-monochlorotoluene

References

Abernethy, S., Bobra, A.M., Shiu, W.Y., Wells, P.G. and Mackay, D. (1986). Acute lethal toxicity of hydrocarbons and chlorinated hydrocarbons to two planktonic crustaceans: the key role of organism-water partitioning. Aquat. Toxicol. **8**, 163-174.

Adema, D.M.M. (1978). Daphnia magna as a test animal in acute and chronic toxicity tests. Hydrobiologia **59**, (2), 125-134.

Adema, D.M.M. and Vink, G.J. (1981). A comparative study of the toxicity of 1,1,2-trichloroethane, dieldrin, pentachlorophenol and 3,4 dichloroaniline for marine and fresh water organisms. Chemosphere **10**, (6), 533-554.

Alexander, H.C., McCarty, W.M. and Bartlett, E.A. (1978). Toxicity of perchloroethylene, trichloroethylene, 1,1,1-trichloroethane, and methylene chloride to fathead minnows. Bull. Environ. Contam. Toxicol. **20**, 344-352.

Baily, Liu, and Javitz (1985). Time/toxicity relationships in short-term static, dynamic, and plug-flow bioassays. ASTM 891, 193-212.

Benoit, D.A., Puglisi, F.A. and Olson, D.L. (1982). A fathead minnow Pimephales promelas early life stage toxicity test method evaluation and exposure to four organic chemicals. Environ. Pollut. Ser. A Ecol. Biol. **28**, 189-197.

Berry, W.O. and Brammer, J.D. (1977). Toxicity of water-soluble gasoline fractions to fourth-instar larvae of the mosquito Aedes aegypti L. Environ. Pollut. **13**, 229-234.

Brenniman, G., Hartung, R. and Weber Jr., W.J. (1976). A continuous flow bioassay method to evaluate the effects of outboard motor exhausts and selected aromatic toxicants on fish. Water Res. **10**, 165-169.

Bridié, A.L., Wolff, C.J.M. and Winter, M. (1979). The acute toxicity of some petrochemicals to goldfish. Water Res. **13**, 623-626.

Bringmann, G. and Kühn, R. (1978). Testing of substances for their toxicity treshold: Model organisms Microcystis (Diplocystis) aeruginosa and Scenedesmus quadricauda. Mitt. Internat. Verein. Limnol. **21**, 275-284.

Bringmann, G. and Kühn, R. (1980). Comparison of the toxicity tresholds of water pollutants to bacteria, algae, and protozoa in the cell multiplication inhibition test. Water Res. **14**, 2[illegible]1-241.

Bringmann, G. and Kühn, R. (1980a). Bestimmung der biologischen Schadwirkung wassergefährdender Stoffe gegen Protozoen II. Bakterienfressende Ciliaten. Z. f. Wasser- und Abwasser-Forschung **13**, (1), 26-31.

Bringmann, G. and Kühn, R. (1980b). Bestimmung der biologischen Schadwirkung wassergefährdender Stoffe gegen Protozoen III. Saprozoische Flagellaten. Z. f. Wasser- und Abwasser-Forschung **13**, (5), 170-173.

Bringmann, G. and Kühn, R. (1982). Ergebnisse der Schadwirkung wassergefährdender Stoffe gegen Daphnia magna in einem weiterentwickelten standardisierten Testverfahren. Z. f. Wasser- und Abwasser-Forschung **15**, (1), 1-6.

Brooke, L.T., Call, D.J., Geiger, D.L., Northcott, C.E., Poirrier, S.H. (eds) (1985). Acute toxicities of organic chemicals to fathead minnows (Pimephales promelas), vol I, II and III. Center for Lake Superior Environmental Studies, University of Wisconsin-Superior.

Buccafusco, R.J., Ells, S.J., and LeBlanc, G.A. (1981). Acute toxicity of priority pollutants to bluegill (Lepomis macrochirus). Bull. Environ. Contam. Toxicol. **26**, 446-452.

Canton, J.H. and Adema, D.M.M. (1978). Reproducability of short-term and reproduction toxicity experiments with Daphnia magna and comparison of the sensitivity of Daphnia magna with Daphnia pulex and Daphnia cucullata in short-term experiments. Hydrobiologia **59**, (2), 135-140.

Conway, R.A., Waggy, G.T., Spiegel, M.H., and Berglund, R.L. (1983). Environmental fate and effects of ethylene oxide. Environ. Sci. Technol. **17**, (2), 107-112.

Criteriadocument Chloroform (1986). RIVM report No. 738513 004.

Dawson, G.W., Jennings, A.J., Drozdowski, D. and Rider, E. (1975/1977). The acute toxicity of 47 industrial chemicals to fresh and saltwater fishes. Journal of Hazardous Materials **1**, 303-318

Galassi, S., Mingazzini, M., Viganò, L. Cesareo, D. and Tosato, M.L. (1988). Approaches to modeling toxic responses of aquatic organisms to aromatic hydrocarbons. Ecotoxicol. Environ. Saf. **16**, 158-169.

Henderson, C., Pickering, Q.H., and Lemke, A.E. (1961). The effect of some organic cyanides (nitriles) on fish. Proc. 15th Industrial Waste Conf. Purdue University, 45, 120-130.

Herman, D.C., Inniss, W.E. and Mayfield, C.I. (1990). Impact of volatile aromatic hydrocarbons, alone and in combination, on growth of the freshwater alga Selenastrum capricornutum. Aquat. Toxicol. **18**, (2), 87-100.

Hermens, J.L.M. (1983). Quantitative structure toxicity relationships and mixture toxicity studies of aquatic pollutants. Thesis, State University Utrecht, The Netherlands.

Hermens, J., Canton, H., Janssen, P. and Jong, R. de (1984). Quantitative structure-activity relationships and toxicity studies of mixtures of chemicals with anaesthetic potency: acute lethal and sublethal toxicity to Daphnia magna. Aquat. Toxicol. **5**, 143-154.

Hermens, J., Busser, F., Leeuwangh, P. and Musch, A. (1985). Quantitative structure-activity relationships and mixture toxicity of organic chemicals in Photobacterium phosphoreum: the Microtox test. Ecotoxicol. Environ. Saf. **9**, 17-25.

Holcombe, G.W., Phipps, G.L., Sulaiman, A.H. and Hoffman, A.D. (1987). Simultaneous multiple species testing: acute toxicity of 13 chemicals to 12 diverse freshwater amphibians, fish, and invertebrate families. Arch. Environ. Contam. Toxicol. **16**, 697-710.

Hutchinson, T.C., Hellebust, J.A., Tam, D., Mackay, D., Mascarenhas, R.A. and Shiu, W.Y. (1980). The correlation of the toxicity to algae of hydrocarbons and halogenated hydrocarbons with their physical-chemical properties. In: Hydrocarbons and halogenated hydrocarbons in the aquatic environment. Afghan, B.K. and Mackay, D. (eds), Plenum Press, New York, 577-586.

Juhnke, I. and Lüdemann, D. (1978). Ergebnisse der Untersuchung von 200 chemischen Verbindungen auf akute Fischtoxizität mit dem Goldorfentest. Z. f. Wasser- und Abwasser-Forschung **11**, (5), 161-164.

Kauss, P.B. and Hutchinson, T.C. (1975). The effects of water-soluble petroleum components on the growth of Chlorella vulgaris Beijerinck. Environ. Pollut. **9**, 157-174.

Knie, J., Hälke, A., Juhnke, I. and Schiller, W. (1983). Ergebnisse der Untersuchungen von chemischen Stoffen mit vier Biotests. Deutsche Gewässerkundliche Mitteilungen **27**, (3), 77-79.

Könemann, H. (1981). Quantitative structure-activity relationships in fish toxicity studies. Toxicology **19**, 209-221.

Kühn, R. and Pattard, M. (1990). Results of the harmfull effects of water pollutants to green algae (Scenedesmus subspicatus) in the cell multiplication inhibition test. Water Res. **24**, (1), 31-38.

Kühn, R., Pattard, M., Pernak, K. and Winter, A. (1989). Results of the harmful effects of water pollutants to Daphnia magna in the 21 day reproduction test. Water Res. **23**, (4), 501-510.

LeBlanc, G.A. (1980). Acute toxicity of priority pollutants to water flea (Daphnia magna) Bull. Environ. Contam. Toxicol. **24**, 684-691.

Leeuwen, C.J. van, Adema, D.M.M. and Hermens, J. (1990). Quantitative structure-activity relationships for fish early life stage toxicity. Aquat. Toxicol. **16**, 321-334.

Loekle, D.M., Schecter, A.J. and Christian, J.J. (1983). Effects of chloroform, tetrachloroethylene, and trichloroethylene on survival, growth, and liver of Poecilia sphenops. Bull. Environm. Contam. Toxicol. **30**, 199-205.

Mayes, M.A., Alexander, H.C. and Dill D.C. (1983). A study to assess the influence of age on the response of fathead minnows in static acute toxicity tests. Bull. Environ. Contam. Toxicol. **31**, 139-147.

Pickering, Q.H. and Henderson, C. (1966). Acute toxicity of some important petrochemicals to fish. J. Water Poll. Control Fed. **38**, (9), 1419-1429.

Randall, T.L., and Knopp, P.V. (1980). Detoxification of specific organic substances by wet oxidation. J. Water Poll. Control Fed. **52**, 2117-2130.

Richter, J.E., Peterson, S.F. and Kleiner, C.F. (1983). Acute and chronic toxicity of some chlorinated benzenes, chlorinated ethanes, and tetrachloroethylene to Daphnia magna. Arch. Environ. Contam. Toxicol. **12**, 679-684.

Rogerson, A., Shiu, W.Y., Huang, G.L., Mackay, D. and Berger, J. (1983). Determination and interpretation of hydrocarbon toxicity to ciliate protozoa. Aquat. Toxicol. **3**, 215-228.

Shubat, P.J., Poirier, S.H., Knuth, M.L. and Brooke, L.T. (1982). Acute toxicity of tetrachloroethylene and tetrachloroethylene with dimethylformamide to rainbow trout (Salmo gairdneri). Bull. Environ. Contam. Toxicol. **28**, 7-10.

Slooff, W. (1979). Detection limits of a biological monitoring system based on fish respiration. Bull. Environ. Contam. Toxicol. **23**, 517-523.

Slooff, W., Canton, J.H. and Hermens, J.L.M. (1983). Comparison of the susceptibility of 22 freshwater species to 15 chemical compounds. I (sub)acute toxicity tests. Aquatic Toxicol. **4**, 113-128.

Smith, A.D., Bharath, A., Mallard, C., Orr, D., Smith, K., Sutton, J.A., Vukmanich, J., McCarty, L.S. and Ozburn, G.W. (1991). The acute and chronic toxicity of ten chlorinated organic compounds to the American flagfish (Jordanella floridae). Arch. Environ. Contam. Toxicol. **20**, 94-102.

Thompson, R.S. and Carmichael, N.G. (1989). 1,1,1-Trichloroethane: medium-term toxicity to carp, daphnids and higher plants. Ecotoxicol. Environ. Saf. **17**, 172-182.

Tonogai, Y., Ogawa, S., Ito, Y., and Iwaida, M. (1982). Acute survey on TLM (median tolerance limit) values of environmental pollutants, especially on amines, nitriles, aromatic nitrogen compounds. J. Toxicol. Sci. **7**, (3), 193-203.

U.S. Environmental Protection Agency (1983). Health assessment document for tetrachloroethylene (perchloroethylene) N.B. External Review Draft.

Walbridge, C.T., Fiandt, J.T. Phipps, G.L. and Holcombe, G.W. (1983). Acute toxicity of ten chlorinated aliphatic hydrocarbons to the fathead minnow (Pimephales promelas). Arch. Environ. Contam. Toxicol. **12**, 661-666.

Wellens, H. (1982). Vergleich der Empfindlichkeit von Brachydanio rerio und Leuciscus idus bei der Untersuchung der Fischtoxizität von chemischen Verbindungen und Abwässern. Z. Wasser Abwasser Forsch. **15**, (2), 49-52.

Wolf, W. De, Canton, J.H., Deneer, J.W., Wegman, R.C.C. and Hermens, J.L.M. (1988). Quantitative structure-activity relationships and mixture-toxicity studies of alcohols and chlorohydrocarbons: reproducibility of effects on growth and reproduction of Daphnia magna. Aquat. Toxicol. **12**, 39-49.

Yoshioka, Y., Ose, Y. and Sato, T. (1985). Testing for the toxicity of chemicals with Tetrahymena pyriformis. The Sci. of Total Environm. **43**, 149-157.

Yoshioka, Y., Ose, Y. and Sato, T. (1986). Correlation of the five test methods to assess chemical toxicity and relation to physical properties. Ecotoxicol. Environ. Saf. **12**, 15-21.

Zwart, D de. and Slooff, W. (1987). Toxicity of mixtures of heavy metals and petrochemicals to Xenopus laevis. Bull. Environ. Contam. Toxicol. **38**, 345-351.

References: evaluated but rejected

Birge, W.J., Black, J.A. and Bruser, D.M. (1979). Toxicity of organic chemicals to embryo-larval stages of fish. US-EPA 560/11-79-007.

Blum, D.J.W., and Speece, R.E. (1991). A database of chemical toxicity to environmental bacteria and its use in interspecies comparisons and correlations. Res. J. Water Pollut. Control Fed. **63**, (3), 198-207.

Bringmann, G. and Kühn, R. (1977). Befunde der Schadwirkung wassergefährdender Stoffe gegen Daphnia magna. Z. f. Wasser- und Abwasser-Forschung **10**, (5), 161-166.

Bringmann, G. and Kühn, R. (1978). Bestimmung der biologischen Schadwirkung wassergefähr-dender Stoffe gegen Protozoen I. Bakterienfressende Flagellaten (Modellorganismus: Entosiphon sulcatum Stein). Z. f. Wasser- und Abwasser-Forschung **11**, (6), 210-215.

Bringmann, G. and Kühn, R. (1979). Vergleich der toxischen Grenzkonzentrationen wassergefährdender Stoffe gegen Bakterien, Algen und Protozoen im Zellvermehrungshemmtest. Haustechnik - Bauphysik - Umwelttechnik gi **100**, 249-252.

Call, D.J., Brooke, L.T., Knuth, M.L., Poirier, S.H. and Hoglund, M.D. (1985). Fish subchronic toxicity prediction model for industrial organic chemicals that produce narcosis. Environ. Toxicol. Chem. **4**, 335-341.

Erben, R. (1978). Effects of some petrochemical products on the survival of Dicranophorus forcipatus O.F. Müller (Rotatoria) under laboratory conditions. Verh. Internat. Verein. Limnol. **20**, 1988-1991.

Grbic, D. and Munjko, I. (1977). Growth and changes of Streptomycetes in media with arylalkenes. Biologia (Bratislava) **32**, (3), 179-186.

Hall, L.W., Maynard, E.L. and Kier, L.B. (1989). Structure-activity relationship studies on the toxicities of benzene derivates: III. Predictions and extension to new substituents. Environ. Toxicol. Chem. **8**, 431-436.

Hall, L.W., Maynard, E.L. and Kier, L.B. (1989). QSAR investigation of benzene toxicity to fathead minnow using molecular connectivity. Environ. Toxicol. Chem. **8**, 783-788.

Jackson, S., and Brown, V.M. (1970). Effects of toxic wastes on treatment processes and watercourses. Water Pollut. Contr. **69**, 392-313.

Kamlet, M.J., et al., (1987). Solubility properties in polymers and biological media. Environ. Sci. Technol. **21**, (2), 149-155.

Munjko, I. and Grbic, D. (1977). Influence of styrene and alpha-methylstyrene upon algae and moulds. Biologia (Bratislava) **32**, (3), 173-177.

Paulet G., and Vidal, M. (1975). De la toxicité de quelques esters acryliques et méthacryliques de l'acrylamide et des polyacrylamides. Arch. Mal. Prof. Med. Trav. Secur. Soc. **36**, 58-60.

Slooff, W. and Baerselman, R. (1980). Comparison of the usefullness of the Mexican axolotl (Ambystoma mexicanum) and the clawed toad (Xenopus laevis) in toxicological bioassays. Bull. Environ. Contam. Toxicol. **24**, 439-443.

Veith, G.D., Call, D.J. and Brooke, L.T. (1983). Estimating the acute toxicity of narcotic industrial chemicals to fathead minnows. In: Aquatic toxicology and hazard assessment: 6th symp., Bishop, W.E., Cardwell, R.D. and Heidolph, B.B. (eds).

Walsh, D.F., Armstrong, J.G., Bartley, T.R., Salmon, H.A. and Frank, P.A. (1977). Residues of emulsified xylene in aquatic weed control and their impact on rainbow trout. Nat. Techn. Inform. Serv.

PB-267270.

Appendix 3: Toxicity data for saltwater organisms

In this appendix toxicity data for saltwater organisms are presented in three different tables:
- table 3.1: acute data: L(E)C50 values,
- table 3.2: chronic data: NOEC values,
- table 3.3: data from deviating tests.

In tables 3.1 and 3.2 the data used for data set II (stringent selection with respect to maintenance of test concentration from tests carried out according to OECD guidelines) are printed in bold.

Legenda:

analysed	N not analysed Y yes (analysed)
test type	S: static; SS: semi-static; IF: intermittent flow; CF: continuous flow
test water	SW: seawater; FS: filtered seawater; ES: enriched seawater; SA: salt water; AS: artificial seawater; AM: artificial medium
exp. time	exposure time: h: hour(s); d: day(s); w: week(s)
-	no information presented in literature
$t^{1/2}$	half-life (h)

Content:

Table 3.1.1 Acute toxicity of to acrylonitrile marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
annelides												
Ophryotrocha diadema	N	S	-	FS	-	21	-	32	48 h	LC50	67.5[1]; 2[2]	Parker, 1984
fish												
Lagodon rhomboides (57-113 mm)	N	S	-	SW	-	13.7-20.4	aerated	-	24 h	LC50	24.5[1]; 5[3]	Daugherty, 1951

[1] result from reference
[2] recalculation: concentration after 24 h, presumed t½ = 5 h
[3] recalculation: concentration after 12 h, presumed t½ = 5 h

Table 3.1.2 Acute toxicity of benzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Dunaliella biocula	N	S[1]	-	ES	-	-	-	-	4 h	EC50[2]	**180**[3]	Jensen, 1984
crustaceans												
Artemia salina (nauplii)	N	S[4]	-	AS	-	24.5	-	-	24 h	LC50	**66**[5]; 13[6]	Price, 1974
Artemia sp. (nauplii)	N	S[7]	≥ 97%	SW	-	20	≥ 5-9[8]	30	24 h	LC50	**127**	Abernethy, 1986
Cancer magister (larva)	N[9]	SS[10]	-	SW	-	13	-	30	96 h	LC50	**108**[11]; 84[12]	Caldwell, 1976
Crangon franciscorum (adult)	Y[13]	S	> 99%	SW	-	16	-	25	96 h	LC50	**20**	Benville, 1977
Palaemonetes pugio (larva)	Y	S	high	AS	8.1	21	> 5	15	96 h	LC50	**27.0**	Tatem, 1978
Palaemonetes pugio (larva)	-	S	-	-	-	20	-	15	24 h	LC50	90.8	Persoone, 1982[14]
Palaemonetes pugio (larva)	-	S	-	-	-	20	-	25	24 h	LC50	74.4	Persoone, 1982[14]
Palaemonetes pugio (adult)	-	S	-	-	-	20	-	15	24 h	LC50	38.0	Persoone, 1982[14]
Palaemonetes pugio (adult)	-	S	-	-	-	20	-	25	24 h	LC50	33.5	Persoone, 1982[14]
Palaemonetes pugio (adult)	-	S	-	-	-	24	-	-	48 h	LC50	33	Tatem, 1973
Scylla serrata (juvenile)	N	S	-	SW	7.6-8	27-29	6.3-8	30-31	96 h	LC50	**380**[5]; 0.5[15]	Kulkarni, 1983
molluscs												
Crassostrea gigas (larva)	-	S	-	-	-	-	-	-	48 h	LC50	924	Persoone, 1982[16]
Tapes semidecussata	Y[17]	CF[18]	-	FS	7.2	13.5-15.2	5.4-5.6	30	96 h	LC50	165[19,20]	Nunes, 1978
fish												
Clupea harengus (eggs)	Y[21]	S	-	FS	-	14.2	-	24	96 h	LC50	**20**[22]	Struhsaker, 1974
Clupea harengus (larva)	Y[21]	S	-	FS	7.9	12.9	7.0	22	48 h	LC50	**10**[22]	Struhsaker, 1974
Engraulis mordax (egg/larva)	Y[21]	S	-		7.9	17.6	7.3	30	8 h	LC50	**11**[22]	Struhsaker, 1974

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Morone saxatilis (juvenile)	Y[13]	S	> 99%	SW	-	16	-	25	96 h	LC50	**5.8**	Benville, 1977
Morone saxatilis (juvenile, 1.5 g; 52 mm)	Y[23]	CF	-	FS	7.7	17.4	7.7	29	72-96 h	LC50	**9.6**	Meyerhoff, 1975
Oncorhynchus kisutch (juvenile)	N	S[24]	-	AS	8.1	8	65-80% sat.[25]	30	96 h	LC50	40[26];0.1[17]	Morrow, 1975

1 closed with glass stoppers
2 effect: reduction of photosynthesis
3 extrapolation form graph
4 loosely capped
5 result from reference
6 recalculation: concentration after 12 h, presumed t½ = 5 h
7 closed with teflon-lined screw caps; no air space
8 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
9 concentrations declined by 25-50% in 24 h
10 renewal at 24-h intervals
11 result from reference; based on initial concentration
12 recalculation based on notes 9 and 10: t½ = 33 h, concentration after 12 h is presented
13 analysed at 0, 24, 48, 72 and 96 h
14 original reference, Potera 1975, not checked
15 recalculation: concentration after 48 h, presumed t½ = 5 h
16 original reference, LeGore 1974, not checked
17 analysed several times daily
18 reported that benzene concentration decreased
19 based on mean of measured concentrations
20 90% mortality in duplo
21 analysed at 6, 12, 18, 24, 48 and 96 h
22 based on average of calculated concentrations
23 analysed at 2, 4, 8, 20, 24, 32, 48, 72 and 96 h
24 covered with a sheet of glass
25 fully aerated
26 result from reference; extrapolated from graph

Table 3.1.3 Acute toxicity of 1,2-dichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp. (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	**15.0**	Abernethy, 1986
Palaemonetes pugio	N	S	-	AS	8.3-8.7	22	()[3]	25	96 h	LC50	9.4[4]; 0.01[5]	Curtis, 1979
Palaemonetes pugio	N	S	-	AS	8.3-8.7	22	-	25	96 h	LC50	10.0[4]; 0.01[5]	Curtis, 1981
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	9.7[4]; 0.01[5]	Heitmuller, 1981
Menidia beryllina (4-10 cm)	N	S	-	AS	7.6-7.9	20	aerated	-	96 h	LC50	7.3[4]; 0.01[5]	Dawson, 1977

[1] closed with teflon-lined screw caps; no air space
[2] initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
[3] intensely aerated prior to start of experiment
[4] result from reference
[5] recalculation: concentration after 48 h, presumed $t_{1/2}$ = 5 h

Table 3.1.4 Acute toxicity of 1,3-dichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	7.8[1]; 0.01[2]	Heitmuller, 1981

[1] result from reference
[2] recalculation: concentration after 48 h, presumed $t_{1/2}$ = 5 h

Table 3.1.5 Acute toxicity of 1,4-dichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp. (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	**13.7**	Abernethy, 1986
Palaemonetes pugio	N	S	-	AS	8.3-8.7	22	()[3]	25	96 h	LC50	69.0[4]; 0.1[5]	Curtis, 1979
Palaemonetes pugio	N	S	-	AS	8.3-8.7	22	-	25	96 h	LC50	60.0[4]; 0.1[5]	Curtis, 1981
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	7.4[4]; 0.01[5]	Heitmuller, 1981

1 closed with teflon-lined screw caps; no air space
2 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
3 intensely aerated prior to start of experiment
4 result from reference
5 recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.6 Acute toxicity of 1,2-dichloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina (nauplii)	N	S[1]	-	AS	-	-	-	-	24 h	LC50	320[2]; 61[3]	Price, 1974
Artemia salina (nauplii)	N	S[4]	≥ 98%	AS	8.5-8.7	19	6.5-8.1	32	24 h	EC50[5]	**93.6**	Foster, 1984
Crangon crangon	N	S[6]	-	SW	-	16	aerated	33	24 h	LC50	170[7]; 32[3]	Rosenberg, 1975
molluscs												
Elminius modestus (nauplii)	N	S[8]	-	SW	-	-	-	-	48 h	LC50	186[2]; 61[9]	Rosenberg, 1975
annelides												
Ophryotrocha labronica (adult)	N	SS[10]	-	SW	-	23	-	33	24 h	LC50	400[7]; 76[3]	Rosenberg, 1975
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	180[2]; 0.2[11]	Heitmuller, 1981
Limanda limanda (15-20 cm)	Y[12]	CF	-	SW	-	-	no aeration[13]	-	96 h	LC50	**115**	Pearson, 1975

1 loosely capped
2 result from reference
3 recalculation: concentration after 12 h, presumed t½ = 5 h
4 closed with foiled cork stoppers
5 effect: immobilization
6 partly covered with glass
7 result from reference; interpretation from figure
8 closed with glass stoppers
9 recalculation: concentration after 24 h, presumed t½ = 25 h
10 covered with Al-foil
11 recalculation: concentration after 48 h, presumed t½ = 5 h
12 concentration monitored regularly before, in and after flow-through apparatus
13 O_2-concentration of incoming seawater

Table 3.1.7 Acute toxicity of dichloromethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	330[1]; 0.4[2]	Heitmuller, 1981

[1] result from reference
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.8 Acute toxicity of 1,2-dichloropropane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Phaeodactylum tricornutum	-	-	-	-	-	-	-	-	48 h	EC50[7]	50	Pearson, 1975
molluscs												
Elminius modestus (nauplii)	N	S[1]	-	SW	-	-	-	-	48 h	LC50	53[2]; 27[3]	Pearson, 1975
fish												
Limanda limanda (15-20 cm)	Y[4]	CF	-	SW	-	-	no aeration[5]	-	96 h	LC50	61	Pearson, 1975
Menidia beryllina (4-10 cm)	N	S	-	AS	7.6-7.9	20	aerated	-	96 h	LC50	240[2]; 0.3[6]	Dawson, 1977

[1] closed with glass stoppers
[2] result from reference
[3] recalculation: concentration after 24 h, presumed t½ = 25 h
[4] concentration monitored regularly before, in and after flow-through apparatus
[5] O_2-concentration of incoming seawater
[6] recalculation: concentration after 48 h, presumed t½ = 5 h
[7] effect: carbon uptake, determined by use of carbon-14 labelled sodium carbonate

Table 3.1.9 Acute toxicity of 1,3-dichloropropane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	87[1]; 0.1[2]	Heitmuller, 1981

[1] result from reference
[2] Recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.10 Acute toxicity of 1,3-dichloropropene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Skeletonema costatum	N	S	-	-	-	-	-	-	96 h	EC50[1]	1.0	Krijgsheld, 1984[2]
Skeletonema costatum	N	S	-	-	-	-	-	-	96 h	EC50[3]	1.0	Krijgsheld, 1984[2]
crustaceans												
Mysidopsis bahia	N	S	-	-	-	-	-	-	96 h	LC50	0.8	Krijgsheld, 1984[2]
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	1.8[4]; 0.002[5]	Heitmuller, 1981

[1] effect: reduction chlorophyll
[2] original reference, nr. 259 in EEG report, not checked
[3] effect: cell number
[4] result from reference
[5] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.11 Acute toxicity of ethylbenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp. (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	15.4	Abernethy, 1986
Cancer magister (larva)	N[3]	SS[4]	-	SW	-	13	-	30	96 h	LC50	13[5]; 10[6]	Caldwell, 1976
Crangon franciscorum (adult)	Y[7]	S	> 99%	SW	-	16	-	25	96 h	LC50	0.49	Benville, 1977
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	280[8]; 0.4[9]	Heitmuller, 1981
Morone saxatilis (juvenile)	Y[7]	S	> 99%	SW	-	16	-	25	96 h	LC50	4.3	Benville, 1977
Oncorhynchus kisutch (juvenile)	N	S	-	AS	8.1	8	65-80% sat.[10]	30	96 h	LC50	30[11]; 0.04[9]	Morrow, 1975

1 closed with teflon-lined screw caps; no air space
2 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
3 concentration declined by 25-50% in 24 h
4 renewal at 24 h intervals
5 result from reference; based on initial concentrations
6 recalculation based on notes 3 and 4: t½ = 33 h, concentration after 12 h is presented
7 analysed at 0, 24, 48, 72 and 96 h
8 result from reference
9 recalculation: concentration after 48 h, presumed t½ = 5 h
10 fully aerated
11 result from reference; extrapolated from graph

Table 3.1.12 Acute toxicity of ethylene oxide to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina	N	S	-	AS	-	24.5	aerated[1]	-	48 h	LC50	745[2]; 27[3]	Conway, 1983

1 minimal aeration
2 result from reference
3 recalculation: concentration after 24 h, presumed t½ = 5 h

Table 3.1.13 Acute toxicity of hexachloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	2.4[1]; 0.003[2]	Heitmuller, 1981

1 result from reference
2 recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.14 Acute toxicity of monochlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Skeletonema costatum	N	S[1]	-	AM	8.0-8.2	19.5-20.6	-	-	120 h	EC50[2]	202[3]; 38[4]	Cowgill, 1989
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	10[3]; 0.001[5]	Heitmuller, 1981

1 silicone closures covered with parafilm
2 effect: growth
3 result from reference
4 recalculation: concentration after 60 h, presumed t½ = 25 h
5 recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.15 Acute toxicity of 2-monochlorotoluene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Nitocra spinipes	N	S	-	FS	7.8	10 or 21[1]	≥ 5[2]	7	96 h	LC50	45[3]; 5[4]	Bengtsson, 1983[5]
fish												
Alburnus alburnus	N	S[6]	-	FS	7.8	20-22	≥ 5[2]	7	96 h	LC50	7.8[3]; 4[7]	Bengtsson, 1983[5]

1 not clear in article
2 measured at end of exposure time
3 result from reference
4 recalculation: concentration after 48 h, presumed t½ = 15 h
5 test conditions from Lindén, 1979
6 glass aquaria sealed with silicone-rubber
7 recalculation: concentration after 48 h, presumed t½ = 50 h

Table 3.1.16 Acute toxicity of 3-monochlorotoluene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Nitocra spinipes	N	S	-	FS	7.8	10 or 21[1]	≥ 5[2]	7	96 h	LC50	25[3]; 3[4]	Bengtsson, 1983[5]

1 not clear in article
2 measured at end of exposure time
3 result from reference
4 recalculation: concentration after 48 h, presumed t½ = 15 h
5 test conditions from Lindén, 1979

Table 3.1.17 Acute toxicity of 4-monochlorotoluene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Nitocra spinipes	N	S	-	FS	7.8	10 or 21[1]	≥ 5[2]	7	96 h	LC50	15[3]; 2[4]	Bengtsson, 1983[5]

[1] not clear in article
[2] measured at end of exposure time
[3] result from reference
[4] recalculation: concentration after 48 h, presumed t½ = 15 h
[5] test conditions from Lindén, 1979

Table 3.1.18 Acute toxicity of pentachlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	0.8[1]; 0.001[2]	Heitmuller, 1981
Cyprinodon variegatus (juvenile, 27-32 d)	Y	CF	96%	-	-	28	-	23	96 h	LC50	**0.46**	Mayer, 1987

[1] result from reference
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.19 Acute toxicity of pentachloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	116[1]; 0.1[2]	Heitmuller, 1981

[1] result from reference
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.20 Acute toxicity of styrene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans Artemia salina	N	S[1]	-	AS	-	-	-	-	24 h	LC50	68[2]; 13[3]	Price, 1974
fish Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	9.1[2]; 0.01[3]	Heitmuller, 1981

[1] loosely capped
[2] result from reference
[3] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.21 Acute toxicity of 1,2,3,5-tetrachlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	3.7[1]; 0.005[2]	Heitmuller, 1981

[1] result from reference
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.22 Acute toxicity of 1,2,4,5-tetrachlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	0.8[1]; 0.001[2]	Heitmuller, 1981

[1] result from reference
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.23 Acute toxicity of 1,1,2,2-tetrachloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	12[1]; 0.02[2]	Heitmuller, 1981

[1] result from reference
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.24 Acute toxicity of tetrachloroethene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
molluscs												
Elminius modestus (nauplii)	N	S[1]	-	SW	-	-	-	-	48 h	LC50	3.5[2]; 2[3]	Pearson, 1975
fish												
Limanda limanda (15-20 cm)	Y[4]	CF	-	SW	-	-	no aeration[5]	-	96 h	LC50	**5**	Pearson, 1975
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	41[2]; 0.006[6]	Heitmuller, 1981

1 closed with glass stoppers
2 result from reference
3 recalculation: concentration after 24 h, presumed t½ = 25 h
4 concentration monitored regularly before, in and after flow-through apparatus
5 O_2-concentration of incoming seawater
6 recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.25 Acute toxicity of tetrachloromethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Limanda limanda (15-20 cm)	Y[1]	CF	-	SW	-	-	no aeration[2]	-	96 h	LC50	**50**	Pearson, 1975
Menidia beryllina (4-10 cm)	N	S	-	AS	7.6-7.9	20	aerated	-	96 h	LC50	150[3]; 0.2[4]	Dawson, 1977

1 concentration monitored regularly before, in and after flow-through apparatus
2 O_2-concentration of incoming seawater
3 result from reference
4 recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.26 Acute toxicity of toluene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Dunaliella biocula	N	S[1]	-	ES	-	-	-	-	4 h	EC50[2]	56[3]	Jensen, 1984
crustaceans												
Artemia sp. (nauplii)	N	S[4]	≥ 97%	SW	-	20	≥ 5-9[5]	30	24 h	LC50	59	Abernethy, 1986
Artemia salina (nauplii)	N	S[6]	-	AS	-	24.5	-	-	24 h	LC50	33[7]; 6[8]	Price, 1974
Cancer magister (larva)	N[9]	SS[10]	-	SW	-	13	-	30	96 h	LC50	28[11]; 5[12]	Caldwell, 1976
Cirolana borealis	N	SS[13]	-	SW	-	8-10	-	33.5-34.5	69 h	LC50[14]	12.5[7]; 0.4[15]	Bakke, 1979
Crangon franciscorum (adult)	Y[16]	S	> 99%	SW	-	16	-	25	96 h	LC50	4.3	Benville, 1977
Eualus spp. (0.8 g, 6 cm)	Y[17]	S	-	SW	-	4	> 80% sat.[18]	26-28	96 h	LC50	21.4	Korn, 1979
Eualus spp. (0.8 g, 6 cm)	Y[19]	S	-	SW	-	8	> 80% sat.[18]	26-28	96 h	LC50	20.2	Korn, 1979
Eualus spp. (0.8 g, 6 cm)	Y[20]	S	-	SW	-	12	> 80% sat.[18]	26-28	96 h	LC50	14.7	Korn, 1979
Hemigrapsus nudus	Y[21]	CF	-	SW	-	9.6-10.1	-	28-29	96 h	LC50	30[3]	Gharrett, 1987
Palaemonetes pugio (larva)	Y	S	high	AS	8.1	21	> 5	15	96 h	LC50	9.5	Tatem, 1978
Scylla serrata (juvenile)	N	S	-	SW	7.6-8	27-29	6.3-8	30-31	96 h	LC50	149[7]; 0.2[22]	Kulkarni, 1983
fish												
Cyprinodon variegatus (juv.)	Y[23]	IF	-	FS	-	29	-	15	96 h	LC50	13[24]	Ward, 1981
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	180[7]; 0.2[22]	Heitmuller, 1981
Morone saxatilis (juvenile)	Y[16]	S	> 99%	SW	-	16	-	25	96 h	LC50	7.3	Benville, 1977
Oncorhynchus gorbuscha (fry) (0.35 g, 3.5 cm)	Y[17]	S	-	SW	-	4	> 80% sat.[18]	26-28	96 h	LC50	6.41	Korn, 1979
Oncorhynchus gorbuscha (fry) (0.35 g, 3.5 cm)	Y[19]	S	-	SW	-	8	> 80% sat.[18]	26-28	96 h	LC50	7.63	Korn, 1979
Oncorhynchus gorbuscha (fry) (0.35 g, 3.5 cm)	Y[20]	S	-	SW	-	12	> 80% sat.[18]	26-28	96 h	LC50	8.09	Korn, 1979
Oncorhynchus gorbuscha (fry) (1-2 g, 4.5-5.5 cm)	Y	S	-	SW	-	12	> 80% sat.	26-28	24 h	LC50	5.38	Thomas, 1979
Oreochromis mossambicus[25] (40-50 g)	N	SS[9]	-	SA	-	-	-	35	96 h	LC50	90[26]; 17[12]	Dangé, 1986

1 closed with glass stoppers
2 effect: reduction of photosynthesis
3 extrapolation from graph
4 closed with teflon-lined screw caps; no air space
5 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
6 loosely capped
7 result from reference
8 recalculation: concentration after 12 h, presumed t½ = 5 h
9 concentrations declined by 25-50% in 24 h
10 renewal at 24 h intervals
11 result from reference; based on nominal initial concentrations
12 recalculation based on note 9: concentration after 12 h, presumed t½ = 5 h
13 medium changed every second day; same medium is circulating
14 presented as LT50 (medium lethal effect time)
15 recalculation: concentration after 24 h, presumed t½ = 5 h
16 analysed at 0, 24, 48, 72 and 96 h
17 analysed at several times; after 96 h 25% of initial concentration left
19 analysed at several times; after 96 h reduced to non-detectable level
18 aerated after 48 h
20 analysed at several times; after 72 h reduced to non-detectable level
21 measured five times daily
22 recalculation: concentration after 48 h, presumed t½ = 5 h
23 initial and final concentration
24 based on mean of measured concentrations
25 freshwater euryhaline species tolerant for saltwater
26 result from reference; extrapolated from figure

Table 3.1.27 Acute toxicity of 1,2,3-trichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp. (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	**2.4**	Abernethy, 1986

1 closed with teflon-lined screw caps; no air space
2 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated

Table 3.1.28 Acute toxicity of 1,2,4-trichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Nitocra spinipes	N	S	-	FS	7.8	10 or 21	≥ 5[1]	7	96 h	LC50	2.6[2]; 0.003[3]	Bengtsson, 1983[4]
Palaemonetes pugio (adult)	Y[5]	CF	-	FS	7.8-8.2	22-25	> 70% sat.	()[6]	96 h	LC50	0.54[7]	Clark, 1987
fish												
Branchiostoma caribaeum (adult)[8]	Y[5]	CF	-	FS	7.8-8.2	22-25	> 70% sat.	()[6]	96 h	EC50[9]	6[7]	Clark, 1987
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	S	-	25-31	no aeration	10-31	96 h	LC50	21[2]; 0.03[3]	Heitmuller, 1981

[1] measured at end of exposure time
[2] result from reference
[3] recalculation: concentration after 48 h, presumed t½ = 5 h
[4] test conditions from Lindén, 1979
[5] measured concentrations were 75-95% of nominal concentrations
[6] salinity of incoming seawater; monitored continuously
[7] based on nominal concentrations
[8] amphioxus, a chordate
[9] effect: immobilization

Table 3.1.29 Acute toxicity of 1,1,1-trichloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (juvenile, 8-15 mm)	N	S	> 80%	FS	-	25-31	no aeration	10-31	96 h	LC50	71[1]; 0.1[2]	Heitmuller, 1981

[1] result from literature
[2] recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.1.30 Acute toxicity of 1,1,2-trichloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Chlamydomonas sp.	Y[1]	-[2]	pure	ES	± 8	-	≥ 70% sat.	-	96 h	EC50[3]	**260**[4]	Adema, 1981
Chlorella ovalis	Y[1]	-[2]	pure	ES	± 8	-	≥ 70% sat.	-	96 h	EC50[3]	**200**[4]	Adema, 1981
Dunaliella sp	Y[1]	-[2]	pure	ES	± 8	-	≥ 70% sat.	-	96 h	EC50[3]	**200**[4]	Adema, 1981
Phaeodactylum tricornutum	Y[1]	-[2]	pure	ES	± 8	-	≥ 70% sat.	-	96 h	EC50[3]	**60**[4]	Adema, 1981
annelides												
Ophryotrocha diadema (adult, 4 cm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	96 h	LC50	**190**[4]	Adema, 1981
crustaceans												
Artemia salina (larva, 3 d, 1 mm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	96 h	LC50	**40**[4]	Adema, 1981
Artemia salina (adult, 1 cm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	96 h	LC50	**52**[4]	Adema, 1981
Chaetogammarus marinus (larva, 5 mm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	48 h	LC50	**72**[4]	Adema, 1981
Chaetogammarus marinus (adult, 1 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	48 h	LC50	**82**[4]	Adema, 1981
Crangon crangon (adult, 4 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	96 h	LC50	**43**[4]	Adema, 1981
Palaemonetes varians (adult, 4 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	96 h	LC50	**43**[4]	Adema, 1981
Temora longicornis (adult, 1 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	96 h	LC50	**43**[4]	Adema, 1981
molluscs												
Mytilus edulis (adult, 3 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	96 h	LC50	**110**[4]	Adema, 1981
fish												
Gobius minutus (adult)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	24 h	LC50	**43**[4]	Adema, 1981
Pleuronectes platessa (egg → larva)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	48 h	LC50	**125**[4]	Adema, 1981
Pleuronectes platessa (yolk-sac larva)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	96 h	LC50	**55**[4]	Adema, 1981
Pleuronectes platessa (0 group, 4-8 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	48 h	LC50	**34**[4]	Adema, 1981
Pleuronectes platessa (1 group, ~ 10 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	48 h	LC50	**60**[4]	Adema, 1981
Pleuronectes platessa (2 group, ~ 20 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	48 h	LC50	**45**[4]	Adema, 1981
Poecilia reticulata (young)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	24 h	LC50	**43**[4]	Adema, 1981
Poecilia reticulata (adult)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	48 h	LC50	**70**[4]	Adema, 1981

1 analysed during the tests; never less than 70% of nominal concentration
2 S, SS and CF
3 effect: growth
4 average of results of S-, SS- and CF-tests

Table 3.1.31 Acute toxicity of trichloroethene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Phaeodactylum tricornutum	-	-	-	-	-	-	-	-	48 h	EC50[15]	8	Pearson, 1975
Skeletonema costatum	Y[1]	S	-	AS	-	20	-	30	96 h	EC50[14]	95[2]; 77[3]	Ward, 1986
annelides												
Ophryotrocha labronica	N	SS[8]	-	SW	-	23	-	33	24 h	LC50	250[9]; 9[10]	Rosenberg, 1975
crustaceans												
Mysidopsis bahia	Y[1]	S	-	FS	-	22	-	20	96 h	LC50	14[2]; 5[4]	Ward, 1986
molluscs												
Elminius modestus (nauplii)	N	S[5]	-	SW	-	-	-	-	48 h	LC50	20[6]; 10[7]	Pearson, 1975
fish												
Cyprinodon variegatus (6 days after hatching)	Y[1]	S	-	FS	-	22	-	20	96 h	LC50	52[2]; 22[11]	Ward, 1986
Limanda limanda (15-20 cm)	Y[12]	CF	-	SW	-	-	no aeration[13]	-	96 h	LC50	16	Pearson, 1975

1 initial and final concentrations
2 based on average of initial and final concentrations
3 recalculation: initial concentration = 150 mg/l, final concentration = 40 mg/l; t½ = 50 h, concentration after 48 h is presented
4 recalculation: initial concentration = 27 mg/l, final concentration = 1 mg/l; t½ = 20 h, concentration after 48 h is presented
5 closed with glass stoppers
6 result from reference
7 recalculation: concentration after 24 h, presumed t½ = 25 h
8 covered with Al-foil
9 result from reference; interpretation from figure
10 recalculation: concentration after 12 h, presumed t½ = 5 h
11 recalculation: initial concentration = 99 mg/l, final concentration = 5 mg/l; t½ = 22 h, concentration after 48 h is presented
12 concentration monitored regularly before, in and after flow-through apparatus
13 O_2-concentration of incoming seawater
14 effect: cell count and chlorophyll a
15 effect: carbon uptake, determined by use of carbon-14 ' 'elled sodium carbonate

Table 3.3.32 Acute toxicity of 2-xylene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp. (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	23.7	Abernethy, 1986
Cancer magister (larva)	N[4]	SS[5]	-	SW	-	13	-	30	96 h	LC50	6[6]; 5[7]	Caldwell, 1976
Crangon franciscorum (adult)	Y[3]	S	> 99%	SW	-	16	-	25	96 h	LC50	1.3	Benville, 1977
echinoderms												
Strongylo centrotus (eggs)	N[8]	S[9]	> 98%	FS	-	5	-	-	96 h	EC50[10]	4.1[11]; 0.01[2]	Falk-Petersen, 1985
fish												
Morone saxatilis (juvenile)	Y[3]	S	> 99%	SW	-	16	-	25	96 h	LC50	11	Benville, 1977

1 closed with teflon-lined screw caps; no air space
2 initial concentration 8-9 mg/l, final ≥ mg/l; not aerated
3 analysed at 0, 24, 48, 72 and 96 h
4 concentration declined by 25-50% in 24 h
5 renewal at 24 h intervals
6 result from reference; based on initial concentration
7 recalculation based on note 4 and 5: t½ = 33 h, concentration after 12 h
8 more than 70% evaporated in 4 days under indentical circumstances in other experiments
9 covered with Al-foil
10 effects: mortality, pathology, inhibition of cleavage and differentiation, pigments defects
11 result from reference
12 recalculation: concentration after 48 h, presumed t½ = 5 h

Table 3.3.33 Acute toxicity of 3-xylene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp. (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	**19.3**	Abernethy, 1986
Cancer magister (larva)	N[3]	SS[4]	-	SW	-	13	-	30	96 h	LC50	**12**[5]; 9[6]	Caldwell, 1976
Crangon franciscorum (adult)	Y[8]	S	> 99%	SW	-	16	-	25	96 h	LC50	**3.7**	Benville, 1977
fish												
Morone saxatilis (juvenile)	Y[7]	S	> 99%	SW	-	16	-	25	96 h	LC50	**9.2**	Benville, 1977

1 closed with teflon-lined screw caps, no air space
2 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
3 concentration declined by 25-50% in 24 h
4 renewal at 24 h intervals
5 result from reference; based on initial concentration
6 recalculation based on notes 3 and 4: $t_{1/2}$ = 33 h, concentration after 12 h is presented
7 analysed at 0, 24, 48, 72 and 96 h

Table 3.1.34 Acute toxicity of 4-xylene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia sp (nauplii)	N	S[1]	≥ 97%	SW	-	20	≥ 5-9[2]	30	24 h	LC50	**24.6**	Abernethy, 1986
Crangon franciscorum (adult)	Y[3]	S	> 99%	SW	-	16	-	25	96 h	LC50	**2.0**	Benville, 1977
fish												
Morone saxatilis (juvenile)	Y[3]	S	> 99%	SW	-	16	-	25	96 h	LC50	**2.0**	Benville, 1977

1 closed with teflon-lined screw caps; no air space
2 initial concentration 8-9 mg/l, final ≥ 5 mg/l; not aerated
3 analysed at 0, 24, 48, 72 and 96 h

Table 3.2.1 Chronic toxicity of benzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Skeletonema costatum	Y[1]	S[2]		SW	-	-	-	-	10 d	NOEC[3]	10[4]	Atkinson, 1977
Skeletonema costatum	Y[5]	S[6]	analytical grade	ES	-	18	-	-	3 d	NOEC[3]	**35**[7]; 20[8]	Dunstan, 1975
Skeletonema costatum	N	S[6]	analytical grade	ES	-	18	-	-	3 d	NOEC[3]	**20**[9]; 11[10]	Dunstan, 1975
crustaceans												
Cancer magister (larva)	Y	CF	-	SW	-	13	saturated	29-34	40 d	NOEC[11]	**0.18**	Caldwell, 1976
Cancer magister (larva)	Y	CF	-	SW	-	13	saturated	29-34	40 d	NOEC[12]	**1.2**	Caldwell, 1976

1 several measurements, minimum benzene loss
2 closed with rubber stoppers; other test (same article) shows effectivity of this closure
3 effect: growth (number of cells)
4 not reliable because figure used for extrapolation contains too few data
5 initial and final concentrations
6 closed with rubber stoppers
7 based on measured initial concentration
8 recalculation: exponential average of measured initial and final concentrations
9 based on nominal initial concentration
10 recalculation: concentration after 36 h; t½ = 43 h, initial and nominal concentrations from article
11 effect: mortality
12 effect: molting frequency

Table 3.2.2 Chronic toxicity of 1,2-dichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Protococcus sp.	N	S[1]	-	ES	-	-	-	22-28	10-14 d	NOEC[2]	7.6[3]; 0.00[4]	Ukeles, 1962
Chlorella sp.	N	S[1]	-	ES	-	-	-	22-28	10-14 d	NOEC[2]	7.6[3]; 0.00[4]	Ukeles, 1962
Dunaliella euchlora	N	S[1]	-	ES	-	-	-	22-28	10-14 d	NOEC[2]	7.6[3]; 0.00[4]	Ukeles, 1962
Phaeodactylum tricornutum	N	S[1]	-	ES	-	-	-	22-28	10-14 d	NOEC[2]	7.6[3]; 0.00[4]	Ukeles, 1962
Monochrysis lutheri	N	S[1]	-	ES	-	-	-	22-28	10-14 d	NOEC[2]	7.6[3]; 0.00[4]	Ukeles, 1962
molluscs												
Mercenaria mercenaria (eggs)	N	SS[5]	-	SW	-	24	-	-	10 d	NOEC[6]	5[3,8]; 1[7]	Davis, 1969
Mercenaria mercenaria (larva)	N	SS[5]	-	SW	-	24	-	-	10 d	NOEC[9]	5[3,8]; 1[7]	Davis, 1969
Mercenaria mercenaria (larva)	N	SS[5]	-	SW	-	24	-	-	10 d	NOEC[10]	5[3,8]; 1[7]	Davis, 1969

1 test tubes loosely capped
2 effect: growth
3 result from reference
4 recalculation: concentration after 7 d, presumed t½ = 5 h
5 renewal every second day
6 effect: eggs developing
7 recalculation: concentration after 12 h, presumed t½ = 5 h
8 result derived from one experiment, no duplos
9 effect: mortality
10 effect: increase in length

Table 3.2.3 Chronic toxicity of 1,2-dichloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
annelides												
Ophryotrocha labronica (adult)	N	SS[1]	-	SW	-	23	-	33	9 d	NOEC[2]	**200**[3]	Rosenberg, 1975
Ophryotrocha labronica (adult)	N	SS[1]	-	SW	-	23	-	33	15 d	NOEC[4]	**400**[5]	Rosenberg, 1975
Ophryotrocha labronica (eggs)	N	SS[1]	-	SW	-	23	-	33	15 d	NOEC[6]	**200**[5]	Rosenberg, 1975

1 covered with Al-foil; test solution renewed every second day
2 effect: mortality
3 interpretation from figure
4 effect: number of eggs laid
5 interpretation from table
6 effect: % hatching

Table 3.2.4 Chronic toxicity of monochlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Skeletonema costatum	N	S[1]	-	AM	8.0-8.2	19.5-20.6	-	-	5 d	NOEC[2]	100[3]; 19[4]	Cowgill, 1989

1 silicone closures covered with parafilm
2 effect: growth
3 result from reference
4 recalculation: concentration after 2½ d, presumed t½ = 25 h

Table 3.2.5 Chronic toxicity of pentachloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Champia parvula	N	SS[1]	-	ES	-	22-24	aerated	30	14 d	NOEC[2]	32[3]; 8[4]	Thursby, 1985
Champia parvula	N	SS[1]	-	ES	-	22-24	aerated	30	14 d	NOEC[5]	10[3]; 2[4]	Thursby, 1985

1 in screw-capped erlenmeyer flasks; media changed after 7 and 11 days
2 effect: growth
3 result from reference, extrapolated in figure
4 recalculation based on note 1: average of concentration after 3½, 9 and 12½ d, presumed t½ = 25 h
5 effect: reproduction

Table 3.2.6 Chronic toxicity of 1,2,4,5-tetrachlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
fish												
Cyprinodon variegatus (embryo-juvenile)	Y[1]	IF	-	FS	7.3-8.3	30	3.6-7.4	12-28	28 d	NOEC[2]	0.09[3,4]	Ward, 1981

1 analysed weekly
2 effect: hatching succes embryos and growth and survival juveniles
3 based on mean of measured concentrations; presented as MATC = 0.09-0.18 mg/l
4 21% mortality in control

Table 3.2.7 Chronic toxicity of toluene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Skeletonema costatum	N[1]	S[2]	reagent grade	ES	-	18	-	-	3 d	NOEC[3]	**5**[4]	Dunstan, 1975
Cricosphaera carterae	N[1]	S[2]	reagent grade	ES	-	18	-	-	3 d	NOEC[3]	**5**[4]	Dunstan, 1975
fish												
Cyprinodon variegatus (embryo-juvenile)	Y[5]	IF	-	FS	7.8-8.5	29	4-7.8	20-30	28 d	NOEC[6]	**3.2**[7]	Ward, 1981

[1] same test, other dilution: final concentration 10-50% of initial concentrations
[2] closed with rubber stoppers
[3] effect: growth
[4] recalculation based on note 1: t½ = 36 h, concentration after 36 h
[5] weekly analysed
[6] effect: hatching succes embryos and growth and survival juveniles
[7] based on mean of measured concentrations; presented as MATC = 3.2 - 7.7 mg/l

Table 3.2.8 Chronic toxicity of trichloromethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Skeletonema costatum	N	S[1]	-	AM	8.0-8.2	19.5-20.6	-	-	5 d	NOEC[2]	216[3]; 41[4]	Cowgill, 1989

[1] silicone closures covered with parafilm
[2] effect: number of cells and cell volume
[3] result from literature
[4] recalculation: concentration after 2½ d, presumed t½ = 25 h

Table 3.2.9 Chronic toxicity of 1,3,5-trichlorobenzene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
molluscs												
Mercenaria mercenaria (larva)	N	SS[1]	-	SW	-	24	-	-	10 d	NOEC[2]	1.0[3,5]; 0.04[4]	Davis, 1969

[1] renewal every second day
[2] effect: survival of larvae
[3] result from reference
[4] recalculation: concentration after 24 h, presumed t½ = 5 h
[5] result derived from one experiment, no duplos

Table 3.2.10 Chronic toxicity of 1,1,2-trichloroethane to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
annelides												
Ophryotrocha labronica (eggs)	N	SS[1]	-	SW	-	23	-	33	15 d	NOEC[2]	**50[3]**	Rosenberg, 1975
Ophryotrocha labronica (adult)	N	SS[1]	-	SW	-	23	-	33	9 d	NOEC[4]	**33[5]**	Rosenberg, 1975
crustaceans												
Artemia salina (larva, 3d, 1 mm)	Y[6]	-[7]	pure	AS	±8	-	≥70% sat	-	3 w	NOEC[8]	**10[9]**	Adema, 1981
fish												
Pleuronectes platessa (egg → larva)	Y[6]	-[7]	pure	AS	±8	-	≥70% sat	-	8 w	NOEC[10]	**3.0[9]**	Adema, 1981

[1] covered with Al-foil; test solution renewed every second day
[2] effect: % hatching
[3] interpretation from table
[4] effect: mortality
[5] interpretation from figure; NOEC=LOEC/3
[6] analysed during the tests; never less than 70% of nominal concentration
[7] S, SS and CF
[8] effect: reproduction
[9] average of results of S, SS en CF-tests
[10] effect: teratogenicity, growth, mortality

Table 3.2.11 Chronic toxicity of trichloroethene to marine organisms

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
annelides												
Ophryotrocha labronica (adult)	N	SS[1]	-	SW	-	23	-	33	9 d	NOEC[2]	**100**[3]	Rosenberg, 1975
Ophryotrocha labronica (adult)	N	SS[1]	-	SW	-	23	-	33	15 d	NOEC[4]	**75**[5]	Rosenberg, 1975
Ophryotrocha labronica (eggs)	N	SS[1]	-	SW	-	23	-	33	15 d	NOEC[6]	**25**[5]	Rosenberg, 1975

1 covered with Al-foil; test solution renewed every second day
2 effect: mortality
3 interpretation from figure
4 effect: number of eggs laid
5 interpretation from table
6 effect: % hatching

Table 3.3.1 Toxicity data for marine organisms, values from deviating tests: benzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
algae												
Dunaliella biocula	N	S[1]	-	ES	-	-	-	-	4 h	NOEC[2]	10[3]	Jensen, 1984
molluscs												
Balanus eburneus	N	S	-	FS	-	-	-	30	72 h	EC50[4]	215[5]	Blundo, 1978

[1] closed with glass stoppers
[2] effect: reduction of photosynthesis
[3] extrapolation from graph
[4] effect: phototactic response
[5] extrapolated from graph

Table 3.3.2 Toxicity data for marine organisms, values from deviating tests: 1,2-dichlorobenzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
molluscs												
Crassostrea virginica (young)	N	CF	-	SW	-	-	-	-	24 h	LOEC[1]	1.0	Butler, 1962
echinoderms												
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[2]	0.14	Pagano, 1988
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[3]	1.47	Pagano, 1988
Paracentrotus lividus (sperm)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[4]	1.47	Pagano, 1988

[1] effect: growth
[2] effect: genotoxicity
[3] effect: development
[4] effect: inactivation

Table 3.3.3 Toxicity data for marine organisms, values from deviating tests: 1,3-dichlorobenzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
echinoderms												
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[1]	≤ 0.14[2]	Pagano, 1988
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[3]	1.47	Pagano, 1988

1 effect: development
2 lowest concentration tested
3 effect: genotoxicity

Table 3.3.4 Toxicity data for marine organisms, values from deviating tests: 1,4-dichlorobenzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
echinoderms												
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[1]	≤ 0.14[2]	Pagano, 1988

1 effect: genotoxicity
2 lowest concentration tested

Table 3.3.5 Toxicity data for marine organisms, values from deviating tests: 1,2-dichloroethane

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina (nauplii)	N	S	-	AS	-	25	-	35	24 h	LOEC[1]	≤ 0.25[2]	Kerster, 1983
Artemia salina (nauplii)	N	S[3]	≥ 98%	50% ASW	8.3-8.6	19	7.3-8.7	-	24 h	EC50[4]	79.7	Foster, 1985
Artemia salina (nauplii)	N	S[3]	≥ 98%	25% ASW	8.3-8.6	19	7.3-8.7	-	24 h	EC50[4]	36.4	Foster, 1985

1 effect: teratogenicity
2 lowest concentration tested
3 closed with foiled cork stoppers
4 effect: immobilization

Table 3.3.6 Toxicity data for marine organisms, values from deviating tests: hexachloroethane

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
echinoderms												
Arbacia punctulata (embryo)	N	S	-	FS	-	20	-	30	48 h	EC50[1]	9.32	Jackim, 1984

[1] effect: growth, determined by tritium-labelled thymidine incorporation

Table 3.3.7 Toxicity data for marine organisms, values from deviating tests: monochlorobenzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
echinoderms												
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[1]	11	Pagano, 1988
Paracentrotus lividus (embryo)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[2]	1.1	Pagano, 1988
Paracentrotus lividus (sperm)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[3]	1.1	Pagano, 1988
Paracentrotus lividus (sperm)	N	S	≥ 99%	FS	8.2-8.4	-	-	37.6-37.8	48 h	LOEC[4]	1.1	Pagano, 1988

[1] effect: development
[2] effect: genotoxicity
[3] effect: inactivation
[4] effect: development offspring

Table 3.3.8 Toxicity data for marine organisms, values from deviating tests: tetrachloroethene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina (nauplii)	N	S	-	AS	-	25	-	35	24 h	LOEC[1]	≤ 0.25[2]	Kerster, 1983

[1] effect: teratogenicity
[2] lowest concentration tested

Table 3.3.9 Toxicity data for marine organisms, values from deviating tests: toluene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina (nauplii)	N	S	-	AS	-	25	-	35	24 h	LOEC[1]	≤ 0.25[2]	Kerster, 1983
Cirolana borealis	N	SS[3]	-	SW	-	8-10	-	33.5-34.5	96 h	NOEC[4]	1.25	Bakke, 1979
molluscs												
Balanus eburneus	N	S	-	FS	-	-	-	30	72 h	EC50[5]	77[6]	Blundo, 1978

[1] effect: teratogenicity
[2] lowest concentration tested
[3] medium is circulating; changed after two days
[4] effect: mortality
[5] effect: phototactic response
[6] extrapolation from graph

Table 3.3.10 Toxicity data for marine organisms, values from deviating tests: 1,2,4-trichlorobenzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Palaemonetes pugio (adult)	Y[1]	CF	-	FS	7.8-8.2	22-25	> 70% sat.	()[2]	96 h	NOEC[3]	0.24[4]	Clark, 1987
Artemia salina (nauplii)	N	S	-	AS	-	25	-	35	24 h	LOEC[5]	≤ 0.25[6]	Kerster, 1983
fish												
Branchiostoma caribaeum[7] (adult)	Y[1]	CF	-	FS	7.8-8.2	22-25	> 70% sat.	()[2]	96 h	NOEC[3]	1.5[4]	Clark, 1987

[1] measured concentrations were 75-95% of nominal concentrations
[2] salinity of incoming seawater; monitored continuously
[3] effect: mortality
[4] based on nominal concentrations
[5] effect: teratogenicity
[6] lowest concentration measured
[7] amphioxus, a chordate

Table 3.3.11 Toxicity data for marine organisms, values from deviating tests: 1,3,5-trichlorobenzene

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
molluscs												
Crassostrea virginica (eggs)	N	SS[1]	-	SW	-	24	-	-	12 d	LOEC[2]	≤ 1.0[3,4]	Davis, 1969
Mercenaria mercenaria (eggs)	N	SS[1]	-	SW	-	24	-	-	10 d	LOEC[2]	≤ 1.0[3,4]	Davis, 1969

[1] renewal every second day
[2] effect: developing eggs
[3] lowest concentration tested
[4] only one experiment

Table 3.3.12 Toxicity data for marine organisms, values from deviating tests: 1,1,2-trichloroethane

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina (larva, 3 d, 1 mm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	7 d	LC50	36[3]	Adema, 1981
Artemia salina (larva, 3 d, 1 mm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	3 w	LC50	36[3]	Adema, 1981
Artemia salina (larva, 3 d, 1 mm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	3 w	EC50[4]	15[3]	Adema, 1981
Artemia salina (adult, 1 cm)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	10 d	LC50	43[3]	Adema, 1981
Chaetogammarus marinus (larva, 5 mm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	48[3]	Adema, 1981
Chaetogammarus marinus (larva, 5 mm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	3 w	LC50	41[3]	Adema, 1981
Chaetogammarus marinus (adult, 1 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	62[3]	Adema, 1981
Chaetogammarus marinus (adult, 1 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	14 d	LC50	50[3]	Adema, 1981
Palaemonetes varians (adult, 4 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	43[3]	Adema, 1981
Crangon crangon (adult, 4 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	42[3]	Adema, 1981
molluscs												
Crepidula fornicata (veliger)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	170[3]	Adema, 1981
Mytilus edulis (adult, 3 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	80[3]	Adema, 1981
Mytilus edulis (adult, 3 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	14 d	LC50	65[3]	Adema, 1981
fish												
Poecilia reticulata (young)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	40[3]	Adema, 1981
Poecilia reticulata (adult)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	45[3]	Adema, 1981
Gobius minutus (adult)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	43[3]	Adema, 1981
Pleuronectes platessa (0 group, 4-8 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	27[3]	Adema, 1981
Pleuronectes platessa (1 group ~ 10 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	55[3]	Adema, 1981
Pleuronectes platessa (2 group ~ 20 cm)	Y[1]	-[2]	pure	SW	± 8	-	≥ 70% sat.	-	7 d	LC50	36[3]	Adema, 1981
Pleuronectes platessa (egg-larva)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	4 w	LC50	5.5[3]	Adema, 1981
Pleuronectes platessa (egg-larva)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	8 w	LC50	5.5[3]	Adema, 1981
Pleuronectes platessa (egg-larva)	Y[1]	-[2]	pure	AS	± 8	-	≥ 70% sat.	-	7 d	LC50	6.0[3]	Adema, 1981

[1] analysed during tests; never less than 70% of nominal concentration
[2] S, SS and CF
[3] average of results of S-, SS- and CF-tests
[4] effect: reproduction

Table 3.3.13 Toxicity data for marine organisms, values from deviating tests: trichloromethane

Organism	Analysed	Test type	Purity substance	Test water	pH	Temp °C	O_2 mg/l	Salinity in ‰	Exp. time	Criterion	Result mg/l	Reference
crustaceans												
Artemia salina (nauplii)	N	S[1]	≥ 98%	50% AS	8.3-8.6	19	7.3-8.7	-	24 h	EC50[2]	37.0	Foster, 1985
Artemia salina (nauplii)	N	S[1]	≥ 98%	25% AS	8.3-8.6	19	7.3-8.7	-	24 h	EC50[2]	31.1	Foster, 1985

[1] closed with foiled cork stoppers
[2] effect: immobilization

References

Abernethy, S. et al. (1986). Acute lethal toxicity of hydrocarbons and chlorinated hydrocarbons to two planktonic crustaceans: The key role of organism - water partitioning. Aquatic Toxicol. **8**, 163-174.

Adema, D.M.M. and Vink, G.J. (1981). A comparative study of the toxicity of 1,1,2-trichloroethane, dieldrin, penta-chlorophenol and 3,4-dichloroaniline for marine and fresh water organisms. Chemosphere **10**, (6), 533-554.

Atkinson, L.P. et al. (1977). Analysis and control of volatile hydrocarbon concentrations during oil bioassays. Water, Air and Soil Pollution **8**, 235-242.

Atri, F.R. (1985). Chlorierte kohlenwasserstoffe in der Umwelt I, Trichlorethylen, Perchlorethylen, 1,1-Dichlorethylen, 1,2-Dichlorethylen. Schiftenreihe des Vereins für WasserBoden- und Lufthygiene 60, Verlag, Stuttgart.

Bakke, T. and Skjoldal, H.R. (1979). Effects of toluene on the survival, respiration and adenylate system of a marine isopod. Marine Poll. Bull. **10**, 111-115.

Bengtsson, B.E. and Tarkpea, M. (1983). The acute aquatic toxicity of some substances carried by ships. Marine Pollution Bulletin **14**, (6), 213-214.

Bentley, R.E. et al. (1975). Acute toxicity of chloroform to bluegill (Lepomis macrochirus), rainbow trout (Salmo gairdneri), and pink shrimp (Penaeus duorarum). USEPA Contract No. WA-6-99-1414-B.

Benville, P.E. and Korn, S. (1977). The acute toxicity of six monocyclic aromatic crude oil components to striped bass (Morone saxatilis) and bay shrimp (Crangon franciscorum). Calif. Fish. and Game **63**, (4), 204-209.

Blundo R. (1978). The toxic effects of the water-soluble fractions of No. 2 fuel oil and of three aromatic hydrocarbons on the behavior and survival of barnacle larvae. Contributions in Marine Science 21, 25-37.

Butler, P.A. et al. (1962). Effect of pesticides on oysters. In: Proceeding of the National Shellfisheries Association, Washington 1980.

Caldwell, R.S. et al. (1976). Effects of a seawater-soluble fraction of cook inlet crude oil and its major aromatic components on larval stages of the dungeness crab, Cancer magister dana. In: D.A. Wolfe (ed.). Fate and effects of petroleum hydrocarbons in marine organisms and ecosystems, Pergamon press, New York, 210-220.

Clark, J.R. et al. (1987). Waterborne and sediment-source toxicities of six organic chemicals to grass shrimp (Palaemonetes pugio) and Amphioxus (Branchiostoma caribaeum). Arch. Environ. Contam. Toxicol. **16**, 401-407.

Conway, R.A., et al. (1983). Environmental fate and effects of ethylene oxide. Environ. Sci. Technol. **17**, (2), 107-112.

Cowgill, U.M. et al. (1989). Toxicity of nine Benchmark chemicals to Skeletonema costatum, a marine diatom. Environ. Toxicol. Chem. **8**, 451-455.

Curtis M.W. and Ward, C.H. (1981). Aquatic toxicity of forty industrial chemicals: Testing in support of hazardous substance spill prevention regulation. Journal of Hydrology **51**, 359-367.

Curtis, M.W. et al. (1979). Acute toxicity of 12 industrial chemicals to freshwater and saltwater organisms. Water Research **13**, 137-141.

Dangé, A.D. (1986). Branchial Na^{+}-K^{+}-ATPase Inhibition in a freshwater Eurohaline teleost, Tilapia (Oreochromis mossambicus), during short-term exposure to toluene or naphtalene: influence of salinity. Environ. Poll. A **42**, 273-286.

Daugherty F.M. and Garrett, J.T. (1951). Toxicity levels of hydrocyanic acid some industrial by-products. Texas Journal of Science **3**, 391-396.

Davis, H.C. and Hidu, H. (1969). Effects of pesticides on embryonic development of clams and oysters and on survival and growth of the larvae. Fish. Bull. **67**, (2), 393-404.

Dawson, G.W. et al. (1977). The acute toxicity of 47 industrial chemicals to fresh and saltwater fishes. J. Haz. Mat. **1**, 303-318.

Dunstan, W.M. et al. (1975). Stimulation and inhibition of phytoplankton growth by low molecular weight hydrocarbons. Marine Biology **31**, 305-310.

Erickson, S.J. and Freeman, A.E. (1977). Toxicity screening of fifteen chlorinated and brominated compounds using four species of marine phytoplankton. In: R.L. Julley (ed.). Water chlorination: Environmental impact and health effects 2, Ann Arbor Sci., Ann Arbor M.I., 307-310.

Falk-Petersen, I.B. et al. (1985). Toxic effects of hydroxylated aromatic hydrocarbon on marine embryos. Sarsia **70**, 11-16.

Foster, G.D. and Tullis, R.E. (1984). A quantitative structure-activity relationship between partition coefficients and the acute toxicity of naphthalene derivatives in Artemia salina nauplii. Aquatic Toxicol. **5**, 245-254.

Foster, G.D. and Tullis, R.E. (1985). Quantitative Structure-Toxicity Relationships with osmotically stressed Artemia salina nauplii. Environ. Poll. A **38**, 273-281.

Gharrett, J.A. and Rice, S.D. (1987). Influence of simulated tidal cycles on aromatic hydrocarbon uptake and elimination by the shore crab Hemigrapsus nudus. Marine Biology **95**, 365-370.

Government Publishing Office (1980). Degradability, ecotoxicity and bioaccumulation; the determination of the possible effects of chemicals and wastes on the aquatic environment. The Hague, The Netherlands.

Heitmuller, P.T. et al. (1981). Acute toxicity of 54 industrial chemicals to sheepshead minnows (Cyprinodon variegatus). Bull. Environ. Contam. Toxicol. **27**, 596-604.

Jackim, E. and Nacci, D. (1984). A rapid aquatic toxicity assay utilizing labeled thymidine incorporation in red urchin embryos. Environ. Toxicol. Chem. **3**, 631-636.

Jensen K. et al. (1984). The effect of aromatic hydrocarbon on the productivity of various marine planktonic algae. Limnologica **15**, (2), 581-584.

Kerster, H.W. (1983). Brine shrimp (Artemia salina nauplii) as a teratogen test system. Ecotoxicol. Environ. Safe. **7**, 342-349.

Korn, S. et al. (1979). Effects of temperature on the median tolerance limit of Pink salmon and shrimp exposed to toluene, naphtalene and cook inlet crude oil. Bull. Environ. Contam. Toxicol **21**, 521-525.

Krijgsheld, K.R. (1984). Assesment of the impact of the emission of certain organochlorine compounds: chlorophenols, chloroprenes and epichlorohydrin on the aquatic environment (toxicity, persistence, bioaccumulation and other ecotoxicological data). ESF XI/1/85.

Kulkarni, B. (1990). Chronic toxicity of benzene on enzymes in the intertidal clam Gafrarium divaricatum (Gmelin). Proc. Indian Nat. Sci. Acad. B56, 5 & 6, 425-428.

Kulkarni, B.G. and Masurekar, V.B. (1983). Acute toxicities of some petroleum hydrocarbons to crab, Scylla serrata (forskal). Geobios **10**, (2), 63-67.

LeGore, R.S. (1974). The effect of Alaskan crude oil and selected hydrocarbon compounds on embryonic development of the Pacific oyster, Crassostrea gigas. PhD Dissertation, Univ. of Washington.

Lindén, E., et al. (1979). The acute toxicity of 78 chemicals and pesticide formulations against two brackish water organisms, the bleak (Alburnus alburnus) and the harpacticoid (Nitocra spinipes). Chemosphere **11/12**, 843-851.

Madeley, J.R. (1973). The acute toxicity of chlorinated hydrocarbons to fish. A review of the work carried out at Brixham Laboratory to June 1973. ICI-BL/B/1521.

Mayer, F.L. (1987). Acute toxicity handbook of chemicals to estuarine organisms. US Dept. of Commerce, National Technical Information Service, Springfield VA, 283 PP. EPA/600/8-87/017.

Meyerhoff, R.D. (1975). Acute toxicity of benzene, a component of crude oil, to juvenile striped bass (Morone saxatilis). J. Fish. Res. Board Can. **32**, (10), 1864-1866.

Moles, A., et al. (1979). Sensitivity of Alaskan freshwater and anadromous fishes to Prudhoe Bay crude oil and benzene. Trans. Am. Fish. Soc. **108**, 408-414.

Morrow, J.E. et al. (1975). Effects of some components of crude oil on young coho salmon. Copeia **2**, 326-331.

Nunes, P., Benville, P.E. (1978). Acute toxicity of the water-soluble fraction of cook inlet crude oil to the Manila clam. Marine Poll. Bull. **9**, 324-331.

Parker, J.G. (1984). The effects of selected chemicals and water quality on the marine polychaete Ophryotrocha diadema. Water Research **18**, (7), 865-868.

Pearson, C.R. and McConnell, G. (1975). Chlorinated C_1 and C_2 hydrocarbons in the marine environment. Proc. R. Soc. Lond. B. 189, 305-332.

Persoone, G. and Vanhaecke, P.V. (1982). Evaluation of the impact of benzene, chloroform and carbon tetrachloride on the aquatic environment. CEC XI/627/82.

Potera, G.T. (1975). Effects of benzene, toluene and ethylbenzene on several important members of the estuarine ecosystem. Diss. Abstr. Int. B **36**, (5), 117 pp.

Price, K.S., et al. (1974). Brine skrimp bioassay and seawater BOD of petrochemicals. J. Water. Poll. Contr. Fed. **46**, (1), 63-77.

Rosenberg, R. et al. (1975). Toxic effects of aliphatic chlorinated by-products from vinyl chloride production on marine animals. Water Research **9**, 607-612.

Stewart, M.E. et al. (1979). By-products of oxidative biocides: toxicity to oyster larvae. Marine Poll. Bull. **10**, 166-169.

Struhsaker, J.W. et al. (1974). Effects of benzene (a water-soluble component of crude oil) on eggs and larvae of pacific herring and northern anchovy. In: Vernberg (eds.) et al. Pollution and physiology of marine organisms, Academic Press, New York, 253-284.

Tatem, H.E. (1978). The toxicity of oils and petroleum hydrocarbon to estuarine crustaceans. Estuarine and Coastal Marine Science **6**, 365-373.

Tatem, H.E. and Anderson, J.W. (1973). The toxicity of four oils to Palaemonetes pugio (Holthuis) in relation to uptake and retention of specific petroleum hydrocarbons. American Society of Zoologists **13**, (4), 1307-1308.

Thomas R.E. and Rice, S.D. (1979). The effects of exposure temperatures on oxygen consumption and opercular breathing rates of pink salmon fry exposed to toluene, naphtalene and water-soluble fractions of cook inlet crude oil and No. 2 fuel oil. Marine Pollution: Functional Responses **79**, 39-52.

Thursby, G.B. et al. (1985). Effect of organic chemicals on growth and reproduction in the marine red alga Champia parvula. Environ. Toxicol. Chem. **4**, 797-805.

Ukeles, R. (1962). Growth of pure cultures of marine phytoplankton in the presence of toxicants. Applied Microbiology **10**, 532-537.

US-EPA (1978). In-depth studies on health and environmental impacts of selected water pollutants. US-EPA Contract No. 68-01-4646.

Ward, G.S. and Parrish, P.R. (1981). Early life stage toxicity tests with a saltwater fish: Effects of eight chemicals on survival, growth and development of sheepshead minnows (Cyprinodon variegatus). J. Toxicol. Environ. Health **8**, 225-240.

Ward, G.S. et al. (1986). Acute toxicity of trichloroethylene to saltwater organisms. Bull. Environ. Contam. Toxicol. **37**, 830-836.

Winters, K. et al. (1977). Water-soluble extractives from petroleum oils: chemical characterization and effects on microalgae and marine animals. Rapp. P.-v. Réun. Cons. Int. Explor. Mer. **171**, 166-174.

References: evaluated but rejected

Anderson, J.W. et al (1974). Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish. Marine Biology **27**, 75-88.

Anderson, R.S. et al. (1981). Effects of environmental pollutants on immunological competency of the clam Mercenaria mercenaria: impaired bacterial clearance. Aquatic Toxicology **1**, 187-195.

Barnett, C.J. and Kontogiannis, J.E. (1975). The effect of crude oil fractions on the survival of a tidepool copepod, Tigri-opus californicus. Environ. Pollut. **8**, 45-54.

Biggs, D.C. et al. (1979). Effects of trichloroethylene, hexachlorobenzene and polychlorinated biphenyls on the growth and cell size of marine phytoplankton. Bull. Environ. Contam. Toxicol. **21**, 196-201.

Boese, B.L. et al (1982). Effects of petroleum refinery waste-water exposure on gill ATPase and selected blood parameters in the pacific staghorn sculpin (Leptocottus armatus). Comp. Biochem. Physiol. **71C**, 63-67.

Boese, B.L. et al (1990). Depuration kinetics of hexachlorobenzene in the clam Macoma nasuta. Comp. Biochem. Physiol. **96C**, (2), 327-331.

Brocksen, R.W. and Bailey, H.T. (1973). Respiratory response of juvenile chinook salmon and striped bass exposed to benzene, a water-soluble component of crude oil. Proc. Joint Conf. Prev. Contr. Oil Spills, 783-791.

Brooks, J.M. et al. (1977). (Gulf Underwater Flare Experiment [GUFEX]): Effect of hydrocarbons on phytoplankton. Giam, Proc. Pollution effects marine organisms, D.C. Heath, Co. Lexington, Ma, 45-75.

Brown, E.R. et al. (1977). Chemical pollutants in relation to diseases in fish. Ann. Acad. Sci. **298**, 535-546.

Butler, P.A. (1965). Commercial fishery investigations. US Fish. Wild. Serv., Pestic. Wild. Stud., Circ. 226. Washington DC, 65-77.

Calamari, D. et al. (1983). Toxicity of selected chlorobenzenes to aquatic organisms. Chemosphere **12**, (2), 253-262.

Casillas, E. et al. (1983). Relationship of serum chemistry values to lever and kidney histopathology in English sole (Parophrys vetulus) after acute exposure to carbon tetrachloride. Aquat. Tox. **3**, (1), 61-78.

Casillas, E. and Ames, W. (1986). Hepatotoxic effects of CCl_4 on English sole (Parophrys vetulus): possible indicators of liver dysfunction. Comp. Biochem. Physiol. **84C**, (2), 397-400.

Dangé A.D. and Masurekar V.B. (1981). Toluene toxicity effects of sublethal levels on enzyme activities in seawater adapted tilapia (Sarotherodon mossambicus Peters). J. Biosci. **3**, (2), 129-134.

Davis, H.C. (1961). Effects of some pesticides on eggs and larvae of oysters (Crassostrea virginica) and clams (Venus mercenaria). Commercial Fischeries Review **23**, (12), 8-23.

Donahue, W.H. et al. (1977). Effects of water-soluble components of petroleum oils and aromatic hydrocarbons on barnacle larval. Environ. Pollut. **13**, 187-202.

Eldridge, M. B. et al. (1977). Energetics of pacific herring (Clupea harengus pallasi) embryos and larvae exposed to low concentrations of benzene, a monoaromatic component of crude oil. Trans. Am. Fish. Soc. **106**, (5), 452-461.

Erben, R. (1978). Effects of some petrochemical products on the survival of Dicranophorus forcipatus O.F. Müller (Rotatoria) under laboratory conditions. Verh. Internat. Verein. Limnol. **20**, 1988-1991.

Erickson, S.J. and Hawkins, C.E. (1980). Effects of halogenated organic compounds on photosynthesis in estuarine phytoplankton. Bull. Environ. Contam. Toxicol. **24**, 910-915.

Garrett, J.T. (1957). Toxicity investigations on aquatic and marine life. Public Works **88**, 95-96.

Giam, C.S. and Dou, H.J.M. (eds) (1984). Strategies and advanced techniques for marine pollution studies: Mediteranean Sea. Nato ASI Series, Serie G: Ecological Science 9, Springer-Verlag.

GoksØyr, A. et al. (1991). Immunochemical detection of cytochrome P450IA1 induction in cod larvae and juveniles exposed to a water-soluble fraction of north sea crude oil. Marine Poll. Bull. **22**, (3), 122-127.

Grosch, D.S. (1973). Reproduction tests: The toxicity for Artenia of derivates from non-persistent pesticides. Biol. Bull. **145**, 340-351.

Hansen, D.J. et al. (1977). Endrin: effects on the entire life cycle of a saltwater fish, Cyprinodon variegatus. J. Toxicol. Environ. Health **3**, 721-733.

Harwig, J. and Scott, P.M. (1971). Brine shrimp (Artemia salina L.) larvae as a screening system for fungal toxins. Applied Microbiology **21**, (6), 1011-1016.

Idoniboye-Obu, B. (1979). Toxicity of isolates water-soluble C^6 petroleum hydrocarbons to lobsters, Homaurus americanus. In: Nielsen et al (eds), Symp: Animals as monitors of environmental pollutans, Storrs, C.N., 383-384.

Jensen, S. et al. (1975). On the chemistry of EDC-tar and its biological significance in the sea. Proc. R. Soc. Lond. B. 189, 333-346.

Jernelov, A. et al. (1972). Biologial effects and physical properties in the marine environment of aliphatic chlorinated by-products from vinyl chloride production. Water Research Pergamon Press **6**, 1181-1191.

Jones, H.R. (1971). Environmental control in the organic and petrochemical industies. Noyes Data Corporation, New Jersey, 257 pp.

KjØrsvik, E. et al. (1982). Effects of short-term exposure to xylenes on the early cleavage stages of cod eggs (Gadus morhua, L.). Sarsia **67**, 299-308.

Klapow, L.A. and Lewis, R.H. (1979). Analysis of toxicity data for California marine water quality standards. J. Water Poll. Contr. Fed. **51**, (8), 2054-2070.

Kontogiannis, J.E. and Barnett, C.J. (1973). The effect of oil pollution on survival of the tidal pool copepod, Tigriopus californicus. Environ. Pollut. **4**, 67-79.

Korn, D. (1976). Effect of benzene on growth, fat content, and caloric content of stripes bass, Morone saxatilis. Fishery Bulletin/Fish and Wildlife Service, U.S. Dept. of the Interior **74**, Washington, 1941.

Laska, A.L. et al. (1978). Acute and chronic effects of hexachlorobenzene and hexachlorobutadiene in Red Swamp Crayfish (Procambarus clarki) and selected fish species. Toxicology and Applied Pharmacology **43**, 1-12.

Le Roux, S. and Lucas, A. (1978). Techniques d'etude des effets des hydrocarbures sur la physiologie des larves de moules. Rev. Int. Océanogr. Méd. **49**, 75-79.

Linder, R. et al. (1980). Acute and subchronic toxicity of pentachlorobenzene. J. Environ. Path. Toxicol. **4**, 183-196.

Loekle, D.M. et al. (1983). Effects of chloroform, tetrachloroethylene and trichloroethylene on survival, growth and liver of Poecilia sphenops. Bull. Environ. Contam. Toxicol. **30**, 199-205.

MacFarlane, R.B. and Benville, P.E. (1986). Primary and secondary stress responses of striped bass (Morone saxatilis) exposed to benzene (effect: primary and secondary stress respons). Marine Biology **92**, 245-254.

MacKenzie, C.L. and Shearer, L.W. (1959). Chemical control of Polydora websteri and other annelids inhabiting oyster shells. Proc. Nat. Shellfish. Assoc. 50, Washington, 1980.

Major, C.W. (1977). The effect of pure oil subcomponents on Mytilus edulis, the blue mussel. In: Vernberg, F.J. (eds.). Physiol. Respons Mar. Biota Pollut. Academic Press, New York 315-322.

Maynard, D.J. and Weber, D.D. (1981). Avoidance reactions of juvenile Coho salmon (Oncorhynchus kisutch) to monocyclic aromatics. Can. J. Fish. Aquat. Sci. **38**, 772-778.

McConnell, G. et al. (1975). Chlorinated hydrocarbons and the environment. Endeavour **34**, (121), 13-18.

McLeese, D.W. and Metcalfe, C.D. (1980). Toxicities of eight organochlorine compounds in sediment and seawater to Crangon septemspinosa. Bull. Environ. Contam. Toxicol. **25**, 921-928.

Mehlman, M.A. et al. (1984). Advances in modern environmental toxicology, volume 7. Renal effects of petroleum hydrocarbons. Princeton Scientific Publishers Inc., New Jersey.

Moles, A. et al. (1981). Reduced growth of Coho salmon fry exposed to two petroleum components, toluene and naphthalene, in fresh water. Trans. Am. Fish. Soc. **110**, 430-436.

National academy of sciences (1975). Assesing potential ocean pollutants, Washington DC, 438 pp.

Neff. J. M. and Anderson, J.W. (1975). An Ultraviolet Spectrophotometric Method for the determination of napthalene and alkylnapthalenes in the tissues of oil-contaminted marine animals. Bull. Environ. Contam. Toxicol. **14**, 122-128.

Oshida, P.S. (1977). Toxicity of a chlorinated benzene to sea urchin embryos. Coastal Water Res. Proj. Ann. Rap. (South California) 187-192.

Pagano, G. et al. (1978). Embryotoxic and teratogenic effects of styrene derivatives on sea urchin development. Scand.j. Work. Environ. Health **4**, (2), 136-141.

Persoone, G. and Uyttersprot, G. (1975). The influence of inorganic and organic pollutants on the rate of reproduction of an marine hypotrichous ciliate: Euplotes vannus muller. Rev. Intern. Oceánogr. Méd. **37-38**, 125-151.

Pill, K.G. (1991). Estimating the toxicity of chlorinated organic compounds using a multiparameter bacterial bioassay. Environ. Toxicol. Water Qual. **6**, 271-291.

Reish, D. et al. (1979). Marine and estuarine pollution. J. Water Pollut. Control Fed. **51**, (6), 1477-1517.

Robinson, A.B. et al. (1965). Anesthesia of Artemia larvae: method for quantitative study. Science **149**, 1255-1258.

Rogerson, A. et al. (1983). Determination and interpretation of hydrocarbon toxicity to ciliate protozoa. Aquatic Toxicology **3**, 215-228.

Rosenberg, R. (1972). Effects of chlorinated aliphatic hydrocarbons on larval and juvenile Balanus balanoides (L.). Environ. Pollut. **3**, 313-318.

Samoiloff, M.R. et al. (1980). A rapid simple long-term toxicity assay for aquatic contaminants using the nematode Panagrellus redivivus. Can. J. Fish. Aquat. Sci. **37**, 1167-1174.

Schultz, T.W. et al. (1978). Structure-toxicity correlations of organic contaminants in aqueous coal-conversion effluents. Arch. Environ. Contam. Toxicol. **7**, 457-463.

Sicko-Goad, L. et al. (1989). Effects of chlorinated benzenes on diatom fatty acid composition and quantitative morphology.IV, Pentachlorobenzene and comparison with trichlorobenzene isomers. Archiv. Environ. Contam. Toxicol. **18**, (5), 656-668.

Skinner, C.E. (1972). The role of algae in the deterioration of decorative and marine paints. FATIPEC Cong. **11**, 421-427.

Tagatz, M.E. et al. (1985). Effects of 1,2,4-trichlorobenzene on estuarine macrobenthic communities exposed via water and sediment. Ecotoxicol. Environ. Safe. **10**, 351-360.

Tagatz, M.E. et al. (1986). Toxicity of dibutyl phthalate-contaminated sediment to laboratory- and field- colonized estuarine benthic communities. Bull. Environ. Contam. Toxicol. **37**, 141-150.

Thurston, R.V. et al. (1985). Compartive toxicity of ten organic chemicals to ten common aquatic species. Water Res. **19**, (9), 1145-1155.

Young, L.Y. an Mitchell, R. (1973). Negative chemotaxis of marine bacteria to toxic chemicals. Applied Microbiology **25**, 972-975.

Appendix 4. Toxicity data for soil organisms

Legenda:

art. soil	artificial soil
% om	% organic matter (if presented in % organic carbon a factor of 1.7 was used to calculate % om)
exp. time	exposure time
criterion	LC: lethal concentration; EC: effect concentration; NOEC: no observed effect concentration
test time	h: hours; d: days
st. soil	standard soil (10 % om and 25% clay)

Content:

Table 4.1 Toxicity to soil organisms, data used for extrapolation

organism	soil	pH	% o.m.	% clay	temp °C	exp. time	criterion	result test soil mg/kg dw	result st. soil[a] mg/kg dw	reference
1,2-DICHLOROPROPANE										
Oligochaeta										
Eisenia foetida Allolobophora tuberculata Eudrilus eugeniae Perionyx excavatus	art. soil	6	10[b]	20[b]	20	14 d	LC50	4,240	4,240	Neuhauser, 1986
TETRACHLOROETHYLENE										
Oligochaeta										
Eisenia foetida	art. soil	6	10[b]	20[b]		14 d	LC50	155	155	Vonk et al., 1986
TOLUENE										
Plants										
Lactuca sativa	OECD	7.8	1.4	12	20	14 d 7 d	EC50[c] NOEC[c]	>1000 100	>140 14	Adema & Henzen 1990
Oligochaeta										
Eisenia foetida	art. soil	6	10[b]	20[b]		28 d	NOEC[d]	49.6[b]	155	Vonk et al., 1986

a = test result converted to standard soil with a % o.m. of 10
b = estimated from value presented by the author
c = growth
d = cocoon production

References table 4.1

Adema, D.M.M., and Henzen, L. (1990). De invloed van 50 prioritaire stoffen op de groei van Lactuca sativa (sla). TNO report No. R90/101 (in Dutch).

Denneman, C.A.J., van Gestel, C.A.M. (1990). Bodemverontreiniging en bodemecosystemen: voorstel voor C-(toetsings)waarden op basis van ecotoxicologische risico's. RIVM report No. 72501001 (in Dutch).

Neuhauser, E.F., Durkin, P.R., Malecki, M.R., and Anatra, M. (1986). Comparative toxicity of ten organic chemicals to four earthworm species. Comp. Biochem. Physiol. 83C, 197-200.

Vonk, J.W., Adema, D.M.M., and Barug, D. (1986). Comparison of the effects of several chemicals on microorganisms, higher plants and earthworms. In: J.W. Assink and W.J. van den Brink (eds) Contaminated Soil, Martinus Nijhoff Publishers, Dordrecht, p. 191-202.

Table 4.2 Toxicity to soil organisms, data from deviating tests

organism	soil	pH	% o.m.	% clay	temp °C	exp. time	criterion	result test soil mg/kg dw	result st. soil[a] mg/kg dw	reference
DICHLOROMETHANE										
enzymatic activities:										
ß-glucosidase	Ap-horizon (arable brown soil)	6.8	2.45		25	14 d	EC50	10[b]	39	Kanazawa and Filip, 1986
							NOEC	1	3.9	
ß-a[illegible]ylglucosaminidase	Ap-horizon (arable brown soil)	6.8	2.45		25	3 d	EC20	10[c]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
proteinase	Ap-horizon (arable brown soil)	6.8	2.45		25	28 d	EC63	10[c]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
phosphatase	Ap-horizon (arable brown soil)	6.8	2.45		25	28 d	EC65	10[b]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
phosphodiesterase	Ap-horizon (arable brown soil)	6.8	2.45		25	14 d	EC59	10[b]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
1,3-DICHLOROPROPENE										
enzymatic activity										
N_2-f[illegible]ing	sandy loam	7.8	2.9		28	6 d	NOEC[d]	>300[e]	>1040	Tu, 1978
								>60[f]	>210	
								>60[g]	>210	
								>60[h]	>210	
								>80[i]	>280	
N_2-fixing	organic soil	7.6	49.3		28	6 d	NOEC[d]	>300[e]	>61	Tu, 1979
								>60[f]	>12	
								>60[g]	>12	
								>60[h]	>12	
								>80[i]	>16	
N_2-fixing	clay loam	7.2	1.75		28	7 d	NOEC[d]	>300[e]	>1710	Tu, 1981b
								>60[f]	>340	
								>60[g]	>340	
								>60[h]	>340	
								>80[i]	>460	

organism	soil	pH	% o.m.	% clay	temp °C	exp. time	criterion	result test soil mg/kg dw	st. soil[a] mg/kg dw	reference
dehydrogenase										
	organic soil ('well drained': 172% moisture holding capacity)	7.2	45.6		28	14 d	NOEC	>300[e]	>66	Tu, 1981a
								>60[f]	>13	
								>60[g]	>13	
								>60[h]	>13	
								>80[i]	>18	
	clay loam	7.2	1.75			7 d	NOEC	>300[e]	>1710	Tu, 1981b
								>60[f]	>340	
								>60[g]	>340	
								>60[h]	>340	
								>80[i]	>460	
urease										
	organic soil ('well drained': 172% moisture holding capacity)	7.2	45.6		28	14 d	NOEC	>300[e]	>66	Tu, 1981a
								>60[f]	>13	
								>60[g]	>13	
								>60[h]	>13	
								>80[i]	>18	
	clay loam	7.2	1.75			7 d	NOEC	>300[e]	>1710	Tu, 1981b
								>60[f]	>340	
								>60[g]	>340	
								>60[h]	>340	
								>80[i]	>460	
phosphatase										
	organic soil ('well drained': 172% moisture holding capacity)	7.2	45.6		28	2 h	NOEC	>300[e]	>66	Tu, 1981a
							NOEC	>60[f]	>13	
							EC45	30[g]	7	
							EC34	30[h]	7	
							EC30	40[i]	9	
	clay loam	7.2	1.75			2 h	EC31	>300[e]	>1710	Tu, 1981b
							NOEC	>60[f]	>340	
							NOEC	>60[g]	>340	
							NOEC	>60[h]	>340	
							EC27	>80[i]	>460	
bacteria										
non-symbiotic nitrogen fixers	sandy loam	7.8	2.9		28	6 d	NOEC	>300[e]	>1040	Tu, 1978
								>60[f]	>210	
								>60[h]	>210	
								>60[i]	>210	
								>80[j]	>280	
non-symbiotic nitrogen fixers	organic soil	7.6	49.3		28	7 d	NOEC	>300[e]	>61	Tu, 1979
								>60[f]	>12	
								>60[g]	>12	
								>60[h]	>12	
								>80[i]	>16	

organism	soil	pH	% o.m.	% clay	temp °C	exp. time	criterion	result test soil mg/kg dw	st. soil[a] mg/kg dw	reference
non-symbiotic nitrogen fixers	clay loam	7.2	1.75			7 d	NOEC	>300[e]	>1710	Tu, 1981b
								>60[f]	>340	
								>60[g]	>340	
								>60[h]	>340	
								>80[i]	>460	
bacteria	sandy loam	7.8	2.9		28	6 d	NOEC	>300[e]	>1040	Tu, 1978
							NOEC	>60[f]	>210	
							EC17	60[g]	210	
							NOEC	>60[h]	>210	
							NOEC	>80[i]	>280	
bacteria	organic soil	7.6	49.3		28	7 d	NOEC	>300[e]	>61	Tu, 1979
								>60[f]	>12	
								>60[g]	>12	
								>60[h]	>12	
								>80[i]	>16	
fungi										
fungi	sandy loam	7.8	2.9		28	6 d	NOEC	>300[e]	>1040	Tu, 1978
							NOEC	>60[f]	>210	
							NOEC	>60[g]	>210	
							NOEC	>60[h]	>210	
							EC30	80[i]	280	
fungi	organic soil	7.6	49.3		28	7 d	NOEC	>300[e]	>61	Tu, 1979
								>60[f]	>12	
								>60[g]	>12	
								>60[h]	>12	
								>80[i]	>16	
TRICHLOROETHYLENE										
enzymatic activities:										
ß-glucosidase	Ap-horizon (arable brown soil)	6.8	2.45		25	56 d	EC23	10[c]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
ß-acetylglucosaminidase	Ap-horizon (arable brown soil)	6.8	2.45		25	3 d	EC11	1[c]	3.9	Kanazawa and Filip, 1986
						56 d	NOEC	0.1	0.39	
proteinase	Ap-horizon (arable brown soil)	6.8	2.45		25	56 d	EC74	10[c]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
phosphatase	Ap-horizon (arable brown soil)	6.8	2.45		25	28 d	EC81	10[b]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
phosphodiesterase	Ap-horizon (arable brown soil)	6.8	2.45		25	56 d	EC56	10[c]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	

organism	soil	pH	% o.m.	% clay	temp °C	exp. time	criterion	result test soil mg/kg dw	st. soil[a] mg/kg dw	reference
TETRACHLOROETHYLENE										
Oligochaeta										
Eisenia foetida	art. soil	6	10[j]	20[j]		14 d	NOEC[k]	<28[l]	<28	Vonk et al., 1986
							LC50	155	155	
microbial processes										
nitrification										
	sand	5.2	6[j]	5[j]		28 d	NOEC	<45.5	<75.8	Vonk et al., 1986
	loam	7	3[j]	18[j]		28 d	NOEC	<0.13[l]	<0.43	
respiration										
	sand	5.2	6[j]	5[j]		5 h	NOEC	<2,274	<3,790	Vonk et al.)86
	loam	7	3[j]	18[j]		5 h	NOEC	<2,492	<8,307	
enzymatic activities										
ß-glucosidase										
	Ap-horizon (arable brown soil)	6.8	2.45		25	28 d	EC29	10[b]	39	Kanazawa and Filip, 1986
						56 d	NOEC	>10	>39	
ß-acetylglucosaminidase										
	Ap-horizon (arable brown soil)	6.8	2.45		25	28 d	EC26	10[b]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
proteinase										
	Ap-horizon (arable brown soil)	6.8	2.45		25	7 d	EC43	10[c]	39	Kanazawa and Filip, 1986
						56 d	NOEC	1	3.9	
phosphatase										
	Ap-horizon (arable brown soil)	6.8	2.45		25	56 d	NOEC	>10	>39	Kanazawa and Filip, 1986
phosphodiesterase										
	Ap-horizon (arable brown soil)	6.8	2.45		25	14 d	EC67	10[b]	39	Kanazawa ar Filip, 1986
						56 d	NOEC	1	3.9	
TOLUENE										
Oligochaeta										
Eisenia foetida	art. soil	6	10[j]	20[j]		28 d	LC50	155[j]	155	Vonk et al., 1986
microbial processes										
nitrification										
	sand	5.2	6[j]	5[j]		28 d	NOEC	<20	<12	Vonk et al., 1986
	loam	5.2	3[j]	18[j]		28 d	NOEC	<20	<6	
respiration										
	sand	5.2	6[j]	5[j]		6 h	NOEC	300[k]	180	Vonk et al., 1986
	loam	5.2	3[j]	18[j]		6 h	NOEC	300[k]	90	

a = test result converted to standard soil with a % o.m. of 10
b = maximal inhibition, disappeared after 56 days (results presented only as diagram)
c = maximal inhibition (results presented only as diagram)
d = ethene reduction
e = test carried out with formulation DD (57.2% 1,3-dichloropropene, ≤34.0% 1,2-dichlororpropane and several other C_3 hydrocarbons)
f = test carried out with formulation Telone (≥78% 1,3-dichloropropene, ≤20.5% related chlorinated hydrocarbons, and 1.5% epichlorohydrin)
g = test carried out with formulation Telone C (85% 1,3-dichloropropene and related C_3 hydrocarbons and 15% chloropicin)
h = test carried out with formulation Telone II (92% 1,3-dichloropropene and related C_3 hydrocarbons and 12% chloropicin)
i = test carried out with formulation Vorlex (80% 1,3-dichloropropene and related C_3 hydrocarbons and 20% methyl isothiocyanate)
j = estimated from value presented by the author
k = cocoon production
l = % effect not presented
m = % effect 32

Refe ces table 4.2

Kanazawa, S., and Filip, Z. (1986). Effects of trichloroethylene, tetrachloroethylene and dichloromethane on enzymatic activities in soil. Appl. Microbiol. Biotechnol. **25**, 76-81.

Tu, C.M. (1978). Effect of pesticides on acetylene reduction and microorganisms in a sandy loam. Soil Biol. Biochem. **10**, 451-456.

Tu, C.M. (1979). Influence of pesticides on acetylene reduction and growth of microorganisms in an organic soil. J. Environ. Sci. Health **B14**, (6), 617-624.

Tu, C.M. (1981a). Effects of some pesticides on enzyme activities in an organic soil. Bull. Environm. Contam. Toxicol. **27**, 109-114.

Tu, C.M. (1981b). Effects of pesticides on activities of enzymes and microorganisms in a clay soil. J. Environ. Sci. Health **B16**, (2), 179-191.

Vonk, J.W., Adema, D.M.M., and Barug, D. (1986). Comparison of the effects of several chemicals on microorganisms, higher plants and earthworms. In: J.W. Assink and W.J. van den Brink (eds) Contaminated Soil, Martinus Nijhoff Publishers, Dordrecht, p. 191-202.

Refe ces evaluated but rejected

Armstrong, A.Q., et al. (1991). Environmental factors affecting toluene degradation in ground water at a hazardous waste site. Environ. Toxicol. Chem. **10**, (2), 147-158.

Fortnum, B.A., et al. (1990). Spring or fall fumigation for control of Meloidogyne spp. on tobacco. Suppl. to Journal of Nematology, **22(4S)**, 645-650.

Ivens, G.W. (1952). The phytotoxicity of mineral oils and hydrocarbons. Ann. Appl. Biol. **39**, 418-422.

Swanwick, J.D., and Foulkes, M. (1971). Inhibition of anaerobic digestion of sewage sludge by chlorinated hydrocarbons. Wat. Pollut. Control 58-70.

Roberts, B.L., and Dorough, H.W. (1984). Relative toxicities of chemicals to the earthworm Eisenia foetida. Environ. Toxicol. and Chem. **3**, 67-78.

Watson, B., et al. (1989). Physicochemical properties as predictors of organic chemical effects on soil microbial respiration. Environ. Toxicol. Chem. **8**, 53-63.

Weingartner, D.P., and Shumaker, J.R. (1990). Effects of soil fumigants and aldicarb on nematodes, tuber quality, and yield in potato. Suppl. to Journal of Nematology **22(4S)**, 767-774.

Appendix 5. Toxicity data used for extrapolation

Table 5.1. Freshwater organisms: NOEC and L(E)C50 values (in mg/l) used in the method of Aldenberg and Slob and the modified EPA method: Data set I (studies which meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance).

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	modified EPA L(E)C50
acrylonitril	crustaceans			7.6
3-chloropropene	bacteria	58		
	blue algae	4.1		
	green algae	3.2		
	protozoans	4.3		
		4.2		
1,2-dichloroethane	bacteria	68		
	blue algae	53		
	green algae	360		
	protozoans	470		
		560		
		530		
	crustaceans	11		
	fish	29		
1,2-dichloropropane	fish		6	
	crustaceans			45
1,3-dichloropropene	fish			6.1
ethylbenzene	bacteria	6		
	blue algae	17		
	green algae	1		
	protozoans	470		
		70		
ethylene oxide	fish			84
2-monochlorotoluene	bacteria	8		
	blue algae	16		
	green algae	29		
	crustaceans	0.21		

compound	taxonomic group	Aldenberg & Slob NOEC	EPA NOEC	L(E)C50
4-monochlorotoluene	crustaceans		0.32	3.6
styrene	blue algae		34	
	crustaceans			23
tetrachloroethene	crustaceans		0.51	
	fish			4.9
1,1,1-trichloroethane	bacteria	47		
	blue algae	180		
	green algae	220		
	crustaceans	1.3		
	fish	7.7		
1,1,2-trichloroethane	bacteria	47		
	blue algae	180		
	green algae	220		
	molluscs	10		
	crustaceans	13		
	fish	18		
trichloroethene	bacteria	33		
	blue algae	32		
	green algae	180		
	protozoans	600		
	fish	5.8		
trichloromethane	bacteria	63		
	blue algae	93		
	green algae	550		
		110		
	crustaceans	9.7		
2-xylene	green algae		1	
	crustaceans			2.3
3-xylene	green algae		0.7	
	green algae			4.9
4-xylene	green algae		0.9	
	fish			2.6

Table 5.2. Freshwater organisms: NOEC and L(E)C50 values (in mg/l) used in the method of Aldenberg and Slob and the modified EPA method: Data set II (stringent selection based on maintenance of the test concentrations from data set I).

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	modified EPA L(E)C50
acrylonitril	crustaceans			9.3
3-chloropropene	bacteria		58	
	amphibians			0.34
1,2-dichloroethane	crustaceans		11	
	fish			130
1,2-dichloropropane	fish		6	
	crustaceans			45
1,3-dichloropropene	fish			6.1
ethylbenzene	green algae		1	
	crustaceans			2.1
2-monochlorotoluene	crustaceans		0.21	
4-monochlorotoluene	crustaceans		0.32	
				3.6
styrene	bacteria		36	
	crustaceans			23
tetrachloroethene	crustaceans		0.51	
	fish			4.9
1,1,1-trichloroethane	crustaceans		1.3	
	bacteria			8
1,1,2-trichloroethane	bacteria	47		
	molluscs	10		
	crustaceans	13		
	fish	18		
trichloroethene	fish		5.8	
	crustaceans			13[1]
trichloromethane	crustaceans		9.7	
	fish			18

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	modified EPA L(E)C50
2-xylene	green algae		1	
	crustaceans			2.3[2]
3-xylene	green algae		0.7	
	green algae			4.9
4-xylene	green algae		0.9	
	fish			2.6

1 geometric mean of two EC50 values of 7.8 and 21 mg/l for *Daphnia magna*

2 geometric mean of three EC50 values of 1, 3.8 and 3.2 mg/l for *Daphnia magna*

Table 5.3. Saltwater organisms: NOEC and L(E)C50 values (in mg/l) used in the method of Aldenberg and Slob and the modified EPA method: Data set I (studies which meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance).

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	modified EPA L(E)C50
acrylonitril	fish			25
1,2-dichloroethane	worms		200	
	crustaceans			94
1,2-dichloropropane	green algae			50
1,3-dichloropropene	green algae			0.8
ethylbenzene	crustaceans			0.49
ethylene oxide	crustaceans			745
2-monochlorotoluene	fish			7.8
3-monochlorotoluene	crustaceans			25
4-monochlorotoluene	crustaceans			15
styrene	fish			9.1
tetrachloroethene	molluscs			3.5
1,1,1-trichloroethane	fish			71
1,1,2-trichloroethane	fish		3	
	fish			34
trichloroethene	worms		25	
	green algae			8
trichloromethane	green algae		200	
2-xylene	crustaceans			1.3
3-xylene	crustaceans			3.7
4-xylene	crustaceans, fish			2

Table 5.4. Saltwater organisms: NOEC and L(E)C50 values (in mg/l) used in the method of Aldenberg and Slob and the modified EPA method: Data set II (stringent selection based on maintenance of the test concentrations from data set I).

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	modified EPA L(E)C50
1,2-dichloroethane	worms		200	
	crustaceans			94
1,2-dichloropropane	green algae			61
ethylbenzene	crustaceans			0.49
tetrachloroethene	fish			5
1,1,2-trichloroethane	fish		3	
	fish			34
trichloroethene	worms		25	
	crustaceans			14
2-xylene	crustaceans			1.3
3-xylene	crustaceans			3.7
4-xylene	crustaceans			2

Table 5.5. Fresh and saltwater organisms: NOEC and L(E)C50 values (in mg/l) used in the method of Aldenberg and Slob and the modified EPA method: Data set I (studies which meet the reliability criteria according to OECD guidelines, without selecting on special precautions for concentration maintenance).

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	modified EPA L(E)C50
acrylonitril	crustaceans			7.6
3-chloropropene	bacteria	58		
	blue algae	4.1		
	green algae	3.2		
	protozoans	4.3		
		4.2		
1,2-dichloroethane	bacteria	68		
	blue algae	53		
	green algae	360		
	protozoans	470		
		560		
		530		
	worms	200		
	crustaceans	11		
	fish	29		
1,2-dichloropropane	fish		6	
	crustaceans			45
1,3-dichloropropene	crustaceans			0.8
ethylbenzene	bacteria	6		
	blue algae	17		
	green algae	1		
	protozoans	470		
		70		
ethylene oxide	fish			84
2-monochlorotoluene	bacteria	8		
	blue algae	16		
	green algae	29		
	crustaceans	0.21		
3-monochlorotoluene	crustaceans			25
4-monochlorotoluene	crustaceans		0.32	
				3.6

compound	taxonomic group	Aldenberg & Slob NOEC	EPA NOEC	L(E)C50
styrene	blue algae		34	
	fish			9.1
tetrachloroethene	crustaceans		0.51	
	molluscs			3.5
1,1,1-trichloroethane	bacteria	47		
	blue algae	180		
	green algae	220		
	crustaceans	1.3		
	fish	7.7		
1,1,2-trichloroethane	bacteria	47		
	blue algae	180		
	green algae	220		
	molluscs	10		
	worms	33		
	crustaceans	13		
		10		
	fish	18		
		3		
trichloroethene	bacteria	33		
	blue algae	32		
	green algae	180		
	protozoans	600		
	worms	25		
	fish	5.8		
trichloromethane	bacteria	63		
	blue algae	93		
	green algae	550		
		110		
		220		
	crustaceans	9.7		
2-xylene	green algae		1	
	crustaceans			1.3
3-xylene	green algae		0.7	
	crustaceans			3.7
4-xylene	green algae		0.9	
	fish, crustaceans			2.0

Table 5.6. Fresh and saltwater organisms: NOEC and L(E)C50 values (in mg/l) used in the method of Aldenberg and Slob and the modified EPA method: Data set II (stringent selection based on maintenance of the test concentrations from data set I).

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	L(E)C50
acrylontril	fish			9.3
3-chloropropene	bacteria		58	
	amphibians			0.34
1,2-dichloroethane	bacteria	68		
	worms	200		
	crustaceans	11		
	fish	29		
1,2-dichloropropane	fish		6	
	crustaceans			45
1,3-dichloropropene	fish			6.1
ethylbenzene	green algae		1	
	crustaceans			0.49
2-monochlorotoluene	crustaceans		0.21	
4-monochlorotoluene	crustaceans		0.32	
				3.6
styrene	bacteria		36	
	crustaceans			23
tetrachloroethene	crustaceans		0.51	
	fish			4.9
1,1,1-trichloroethane	crustaceans		1.3	
	bacteria			8
1,1,2-trichloroethane	bacteria	47		
	molluscs	10		
	worms	33		
	crustaceans	13		
		20		
	fish	18		
		3		

compound	taxonomic group	Aldenberg & Slob NOEC	modified EPA NOEC	L(E)C50
trichloroethene	fish crustaceans		5.8	13[1]
trichloromethane	crustaceans fish		9.7	18
2-xylene	green algae crustaceans		1	1.3
3-xylene	green algae crustaceans		0.7	3.7
4-xylene	green algae crustaceans		0.9	2.0

1 geometric mean of two EC50 values of 7.8 and 21 mg/l for *Daphnia magna*