TA-2140/2005

A study of the priority substances of the Water Framework Directive

Monitoring and need for screening

sft: Bergfald & Co as

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This report has been produced by Bergfald & Co on behalf of the Norwegian Pollution Control Authority (SFT). The sections on analysis and detection limits are written by Martin Slabach at the Norwegian Institute for Air Research (NILU).

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CONTENTS

Introduction.....6
Methods.....8

Priority substances in the Water Framework Directive (WFD).....10
1 Alachlor 12
2 Anthracene 14
3 Atrazine 15
4 Benzene 17
5 Pentabromodiphenylether, PeBDE 19
6 Cadmium and its compounds 21
7 C10-C13 chloroalkanes (SCCP) 24
8 Chlorfenvinphos 26
9 Chlorpyrifos 28
10 Dichloroethane (EDC) 30
11 Dichloromethane 32
12 Di(2-ethylhexyl)phthalate (DEHP) 33
13 Diuron 35
14 Endosulfan 37
15 Fluoranthene 39
16 Hexachlorobenzene (HCB) 40
17 Hexachlorobutadiene (HCBD) 43
18 Hexachlorocyclohexane (HCH) 44
18 b Lindane 46
19 Isoproturon 49
20 Lead and its compounds 51
21 Mercury and its compounds 54
22 Naphthalene 57
23 Nickel and nickel compounds 58
24 Nonylphenols 60
25 Octylphenols 62
26 Pentachlorobenzene 63
27 Pentachlorophenol/PCP 65
28 Polyaromatic hydrocarbons (PAH) 67
29 Simazine 70
30 Tributyltin compounds 72
31 Trichlorobenzene 74
32 Trichloromethane/chloroform 75
33 Trifluralin 77

Substances with special interest for Norway.....79
a Copper 80
b Zinc 82
c Chromium 84
d Arsenic 86
e PCB 88
f Polychlorinated dibenzodioxins and dibenzofurans (dioxins) 91
g C14-C17 chloroalkanes (MCCP) 93
h Perfluoroalkyl compounds (PFAS) 95

Appendix a.....97
Detection limits and measurement uncertainty 97

Appendix b.....99
SFT's classification system for water, sediment and biota in fresh and salt water 99

Appendix c.....102
Short list of words and terms 102

Appendix d.....103
Map over Norway with counties 103

INTRODUCTION

The Norwegian Pollution Control Authority (SFT) has commissioned a literature study of the 33 priority substances in the Water Framework Directive (WFD). SFT also added 8 substances with special interest for Norway. The study has been conducted within a limited time frame, and is a compilation of available literature on the substances. No new research has been performed.

The study has been commissioned by the SFT for three main reasons:
1. It is designed to provide an overview of all monitoring in Norway of the 33 substances on the WFD list.
2. It will provide much needed background information for important decisions on which substances that will be included in new monitoring and screening programmes and which matrix's should be investigated.

CAS	Substance	Need for screening
85535-84-8	C10-13-chloroalkanes	There is a need for further screening of SCCA in marine and fresh water sediment as well as in biota.
470-90-6	Chlorfenvinphos	There is a need for new screening of chlorfenvinphos in rivers and streams.
107-06-2	1,2-Dichloroethane	Further screening may be necessary around the Hydro Rafnes plant in Grenland.
117-81-7	Di(2-ethylhexyl)phthalate (DEHP)	DEHP should be screened in marine and fresh water sediment and in marine and fresh water biota.
87-68-3	Hexachlorobutadiene	There may be a need for screening close to three different industrial sites.
34123-59-6	Isoproturon	The levels found in Norwegian environment are low, but data are very limited. Isoproturon should be included in future screening of both marine and fresh water environment.
25154-52-3	Nonylphenols (incl. 4-(para)-nonylphenol)	Nonylphenol and nonylphenol ethoxylates should be screened again in marine sediments. In addition, screening should be done in fresh water sediment and marine and fresh water biota.
1806-26-4	Octylphenols (incl. para-tert-octylphenol)	Octylphenols should be screened together with Nonylphenols, at the same localities.
608-93-5	Pentachlorobenzene	There is no need for a screening of pentachlorobenzene, but the substance should be investigated in connection with Lindane monitoring.
87-86-5	Pentachlorophenol	PCP in construction wood and pallets are monitored in Denmark. PCP in such wood should be screened, in order to asses the risk of dioxin emissions from incineration of pallets and construction wood, as biofuel is excluded from waste incineration regulations, and does not have to use filters to clean emissions. There is also a need for screening of PCP in Norwegian environment. This screening should be done on places where PCP pollution should be expected, such as wood treatment plants, window production plants etc.
12002-48-1	Trichlorobenzenes (incl. 1,2,4-Trichlorobenzene)	Trichlorobenzene should be screened in marine and fresh water sediment and biota.
	Chromium	Chromium should be screened in marine sediments.
	Arsenic	Arsenic should be screened in marine sediments and in marine biota. It should also be screened in fresh water biota.
	MCCP	MCCP was screened in 2003. This screening should be repeated within a few years in order to get a trend.
	PFAS	There is a need for screening of PFAS close to producers of greaseproof paper.

Table 1: *Suggestions for screening*

3. The study can be used as basis for deciding upon which substances that should not be included in the monitoring programmes within the WFD for Norway.

The bulk of the report consists of fact sheets for the 33 WFD priority substances and eight additional substances and recommendations regarding future screening of these.

Among the 33 substances in the WFD there are 12 pesticides and biocides, 4 metals, 3 PAHs and 1 fact sheet for generic PAH. Among the 8 "Norwegian" substances there are 4 metals, PCB, MCCP, dioxins and PFOS. The fact sheets for these substances are less detailed regarding physical-chemical and toxicological properties.

Based on the information compiled in this report Bergfald & Co has recommended screening of some substances. Further monitoring is also necessary for several substances. Information about monitoring is given in the individual fact sheets.

METHODS

There have been used a wide range of sources. Where material has been unavailable from published reports, contacts have been made to key personnel in the Norwegian Food Control Authority, the Swedish Chemical Inspectorate, Norwegian Institute for Marine Research etc.

In the descriptions of toxicity and general properties we have primarily used data from four sources: CIRCA fact sheets, WHO's environmental health criteria's (if available), HSDB (Hazardous Substances Data Bank, Toxnet, at the United States National Library of Medicine), and ClassLab. We have also used EXTOXNET (a cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University, and the University of Idaho) on all pesticides. In addition we have checked all substances against the EU list of suspected endocrine disruptors. For some substances, especially where data have been hard to find, we have used other sources.

Where possible we have tried to find quantitative data on toxicological effects. No-effect values have proved difficult to find, but they are given for a few of the substances. We have looked for data that will allow for comparison between the substances. Mainly we have used acute oral LD50 values for rats, and LC50 values for fish (and for daphnia magna where fish is not available), with the shortest exposure period available. Note that these values only refer to acute toxicity, and that other long term effects are not included. The definition of toxicity used is as follows:
Highly Toxic: LD50 < 50 mg/kg
Toxic: LD50 50-500 mg/kg
Slightly toxic: LD50 500 -5000 mg/kg

Bioaccumulation (based on CEFIC position paper 16.10.1995) of a substance is its capacity to accumulate in the tissues of organisms either through exposure to water, air or soil or through consumption of food. It is calculated as the ratio (BAF) of its concentration in the organism to the concentration in the medium to which this organism is exposed. When the intake in the organism is only due to the substance dissolved in the medium, generally water, the ratio is called the Bioconcentration Factor (BCF). Generally, fish are the preferred test organisms.

The tendency of substances to bioconcentrate relates to the hydrophobicity or lipophilicity of the substance. Therefore it is suggested the logarithm of the substance's octanol-water partition coefficient (log Kow) be used to estimate the bioconcentration potential. The use of this coefficient does not consider the metabolism and implies biological stability. Consequently, criteria recommended for bioaccumulation are preferably based on the BAF or BCF values. If they are not available, the log Kow, used with scientific judgment, is a useful screening criterion.

To be considered as liable to bioaccumulate a substance must be characterized by
- either a BAF or BCF value higher than 5000
- or, in the absence of available BAF or BCF data, an octanol-water partition coefficient, log Kow, higher than 5.0

Substances with molecular weight > 600 have little bioaccumulation potential regardless of log Kow values.

Metabolites are indicated for the substances (where relevant). Some metabolites may be more toxic or persistent than the original substance. Some of the priority substances are also metabilites of other priority substances. This is indicated in the fact sheets for each substance. There is little information on monitoring of metabolites of the 33 priority substances.

The data in the "Production and use-parts" and "Emissions, discharges, distribution and hot-spots -parts" are mainly from Norwegian sources. This part gives data for total use and total emissions in Norway (to water, air and soil), and then specific data for discharges to water where possible. For most substances we have relied on data provided by the SFT at the www.miljostatus.no homepage. The SFT also provided information regarding use and emissions of 20 substances in 1995 and 2002 (occasionally 2003). Furthermore we have looked for

all substances in the Norwegian Product Register.

Data on use and sales of pesticides are from the Norwegian Food Control Authority. There are no data on pesticides prior to 1974. Some detailed information has been provided by Merethe Dæhli at the Norwegian Food Control Authority in Ås. The Swedish Chemical Inspectorate has also given some help regarding Swedish regulations and new EU assessments of some pesticides. For relevant substances with use other than for plant and crop protection (such as Lindane) we have also checked with the Norwegian Product Register for non-agricultural use.

We have defined hotspots as areas with high levels of pollution, or areas where there are indications that high levels of pollution may be present. Hotspots have mainly been picked based on data from www.miljostatus.no, and on information compiled in the chapter "Monitoring and information" from the report "Kostholdsråd i norske havner og fjorder" by Bergfald & Co as (to be published). Some (possible) hotspots are suggested based on suspicion and / or experience.

Data in the Monitoring sections come from a wide range of reports. The most useful of these are the JOVÅ programme, the JAMP programme and Statlig program for forurensningsovervåking in addition to several Norwegian local and regional investigations. We have also used some reports from Naturvårdsverket in Sweden and Miljøstyrelsen in Denmark. This information has also been important when possible hotspots have been suggested.

Conclusions in the sections describing "Need for further screening and monitoring" are based on facts from the chapters discussed above. Bergfald has arranged two internal working group meetings in order to assess the need for further monitoring for the substances.

The sections on analysis and detection limits were written by Martin Slabach at the Norwegian Institute for Air Research (NILU). The surveys of analytical methods used for compounds of the WFD are based on the following sources:

1. Own experience and information
2. Information available from several European analytical laboratories via internet, catalogues, or direct contact.
3. Official method descriptions given by US-EPA and AOAC.
4. Scientific publications cited in the reference list.

This information was critically reviewed with special emphasis on the relevance of the published method for sample types and concentration ranges expected in the WFD.

PRIORITY SUBSTANCES IN THE WATER FRAMEWORK DIRECTIVE (WFD)

The Water Framework Directive is designed to protect Europes rivers and water basins. In was adopted in 2000. One part of the directive concerns emissions of chemicals that can be harmful for humans and the environment; this is regulated in article 16. The Directive is relevant for Norway through the EEA agreement. The final decision on priority hazardous substances (2455/2001/EC) was adopted on 20 November 2001, but the list will be reviewed. The EU Commission is preparing a proposal for community-wide environmental quality standards and emission controls for the 33 priority substances. The priority Substances are given different status regarding reduction or phase out:

A: Priority hazardous substances, these substances will be subject to cessation or phasing out of discharges, emissions and losses within an appropriate timetable that shall not exceed 20 years.
B: Priority substances under review, to be moved to either category A or C.
C: Priority substances to be reduced in use, in order to reach a concentration target.

In table two status for Norway is indicated, if substances are totally phased out, banned or never used, (if applicable). It should be emphasized that many substances also have national Norwegian targets for phase out by 2005 or reduction or significant reduction by 2010.

Name	Number (fact sheet)	Category	Status in Norway
Brominated diphenylethers, (PeBDE)	5	A	New use banned from 2004 (PeBDE).
Cadmium	6	A	
Chloroalkanes (C10-C13)	7	A	Banned from 2002.
Hexachlorobenzene	16	A	
Hexachlorobutadiene	17	A	No use or emissions known for 10 years.
Lindan	18b	A	Banned from 1992.
Mercury	21	A	
Nonylphenols	24	A	(Mainly) banned from 2002.
Pentachlorobenzene	26	A	Not registered in the Norwegian Product Register.
PAH	28	A	
TBT	30	A	New use banned from 2003, existing use from 2008.
Anthracene	2	B	Banned from 1990.
Atrazine	3	B	
Chlorpyrifos	9	B	Not registered in the Norwegian Product Register.
DEHP	12	B	Banned in small children products.
Diuron	13	B	No agricultural use, but in use as marine biocide.
Endosulfan	14	B	Banned from 1997.
Isoproturon	19	B	Banned from 2006.
Lead	20	B	
Naphthalene	22	B	
Octylphenols	25	B	(Mainly) banned from 2002.
Pentachlorophenol	27	B	Not in use, may be present in imported products.
Simazine	29	B	Restricted, no imports since 1995.
Trichlorobenzenes	31	B	Not registered in the Norwegian Product Register since 1995.
Trifluralin	33	B	Banned from 1993.
Alachlor	1	C	Never used.
Benzene	4	C	
Chlorfenvinphos	8	C	Not sold since 2002, banned from 2006.
1,2 Dichloroethane	10	C	
Dichloromethane	11	C	
Fluoranthene	15	C	
Nickel	23	C	
Trichloromethane	32	C	

Table 2: *Status for priority substances*

1 Alachlor

■ **Alachlor is an herbicide (pesticide), used against grass weeds and broadleaves.**
■ **No information on use in Norway is available.**
■ **There are no available data on environmental distribution in Norway.**
■ **The potential for transboundary pollution is limited due to short life span in air.**
■ **No further screening is considered necessary.**

Production and use

Alachlor has not been approved as herbicide in Norway, and there is no registered import since 1974. Alachlor has been banned in Sweden since 1978, widely used in the US.

Emissions, discharges, distribution and hot-spots

There is no available data on environmental distribution in Norway.

Monitoring

There is no available data on screening or monitoring in Norway.

Need for further screening and monitoring

There is no recorded use of alachlor in Norway. In Sweden no concentrations of alachlor above detection limits were found in fish, sediments or ground water (IVL Rapport, 2004). There is no need for further screening or monitoring.

Analysis

The analysis of alachlor is often part of multi pesticide packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), eventually clean-up with SPE and separation and quantification with GC-based methods: GC/MS or GC/ECD, however, also LC/MS methods can be used.

Synergy with other analyses

Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other amide-type herbicides as for example metolachlor.

FACTS

Cas no.: 15972-60-8

Synonyms: Acetamide, 2-chloro-N-(2,6-diethylphenyl)-n-(methoxymetyl)- Alanex, Bronco, Cannon, Crop Star, Lariat, Lasso, and Partner.

Properties: Alachlor is a colourless to yellow crystal compound

Toxic effects: Slightly toxic. Oral LD50 in rat is between 930 mg/kg and 1350 mg/kg. Irritates skin. Alachlor is moderately toxic to fish The LC50 (96-hour) 2.4 mg/l in rainbow trout (*Oncorhynchus mykiss*) (EXTOXNET). It is on the EU list of substances with documented endocrine-disrupting effects.

Log Kow: 3,7

Persistence: Low persistence in soil (8 days) and water (EXTOXNET), higher in anaerobic water (HSDB).

DT50 water = 200 - 500 d (river water without sediment), 23 -206 d (river water after addition of soil or sediment)

DT_{50} whole system = 18 -37 days (CIRCA).

Water solubility: 18,07 mg/l (25°C)

Molecular formula: $C_{14}H_{20}Cl\text{-}NO_2$

Metabolites: diethylaniline (urine), 2-chloro-2',6'-diethylacetanilide and 1-chloro-acetyl-2,3-dihydro-7-ethylindole (soil) (HSDB)

Use: Herbicide, annual grass weeds, some broadleaves for protection of corn, soybeans, and peanuts, potatoes, sorghum etc. (HSDB).

References

■ HSDB, Alachlor
■ CIRCA Royal Haskoning fact sheets on production, use and release of priority substances in the WFD, Alachlor, Final version 31 January 2003
■ IVL Rapport (Naturvårdsverket): Occurrence of the WFD priority substances in Sweden - a summary of recent environmental monitoring. 2004-03-29.
■ Environmental Review no. 15, 2004: List of Undesirable Substances 2004, Appendix B - Substances on the EU list of substances with documented endocrine-disrupting effects
■ EXTOXNET Extension Toxicology Network Pesticide Information Profiles
Alachlor Oregon State University Revised June 1996

■ Mattilsynet: Omsetningsstatistikk for plantevernmidler 1974 til 2004.
■ Simultaneous determination of alachlor, metolachlor, atrazine, and simazine in water and soil by isotope dilution gas chromatography/mass spectrometry. J Assoc Off Anal Chem. 1989 Mar-Apr;72(2):349-54. Huang LQ.

2 Anthracene

■ **Anthracene is a PAH. It bioaccumulates and is a human carcinogen.**
■ **Anthracene is mostly monitored as part of ∑PAH in Norway.**
■ **For further information, see PAH.**

Production and use

Anthracene is a component in creosote, which is being used for wood preservation. It has also been used for the manufacture of anthraquinone, and as an important raw material for the manufacture of fast dyes etc. Anthracene is also present in tobacco smoke. There are no data on use in Norway.

Emissions, discharges, distribution and hot-spots

See PAH.

Monitoring

Anthracene is monitored with ∑PAH in Norway.

Need for further screening and monitoring

See PAH.

Analysis

Detection and limits

See PAH.

Synergy with other analyses

See PAH.

FACTS

Cas no.: 120-12-7

Synonyms: Antracen, Paranaphthalene, Anthracin, Tetra olive N2G.

Properties: Yellow crystals with blue fluorescence.

Toxic effects: Acute LD50 rat is calculated to 8,12 g/kg. Anthracene is irritating, it may damage skin (HSDB) and contact may give allergic reactions. Anthracene is a human carcinogen. Acute LC50 (Daphnia magna) is 0,02 mg/l/ (24 h)

Log Kow: 4,20 - 4,63

Persistence: Half-life in soil for anthracene is 3,3 to 175 days. Half-life in water varies between 1,6 hours in summer and 4,8 hours in winter (CIRCA), considering maximum adsorption the volatilization half-life increases to 16,7 months. Half-life in air varies from hours to days. Bioconcentration in aquatic life ranges from moderate to high. (HSBD)

Water solubility: 0,032 - 0,085 mg/l at 20 °C

Molecular formula: $C\text{-}H_{10}$

Metabolites: 1,2-dihydroxyanthracene --> 2-hydroxy-3-naphthaldehyde--> 2-hydroxy-3-naphthoic acid--> 2,3-dihydroxynaphthalene salicylic acid.

References

■ CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Anthracen , Final version 31 January 2001
■ HSDB: Anthracen
■ SFT: Miljøgifter i produkter Data for 2002

3 Atrazine

■ **Atrazine is an herbicide used on grassy weeds and broadleaves.**
■ **Is a persistent carcinogen and endocrine disruptor.**
■ **Not used in Norway for 15 years.**
■ **Found in water and groundwater in Norway, but not since 1998.**
■ **The potential for long transport is limited due to short life span in air**
■ **There is no need for further screening or monitoring of atrazine.**

Production and use

Atrazine lost its licence in Norway in 1988 due to high persistence in soil and groundwater, and has been banned from use since 1990 (Jordforsk). Banned by the EU from 2003. Statistics shows that 86 000 kilos of triazines were imported from 1974 to 1978. From 1979 to 1990 about 85.000 kilos of atrazine was sold. Main use has been on hard surfaces (roads, parking lots, tennis courts).

Emissions, discharges, distribution and hot-spots

According to Norwegian Food Control Authority, the only user has been the Norwegian army, as they wanted "a product that could be spread in solid form". This information has been provided to the Food Control Authority by the importeur of the product, it may be incorrect.

Monitoring

Atrazine trends have been monitored in the JOVÅ Programme.

Fresh water and groundwater

Atrazine has been found in water and groundwater at levels over a limit set by Jordforsk for "effects in the environment" (MFI) in the period 1990-1994; after 1994 levels have been low. In 1998, atrazine was found in groundwater at a waterworks in Nesbyen in Buskerud County. The levels were below levels considered potentially harmful for health.

Hot-spots

There are no known hotspots in Norway.

FACTS

Cas no.: 1912-24-9

Synonyms: Atrazin, 6-Chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine, Gesaprim and others.

Properties: Colourless or white, crystalline powder. Also available as liquid.

Toxic effects: Slightly toxic, oral LD50 is 3090 mg/kg in rats. Carcinogenic to animals. Toxic to fish, LC50 4,3 mg/l for guppy. May induce hermaphroditism and demasculinize the larynges of frogs. On the EU list of substances with documented endocrine-disrupting effects. Irritant to skin and eyes.

Log Kow: 2,2 - 2,5

Persistence: Half-life: Longer than 1 year under dry or cold conditions in soil, longer in groundwater. Air: 14 hours (photochemical). Often found in wells in areas where it has been used. Low BCF values (0,3-2) suggest potential for bioconcentration in aquatic organisms is low to moderate. (HSDB)

Water solubility: 33-70 mg/l

Molecular formula: C_8-H_{14}-Cl-N_5

Metabolites: N-dealkylation (animals,) hydroxyatrazine and amino-acid conjungates (plants)

Use: Grassy weeds and broadleaves. Used among others on asparagus, corn and sorghum. Produced in several countries in Europe and the US.

Need for further screening and monitoring

The use of atrazine in Norway has been limited, and atrazine has not been found in the environment since 1998. Thus, further screening or monitoring is not considered necessary.

Analysis

The analysis of atrazine is often part of multi pesticide packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), eventually clean-up with SPE and separation and quantification with GC-based methods: GC/MS or GC/ECD, however, also LC/MS methods can be used.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other triazine-type herbicides as for example cyanacine or simazine.

References

■ Landbruks- og matdepartementet: Evaluering av handlingsplan for redusert bruk av plantevernmidler. Accessed 23 October 2005 at http://odin.dep.no/lmd/norsk/dok/andre_dok/rapporter/020005-990279/hov004-bn.html.
■ Environmental Review no. 15, 2004: List of Undesirable Substances 2004, Appendix B - Substances on the EU list of substances with documented endocrine-disrupting effects
■ HSDB Atrazine
■ EXTOXNET database Atrazine
■ CIRCA: Royal Haskoning: Fact Sheets on production, use and releases of priority substances in the WFD, Atrazine 31.01.2003,
■ Hermaphroditic, demasculinized frogs after exposure to the herbicide atrazine at low ecologically relevant doses Tyrone B. Hayes*, Atif Collins, Melissa Lee, Magdelena Mendoza, Nigel Noriega, A. Ali Stuart, and Aaron Vonk Laboratory for Integrative Studies in Amphibian Biology, Group in Endocrinology, Museum of Vertebrate Zoology, Department of Integrative Biology, University of California, Berkeley, CA 94720-3140 2001
■ SNT-Rapport 3 0 2002 Del A: Overflatevatn: Plantevernmiddel i norske drikkevasskjelder Del B: Grunnvatn Plantevernmiddel i utvalde grunnvasskjelder i Noreg
■ Jordforsk: Rapport 1786/2001 Jordsmonnovervåking i Norge Pesticider
■ Haarstad 1996 Kilder til sprøytemiddelforurensing i Norge?
■ Kemikalieinspeksjonen 2005-08-01 Kommissionens beslut för verksamma ämnen i växtskyddsmedel och ämnenas status i Sverige
■ Mattilsynet; Omsetningsstatistikk for plantevernmidler 1974 til 2004.
■ Pesticides News No. 56, June 2002, pages 20-21
■ Mattilsynet. Email from Merethe Dæhli 14.10.2005
■ Simultaneous determination of alachlor, metolachlor, atrazine, and simazine in water and soil by isotope dilution gas chromatography/mass spectrometry. J Assoc Off Anal Chem. 1989 Mar-Apr;72(2):349-54. Huang LQ.

4 Benzene

■ **Benzene is a component of gasoline. It is a widely used solvent and chemical intermediary and well known carcinogen for humans and animals.**
■ **The main source of environmental pollution is transport and incineration.**
■ **There are no data on distribution of benzene in water, sediment or biota.**
■ **No further need for screening or monitoring is considered necessary.**

Production and use

Benzene is a component of gasoline, produced at two refineries in Norway. Import or use of chemicals or mixtures of chemicals with more than 0,1 weight percent benzene have been banned from 1994. Imports of products containing benzene are also illegal. Specific regulations apply to industrial use of benzene, benzene in toys and benzene in fuel.

Emissions, discharges, distribution and hot-spots

Sources of benzene include gasoline, cigarette smoke and smoke from combustion of wood, oil refineries, gas filling stations etc. Building materials may also be a source. The main sources of benzene in the environment are traffic and incineration. Benzene is found in elevated concentrations in urban city air and Statistics Norway has calculated air emission ratios for Norway. Two stroke outboard marine engines may be source to water but no data is found on this.

Monitoring

There are no available data on monitoring or environmental distribution of benzene in water, sediment or biota in Norway.

Need for further screening and monitoring

Benzene is rapidly degraded in water. Environmental exposure to benzene through water is thus regarded as negligible. Thus, there is no need for further screening or monitoring of benzene.

Analysis

The analysis of benzene is often part of packages with several other volatile organic compounds (VOC) or together with other aromatic compounds (BTEX = benzene, toluene, ethyl benzene and xylene).

Methods

The methods are based on purge-and-trap, stripping, or head-space analysis and separation and quantification with GC-based methods: GC/MS or GC/FID.

FACTS

Cas no.: 71-43-2

Synonyms: Annulene, benzine, benzol, benzole, benzol coal naphtha, cyclohexatriene, mineral naphtha, motor benzol, phenyl hydride, pyrobenzol.

Properties: Benzene is a stable colourless liquid.

Toxic effects: Acute LD50 Rat oral 3306 mg/kg. LC50 Rat inhalation 10.000 ppm/7 hour

May cause bone marrow depression leading to lack of red blood cells (aplastic anemia). Irritant to skin. LC50 *Salmo trutta* (brown trout yearlings) 12 mg/l/1 hour, LC50 *Poecilia reticulata* (guppy) 63 mg/l/14 days.

Known carcinogen for humans and animals.

An average exposure of 3,2 mg/m3 (1 ppm) over a 40-year working career has not been statistically associated with any increase in deaths from leukaemia. LD50 values are 3000 to 8100 mg/kg.

Log Kow: 2,13

Persistence: From a few hours and days in air and water, to months in anaerobic water and groundwater. (HSDB)

DT50 in surface water = 4,8 hours

DT_{50} in atmosphere = 1-2 days

DT50 in seawater = 3-23 days.

Does not bio-accumulate (CIRCA).

Water solubility: 1800 mg/litre at 25°C

Molecular formula: C_6-H_6

Metabolites: Phenol catechol and quinol (animal)

Use: Component of petrol. Occurs naturally in crude oil. Used in production of aromatic compounds, polymers etc.

Synergy with other analyses
Sample preparation and quantification can be co-ordinated with the analysis of other BTEX or VOC.

References

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- Beryl C. Nygreen (beryl-c.nygreen@sft.no): Email Wed, 12 Oct 2005 20:53:41

5 Pentabromodiphenylether, PeBDE

■ **Commercial pentabrominated diphenylethers (PeBDE) are a mixture of 24 - 38 % tetra-, 50 - 60 % penta-, and 4 - 8 % hexabromodiphenylether.**
■ **Pentabromodiphenylether (PeBDE) is toxic to aquatic organisms, and both emissions and persistence are high.**
■ **Screening in Norway was done in 2004 for PolyBDE including PeBDE. New screening is considered unnecessary, but further monitoring of PBDE should continue.**

FACTS

Cas no.: 32534-81-9

Synonyms: Brominated flame retardants (BFR), PBDE (Polybrominated diphenyl ethers) polybrominated biphenyl oxide, Benzene-1,1'-oxybis-pentabromoderivate, pentabromophenoxybenzene.

Properties: White crystalline solid

Toxic effects: Acute toxicity for commercial PeBDE (LD50 rat oral) is 5 800 mg/kg (WHO). The substance is on the EU list of endocrine disruptors, and it is considered very toxic to aquatic organisms (ClassLab). PeBDE is also suspected of neurotoxic developmental effects.

Log Kow: 5,03 - 8,09

Persistence: Long half lives (years) has been suggesteted. Half-life by biodegradation in aerobic sediment is estimated to 600 days, in soil to 150 days, in water 150 days and in atmosphere (photochemical) 29 days. (CIRCA)

Bioconcentration in aquatic organisms is high to very high evaporation from water surfaces is expected to be an important fate process for pentabromodiphenyls, but will be attenuated by adsorption to particles and sediments. (HSBD)

Water solubility: < 10 µg/l 20°C

Molecular formula: $C_{12}H_5Br_5O$

Metabolites: PeBDE may form or cause formation of brominated and chlorobrominated dioxins and furans during combustion.

Production and use

Globally, PeBDE is a flame retardant, especially in high impact polystyrene, ABS, flexible polyurethane foam, textile coatings, wire and cable insulation, electrical connectors and other interior parts. Main use in Norway seems to be in electric components (circuit boards). St. meld. nr. 25 (2002-2003) estimates that between 300 and 600 tons of brominated flame retardants are sold annually, and that about 50 tons are used in production in Norway. PeBDE is a small fraction of the flame retardants in use, and we have found no exact data on amounts in use. According to NILU about 10 % of the flame retardants in use are polybrominated diphenylethers, (PBDE) and only a part if this is PeBDE. Swedish authorities have an estimate of 15 percent PBDE. The most common brominated flame retardants are tetrabromobisphenol A (TBBPA) and hexabromocylododecane (HBCD).

Products with more than 0,25 % HBCD, TBBPA, penta-, okta- or dekaBDE are classified as hazardous waste and new use of PeBDE is banned in Norway from 2004. The regulations are expected to decrease emissions. Other new regulations improving management of waste with brominated flame retardants (EE regulations and regulations regarding shredding systems (fluff)) will probably have some positive effects.

Emissions, discharges, distribution and hot-spots

Data on PeBDE emissions to the environment are lacking. As PeBDE has wide application in polymers, textiles and electronics, it will leak from landfills. PeBDE may also be released to the environment through evaporation from products and from recycling of products.

Marine sediment

Marine sediments in Åsefjorden in Ålesund in Møre og Romsdal County have high PolyBDE concentrations. This also applies for Rubbestadneset in Bømlo in Hordaland County.

Marine biota

Blue mussels (*Mytilus edulis*) in Åsefjorden have PolyBDE concentrations which are high in an international context. For cod (*Gadus morhua*) liver, Inner Oslofjord (Oslo and Akershus Counties) and Bømlo in Hordaland County have the highest concentrations, but these con-

centrations are moderate compared to other international studies.

Fresh water sediment
PBDE levels in fresh water sediment except Mjøsa are relatively low.

Fresh water biota
Very high levels of PeBDE have been found in trout (Salmo trutta) in Mjøsa. The levels are among the highest levels reported internationally.

Hotspots
Åsefjorden and Mjøsa are hotspots for PeBDE. Further investigations have been initiated both places.

Monitoring
PolyBDE has been screened in several studies in biota and sediments, but there are no time series.

Need for further screening and monitoring
PolyBDE was screened in 2003 and 2004. Thus, there is no further need for screening now, but levels are high for some locations and monitoring should continue in order to establish time series.

Analysis
During the last years the analysis of PolyBDE has established a high level of quality which in some years will be comparable to for example dioxin analysis. Due to the use of PolyBDE in consumer products the risk of incidental contamination is higher than for the analysis of other POPs. In addition special care must be taken for the correct analysis of BDE-209 or decabromo diphenylether due the extremely low volatility of this congener.

Methods
The methods are based on extraction with an organic solvent, chromatographic clean-up and separation and quantification with GC-based methods: normally GC/MS with different modes of ionization. Quantification for the most advanced methods is based on the use of 13C-labelled internal standards.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other persistent organic pollutants as PCB, HCH, and SCCP/MCCP.

References

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- HSDB database, Polybrominated diphenylethers
- ClassLab: Polybromerte difenyletere
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- Stortingsmelding nr. 25 (2002-2003)
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6 Cadmium and its compounds

■ **Cadmium is a toxic heavy metal, it is not found in pure state in nature**
■ **Cadmium has been used in pigments and batteries. Artificial fertilizers contain cadmium as a pollutant.**
■ **No further screening is considered necessary, but monitoring of cadmium should continue.**

Production and use

Cadmium is associated with zinc and non ferrous ores, and usually present in cement and phosphate fertilizer, as well as in fossil fuels. Cadmium has been widely used, in pigments and is still in widespread use in electronics metallurgy and for corrosive protection. In Norway, main use by 2002 was in batteries. Use in new produced or imported products has dropped from more than 40 tonnes annually in the nineties to 27 tons in 2002. Cadmium pollutants in zink sacrificial anodes are now the single largest source, with 100 kilos in 2002. Production is stopped in Norway. Some compounds and uses are banned or regulated.

Emissions, discharges, distribution and hot-spots

Emissions have dropped from 43 tons in 1985, via 5 tons in 1995 to 1 tonne in 2003. Discharges to water in the same period have dropped from about 3,5 tons to about 600 kilos. Main emissions come from products, industrial sources, and the oil and gas sector, but 29 percent of emissions in 2002 are "diffuse" or from "other" sources. Cadmium is a long range transboundary pollutant and increased levels are found in soil in South Norway. According to SFT almost 2/3 of the annual cadmium pollutions come from sources outside Norway.

Marine sediment

Cadmium has been found in some harbours, but generally not in very high concentrations. The highest concentration was found in Henningsvær harbour in Lofoten in Nordland County (class V).

Marine biota

Marine biota is generally moderately to markedly polluted by cadmium. In Sørfjorden in Hordaland County, Harstad in Troms County and Årdalsfjorden in Sogn og Fjordane County there are restrictions on consumption of shellfish due to high cadmium concentrations.

Fresh water

Since 1990 ten rivers have been monitored on a monthly basis and more than one hundred rivers on a yearly basis and cadmium levels are generally low. Rivers influenced with runoff from mines will have higher levels.

FACTS

Cas no.: 7440-43-9

Synonyms/compounds: Cadmiumchloride Cadmiumacetaat, Cadmiumoxide, Cadmiumhydroxide, Cadmiumsulfide, Cadmiumsulfate, Cadmiumsulfite.

Properties: Metal. Not found in pure state in nature.

Toxic effects: Cadmium and its compounds are toxic (acute and chronic) for mammals. They are listed as probable human carcinogens. Cadmium compounds are also very toxic to aquatic life forms, especially in fresh water (ClassLab, WHO, HSDB).

Log Kow: -

Persistence: Cadmium accumulates in soil, and plant uptake is a problem. Cadmium and its compounds do not form stable metal-organic complexes and are susceptible to changes in soil acidity. In water, cadmium is adsorbed to particulate matter. Cadmium accumulates in liver and kidneys in humans, while uptake of cadmium by daphnia, aquatic insects, molluscs, and crayfish is appreciable.

Water solubility: Insoluble, some compounds are soluble.

Molecular formula: Cd

Cadmiumchloride: CdC_{l2}

Cadmiumacetate: $C_4H_6CdO_4$

Cadmiumoxide: CdO

Cadmiumhydroxide: $Cd(OH)_2$

Cadmiumsulfide: CdS

Cadmiumsulfate: $CdSO_4$

Cadmiumsulfite: $CdSO_3$

Metabolites: None

Fresh water sediment
Fresh water sediments are generally contaminated by cadmium. As long range transport is the main source, lakes are more polluted in southern and eastern Norway than further north. Mining is the other important factor for cadmium pollution.

Fresh water biota
The levels of cadmium in fresh water biota are generally low.

Hotspots
Hotspots for cadmium pollution are Sørfjorden and Hardangerfjorden in Hordaland County, Orkdalsfjorden in Sør-Trøndelag County and rivers/ streams influenced with runoff from zinc mines. Zinc has been mined many places, but particulary at Sauda in Rogaland County. High concentrations of cadmium have been found from electroplating installations at the former Fornebu Airport in Oslo. These activities ended in the late 1970ties.

Monitoring
Cadmium has been monitored in JAMP. Thus, there are time series. There are also several other studies of cadmium, but without time series.

Need for further screening and monitoring
Cadmium compounds are thoroughly screened. There is no further need for screening. However, cadmium levels in Norwegian environment are high. Monitoring should continue in order to estimate health risks and effectiveness of policies and measures regarding use and waste management.

Analysis
There are several well-established techniques for determination of Cd. Several companies offer this service in Norway and Europe. The most frequently techniques are Inductively coupled plasma mass spectrometry (ICP-MS), Inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods
Water samples are acidified with 1-10% nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of cadmium can also be used for determination of Pb, Hg, Ni, Cu, Cr, As and Ni.

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- CIRCA, Royal Haskoning Fact sheets on production, use and release of priority substances in the WFD, Cadmium , Final version 31 January 2001
- World Health Organization; Environmental Health Criteria 134. Cadmium. Geneva, Switzerland (1992)
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7 C10-C13 chloroalkanes (SCCP)

■ SCCP are persistent and toxic to aquatic organisms.
■ SCCP is a Priority Hazardous substance to be phased out in the EU.
■ There is a need for further screening of SCCP in marine and fresh water sediment as well as in biota.

Production and use

Globally, main use have been extreme pressure agents in cutting fluids, flame-retardants in textiles and rubbers, plasticisers and flame retardants in paints and coatings, sealants, adhesives and fat liquoring agents in the leather industry. There has been no SCCP production in Norway, but the compounds have been widely used as substitute for PCB. SCCP were used in paints (for ships), cutting fluids, joint fillers etc. Total use in Norway dropped from 200 tons in 1991 to 6 tons in 2003. Short chain chlorinated paraffins with more than 48 weight percent chlorine have been banned from 2002, some exemptions are allowed until 2005. The ban has caused an increase in the use of other chloroalkanes. SCCP are also banned in EU as cutting fluids and for treatment of leather.

Emissions, discharges, distribution and hot-spots

Norwegian emissions in 2003 were estimated to 0,3 tons, dropping from about 1 ton in 1995. Discharges to water have dropped from about 600 kilos in 1995 to 0,1 tons in 2003. SCCP has been a substitute for PCBs as these were being phased out. Paint producers have had large emissions (Stabil Alna in Oslofjorden, Hempel in Hordaland), as may shipyards, window producers and mechanical industry. SCCP have also been found in municipal land fills and downstream municipal waste water treatment plants.

Marine sediment

SCCP were screened in Drammensfjorden in Buskerud County and four other areas from Tønsberg in Vestfold County to Tromsø in Troms County. The highest levels, 1300 ng/g dry weight, were found close to a quay belonging to Hellik Teigen AS.

FACTS

Cas no.: 85535-84-8

Synonyms: Short Chain Chlorinated Paraffins, SCCA.

Properties: Light yellow to amber, thick oily liquid, usually odourless.

Toxic effects: Acute oral toxicity (LD100) for humans at > 15 g/kg, but data are limited (HSDB). SCCP are possible carcinogens. Toxic to aquatic organisms (ClassLab); values for LC50 - EC50 ranging from 14 to 530 µg/l (WHO).

Log Kow: 4,39-8,69

Persistence: SCCP are not readily biodegradable (WHO). Half-life in air has been estimated to range from 0,85 to 7,2 days (CIRCA). There are limited data on persistence in soil and water, but SCCP adsorbs to sediments and soil. High bioconcentration in aquatic organisms.

Water solubility: Practically insoluble.

Marine biota

SCCP were found in blue mussels (*Mytilus edulis*) in Oslofjorden. The levels are significantly higher than the levels found in blue mussels from Færder in Vestfold County, Lista in Vest-Agder County, Bømlo in Hordaland County, Svolvær in Nordland County and Varangerfjorden in Finnmark County. In cod liver (*Gadus morhua*), SCCP concentrations vary in a different pattern. Levels are higher at Lista and lower in Drammensfjorden.

Fresh water sediments

SCCP in Mjøsa have been measured to 130-510 ng/g dry weight. The lower parts of Drammenselva have higher four - ten times higher concentrations.

Fresh water biota

SCCP were found in trout (*Salmo trutta*) and char (*Salvelinus alpinus*) in several lakes, generally in higher levels than in marine species.

Other

Sediments from leakage systems for municipal landfills were investigated. Levels were high at Lindum in Drammen, but the results could not be compared to other studies.

Hotspots
The use of marine paint may have caused local hotspots (marinas). Paint manufacture and production and use of sealants (eg. double glazing in windows).

Monitoring
SCCP have been screened in a few studies, but there are no time series.

Need for further screening and monitoring
There has been considerable use of SCCP in Norway, and data on environmental distribution are lacking. There is a need for further screening of SCCP.

Localities for further screening and monitoring
SCCP should be investigated in marine and fresh water sediment, further screening is also necessary in biota. Areas with high PCB levels should be systematically investigated, as should Mjøsa.

Analysis
During the last years the quality of the analysis of SCCP has increased and more laboratories are able to perform this analysis. However, due to the huge amount of compounds in this group and the lack of 13C-labelled internal standards this method has not reached the same standard of analytical quality as for example the analysis of dioxins or PCB.

Methods
The methods are based on extraction with an organic solvent, chromatographic clean-up and separation and quantification with GC-based methods: normally GC/MS with different modes of ionization. The most prominent GC/MS methods for SCCP analyses are based on electron capture negative ion (ECNI) mode with both high- and low resolution MS. A more extensive sample clean up is necessary when using low resolution MS to remove closely related and interfering compounds. With the more sophisticated and expensive high resolution MS instruments, interferences are almost negligible.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other persistent organic pollutants as PCB, HCH, PBDE and MCCP.

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- HSDB: Chlorinated Paraffins
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- Kartlegging av utvalgte nye organiske miljøgifter - bromerte flammehemmere, klorerte parafiner, bisfenol A og triclosan. TA-2006/2004.

8 Chlorfenvinphos

■ **Chlorfenvinphos is an insecticide which was legally in use in Norway until 2004, permissions for use may be obtained until 2006.**
■ **No imports are registered since 2003.**
■ **Chlorfenvinphos was found in four fresh water localities 1995 - 2001.**
■ **There is a need for new screening of chlorfenvinphos in rivers and streams.**

Production and use

Currently in use on cabbage and swede (against maggots *Delia floralis*, and *Delia radicum*). Product and container is classified as hazardous waste. No production in Norway.

64 000 kilos organophosphates were sold from 1974-1978 (less than 10 percent probably Chlorfenvinphos). From 1979 to 2002 43 000 kilos Chlorfenvinphos were sold in Norway. One product sold in Sweden (Birlane Granulate), permission expires in 2004, but will be prolonged by at least one year awaiting EU decision.

12 201 kilos have been imported since 1996 as pesticide, no imports since 2003, as the product (Birlane Granulate) is no longer imported by distributor. Special permissions for use may be granted to 2006.

Emissions, discharges, distribution and hot-spots

Pollution is mainly caused by run-off from agricultural land. No hotspots are found.

Fresh water and groundwater

Chlorfenvinphos was found in four streams in eastern and south west Norway between 1995 and 2001. The concentrations were high enough to cause adverse effects on fresh water environment.

Monitoring

Chlorfenvinphos has been monitored in JOVA since 1995, time series exist.

Need for further screening and monitoring

The concentrations found in former monitoring were quite high. As chlorfenvinphos is being phased out, a new screening should be initiated.

FACTS

Cas no.: 470-90-6

Synonyms: Klorfenvinfos, Birlane, Apachlor, Benzyl alcohol, Dermaton, 2-chloro-1-(2,4-dichlorophenyl)vinyldiethylphosphat.

Properties: Clear/yellowish liquid. Mild odour.

Toxic effects: Very toxic for humans. LD50 rat oral 9,66 mg/kg (HSDB). Very toxic for aquatic organisms. LC50 Guppy (*Libistes reticulatus*) 0,53 mg/l/(48 hours).

Log Kow: 4.15

Persistence: Half-life in air up to 92 hours, up to 23 weeks in soil, up to 7 weeks in water. Groundwater unknown. (HSDB)

DT50 water = 70 days (10°C); 7 days (25°C)),

DT50 whole system = 38 - 40,3 days (20°C) CIRCA

Water solubility: 3,022 mg/l (25°C)

Molecular formula: C_{12}-H_{14}-Cl_3-O_4-P

Metabolites: orto dealkylated metabolites .

Use: Used for insect control.

Localities for further screening and monitoring

The screening of Chlorfenvinphos should be initiated in the same rivers and streams which were investigated by Jordforsk (Report 17/04).

Analysis

The analysis of Chlorfenvinphos is often part of multi pesticide packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), eventually clean-up with SPE and separation and quantification with GC-based methods: GC/MS or GC/NPD.

Synergy with other analyses

Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organophosphorous insecticides as for example chlorpyrifos, malathion or methyl-parathion.

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- CIRCA Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Chlorfenvinphos, Final version 31/01 2003
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- ClassLab.

9 Chlorpyrifos

■ **Chlorpyrifos is one of the most common insecticides worldwide. Increased popularity following DDT ban.**
■ **The substance has been found on imported fruit and vegetables, but data on use and distribution in Norway are limited.**
■ **There are no data on environmental distribution in Norway.**
■ **There is no further need for screening of Chlorpyrifos in Norway.**

Production and use

In Norway, Chlorpyrifos has been used as insecticide for ants. No sales for agricultural purposes found in documentation on use and sales of pesticides. No entries in the Product Register since 2000.

Chlorpyrifos has been restricted banned from agricultural use in in Sweden from 2001, but becomes legal from 2005 as pesticide also due to EC regulations.

It has also been used in veterinary and human medicine (lice).

Emissions, discharges, distribution and hot-spots

Chlorpyrifos may be found around arable lands and possibly in landfills.

Monitoring

Chlorpyrifos has been screened in Sweden and only been found in very low concentrations in a fresh water stream and in compost. There are no data on environmental distribution in Norway.

Need for further screening and monitoring

The use of chlorpyrifos in Norway has been very limited, and chlorpyrifos has not been found in the environment. There is no need for further screening or monitoring of chlorpyrifos.

Analysis

The analysis of chlorpyrifos is often part of multi pesticide packages offered by several laboratories.

FACTS

Cas no.: 2921-88-2

Synonyms: Klorpyrifos, Dursban, chlorpyriphos (F-ISO, JMAF), 0,0-Diethyl-0-3,5,6-trichlor-2-pyridylthiophosphat.

Properties: Granules, wettable powder, dustable powder, and emulsifiable concentrate.

Toxic effects: Chlorpyrifos is toxic to humans. LD50 in rats is 95 to 270 mg/kg. Skin and eye irritant. Toxic to highly toxic to birds. Highly toxic to fresh water fish, aquatic invertebrates and estuarine and marine organisms. The 96-hour LC50 in rainbow trout (*Oncorhynchus mykiss*) is 0,009 mg/L. Toxic to some plants.

Log Kow: 4,66

Persistence: Up to 1 year in soil, half-life up to 80 days in water, may persist longer in groundwater and sediments. BCF value 2,67. (HSDB)

DT50 water = 3-6 days

DT50 whole system = 22 -51 days (CIRCA)

Water solubility: 0,357 mg/l (25°C)

Molecular formula: C_9-H_{11}-Cl_3-N-O_3-P-S

Metabolites: 3,5,6-trichloro-2-pyridinol (urine), (3,5,6-trichloro-2-pyridyl)phosphate.

Use: Insecticide. One of the pesticides most often found in amounts exceeding the maximum residue level according to Mattilsynet (2003).

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), eventually clean-up with SPE and separation and quantification with GC-based methods: GC/MS or GC/NPD.

Synergy with other analyses

Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organophosphorous insecticides as for example chlorfenvinphos, malathion or methyl-parathion.

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■ Royal Haskoning: Fact sheets on production, use and release of priority substances in the

WFD, Chlorpyrifos, Final version 31 January 2001.
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■ Kemikalieinspektionen: Lillian Törnquist, pers. med.

10 Dichloroethane (EDC)

■ EDC is used as solvent and as raw material in PVC production.
■ In other countries, EDC has been found in groundwater in areas with PVC industry.
■ There are no data on environmental distribution of EDC outside Grenland in Norway.
■ Further screening may be necessary in Grenland.

Production and use

Dichloroethane is being used in synthesis of VCM for in PVC production. There is one such plant in Norway, at Rafnes in Grenland. Dichloroethane is also widely used as industrial solvent and glue.

Emissions, discharges, distribution and hot-spots

Only Rafnes sees large scale EDC use in the period. From 1977 to 1985 unintentional ground pollution. Most spills, contaminated soil and contaminated ground water have been cleared. The volumes are not known. Typically the EDC-concentrations in the groundwater have dropped from around 1000 mg/l in the mid 80'ies to less than 50 mg/l today. Remedial action (pumping and stripping of groundwater) have prevented dispersion of the contaminated ground water.

The emissions to air were reported by Norsk Hydro to be 60 tons in 1996, and 35 tons in 1995 and 10 tons/year from 1997 to 2002, dropping to 4 tonnes from 2003. The figures include both fugitive/diffuse emissions, point sources and accidental releases. Discharges to water in 2003 were 3 kilos.

Dichloroethane may form in uncontrolled incineration processes (such as landfill fires). No data are available on amounts, but they are considered by SFT to be small. There are 5-10 large landfill fires in Norway annually.

Marine

There are no available data on dichloroethane in sea, marine sediments or marine biota in Norway.

FACTS

Cas no.: 107-06-2

Synonyms: EDC, etylendiklorid, ethan dichloride, acetylene dichloride, ethane, 1,2-dichloro, 2-dichlorethan; chlorethylen; dichlorethan, 1,2-; diklorетan, 1,2-; EDC; ethan, 1,2-dichlor- ; ethane, 1,2-dichloro- ; Ethylendichlorid ; Ethylenum chloratum ; Freon 150

Properties: Clear colourless oily liquid. May darken. Sweet odour.

Toxic effects: Slightly toxic, acute LD50 rat oral 670-890 mg/kg. A burden of 0,5-1,0 g/kg may cause death in humans. Defattening and irritant for eyes, skin and respiratory system. Possible carcinogen in humans. LC50 Daphnia magna 218 mg/l 48 hour (ClassLab and HSDB).

Log Kow: 1,48

Persistence: Biodegradation in soil or water is not expected to be an important environmental fate process. Half-life 4 to 9 days in lakes (volatilisation) (HSDB)

DT50 water (hydrolysis) = 23 - 300 years at 15°C

DT50 air = 12-121 days (ind. photolysis) CIRCA

Water solubility: 8690 mg/l

Molecular formula: $C_2H_4Cl_2$

Metabolites: Glycolic acid, oxalic acid, chlorethanol, chloraceticacid.

Fresh water, soil and groundwater

The extent of the ground pollution at Rafnes is unknown.

Hot-spots

Rafnes in Grenland is a hot-spot, extent is unknown.

Monitoring

Norsk Hydro is monitoring dichloroethane emissions to air. Discharges to water or soil are unintentional and thus not monitored.

Need for further screening and monitoring

Dichloroethane is easily degraded in fresh water and sea. Anaerobic degradation (groundwater, sediments) is slow. Documentation on levels in ground water is lacking, thus, it may be neces-

sary to investigate the "dichloroethane situation" further.

Localities for further screening and monitoring
As there have been high and repeated emissions at Rafnes, high concentrations of dichloroethane may be found in groundwater and marine sediment here.

Analysis
The analysis of 1,2-dichloroethane is often part of packages with several other volatile organic compounds (VOC).

Methods
The methods are based on purge-and-trap, or head-space analysis and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses
Sample preparation and quantification can be co-ordinated with the analysis of other VOC like compounds or other halogenated and non-halogenated solvents.

References

- CIRCA: Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Dichloroethane, Final version 31 January 2001
- HSDB: Dichloroethane.
- MILJØSTATUS: Dikloretan.
- SFT Dikloretan 1995-2002
- E-mail from Nils Eirik Stamland /HSE-Manager, Hydro Polymers AS.

11 Dichloromethane

■ **Dichloromethane has main use as solvent, but diffuse emissions from PVC production also occurs.**
■ **Possible human and confirmed animal carcinogen.**
■ **There are no data on environmental distribution in Norway.**
■ **There is no need for further screening and monitoring of dichloromethane.**

Production and use

Dichloromethane is produced together with methylchloride and chloroform. In Sweden its use has been banned since 1996, but exceptions are possible. In Norway it's been used as a solvent in the pharmaceutical industry, for paint stripping, for aerosols, for adhesives and for other applications such as metal degreasing, foam blowing (after the fluorocarbon ban), chemical processing, secondary refrigerant medium etc. It is also known to be used in certain types of glues for PVC, as degreaser and paint remover and in the production of polyurethane. Volumes in Norway are unknown.

Emissions, discharges, distribution and hot-spots

There have been diffuse emissions to air from Hydro Polymers (PVC-production). Other emissions are mainly through products. Dichloromethane may be expected to leak from landfills.

Monitoring

There has been no screening or monitoring of dichloromethane in Norway. There are no data on environmental distribution in Norway.

Need for further screening and monitoring

The use in Norway is very limited and occurrence in water is not considered to be a problem. No further screening or monitoring is necessary.

Analysis

The analysis of dichloromethane is often part of packages with several other volatile organic compounds (VOC).

Methods

The methods are based on purge-and-trap, or head-space analysis and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses

Sample preparation and quantification can be co-ordinated with the analysis of other VOC like compounds or other halogenated and non-halogenated solvents.

FACTS

Cas no.: 75-09-2

Synonyms: Diklormetan, methylene chloride, methylene dichloride, aerothene, DCM, Freon 30, metandiklorid, metylendiklorid, metylenklorid.

Properties: Colourless liquid, sweet odour like chloroform.

Toxic effects: Minimum observed effect level for short-term inhalation exposure of dichloromethane was approximately 690 mg/m3. Lethal dose for humans (oral) is 25 ml while LD50 (rat oral) is between 1600 and 3000 mg/kg body weight (WHO). Dichloromethane is also a probable human carcinogen, confirmed animal carcinogen and irritant to skin on repeated contact. LC50 Daphnia magna = 224 mg/l/48 hour.

Log Kow: 1,3 (calculated)

Persistence: Volatile in soil and water (evaporation). Half-life in air 50-119 days. Half-life in water 4 days. Half-life in soil 7-107 days (CIRCA and HSDB)

Water solubility: 13,7 g/l at 20°C

Molecular formula: CH_2Cl_2

Metabolites: Formaldehyde, and formic acid and inorganic chloride (human).

References

■ CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Dichloromethane , Final version 31 January 2001
■ HSDB: Dichloromethane
■ World Health Organization; Environmental Health Criteria 32. METHYLENE CHLORIDE. Geneva, Switzerland. 1984
■ Direktoratet for arbeidstilsynet, 2000: Grunnlag for fastsettelse av administrativ norm for diklormetan

12 Di(2-ethylhexyl)phthalate (DEHP)

■ **DEHP is one of the most common phthalates in use. It is teratogenic, a reproductive effector, it is on the EU list of endocrine disruptors and it is persistent.**
■ **Phthalates have been banned in products for small children.**
■ **A new risk assessment from the EU on DEHP is currently being discussed.**
■ **Further screening is necessary.**

Production and use

DEHP is a widely used plasticiser for the production of PVC products, such as flooring, insulation, electric wiring, sheeting, medical devices, synthetic leather and toys. In non PVC products, DEHP is used as antifoaming agent in paper production, emulsifier for cosmetics, in perfumes and pesticides, as aid in the production of different synthetic materials, adhesives and sealant, lacquers and paints, printing inks for paper and plastic, printing inks for textiles, rubber and ceramics for electronic purposes. In PVC products, DEHP can be more dominant than PVC. Phthalates have been banned in products for children less than three years since 1999. The use of DEHP in products in Norway has dropped from about 2300 tons in 1995 to 124 tons in 2002 according to SFT, but these figures may not be accurate.

Emissions, discharges, distribution and hot-spots

According to Norwegian State Pollution Control Authority the emissions of DEHP has dropped from more than 28 tons in 1995 to approx. 2 tons in 2002, but these figures only includes discharges to municipal waste water. It is considered that about half of the DEHP in municipal waste water was released to water in 1995; the rest followed the sludge/soil. For 2002 about 0,5 tons were released to water.

DEHP has been found in waste water from laundries, car wash installations and industrial sources. DEHP emissions from vehicles come from DEHP in anti corrosive treatment and PVC canopies on trucks. WHO considers that "Transport in the air is the major route by which phthalates enter the environment". DEHP binds readily to suspended solids and particles, and can be found in sediments.

FACTS

Cas no.: 117-81-7

Synonyms: Ftalater, bis-2-ethylhexyl phthalate, DEHP, DOP, 1,2-benzenedicarboxylic acid bis(2-ethylhexyl)ester, phthalic acid bis(2-ethylhexyl)ester DIOP, and many more.

Properties: Colourless, oily liquid, slight odour.

Toxic effects: Acute oral toxicity LD50 rat is more than 25 g/kg, but far lower doses (0,3 g/kg) have caused weight gain. Studies have shown testicular atrophy and increased kidney weights in long term studies (WHO). The new EU risk assessment sets a NOAEL of 4,8 mg/kg/day for humans for testicular toxicity. Both DEHP and the metabolite MEHP show teratogenic properties. Malformations were observed at dietary levels of 0,5-2 g/kg in mice, and embryotoxic effects were observed at dietary levels greater than 10 g/kg. DEHP may also harm reproduction, and it is on the EU list of substances with documented endocrine-disrupting effects. NOEL for Daphnia magna is 72 µg/l, while NOEL for fish (adult) is 62 µg/l. Acute toxicity in rainbow trout (*Oncorhynchus mykiss*) (LC50) is more than 100 mg/l/96 hour and for Daphnia magna LC50 is 1 000 - 5 000 µg/l/48 hour.

Log Kow: 4,88 -7,6

Persistence: Half-life in water is 146 days and in air 1 day (photochemical). Half-life in soil is less than 50 days (CIRCA). Biodegradation is temperature dependent. Below 10 °C or under anaerobic conditions, little or no biodegradation takes place at all. Hydrolysis and volatilisation are not important processes. Bioconcentration is high in a variety of aquatic invertebrates, fish, and amphibians (WHO). Fish metabolize DEHP readily.

Water solubility: 0,3 - 0,4 mg/l, lower in salt water. DEHP will adsorb to particles in water (especially salt water), even though solubility is low (WHO).

Molecular formula: $C_{24}H_{38}O_4$

Metabolites: mono(2-ethylhexyl)phthalate (MEHP).

Marine sediment
DEHP has been investigated in a study in 1996. Higher levels were found outside municipal waste water treatment plants.

Fresh water sediment
The DEHP levels in fresh water sediment were not particularly high.

Hotspots
One hotspot (now cleared) has been Litlevatnet in Ålesund in Møre og Romsdal county, close to a plastic manufacturer. Other hotspots are not known.

Monitoring
DEHP has been investigated in a few studies (see references).

Need for further screening and monitoring
There is a lack of data regarding DEHP in the environment. The use is extensive and persistence in Norwegian climate is high. Thus, a screening of DEHP is considered necessary.

Localities for further screening and monitoring
DEHP should be screened in marine and fresh water sediment and in marine and fresh water biota.

Analysis
During the last years several laboratories have established methods for the analysis of DEHP. The major problem for this analysis is the high level of DEHP as plasticizer in many products with a high risk for incidental contamination.

Methods
The methods are based on extraction with an organic solvent, chromatographic clean-up and separation and quantification with GC-based methods: normally GC/MS.

Synergy with other analyses
Sample extraction and clean-up may be co-ordinated with the analysis of other lipophilic compounds as PCB or HCH, however, the contamination risk for DEHP may require special precautions which may not be necessary for other compounds.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Di(2-ethylhexyl)phthalate, Final version 31 January 2001
- HSDB: Di(2-ethylhexyl)phthalate
- ClassLab: Di(2-ethylhexyl)phthalate
- Miljøstatus: Ftalater
- World Health Organization; Environmental Health 131, Di(2-ethylhexyl)phthalate (DEHP) 1992
- Scientific Committee on Toxicity Ecotoxicity and the Environment (CSTEE) Opinion on the results of a second Risk Assessment of: BIS(2-ETHYLHEXYL) PHTHALATE [DEHP]. 08.01.2004
- List of Undesirable Substances 2004 Appendix B - Substances on the EU list of substances with documented endocrine-disrupting effects
- SFT: DEHP 1995-2002
- Braaten, B., Berge, J. A., Berglind, L., Bækken, T.: Occurrence of phthalates and organotins in sediments and water in Norway. Norsk institutt for vannforskning (NIVA); 1996.

13 Diuron

■ **Diuron is an herbicide. It has not been used as such in Norway, but other, marine, purposes are known.**
■ **The principal metabolite is more toxic than diuron.**
■ **Diuron is found in marine sediments on several locations.**
■ **A screening on diuron has already started, no other measures are necessary at this point.**

Production and use in Norway

Diuron is being used in Norway as an active ingredient in antifouling products According to the Product Register about 4,6 tons was imported in 2004, divided on 16 products. The register lists that as much as 1,4 tons may have been produced in Norway in 2004, (giving a total of 6 tons in 2004) but according to the SFT report TA-2096/2005 there is no production of diuron in Norway.

Diuron may have been used in products for treatment of sea cages for fish farming. Such use has been investigated by the SFT in the report TA-2096/2005 but not found. Diuron is not registered as a pesticide in Norway, and there is no registered use of diuron as herbicide in agriculture since 1974. It was banned in Sweden in 1992 and the Netherlands in 1999.

Emissions, discharges, distribution and hot-spots

The use of diuron in marine anti-fouling has caused marine pollution of diuron.

Monitoring

Diuron was monitored in the study "Kartlegging av utvalgte nye organiske miljøgifter i 2004" with follow-up studies in 2005.

Marine

In 2004 seven sediment localities in southern Norway was investigated, diuron was detected at two, Vrengen in Vestfold County and Rubbestadneset in Hordaland County. The concentration at Rubbestadneset was low, compared to British and Spanish studies. The concentration in Vrengen was quite high in one out of three samples compared to the same studies.

FACTS

Cas no.: 330-54-1

Synonyms: 3-(3,4-dichlorophenyl)-1,1-dimethylurea, Crisuron, Diater, Di-on, Direx, Karmex, Unidron, Uridalk, Weedex.

Properties: White, crystalline solid. Odourless.

Toxic effects: Slightly toxic. Irritant to eyes, respiratory tract and skin. Oral LD50 in rats is 3400 mg/kg. Moderately toxic to fish and highly toxic to aquatic invertebrates. LC50 (96-hour) is 3,5 mg/l for rainbow trout (*Oncorhynchus mykiss*) (EXTOXNET). Teratogenic in high doses. Probable carcinogen. Suspected endocrine disruptor.

Log Kow: 2,67

Persistence: Half-life in soil more than 300 days. (EXTOXNET)

DT50 water = 90 days

DT50 whole system = 200 days (sediment) (CIRCA)

Water solubility: 36,4 mg/l (25°C)

Molecular formula: C_9-H_{10}-Cl_2-N_2-O

Metabolites: 3,4-dichloroaniline, 3,4-dichloronitrobenzene, 3-(3,4-dichlorophenyl)-1-methylurea, n-(3,4-dichlorophenyl)urea. 3,4 dichloraniline is more toxic than Diuron, oral LD50 in rats is around 60 mg/kg (almost highly toxic)

Use: Herbicide. Internationally it is used on fruit trees, ornamental trees and shrubs, olive trees, vineyards, asparagus, non-cultivated lands. Used on hard surfaces, on railways, on pavements, etc. Also used for anti-fouling in marine constructions.

In a follow up study in 2005 ten different sediment samples from Vrengen and sediment samples from seven other localities in the Oslofjord area showed low diuron concentrations. This may indicate that the single high result from 2004 was incorrect.

From the same follow up study the highest diuron concentrations was found in the Inner Oslofjord, this concentration was relatively low compared to the British and Spanish studies

Knotted wrack (*Ascophyllum nodusum*) and bladder wrack (*Fucus vesiculosus*) where analyzed at five stations in Southern Norway.

Diuron was not detected. In blue mussels (*Mytilus edulis*) from seven stations in Southern Norway, diuron was found at two, with the highest concentration in Vrengen. Cod *(Gadus Morhua)* liver from eight stations was also analyzed but diuron was not detected.

Fresh water and groundwater
Two fresh water recipients were investigated, but diuron was not detected. Diuron was neither detected in six fresh water sediment samples from Southern Norway nor in samples of perch (*Perca fluriatilis*) and pike (*Esox lucius*) from four localities in Southern Norway.

Other
Seepage from seven landfills where analyzed, and diuron was found in three samples. In five samples of clean seepage from landfills, diuron was detected in one sample. In treated wastewater from four municipal plants, diuron was found in one. Diuron was not detected in two samples of municipal sewage sludge.

Hot-spots
Vrengen in Vestfold may be a hot spot for diuron.

Need for further screening and monitoring
An extensive screening on diuron has been performed to follow-up the results from the 2004 screening.

Analysis
The analysis of diuron is often part of multi pesticide packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), clean-up with SPE and separation and quantification with LC-based methods: LC/MS or LC/UV.

Synergy with other analyses
Sample extraction and clean-up may be co-ordinated with the analysis of other herbicides as isoproturon, linuron or chlortoluron.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Diuron, Final version 31 January 2001
- HSDB Diuron
- EXTOXNET http://extoxnet.orst.edu/pips/diuron.htm
- Mattilsynet Omsetningsstatistikk for plantevernmidler 1974 -2004
- Jordforsk rapport nr. 17/04. Oversikt over påviste pesticider i perioden 1995-2002.
- Pesticides News No. 67, March 2005, page 20-21
- Statens forurensningstilsyn: Kartlegging av utvalgte nye organiske miljøgifter i 2004. Bromerte flammehemmere, perfluoralkylstoffer, irgarol, diuron, BHT og dicofol (TA-2096/2005) - http://www.sft.no/publikasjoner/overvaking/2096/ta2096.pdf, accessed 23 October 2005.
- Jon Fuglestad. Phone call, 12.12.2005. Diuron results, 2005 follow up study.

14 Endosulfan

■ **Endosulfan is an insecticide and acaricide. Two isomers in commercial product, endosulfan alfa and endosulfan beta mixed 70 / 30.**
■ **Endosulfan was banned in Norway from 1996.**
■ **Endosulfan has been identified as pollutant in air, water, biota and soil. It is persistent in marine organisms.**
■ **Endosulfan is being phased out, no further screening or monitoring is considered necessary.**

Production and use

Endosulfan was formerly used in garden centres and greenhouses, on strawberries, blackcurrant and fruit trees, mainly under the name Thiodan. In Norway it was banned from 1997 due to its toxic effects. In Sweden it was banned in 1995. From 2005 endosulfan is banned throughout EU. 50 000 tons of cyclodiene organochlorines were imported from 1974 -1978 (probably less than 10 % is endosulfan). Between 1979 and 1996, 24 500 kg endosulfan was sold. Endosulfan is no longer in use, but it was found on plants from garden centres in 2002. There are similar reports from Sweden, where endosulfan also has been illegally imported from Finland and used on farm lands.

Emissions, discharges, distribution and hot-spots

Pollution is mainly caused by run-off from agricultural land. No hotspots are found.

Monitoring

Endosulfan was screened in 1997 as part of "Statlig program for forurensningsovervåking", without being detected.

Fresh water biota

In 1997, endosulfan was detected in low concentrations in all samples of biota from Northern and Arctic Norway. This is due to atmospheric long range transport.

Need for further screening and monitoring

There are only low levels of endosulfan in Norwegian environment, and the use is decreasing. There is no need for further screening or monitoring of endosulfan.

FACTS

Cas no.: 115-29-7

Synonyms: 6,9-methano-2,4,3-benzodioxathiepin, Thiodan, Endocide, Beosit, Cyclodan, Malix, Thimul and Thifor and many more.

Properties: Brown crystals, slight sulphur dioxide odour.

Toxic effects: Highly toxic, oral LD50 values ranging from 18 to 160 mg/kg in rats. Mutagenic at high exposure. Highly toxic for some aquatic species, particularly fish. (EXTOXNET) Reproductive effects have been observed in marine mammals.

Log Kow: 3,5

Persistence: Half-life in soil is 50 to 150 days depending on isomer. 28 to 300 days in water, depending on isomer. (Naturvårdsverket, EXTOXNET)

DT50 water = 15 days,

DT50 whole system = 18-21 days (CIRCA).

Persistent in marine organisms.

Water solubility: 0,32-0,52 mg/l

Molecular formula: C_9-H_6-Cl_6-O_3-S

Metabolites: Endosulfan sulfate, endosulfanactone, endosulfan hydroxyether

Use: Endosulfan is used throughout the world to control pests and fungi on fruit, vegetables, tea, grains and on non-food crops such as tobacco and cotton.

Analysis

The analysis of endosulfan is often part of multi pesticide packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses

Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organochloro insecticides as for example HCH, DDT, or chlordanes.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Endosulfan, Final version 31 January 2001
- EXTOXNET: 1996 http://extoxnet.orst.edu/pips/endosulf.htm
- HSDB: Endosulfan
- Kemikalieinspektionen, pers. medd.
- WHO: International programme on chemical safety. Environmental health criteria 40, ENDOSULFAN. 1984.
- Mattilsynet: Omsetningsstatistikk for plantevernmidler 1974 - 2004.
- Länsstyrelsen i Norrbottens län 2004: Användning av bekämpningsmedel i Norrbottens län
- Naturvårdsverket: Redovisning från nationell miljöövervakning 2002 ENDOSULFAN, Ebjørnson 2002
- Mattilsynet: Årsmelding 2002- Rapport for virksomheten, Plantevernmidler
- Mattilsynet: Email from Merethe Dæhli 14.10.2005
- Skotvold, T., E. Wartena & S. Rognerud (1997): Heavy metals and persistent organic pollutants in sediments and fish from lakes in Northern and Arctic regions of Norway. Statlig program for forurensningsovervåking SFT. Rapport 688/97. APN-514.660.1

15 Fluoranthene

■ **Fluoranthene is a PAH. It is persistent and may have genotoxic properties.**
■ **Fluoranthene is mostly monitored as part of ∑PAH in Norway.**
■ **For further information, see PAH.**

Production and use

Fluoranthene occurs primarily in products of incomplete combustion such as cigarette smoke and engine exhaust. Fluoranthene has also been identified in food products such as charbroiled hamburger and seafood, as well as in butter, fats, and oil. Fluoranthene has been found in emissions from oil fires, municipal waste incinerators etc. It also occurs in crude oil and fossil fuels. Fluoranthene is also a content of bitumen road tar-and roof sealant). Globally, commercially produced fluoranthene is used in the production of fluorescent and vat dyes (CIRCA, HSDB).

Emissions, discharges, distribution and hot-spots

See PAH.

Monitoring

Fluoranthene is monitored with ∑PAH in Norway.

Need for further screening and monitoring

See PAH.

Analysis

Detection and limits
See PAH.

Synergy with other analyses
See PAH.

FACTS

Cas no.: 206-44-0

Synonyms: 1,2-benzacenaphthene, benzene, 1,2-(1,8-naphthalenediyl)-benzene, 1,2-(1,8-naphthylene), benzo(jk)fluorene, 1,2-(1,8-naphthylene)benzene

Properties: Pale yellow crystals or needles

Toxic effects: Fluoranthene is an irritant. LC50 for Mysid shrimp is 40 µg/l/96 h, while LC50 for Bluegill (*Leponis macrochirus*) is 3 980 µg/l/96 h. Fluoranthene is not classified as a human carcinogen, but it may have genotoxic properties.

Log Kow: 4,7

Persistence: Half-life for fluoranthene is up to 7,8 years (biodegradation) in soil. Half-life in water (direct photochemical decomposition of fluoranthene in fresh water) is calculated to 21,0 hours near the surface. Half-life in sediment is 143 - 182 days (biodegradation), while half-life in air is 8 hours (photodegradation, vapour) according to HSDB. Bioconcentration in aquatic organisms is high to very high.

Water solubility: 0,265 mg/l at 20 °C

Molecular formula: $C_{16}H_{10}$

Metabolites: Fluoranthene trans-2,3-dihydrodiol, and 8 and 9-hydroxyfluoranthene trans-2,3-dihydrodiols (bacteria).

References

■ CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Fluoranthene , Final version 31 January 2001
■ HSDB: Fluoranthene

16 Hexachlorobenzene (HCB)

■ **Formed in a great variety of reactions such as in the manufacture of pesticides, combustion processes magnesium production and electrolytic production of chlorine.**
■ **HCB was manufactured in EU until 1993, but today occurs only as an unintended contaminant.**
■ **There may be need for further screening.**

Production and use

There is no production or use of HCB today, it only occurs as an unintentional by-product. The substance has not been listed in the Norwegian Product Register since 1995.

Emissions, discharges, distribution and hot-spots

Discharges are reported from Falconbridge, a nickel plant in Kristiansand and Herøya industrial park (Norsk Hydro magnesium plant closed in 2002) has had emissions to air and later, seawater. Emissions are also known from waste incineration. Latest registered discharges (2002) were 8 kilos according to the SFT, mainly from metal production. This represents a drop of almost 90% since 1995.

Monitoring

Monitoring of HCB has been part of JAMP, thus time studies exist. There are also several other studies of HCB.

Marine sediments

In the period 1981-1999 coastal marine sediments have been monitored regarding HCB contamination. The levels were mainly low except in some harbours. In Stavanger and Karmsundet in Rogaland County, the pollution reached class IV (highly polluted). In Kristiansand in Vest-Agder County sediments and cod liver is highly polluted (class IV), similar for Grenland in Telemark County.

Marine biota

HCB has been thoroughly investigated in marine biota since 1983. The levels have been decreasing in horse mussels (*Modiolus modiolus*), blue mussels (*Mytilus edulis*) and cod liver. HCB has also been investigated in flounder (*Platichtus flesus*), dab (*Limada limada*), megrim (*Lepidorhombus whiffiagonis*) and plaice (*Pleuronectes platessa*). In horse mussels and blue mussels the highest levels have been found in Harstad, where the concentrations were class III (polluted). HCB has also been investigated in eggs from birds and in bird livers. The highest liver concentration was found in a gyrfalcon (*Falco rusticolus*), while the higher egg concentrations were found in birds that prey on inland birds, the single highest concentrations was found in a goshawk (*Accipiter gentilis*).

Fresh water sediment

HCB has been investigated in more than 60 lakes all over the country. Levels are low, except in Orrtunvannet in Bergen which has higher contamination level than Stavanger harbour.

FACTS

Cas no.: 118-74-1

Synonyms: HCB, Heksaklorbenzen, Amatin; Anticarie, Bunt-cure, Hexa CB, Pentachlorphenylchlorid, Perchlorbenzol, Sanocide, Sniecotox.

Properties: White needles/chrystals.

Toxic effects: Slightly toxic, acute oral LD50 is 3500 mg/kg for rats. Repeated doses of HCB, even at small amounts, are toxic. The substance is possibly carcinogen in humans and has endocrine-disrupting effects. Via inhalation HCB has moderate acute toxicity, LC50 is 1,6 mg/l for cat. HCB is slightly toxic to fish species, but LC50 largemouth bass (*Micropterus salmoides*) is 12 mg/l/96 hour (HSDB/EXTOXNET).

Log Kow: 3,03-6,92

Persistence: Half-life in water is 5-10 years depending on aerobic/anaerobic conditions; half-life in air (photochemically produced hydroxyl radicals) is 2,6 years (HSDB). Half-life in sediment is estimated to 2 - 7 years (CIRCA). BCF is very high, accumulates in fish and daphnia and other aquatic organisms.

Water solubility: 5-6 µg/l

Molecular formula: C_6-Cl_6

Metabolites: pentachlorobenzene, pentachlorophenol, tetrachloro-1,2-benzenediol, and tetrachloro-1,4-benzenediol (urine rat).

Fresh water biota
There have been investigations of HCB on whitefish (*Coregonus lavaretus*) and perch (*Perca fluriatilis*) in Finnmark and in the livers of pike (Esox lucius), perch and roach (*Rutilus rutilus*) in three lakes in Eastern Norway. All levels are low.

Hot spots
There are marine hotspots for HCB on Frierfjorden/Breviksfjorden in Telemark County and Kristiansandsfjorden in Vest-Agder County. The lake Orrtunvannet in Bergen is also a hotspot.

Need for further screening and monitoring
The dischrages of HCB have recently been reduced. Levels in the environment are low. Thus, no general screening or monitoring is necessary. However, there are hot spots were further monitoring and investigations may be needed.

Localities for further monitoring
Frierfjorden - Breviksfjorden in Telemark County.
Kristiansandsfjorden in Vest-Agder County.
Orrtunvannet, Bergen in Hordaland County

Analysis
The analysis of HCB is often part of multi organochlorine packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organochlorines as for example pentachlorobenzene, PCB, HCH, DDT, or chlordanes.

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17 Hexachlorobutadiene (HCBD)

■ **HCBD bioaccumulate in aquatic organisms and it is quite persistent in the environment.**
■ **HCBD is neither registered in any products nor in the environment in Norway.**

Production and use

Internationally HCBD has been used as a solvent, transformer and hydraulic liquid and in the manufacturing of rubber. No use and no production are known from Norway, and the substance is neither listed in the Norwegian Product Register for the last 10 years, nor in the Norwegian List of Dangerous Substances or ClassLab. According to NOU 1995:4 there were no registered emissions of HCBD in Norway.

Emissions, discharges, distribution and hot-spots

There is no data indicating use or discharges of HCBD in Norway, and no data on environmental distribution. However, the magnesium plant at Herøya in Telemark County may have had discharges to water and the former rubber manufacturers in Askim in Østfold County and Mjøndalen in Buskerud County may have had HCBD emissions to air. Any emissions are likely to be limited and date back in time. Long range transboundary air pollution is likely to be an additional source.

Need for further screening and monitoring

Possible contamination at old industrial sites should be screened.

Localities for further screening and monitoring

The closed magnesium plant at Herøya and former rubber manufacturing in Askim and Mjøndalen may have emitted HCBD.

Analysis

The analysis of HCBD is often part of packages with several other volatile organic compounds (VOC).

Methods

The methods are based on purge-and-trap, or head-space analysis and separation and quantification with GC-based methods: GC/MS or GC/ECD.

FACTS

Cas no.: 87-68-3

Synonyms: 3-hexachlorobutadiene, 1,1,2,3,4,4,-hexachloro-1,3-butadiene, perchlorobutadiene, HCBD 1,3-butadiene, 1,1,2,3,4,4-hexachloro-, butadien, hexachlor-1,3-, butadiene, 1,1,2,3,4,4-hexachloro-, 1,3- , HCBD, hexachlor-1,3-butadien, heksaklorbutadien, Tripen.

Properties: Clear, colourless liquid

Toxic effects: LD50 oral for rat = 200 - 350 mg/kg for HCBD. The substance is mutagenic, a skin and eye irritant and a possible a human carcinogen. In water LC50 for Fathead minnow (*Pimefales promelas*) = 0,09 mg/l/96 hour. (HSDB)

Log Kow: 3,74 - 4,78

Persistence: Half-life in natural waters is between 4 and 52 weeks (CIRCA). Half-life in air is 534 days for HCBD. Bioconcentration in aquatic organisms is very high. (HSDB)

Water solubility: 2-4 mg/l

Molecular formula: C_4-Cl_6

Metabolites: S-(pentachlorobutadienyl)-L-cyteine, N-acetyl-S-(pentachlorobutadienyl)- L-cysteine, and 1,1,2,3-tetrachlorobutenoic acid (urine)

Synergy with other analyses

Sample preparation and quantification can be co-ordinated with the analysis of other VOC like compounds or other halogenated and non-halogenated solvents.

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18 Hexachlorocyclohexane (HCH)

■ **HCH is a pesticide which in its raw form as insecticide against grasshoppers, lice and mites in buildings.**
■ **HCH consists of alpha, beta and gamma and delta isomers. The gamma isomer is Lindane. The alpha and beta isomers are usually byproducts from production of Lindane. This fact sheet covers alpha, beta and delta isomers. Lindane is covered in an own fact sheet.**
■ **There is no registered use in Norway, and low levels of HCH in the environment.**
■ **No further screening or monitoring of HCH is considered necessary.**

Production and use

HCH has usually been a by-product in Lindane production. The alpha isomer is normally constitutes 70 % of HCH, beta is up to 10 percent while the rest is gamma (and delta) isomer and other substances. HCH has sometimes been used as an independent insecticide, less effective but cheaper than Lindane. There is no registered use in Norway, but HCH isomers can be a degradation product of Lindane.

Emissions, discharges, distribution and hot-spots

Probable sources for HCH in Norwegian the environment are transboundary air pollution and decomposition of Lindane.

Monitoring

HCH has been studied in several investigations, but there are no time studies.

Marine sediments

In marine sediments, HCH isomers are investigated together, at 24 localities along the coast. The levels are relatively low, the highest levels are found in Tyssedal in Sørfjorden in Hordaland County.

Marine biota

All HCH isomers are also investigated together in marine biota. Horse mussels (*Modilus modilus*), blue mussels (*Mytilus edulis*), cod liver (*Gadus morhua*), peregrine falcon (*Falco peregrinus*) and gyrfalcon (*Falco rusticolus*) have been investigated. The highest levels are in falcons, but also these levels are relatively low.

FACTS

Cas no.: 608-73-1 (alfa 319-84-6, beta 319-85-7, delta 319-86-8)

Synonyms: Alpha-hexachlorocyclohexane (alpha-HCH), Beta-hexachlorocyclohexane (beta-HCH), Delta-hexachlorocyclohexane (delta-HCH).

Properties: White/yellowish powder/flakes

Toxic effects: Possible carcinogen. Slightly toxic.

Alpha: acute oral LD50 rats between 500-4670 mg/kg. Alpha-HCH has low toxicity for algae. Alpha-HCH is moderately toxic for invertebrates and fish.

Beta: LD50 rats from 1500 mg/kg (8 g/kg body weight for rats (neurological intoxication)). Beta-HCH generally has moderate toxicity for algae, invertebrates and fish and weak estrogenic effect on rats.

Delta: LD50 rats 1000mg/kg

Log Kow: Alpha: 3,8; Beta 3,78; Delta 4,14

Persistence: Alpha: half-lives of 125 and 48 days under aerobic and anaerobic conditions, respectively. Beta is the most persistent isomer with half-life up to 122 days in soil (calculation). Other tests show higher persistence. HCH may convert to other isomers. Adsorbs to suspended solids and sediment in the water column. High to very high potential for bioaccumulation.

Water solubility: Alpha 2 mg/l 28°C; Beta 0,2 mg/l 25°C; Delta 31,4mg/l 25°C

Molecular formula: $C_6H_6Cl_6$

Metabolites: Alpha delta-3,4,5,6-tetrachloro-hexene and pentachlorocyclohexene, urinary metabolite is 2,4,6-tri-chlorophenol.

Fresh water sediments

α-HCH and ß-HCH were investigated in sediments in several lakes in Nordland, Troms and Finnmark. Only α-HCH was found, in low concentrations.

Fresh water biota

Pike liver (*Esox lucius*), perch liver (*Perca fluriatilis*) and roach liver (*Rutilus rutilus*) in three lakes in Eastern Norway were investigated. α-HCH was found in low concentration in one pike liver.

Need for further screening and monitoring
HCH levels in environment are low, and there is no use of HCH in Norway. No further screening or monitoring is considered necessary.

Analysis
The analysis of the different isomers of HCH is often part of multi pesticide packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organochloro insecticides as for example DDT, endosulfan or chlordanes.

References

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18b Lindane

■ **Lindane is the gamma isomer of Hexachlorocyclohexane (HCH).**
■ **Lindane is a broad-spectrum insecticide. It has been used since 1949. Approximately 80% of the total production is used in agriculture.**
■ **Lindane was used in Norway until 1992.**
■ **There is a need for further monitoring of Lindane, both in Hardangerfjorden in Hordaland County and in Nordre Åklangen in Eidskog in Hedmark County.**

Production and use

Internationally, Lindane has been used for seed and soil treatment and for timber and wood treatment. It was banned in Japan from 1971 and in EU from 2000. Globally, it's still in use. The substance was used in forestry and agriculture in Norway until 1992, when it was banned. It was also used in houses against old house borer (*Hylotrupes bajulus*) and as scabies treatment on humans. 50 000 kg Cyclodiene organochlorines were sold between 1974 and 1978 (probably less than 50 % was Lindane). 47 000 kg Lindane were sold between 1979 and 1992. There are no entries of Lindane in the Norwegian Product Register since 1995.

Emissions, discharges, distribution and hot-spots

Lindane emission has mainly been from agricultural use and from forestry. As Lindane has been used on humans and in private homes, summer houses etc. it is reasonable to expect that Lindane is still being stored privately. Lindane may also leak from landfills, and it is a transboundary air pollutant.

Monitoring

Monitoring of Lindane has been studied in several investigations. It is also a part of RID, where time trends exist, but these are highly inaccurate.

Marine sediments

In marine sediments Lindane has been investigated at 25 localities along the coast. The levels are relatively low except in Tyssedal in Sørfjorden and in the inner parts of Sandefjordsfjorden.

FACTS

Cas no.: 58-89-9

Synonyms: Lindan, BHC, Agrocide, Ambrocide, Aparasin, Aphitiria, Benesan, Benexane, benhexachlor, benzene hexachloride, BoreKil, Borer-Tox, Exagama, Gallogama, Gamaphex, gamma-BHC, Gamma-Col, gamma-HCH, Gammex, Gammexane, Gamasan, Gexane, Isotox, Jacutin, Kwell, Lindafor, Lindagronox, Lindaterra, Lindatox, Lintox, Lorexane, New Kotol, Noviagam, Quellada, Steward, Streunex, gamma HCH.

Properties: White to yellow crystalline powder

Toxic effects: Lindane is toxic. Oral LD50 88 - 190 mg/kg in rats. Lindane is an irritant, possibly carcinogen and on the EU list of endocrine disruptors. The substance is highly to very highly toxic to fish and aquatic invertebrate species. Reported 96-hour LC50 values range from 1,7 to 90 µg/l in trout (*Salmo trutta*). It is also highly toxic to bees.

Log Kow: 3,9

Persistence: Half-life is 15 months in soil with 75% - 100 % disappearance 3-10 years (HSDB). Lindane is persistent in salt and fresh water (EXTOXNET), half-life in water is 42 - 400 days (evaporation and bacterial degradation). (HSDB)

DT50 water = 12 days - > 30 days (20°C)

DT50 sediment = 135 days - 162 days (20°C)

DT50 whole system = 91 d - 697 d (CIRCA)

Water solubility: 7,8 - 8,5 mg/l

Molecular formula: C_6-H_6-Cl_6

Metabolites: 2,4,6-, 2,3,5- and 2,4,5-trichlorophenol (human). Gamma-2,3,4,5,6-pentachloro-1-cyclohexene, gamma-3,4,5,6-tetrachloro-1-cyclohexene, beta-3,4,5,6-tetrachloro-1-cyclohexene, pentachlorobenzene, 1,2,4,5-tetrachlorobenzene, and 1,2,3,5-tetrachlorobenzene (bacteria).

Fresh water

Ten large rivers have been investigated for Lindane since 1990. In addition more than one hundred small rivers have been investigated once a year since 1990. The levels are relatively low. Several streams are also investigated, and in Timebekken in Rogaland County elevated levels were found.

Fresh water sediments
69 lakes in South Norway have been investigated. High concentrations of Lindane were found in the lake Nordre Åklangen in Eidskog in Hedmark county, probably due to use of Lindane on wood trunks stored next at the lakeside.

Fresh water biota
Whitefish (*Coreganus waretus*) and perch (*Perca fluriatilus*) in Finnmark has been analyzed, levels here are low. The levels in pike liver (*Esox Lucius*) and perch liver in three lakes in Eastern Norway were higher, but still quite low.

Hot spots
The concentrations of Lindane in the lake Nordre Åklangen in Eidskog are high enough to be defined as a hot spot.

Need for further screening and monitoring
Lindane is found on several locations in relatively high concentrations, and the levels are probably caused by different sources of pollution. This calls for further monitoring of Lindane.

Localities for further screening and monitoring
Marine sediments: Tyssedal and Hardangerfjorden is an area where several organic pollutants are found in higher concentrations. Thus, this area should be monitored regarding these pollutants.

Fresh water sediments: The investigation in the lake Nordre Åklangen in Eidskog in Hedmark County should be repeated in order to detect changes in concentration, environmental distribution.

Analysis
The analysis of the different isomers of HCH is often part of multi pesticide packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organochloro insecticides as for example DDT, endosulfan or chlordanes.

References

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19 Isoproturon

■ **Isoproturon is an herbicide used in cereal production across Europe to control grasses and broadleaves.**
■ **In Norway, isoproturon is prohibited to use from 2006.**
■ **The substance is very toxic for aquatic organisms and moderately persistent.**
■ **The levels found in Norwegian environment are low, but data is very limited. There is further need for screening.**

Production and use

Isoproturon has been allowed to use in Norway until 2006, but sales were stopped by the importer in 2003. Isoproturon has been in agricultural use since 1985, and about 66 000 kilos has been sold in Norway. It has been used on cereals, often against annual bluegrass (*Poa annua*). The product was cancelled because it may cause cancer, and because it may pollute groundwater.

Emissions, discharges, distribution and hot-spots

The main source in Norway is agricultural use.

Monitoring

Isoproturon has been monitored in JOVÅ. Time trends exist.

Fresh water

Isoproturon has not been investigated in marine environments in Norway, nor in ground water. Eight rivers and streams have been analyzed and isoproturon was found in the stream Finsalbekken in Hamar in Hedmark County. The levels in Finsalbekken were relatively high, and may be due to specific soil pollution.

Hot spots

The concentrations of isoproturon in Finsalbekken could be caused by a hot spot.

Need for further screening and monitoring

There are hardly any data, and isoproturon is still being used. These are indications that further studies of isoproturon should be considered.

FACTS

Cas no.: 34123-59-6

Synonyms: 3-(4-isopropylfenyl)-1,1-dimetylurea, Arelon (product name Norway) Alon; Belgran; DPX 6774; Graminon; IP50; Tolkan.

Properties: White to yellowish powder/solid crystalline.

Toxic effects: Isoproturon has only slightly acute toxicity, LD50 (rat oral) > 2000 mg/kg. Isoproturon is a skin irritant and possible carcinogen. Isoproturon is highly toxic to aquatic organisms.

Log Kow: 2,84

Persistence: DT50 water = 20 - 61 days

DT50 whole system = 44 - 276 d (CIRCA)

BCF 2,6-3,6.

Water solubility: 143,8 mg/l

Molecular formula: $C_{12}H_{18}N_2O$

Metabolites: Desmethylisoproturon

Use: Isoproturon is used as herbicide, often in cereal production, against annual grasses and broadleaves. It was re-evaluated in the EU in 2001, and it is certified for use in Sweden.

Localities for further screening and monitoring

Isoproturon should be included in future screening of both marine and fresh water environment.

Finsalbekken and the area around it should also be investigated in order to establish new knowledge of the situation there.

Analysis

The analysis of isoproturon is often part of multi pesticide packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), clean-up with SPE and separation and quantification with LC-based methods: LC/MS or LC/UV.

S

ynergy with other analyses
Sample extraction and clean-up may be co-ordinated with the analysis of other herbicides as diuron, linuron or chlortoluron.

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20 Lead and its compounds

■ **The phasing out of leaded petrol has significantly reduced emissions to air, and reduced airborne pollution in Norway.**
■ **Emissions of lead have not dropped significantly since 1995, but the new ban on leaded shot gun pellets is expected to have some effect.**
■ **No further screening is considered necessary but monitoring should continue in order to evaluate measures and policies.**

Production and use

Lead occurs in a wide variety of minerals. Globally it has been used in construction, ceramics, ammunition, pigments and petrol additives among others.

There have been lead mines in Norway. Lead today is used in fishing lures, cables, sail boat keels, cars, batteries/accumulators, plastics, paints, sand blasting etc. It is also being used in ammunition, but lead is banned in shot gun pellets. Lead has also been released as a by-product from mines and metal smelters. The National target for lead calls for significant reduction of lead emissions before 2010.

Emissions, discharges, distribution and hot-spots

Total Norwegian emissions of lead have decreased from 598 tons in 1995 to 455 tons in 2003. Discharges to water in the same period have dropped from 181 tons to 73 tons in 2003 according to SFT. A drop in lead emissions from oil and gas and industrial sources has been reversed by increased emissions from lead in products. Long range transboundary air pollution deposits to Norway have decreased significantly the latest years; estimates are down from 20 tons in 1991 to approx. 5 tons in 2002. In products, almost no change is detected between 1985 and 2002, annual use is approx. 20 000 tons. The ban on use of lead pellets in shotguns from 2005 will cause a drop in emissions as this is the single largest source. 15 000 tons of lead is estimated to be located in firing ranges. Lost fishing lures may also cause large discharges at popular locations for fishing.

There are several hot spots for lead pollution. One of the largest is Regionfelt Østlandet in Hedmark County, a large military firing range/training field where natural lead sources (gravel with high lead content from the nearby Deifjellet has been used as building material for roads in the area) and use of leaded ammunition together may cause high levels of contamination.

FACTS

Cas no.: 7439-92-1

Synonyms/compounds: Lead carbonate: Cerrusite, lead chloride: cotunite, lead dioxide: plattnerite, lead monoxide: litharge, lead sulphate: anglesite, lead sulphide: galena.

Properties: Metal. Compounds may have other properties.

Toxic effects: Toxic, with variety of toxic effects. LD 100 acute oral for mammals is 50-800 mg/kg. NOEC sheep is 0,1 mg/kg/day. Accumulate in mammals and aquatic organisms. Teratogenic, possible carcinogen (some compounds), may damage reproduction.

Log Kow: -

Persistence: Not subject to degradation. Half life of lead in soil is estimated as 740-5900 years.

Water solubility: Lead is insoluble. Some compounds may be soluble.

Molecular formula: Pb

Metabolites: None

Monitoring

Monitoring of lead has been part of JAMP and RID. Time trends exist. Lead has also been investigated in several other studies (see references).

Marine sediments

Lead is found in most investigated harbours, the highest levels of contamination are found in Tromsø in Troms County and Visnesbukta in Karmøy in Rogaland County, but several other harbours have serious lead pollution.

Marine biota

High lead concentrations are found in biota along the coast. There are restrictions on con-

sumption and sales of seafood due to lead concentrations in Sørfjorden (all seafood), Harstad (liver and shell) and Årdalsfjorden (shellfish). Both swans and ducks are reported with lead poisoning between 1970 and 1990. Cod-liver in Inner Oslofjord has high and increasing lead burdens.

Fresh water
Several rivers have been monitored for lead pollution. High concentrations (class IV - V) were found in samples from Glomma, Numedalslågen, Orreelva and Vefsna. The lead concentrations in streams are not decreasing.

Fresh water sediment
The levels of lead are high in nearly all fresh water sediment in Norway. Atmospheric pollution is a significant source, in addition to mining and local industry.

Fresh water biota
The lead levels in trout in Vefsna are higher than from other rivers. There are not many studies on fresh water biota.

Need for further screening and monitoring
Lead is thoroughly screened and there is no further need for screening. However, monitoring of lead concentrations should continue, both because environmental levels are high and in order to evaluate measures and policies for lead reduction, such as the banning of lead in shotgun ammunition.

Localities for further screening and monitoring
The monitoring of lead should be continued in the same localities which have been monitored earlier.

Analysis
There are several well-established techniques for determination of Pb. Several companies offer this service in Norway and Europe. The most common techniques are inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods
Water samples are acidified with 1-10% nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of lead can also be used for determination of Cu, Hg, Ni, Zn, Cr and As.

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21 Mercury and its compounds

■ **Mercury is a widely used toxic heavy metal which has been used in measuring instruments, switches, lights, dentistry, anti fouling in paints, batteries and chloro-alkali industries.**
■ **Mercury is found in significant levels in fresh water fish in Norway.**
■ **There is no further need for screening, but Inner Oslofjord should be further investigated.**

Production and use

Globally, mercury has been used in dentistry, measuring and control equipment, batteries and lamps. The chloro-alkaline industry is also known to use large amounts. Mercury has also been used as a pesticide and biocide on grain and in paper industry. In Norway, most use is banned or restricted. Currently, Hg is found in old electrical appliances, amalgam in teeth and in lights (tubes, energy saving light bulbs and headlamps on cars). In connection with the phasing out of PCB in road lightning, Hg road lights all over Norway are often substituted with Na (sodium) lamps.

Emissions, discharges, distribution and hot-spots

Mercury has not been mined in Norway, but there has been a limited production as a by-product at Norzink, Odda in Hordaland County.

According to SFT, 1 100 kg Mercury was emitted in 2002. Main emissions were from land based industry (41 %), transport (26 %), amalgam (18 %), waste management - incineration and landfills (7 %), oil and gas industry (3 %) and other (5 %). There has been a 58 % drop in emissions since 1995.

Discharges to water have dropped from 1174 to appr. 65 kilos in 2002. Emissions to air have dropped from 1400 kg in 1990 to 640 kg in 2003. Imported mercury in product has dropped from 3600 kilos to about 40 kilos in the same period. Drop in emission to air is caused by reductions from incinerators and crematoriums, from oil and gas sector and landfills and by reduction from industrial sources often due to closing of plants. Drop in discharges to water are mainly caused by lower emissions from the oil and gas sector and from dentistry. Estimates for concentrations in municipal waste are 1-1,5 mg/kg (EU). Long range transboundary air pollution contributes significantly to mercury pollution in Norwegian environment.

Three main hotspots are former chorine-production plants at Herøya, the landfill Opsund in Sarpsborg, and a sunken German WWII submarine outside Fedje near Bergen. Emissions from smelters due to Mercury pollution in raw materials have created local high Mercury levels around Eramet Porsgrunn, Eramet Sauda, Tinfos Øye, Boliden Odda and Fundia Rana. High concentrations are expected to be found in sinks in older hospitals and at dentists. Finally, minor hotspots may be found downstream from old pulp-plants.

Monitoring

Monitoring of mercury has been part of JAMP and RID. Time trends exist. Mercury has also been investigated in several other studies (see references).

FACTS

Cas no.: 7439-97-6

Synonyms: Kvikksølv. HgS: Cinnabar H2Cl2: Calomel, CH3-Hg methyl mercury (most toxic).

Properties: Heavy silvery liquid.

Toxic effects: Mercury and mercury compounds are toxic. It causes damage on inner organs and is very toxic to aquatic organisms. Both short-term and long-term exposure to mercury in humans may result in central nervous system (CNS) effects. Inorganic mercury accumulates within the brain, causing CNS effects. Organic mercury has high lipid solubility and is distributed throughout the body, accumulating in the brain, kidney, liver, hair, and skin. Some compounds are suspected carcinogen (methyl mercury), and teratogenic. Mammals and aquatic organisms accumulates mercury (HSDB, CIRCA).

Log Kow: -

Persistence: -

Water solubility: Insoluble to 63,9 µg/l

Molecular formula: Hg

Metabolites: -

Marine sediments
There are very high mercury concentrations in Sørfjorden and in Inner Oslofjord. Stavanger harbour and Farsund harbour in Vest-Agder County are also much polluted. Highest concentrations are found in Gunneklevfjorden in Grenland in Telemark County.

Marine biota
In Sørfjorden, mercury levels are very high in blue mussels (*Mytilus edulis*). Mercury levels in cod fillet (*Gadus Morhua*) in Indre Oslofjord are reason for concern, as they are high and rising. Outside Sørfjorden and Indre Oslofjord mercury levels in biota are low to moderate. Extreme concentrations have been found in the livers of golden eagle (*Aquila chrysaetos*) and grey heron (*Ardea cinerea*). General Hg levels in birds are falling.

Fresh water
Mercury concentrations in rivers have been monitored in the RID programme since 1990. In 2003 samples in class V have been taken from Drammenselva, Glomma, Skienselva, Otra and Suldalslågen. For other rivers general concentrations are low. Mercury concentrations found in the RID programme prior to 1999 were generally lower than newer findings. This may be due to the use of a new analytical method since 1999.

Fresh water sediment
Many lakes are investigated. Higher levels of Hg are found in the south and closer to the coast. Air pollution is the most important factor, but mining is responsible for local high concentrations.

Fresh water biota
There are Norwegian mercury related advice and regulations regarding the consumption of pike (*Esox lucius*), perch (*Perca fluviatilis*), char (*Salvelinus alpinus*) and trout (*Salmo trutta*). Large fish are to be avoided. Extreme mercury levels are found in bottom fish in Randsfjorden and Mjøsa.

Need for further screening and monitoring
There is no further need for screening of mercury. Knowledge of environmental levels and distribution is generally good. However, certain localities should be further investigated. As the levels are high and long range transport contribution significant, mercury should be continuously monitored.

Localities for further screening and monitoring
The monitoring in JAMP will continue, including monitoring in Inner Oslofjord where mercury levels in cod fillet are increasing.

Analysis
Mercury analysis is well developed. Techniques such as CV-AFS, CV-AAS and ICP-MS are frequently used for determination of total concentration.

Methods
Water samples are acidified with 1-10% hydrochloric acid and an excess of BrCl is added. For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen peroxide in sealed containers using microwave system. The digest is diluted to volume and an excess of BrCl is added.

Synergy with other analyses
The sample digestion method used for Hg-analysis can also be used for determination of Cu, Pb, Ni, Zn, Cr and As.

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22 Naphthalene

■ **Naphthalene is a PAH. It is persistent and a human carcinogen.**
■ **Naphthalene is mostly monitored as part of ∑PAH 16 in Norway.**
■ **Naphtalene is considered less toxic than other PAHs**
■ **For further information, see PAH.**

Production and use

Globally, the largest releases of naphthalene are results of the combustion of wood and fossil fuels and the production of coal tar. Naphthalene has been used in the manufacturing of azodyes, phthalic anhydride, naphthalensulphonic acid-formaldehyde condensation products, alkyl derivatives and solvent components. Naphthalene is also a component in some fumigants and repellents (moth balls).

Emissions, discharges, distribution and hot-spots

See PAH.

Monitoring

Naphthalene is monitored with ∑PAH 16 in Norway.

Need for further screening and monitoring

See PAH.

Analysis

See PAH.

References

■ CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Naphthalene , Final version 31 January 2001
■ HSDB: Naphthalene.
■ ClassLab: Naftalen

FACTS

Cas no.: 91-20-3

Synonyms: Albo-carbon, Coal tar camphor, Naphthaline, Antimite, Naphthene, Naphthalin, Naftalin, White Tar.

Properties: White scales, balls, powder or cakes. Aromatic odour (mothballs).

Toxic effects: Fatal human dose (oral) is approx. 2 g (48 h) for a child, 5-10 g adult, LD50 (rat oral) is 2,6 g/kg. Naphthalene is an irritant and a possible human carcinogen. It is very toxic to aquatic organisms (ClassLab) with LC50 for Pink salmon (*Oncorhynchus gorbusch*) at 1,4 mg/l (96 h).

Log Kow: 3,01 - 3,7

Persistence: No or little degradation under anaerobic conditions. Half-life in air and water is to 2,4-242 weeks (biodegradation), while half-life in soil for naphthalene may be as low as 2-18 days (biodegradation), while half-life in air is expected to be 16 hours (photolysis). Bioconcentration in aquatic organisms can be high.

Water solubility: 30 mg/l at 20 °C

Molecular formula: $C_{10}H_8$

Metabolites: Via 1,2-epoxide into 1,2-dihydronaphthalene-1,2-diol, 1,2-dihydro-1-naphthol and N-acetyl-s-(2-hydroxy-1,2-dihydronaphthyl)-cysteine.

23 Nickel and nickel compounds

■ **Nickel compounds are confirmed human carcinogens and allergens.**
■ **Nickel is widely used, and there is significant air transport of nickel from Northwest Russia to Norway.**
■ **In general nickel concentrations in Norway are low.**
■ **No further screening is regarded necessary.**

Production and use

Nickel compounds have wide usage. They are present in fossil fuels. Globally, nickel has been important in the production of stainless steel and nickel alloys, electroplating, non-ferrous alloys, catalysts, pigments, component of Ni-Cd and NiMH batteries etc.

Coinage contain up to 25% nickel. Nationally nickel metal is produced at Falconbridge in Kristiansand. According to SFT the annual turnover of nickel has increased from 2257 tons in 1990, via 4755 tons in 1998 to 3665 tons in 2002.

Most of the nickel is in form of alloys. Nickel in waste (from sandblasting sand, batteries and catalysers) has only dropped from 158,5 tons in 1990, to 88,6 tons in 2002. The amount emitted from batteries has remained stable at 65 tons.

Emissions, discharges, distribution and hot-spots

Nickel is emitted by natural (volcanoes, erosion) and anthropogenic sources. Norwegian emissions to air have been stable at 40 tons (fossil fuels, asphalt) since 1995. Emissions to soil have dropped from 33 tons in 1990 (mainly sandblasting sand, some fertilizer) to about one ton in 2002. The data on general discharges to water are scarce; but there have been significant discharges from Falconbridge in Kristiansand in Vest-Agder County. Airborne long range transport of nickel by air is registered from Northwest Russia to Northern Norway. The area around Falconbridge is considered a hotspot. This area is thoroughly investigated.

FACTS

Cas no.: 7440-02-0

Synonyms/compounds:

Nickel acetate tetrahydrate: $Ni(C_2H_3O_2)_2.4H_2O$

Nickel ortho-arsenate: $Ni_3(AsO_4)_2$

Nickel bromate hexahydrate: $Ni(BrO_3)_2.6H_2O$

Nickel carbonate: $NiCO_3$

Nickel carbonate hydroxide: $NiCO_3.2Ni(OH)_2$

Nickel carbonyl: C_4NiO_4

Nickel chloride: $NiCl_2$

Nickel fluoride: NiF_2

Nickel hydroxide (hydrate): $Ni(OH)_2.H_2O$

Nickel nitrate hexahydrate: $Ni(NO_3)2.6H_2O$

Nickel oxide: NiO

Nickel sulfate hexahydrate: $NiSO_4.6H_2O$

Nickel subsulfide: Ni_3S_2

Properties: Silvery white metal

Toxic effects: Nickel compounds are confirmed human carcinogens and may cause allergies (ClassLab, HSDB). LC50 for Daphnia magna is 0,5 mg nickel/litre (96 hour) and 4-20 mg/l for fish (WHO). For mammals the most toxic compound is nickel carbonyl.

LC50 rat is 0,1 mg nickel carbonyl/litre air for a 20 minute exposure.

Log Kow: -

Persistence: Nickel may exhibit a high mobility within the soil profile, reaching ground and surface water and rivers and lakes. Acid rain can mobilize nickel from the soil. Nickel carbonyl may volatilize from water, other compounds will not. Nickel compounds accumulate in plants, and have low to moderate potential for bioconcentration in aquatic organisms.

Water solubility: Insoluble (some compounds are soluble).

Molecular formula: Pure metal: Ni

Metabolites: -

Monitoring

Nickel and nickel compounds have been monitored RID, a time trend exists here. Other studies are included in the references.

Marine sediment
The levels of nickel in marine sediments are generally low. Sediments outside Falconbridge have higher nickel loading, "tilstandsklasse IV" in Hanevika, outside Falconbridge.

Marine biota
The nickel levels in fish are relatively low.

Fresh water
Nickel has been monitored in rivers. Levels are generally low, the highest samples were Class II.

Fresh water sediment
Nickel levels in fresh water sediments are generally low, but increasing with latitude. Åsterudtjernet in Ringerike in Buskerud County and Vollevatnet in Kristiansand in Vest-Agder County have significantly higher concentrations. These are affected by mining and Falconbridge respectively.

Fresh water biota
There are generally low levels of nickel in fresh water biota.

Need for further screening and monitoring
There is no further need for screening of nickel and its compounds.

Analysis
There are several well-established techniques for determination of Ni. Several companies offer this service in Norway and Europe. The most common techniques are Inductively coupled plasma mass spectrometry (ICP-MS), Inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods
Water samples are acidified with 1-10% nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid/hydrogen peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of nickel can also be used for determination of Pb, Hg, Zn, Cr, As and Cu.

References

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24 Nonylphenols

■ **Nonylphenol is a mixture of isomeric monoalkyl phenols, the technical grade is a mixture of 90% 4-nonylphenol and 10% 2-nonylphenol.**
■ **Nonylphenol is found in the environment primarily as a biodegradation product of nonylphenol ethoxylates, and is a recognised endocrine disruptor.**
■ **Nonylphenol and nonylphenol ethoxylates should be screened in Norwegian environment.**

Production and use

In Norway, main users have been Hydro Polymers in Porsgrunn (paste PVC) Grenland, Telemark County, Jotun in Sandefjord, Vestfold County (additives in paint) and some producers of car wash detergents. These sources have all been phased out. Nonylphenol and nonylphenol ethoxylates can be found in some imported products such as paint, car-wash detergents and plastic. The main source in 2002 was "car related products" and detergents. Consumption in 2002 was set to 58 kilos. Imports and use are regulated (mainly banned) since 2002, and there is a national target for phasing out by 2005. Nonylphenols are also used as spermicide (nonoxynol-9) on condoms and contraceptive creams.

Emissions, discharges, distribution and hot-spots

Nonylphenols are mainly discharged to waste water main sources have been garages and car-washing machines, but also from households. Nonylphenol ethoxylates are found in water and sludge from municipal waste water treatment plants. A survey by Aquateam from 1998 showed nonylphenol (+ ethoxylates) in high concentrations in sludge samples from 8 sewage treatment plants in Norway. Concentrations were 22 - 650 mg /kilo dry matter.

There are few data on environmental distribution. SFT has calculated that emissions of nonylphenols have dropped from 170 tonnes in 1991 to 18 tons in 2002; the sharpest drop was from 2001 to 2002. Discharges to water from products (only significant source) have dropped from appr. 184 tons to 15 tons in 2002 according to SFT. It is assumed that the chemicals are discharged via (municipal) waste water.

FACTS

Cas no.: 25154-52-3

Synonyms: nonylfenol, nonyl, NP, nonoxynol-9

Properties: Pale-yellow, viscous liquid. (C9)

Toxic effects: Nonylphenols are slightly toxic when swallowed. They are severely irritating to skin and eyes. Acute LD50 rat oral is 1 600 mg/kg. Nonylphenols are toxic to aquatic organisms; LC50 Rainbow trout (*Oncorhynchus mykiss*) is 0,56-0,92 mg/l/96 h (ClassLab/HSDB). Nonylphenols are also teratogenic, and they are on the EU list of endocrine disruptors.

Log Kow: 4,2 - 4,7

Persistence: Half-life in air is estimated to 7,5 hours (hydroxyl radicals), while half life in water is 17 days (volatilization). Adsorption to suspended solids and sediments will limit volatilization; estimated volatilization half-life from a model pond is greater than 25 years if adsorption is considered. Nonylphenols bioaccumulate in aquatic life forms.

Water solubility: 3-11 mg/l (pH dependent).

Molecular formula: C_{15}-H_{24}-O

Metabolites: The corresponding NP-glucaronide and hydroxy conjungates.

Alkylphenols (including nonylphenol) are released through discharges of "produced water" from offshore oil producing installations. Concentrations are low, but total sum is large due to the large amount of water emitted. SFT has calculated that 23,6 tons alkylphenols (alkylchain of C4 and upwards) was discharged in 1998. According to Institute for Marine Research the discharges of nonylphenol and octylphenol from oil and gas production in the Norwegian sector limited, and discharges of shorter chain alkylphenols is the norm.

Monitoring

Nonylphenol and nonylphenol ethoxylates were investigated in a Norwegian study in 1997.

Marine sediment

The study in 1997 has shown low concentrations of nonylphenol and nonylphenol ethoxylates in several fjords in Akershus, Østfold, Telemark and Hordaland. Concentrations were

similar to concentrations in river deltas in other European countries. Waste water is considered the major source.

Marine biota
Recent research by Institute of Marine Research indicated that discharges from oil producing installations have no effect on the population of cod (*Gadus morhua*). Effects on other marine life have not been researched.

Need for further screening and monitoring
There is a need for further screening of nonylphenol and nonylphenol ethoxylates in the environment.

Localities for further screening and monitoring
Nonylphenol and nonylphenol ethoxylates should be screened again in marine sediments (offshore). In addition, screening should be done in fresh water sediment and marine and fresh water biota. Relevant species should be determined by further studies.

Analysis
The analysis of nonylphenols is often part of multi phenols packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), clean-up with SPE and separation and quantification with either GC- or LC-based methods: GC/MS, LC/MS or LC/UV.

Synergy with other analyses
Sample extraction and clean-up may be co-ordinated with the analysis of other alkylphenols as octylphenol or as pentachlorophenol.

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- Aquateam: - A survey of toxic organics in Norwegian sewage sludge, compost and manure. B. Paulsrud, A. Wien and K.T. Nedland 1998.
- SFT: Utslipp av olje og kjemikalier fra plattformene på norsk kontinentalsokkel in 1998\
- NFR PROSJEKTNR 152231/720 - Contamination of fish in the North Sea by the offshore oil and gas industry.
- Jarle Klungsøyr, Institute of Marine Research, telephone call.

25 Octylphenols

■ **Very limited data is available on octylphenol, but the effects are probably similar to nonylphenols.**
■ **Octylphenol is known to have similar use as nonylphenols but it is less used.**
■ **4-tert-octylphenol may form in waste water via degradation of some alkylphenols.**
■ **Further screening is necessary.**

Production and use

In Norway, no use is known today, but ethoxylates may be present in some imported products. Imports and use are regulated (mainly banned) since 2002, and there is a national target for phasing out by 2005. See fact sheet 24.

Emissions, discharges, distribution and hot-spots

Octylphenols are discharged to waste water or may be formed as a degradation product of alkylphenols in waste water; the main sources are garages, car-wash installations etc. and households, as for nonylphenols. Octylphenols - Ethoxylates are found in sludge from municipal waste water treatment plants. There are no data on environmental distribution. See fact sheet 24.

Need for further screening and monitoring

Octylphenols should be screened together with nonylphenols, at the same localities.

Analysis

The analysis of octylphenols is often part of multi phenols packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), clean-up with SPE and separation and quantification with either GC- or LC-based methods: GC/MS, LC/MS or LC/UV.

Synergy with other analyses

Sample extraction and clean-up may be co-ordinated with the analysis of other phenols as nonylphenol or pentachlorophenol.

FACTS

Cas no.: 4-tert-octylphenol: 140-66-9

octylphenol: 67554-50-1

p-octylphenol: 1806-26-4

1,1,3,3-tetramethylbutylphenol: 27193-28-8

Synonyms: di-iso-butylphenol, para-octylphenol, OP, 1,1,3,3-tetramethyl-4-butylphenol

Properties:

Toxic effects: 4-tert-octylphenol is a skin and eye irritant. Octylphenols are on the EU list of endocrine disruptors.

Log Kow: 5,28 (4-tert-octylphenol)

Persistence: Octylphenols are inherently biodegradable with > 60 % (35 days) in mod. Sturm-test (OECD 301B) (CIRCA). Photodegradation in air is 9 hours. Octylphenols bioaccumulate in aquatic organisms.

Water solubility: 5 mg/l at 25° C (4,821 mg/l for 4-tert)

Molecular formula: $C_{14}H_{22}O$

Metabolites: See nonyphenols, fact sheet 24

References

■ Miljøstatus: Nonyl- og oktylfenoler.
■ CIRCA, Royal Haskoning Fact sheets on production, use and release of priority substances in the WFD, Octylphenol, Final version 31 January 2001.
■ HSDB: 4-tert-octylphenol 140-66-9 and octylphenol 67554-50-1.
■ European Commission 1999; Study on the prioritisation of substances dangerous to the aquatic environment. (98/88/3040/DEB/E1).
■ Environmental Review no. 15, 2004, EU-List of Undesirable Substances 2004
■ Paulsrud, Bjarne; Nedland, Kjell Terje; Wien, Asgeir: Organiske miljøgifter i norsk avløpsslam. SFT-rapport 97:25, TA-1472.
■ Nesgård, Bjørg Synnøve; Røstad, Astrid; Lima-Charles, Michael: Kilder til organiske miljøgifter i kommunalt avløpsvann - bidrag fra småindustri. SFT-rapport 98:22.
■ Lima-Charles, Michael; Nesgård, Bjørg Synnøve: Kilder til organiske miljøgifter i kommunalt avløpsvann: bidrag fra husholdninger. SFT-rapport 98:23, TA-1590.

26 Pentachlorobenzene

■ **Pentachlorobenzene is very toxic to aquatic organisms, persistent and bioaccumulates.**
■ **There is little registered use in Norway, but pentachlorobenzene is a metabolite of Lindane.**
■ **Monitoring should be done together with Lindane.**

Production and use

Globally, pentachlorobenzene is known as an intermediate in the production of the fungicide quintozene, as a flame retardant and as a contaminant of hexachlorobenzene which has been used as a fungicide. The substance has also been used with PCB. There is little registered use in EU. Pentachlorobenzene is not registered in the Norwegian Product Register. Quintozene (sometimes registered in Norway as Kvintosen) has been in use, data show use from 1974 until the fungicide lost its license from 1987. From 700 to almost 5000 kilos were sold per year.

Emissions, discharges, distribution and hot-spots

Pentachlorobenzene may have been present in discharges from Falconbridge in Kristiansand and from the Magnesium production plant at Herøya. Contamination from Quintozene is possible, but there is no information available. As the substance is a metabolite of Lindane, it may be found in areas polluted with Lindane, especially due to its high persistence and tendency to accumulate in fish.

Monitoring

Pentachlorobenzene has been monitored in several studies in Norway.

Marine sediment

Pentachlorobenzene was earlier part of the monitoring programs for the fjords outside the magnesium production plant at Herøya and the nickel smelter Falconbridge in Kristiansand. The concentrations found were low.

In a study from Sandefjordsfjorden and Indre Mefjorden, low concentrations of pentachlorobenzene were found in one sample from the inner parts.

FACTS

Cas no.: 608-93-5

Synonyms: Pentaklorbensen, PeCB; 1,2,3,4,5-pentachlorobenzene, 5CB, PCBz

Properties: Colourless needles, pleasant odour.

Toxic effects: Commercial pentachlorobenzene is an irritant and slightly toxic. Acute LD50 rat oral is 1000-1125 mg/kg. It may cause liver and kidney damage. The substance is very toxic to aquatic organisms (ClassLab). LC50 guppy (*Poecilia reticulata*) 0,178 ppm/14 days and LC50 Daphnia magna 4,1-7,2 mg/l/48 h. Lowest concentration with observed effect on snails and mussels is 0,04 mg/l (Naturvårdsverket).

Log Kow: 4,8 - 5,18

Persistence: Atmospheric half-life for pentachlorobenzene is about 277 days (Hydroxyl radicals). Half life in soil is 200-350 days (lab, HSDB). In water half life depends on amounts of solids, from 194 to 1250 days (Swedish EPA). 41 % photodegradation is registered in surface waters in 24 hours. Under field conditions the strong adsorption to solids may counteract the photodegradation (CIRCA). Bioconcentration in aquatic organisms is very high.

Water solubility: 0,56 mg/l at 20°C

Molecular formula: C_6HCl_5

Metabolites: pentachlorophenol, tetrachlorophenol (2,3,4,5-tetrachlorophenol, 2,3,4,6-tetrachlorophenol, 1,2,3,4-tetrachlorobenzene, 1,2,4,5-tetrachlorobenzene, 1,2,3,5-tetrachlorobenzene, 2,3,4-trichlorphenol, 2,4,6-trichlorphenol, 3,4,5-trichlorphenol, 1,3,5-trichlorbenzene).

Fresh water biota

In a study of fish downstream three municipal landfills in Eastern Norway, pentachlorobenzene was found in samples of pike (*Esox lucius*) liver and perch (*Perca fluviatilis*) liver. The levels were low.

Need for further screening and monitoring

There is no need for a screening of pentachlorobenzene, but the substance should be investigated in connection with Lindane monitoring.

Localities for further screening and monitoring
Investigation of pentachlorobenzene should be from the same samples as Lindane is investigated from.

Analysis
The analysis of pentachlorobenzene is often part of multi organochlorine packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other organochlorines as for example hexachlorobenzene, PCB, HCH, DDT, or chlordanes.

References

- CIRCA, Royal Haskoning Fact sheets on production, use and release of priority substances in the WFD, Pentachlorobenzene, Final version 31 January 2001.
- HSDB: Pentachlorobenzene.
- ClassLab, Pentaklorbenzen.
- Naturvårdsverket: Redovisning från nationell miljöövervakning 2002 - Pentaklorbensen och triklorbensen. May 2002.
- Jordforsk 41/04 "Organiske miljøgifter i fisk nedstrøms avfallsdeponier".
- Miljøovervåkning i Sandefjordsfjorden og indre Mefjorden, 1997-1998. Delrapport 2. Miljøgifter i sedimenter. TA-1585/1998.
- Statlig program for forurensningsovervåkning, Kristiansandsfjorden og Grenlandsfjordene.

27 Pentachlorophenol/PCP

■ **Pentachlorophenol is probably carcinogenic, it may contain dioxins and wood preserved with PCP may form dioxins if incinerated.**
■ **The main use of PCP is wood treatment.**
■ **Use of PCP is strictly regulated in Norway.**
■ **Pentachlorophenol should be screened at localities where it is possible to find high levels of pollution.**

Production and use

Globally, main use of PCP is and has been treatment of wood as a sap stain control, wood preservative (used on wooden pallets) and as a surface biocide for masonry and for preservation of textiles including heavy duty fibres. In Norway, PCP has been used in the paper industry, and as wood preservative. Import is registered by the Norwegian Food Control Authority between 1974 and 1978. Norwegian emissions are to be phased out by 2005. There are no direct emissions today, but PCP may be present in imported products such as textiles, leather and wood.

Emissions, discharges, distribution and hot-spots

Use of PCP in Norway is regulated; chemicals or mixtures of chemicals containing more than 0.1 percent PCP are banned. A report commissioned by Miljøministeriet in Denmark in 2004 stated that 1.2 million tons PCP treated wood were still in use in Denmark, especially in pallets from Southern Europe and in old building materials.

Monitoring

PCP has been investigated on three geographical locations in Norway (Lågendeltaet in Oppland, Mjøsa and Selbusjøen).

Fresh water sediment

The three investigations in Lågendeltaet in Oppland, Mjøsa and Selbusjøen gave very low or no concentrations of PCP. In Selbusjøen use of PCP for wood treatment is known until 1974, but nothing was found.

Need for further screening and monitoring

PCP in construction wood and pallets are monitored in Denmark. Incineration of PCP wood may cause dioxin formation when incinerated.

FACTS

Cas no.: 87-86-5

Synonyms: PCP, penta, 2,3,4,5,6-pentachlorophenol, chlorophen, penchlorol

Properties: White to dark brown crystalline solid with a phenolic odour.

Toxic effects: Commercial pentachlorophenol may contain dioxins, thus the toxicity varies according to this. PCP is considered toxic; LD50 oral rat is from 27 to 211 mg/kg. Inhalation of PCP is considered very toxic (ClassLab), LC50 inhalation rat is from 0,2 to 2,1 mg/l. PCP is irritant to human skin, throat and eyes and highly to very highly toxic to many species of fish; LC50 is 52 µg/L/96 h in rainbow trout (*Oncorhynchus mykiss*). The substance is also strongly toxic to plants. There are also reported chronic effects; PCP may be mutagenic and is probably a human carcinogen (EXTOXNET, HSDB).

Log Kow: 3,32

Persistence: In soil, field half-lives of weeks to months are reported, slower in cold environment. For vapour in air half life is 29 days (photochemically) Weeks to months in sediments, as little as no degradation in anaerobic conditions. EXTOXNET, HSDB). DT50 in aerobic aquatic circumstances, incl. sediment, is 4 days. BCF values from approximately 100 to 1000 (HSDB) indicates low potential for bioaccumulation

Water solubility: 14 mg/l

Molecular formula: C_6-H-Cl_5-O

Metabolites: Tetra- and tri-chlorohydroquinone (in rat) pentachloroanisole (in fungi), tetrachlorohydroquinone and pentachlorophenol glucuronide (found in human urine).

PCP in wood should be screened, in order to asses the risk of dioxin emissions from incineration of pallets and construction wood, as biofuel is excluded from waste incineration regulations, and does not have to use filters to clean emissions. PCP concentrations in Denmark are connected to pallets and to production of building materials such as windows. There is a need for screening of PCP in Norway.

Localities for further screening and monitoring

This screening should be done on places where PCP pollution should be expected, such as in

the recipient of wood treatment plants, window production plants etc.

Analysis

The analysis of PCP is often part of multi phenols or chlorophenols packages offered by several laboratories.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), clean-up with SPE and separation and quantification with either GC- or LC-based methods: GC/ECD, GC/MS, LC/MS or LC/UV.

Synergy with other analyses

Sample extraction and clean-up may be co-ordinated with the analysis of other phenols as octyl- and nonylphenols or other chlorophenols.

References

- CIRCA, Royal Haskoning Fact sheets on production, use and release of priority substances in the WFD, Pentachlorophenol, Final version 31 January 2001.
- HSDB: Pentachlorophenol.
- EXTOXNET Pesticide Information Profiles: Pentachlorophenol, revised 1996.
- ClassLab, Pentaklorfenol.
- FOR 2004-06-01 nr 922: Forskrift om begrensning i bruk av helse- og miljøfarlige kjemikalier og andre produkter (Produktforskriften).
- Miljøministeriet 2004 Survey of Dioxin Emission from PCP-treated Wood Charlotte Libak Hansen and Erik Hansen COWI A/S.
- Mattilsynet: Omsetningsstatistikk for plantevernmidler, 1974-2004.

28 Polyaromatic hydrocarbons (PAH)

- **There are several PAHs, of which approx. 15 are considered human carcinogens.**
- **Many PAHs are persistent and bioaccumulate.**
- **Three PAHs are WFD Priority Substances.**
- **No further PAH screening is considered necessary in Norway, but monitoring should continue, as levels are quite high on several locations.**
- **See also fact sheets 2, 14 and 22 for some specific PAHs**

FACTS

Cas no.: 130498-29-2

Synonyms: Coal tar, Aromatic polycyclic hydrocarbons, Polyarenes.

Properties: Differs, often needles with faint odour.

Toxic effects: Many substances are probable carcinogens (approx. 15) and genotoxic.
Benzo(a)pyrene is considered most toxic, it is carcinogenic, mutagenic, teratogenic and genotoxic.
Many of the PAHs are toxic to aquatic organisms.

Log Kow: In the range of 3 to 6

Persistence: Half life for PAHs varies between substances. Half-lives in soil and sediments vary from days to several years depending on substance, climate, light etc. Half life in fresh water and marine environments varies from days to years, depending on substance and conditions. For many substances volatilization from soil (dry/wet), water and hydrolysis are not important for environmental fate. Many PAHs accumulates in aquatic life forms.

Water solubility: 1,6 to 3,8 µg/l at 25°C for benzo(a)pyrene

Molecular formula: Multi-core aromatic ring systems.

Metabolites: 20 primary and secondary oxidized metabolites and to a variety of conjugates. Several metabolites can induce mutations, transform cells and/or bind to cellular macromolecules, however only a 7,8-diol-9,10-epoxide is presently considered to be an ultimate carcinogenic metabolite (for B(a)P).

Production and use

PAHs are mainly formed from incomplete combustion. Several PAHs are used as intermediates, such as naphthalene, acenaphthene, anthracene, fluorine, fluoranthene, phenanthrene, and pyrene. These are used in polymers, dyes, pigments, surfactants, dispersant's, tanning agents, solvents, insecticides, resins and rubber softeners.

In Norway the historic practice of using woodtar as wood preservative on buildings and boats is still widespread. Creosote is still in use as wood preservative, but with restrictions for use. Creosote can contain up to 85 % PAH (CIRCA). There are restrictions for levels of BaP in creosote.

Emissions, discharges, distribution and hot-spots

Emissions have been stable from 1995 to 2003 at about 200 tons. Discharges to water have increased in the same period from 14 to 29 tons according to the SFT.

Main emitters were metal producers (50 %), households (combustion) and wood preservation (creosote). Wood preservation has reduced emissions with about 30 % since 1995, but was still a large source in 2002.

There are several hotspots for PAH, such as smelters, industrial sites and landfills (manganese, aluminium), sites where creosote has been or are being used, coke production and old gasworks. Emmissions to water from the Hydro aluminium smelter at Sunndalsøra (Møre and Romsdal County) has dropped significantly, from 0,6 tons to 0,04 tons in 2004. Emissions from the aluminium smelter in Mosjøen (Nordland County) gas dropped from 2,5 tons to 0,04 tons in 2004 due to change of technology.

Monitoring

Monitoring of PAH has been part of JAMP and time trends exist here. PAH has also been investigated in several other studies (see references).

Marine sediment

Many Norwegian harbour and fjord sediments are strongly polluted by PAH. Most harbours are screened, as are all fjords with heavy industry.

Marine biota
17 harbours or fjords have restrictions on consumption and sales of seafood because of high levels of PAH.

Fresh water sediment
Many lakes are strongly polluted by PAH, especially along the coast from Grenland to Sogn og Fjordane. Local air pollution (10 km or less to polluter) is a major source.

Fresh water biota
PAH levels in fresh water biota (fish) are found to be low.

Need for further screening and monitoring
PAH is thoroughly screened, and there is probably no further need for screening, although groundwater levels could be further studied. PAH levels in Norwegian environment are high, and monitoring should continue in order to estimate health risks and effectiveness of policies and measures. There is a chance that there might be more hotspots that are currently not mapped / known.

Analysis
PAH-analysis is well developed. PAH analysis are normally performed as a multi-compound method including from 7, 16, up to over 40 different PAH-compounds including anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, fluoranthene, indeno(1,2,3-cd)pyrene, and naphthalene.

Methods
The methods are based on extraction with an organic solvent and chromatographic or liquid-liquid extraction (Grimmer method) clean-up. Separation and quantification is normally performed with either GC- or LC-based methods: normally GC/FID or GC/MS or HPLC/FLD. Quantification for the most advanced methods is based on the use of isotope labelled internal standards. Naphthalene is the most volatile PAH compound and can also be analysed with purge-and-trap methods described for the volatile organic compounds (VOC) (se under benzene or dichloromethane).

Synergy with other analyses
Sample extraction can be co-ordinated with the analysis of other organic semivolatile pollutants as PBDE, HCH, and SCCP/MCCP. However, the clean-up and analysis of PAH is different from the other compounds and is normally performed as a separate method.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, PAH, Final version 31 January 2001.
- HSDB: PAH.
- ClassLab: PAH.
- SFT PAH 1995-2002.
- Heavy metals and persistent organic pollutants in sediments and fish from lakes in Northern and Arctic regions of Norway, rapportnr. 688/97.
- Fylkesvise tiltaksplaner for forurensede sedimenter, Rapport fra fase 1 for Farsundsområdet med Lyngdalsfjorden, Vest-Agder.
- Miljøgifter i fisk, skalldyr og sediment i havneområder og fjorder i Rogaland 1999-2000. TA-1843/2001.
- Miljøgifter i havneområder i Nordland, rapport 876/03.
- Miljøgifter i marine sediment og organismer i havneområdene ved Harstad, Tromsø, Hammerfest og Honningsvåg 1997-98, TA-1697/2000.
- Miljøgifter og radioaktivitet i norsk fauna - inkludert Arktis og Antarktis, utredning for DN nr. 1999-5.
- Miljøgiftundersøkelse i havner i Telemark, Vestfold, Akershus og Østfold 1999. TA-1885-2002.
- Miljøgiftundersøkelse i havner på Agder 1997-1998. PAH, PCB, tungmetaller i TBT i sedimenter og organismer. Rapport 799/00, TA-1728/2000.
- Miljøovervåkning i Sandefjordsfjorden og indre Mefjorden, 1997-1998. Delrapport 2. Miljøgifter i sedimenter. TA-1585/1998.
- National Comments regarding the Norwegian data for 2003. Joint Assessment and Monitoring Programme (JAMP), rapport 921/2004.
- Overvåking av miljøgifter i marine sedimenter og organismer, 1981-1999. Joint Assessment and Monitoring Programme (JAMP), TA-1797-2001.
- Regional undersøkelse av miljøgifter i innsjøsedimenter. Delrapport 1. Organiske mikroforurensninger. Rapportnr. 712/97.
- Sonderende undersøkelser i norske havner og

utvalgte kystområder. Fase 1. Miljøgifter i sedimenter på strekningen Narvik-Kragerø. TA-1159/1994.
■ Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 2. Miljøgifter i sedimenter på strekningen Stavern-Hvitsten. TA-1160/1994.
■ Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 3. Miljøgifter i sedimenter på strekningen Ramsund-Kirkenes. TA-1215/1995.
■ Tatiana Savinova, Vladimir Savinov, Guttorm Christensen, Galina Chernik, Lyudmila Alexeeva, Dmitry Samsonov and Nikolay Kashulin: Screening studies on POP levels in freshwater environment within the joint Russian-Norwegian border area.

29 Simazine

■ **Simazine has been used as herbicide to control grasses and broadleaves. It has also been used to clean aquariums, swimming pools etc.**
■ **The substance was banned in Norway in 1995 and in EU in 2003.**
■ **The levels in Norwegian environment are relatively low, and the use is phased out.**
■ **Further screening or monitoring is not regarded necessary.**

Production and use

Simazine is used as herbicide against annual grasses and broad-leaved weeds in agriculture and forestry. The substance kills algae, and has been used in swimming pools, ponds, aquariums and cooling towers since the 1950ties. Simazine was removed from the Norwegian marked by the importer in 1995, as the product was restricted due to high persistence and high toxicity for algae. There are no entries in the Norwegian Product Register since 1995. Simazine was banned in the EU from 2003.

From 1979 to 1996 about 75 000 kilos of simazine were sold in Norway, peaking in 1988 with more than 7 000 kilos sold.

Emissions, discharges, distribution and hot-spots

The main source for emissions in Norway is agricultural use.

Monitoring

Simazine is monitored in JOVÅ.

Fresh water

Simazine in has been thoroughly monitored in several streams and rivers in Eastern and South Western Norway. Simazine was found in six rivers and streams and in approximately 10 % of the samples taken, but in low concentrations.

Need for further screening and monitoring

Simazine is prohibited throughout Europe, and levels in the environment are low. No further screening is regarded necessary.

Analysis

The analysis of simazine is often part of multi pesticide packages offered by several laboratories.

FACTS

Cas no.: 122-34-9

Synonyms: Simazin, 2-chloro-4,6-bis(ethylamino)-1,3,5-triazine gesatop 50 (50%), fisons simazin 50 (50%), radex framed 50 WP (50%), hora-mazine 50 (50%) Aquazine, Caliber, Cekusan, Cekusima, Framed, Gesatop, Primatol S, Princep, Simadex, Simanex, Sim-Trol, Tanzine and Totazine.

Properties: White powder.

Toxic effects: Simazine is not considered toxic for humans; for technical simazine oral LD50 in rats is > 5000 mg/kg. However, simazine is toxic to sheep and cattle (500/mg/kg is fatal dose). Simazine is irritating to eyes in large doses. Simazine has low toxicity for fish, LC50 rainbow trout (*Oncorhynchus mykiss*) is > 100 mg/l, but it is more toxic to invertebrates.

Log Kow: 2,4

Persistence: Half life for simazine is 22 hours in air, up to 149 days in soil and more than 30 days in water, but these numbers depending on many factors. Plants that are sensitive to simazine accumulate the substance. (EXTOXNET)

DT50 in soil = median value is 49 days,

DT50 in aerobic water = mean value of 61 days. (CIRCA)

Water solubility: 5 - 6,2 mg/l

Molecular formula: C_7-H_{12}-Cl-N_5

Metabolites: N-Desethyl simazine and hydroxy simazine.

Methods

The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), eventually clean-up with SPE and separation and quantification with GC-based methods: GC/MS or GC/ECD, however, also LC/MS methods can be used.

Synergy with other analyses

Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS especially other triazine-type herbicides as for example cyanacine or atrazine.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Simazine, Final version 31 January 2001
- HSBD: Simazine.
- EXTOXNET Pesticide Information Profiles, Simazine revised 1996.
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30 Tributyltin compounds

■ **Tributyltin compounds (TBT) are mainly used for anti fouling on ships.**
■ **TBTs cause imposex in snails.**
■ **In Norway triphenyltin (TPhT) is monitored alongside with TBT.**
■ **Levels in the environment do not decrease substantially, and TBT monitoring should continue.**

FACTS

Cas no.: 56-35-9

Synonyms: TBT, Tributyltin oxide (TBTO), tributyltin fluoride (TBTF), biomet, butinox, C-Sn-9.

Properties:

Toxic effects: TBT is toxic to humans and very toxic to marine organisms. TBT also causes imposex in snails.

Log Kow: 3,19 - 3,84

Persistence: Half life in water (hydrolysis / volatilisation) for TBT is 11 months. By photodegradation, half life is more than 3 months. In water and sediment half life is 4 - 5 months (aerobic biodegradation) or 1 - 3 months (anaerobic biodegradation) (CIRCA). In sediment, degradation may take years (HSDB). TBT compounds accumulate in organisms. BCF in Blue mussels (*Mytilus edulis*) is 10500.

Water solubility: 0,1%

Molecular formula: C_{24}-H_{54}-Sn_2

Metabolites: Hydroxy-tributyltin.

Production and use

TBTs have not been produced in Norway, but they have to a large extent been used for anti fouling and wood preservation. There has been minor use in paint, disinfectants and detergents. The use of TBT and triphenyltin compounds (TPhT) is regulated. New use has been banned since 1990 on smaller boats and new use (import, export, production sales etc) is banned from 2003. All TBT anti fouling on ships is banned from 2008.

Emissions, discharges, distribution and hot-spots

Norwegian emissions of TBT have dropped from 58 tons in 1985 via 29 tons in 1995 to about 7 tons in 2003.

Discharges to water were estimated to be 25 tons in 1995 dropping to 15 tons in 2002, most discharges are considered to be to water as discharges are mainly from marinas and shipyards, but TBT may also leak from other products, or be released from plastics or wood. TBT wood preservatives are not included in the emission estimates, but the tonnage is not large. Removal of old anti fouling in marinas may cause new discharges.

Monitoring

Monitoring of TBT has been part JAMP and time trends exist here. TBT has also been investigated in several other studies (see references).

Marine sediment

Levels of TBT in marine sediments are very high in many fjords, harbours and shipyards.

Marine biota

Shellfish in harbours are highly contaminated all along the coast. Imposex is shown in half the investigated female snail population. Costal areas in Finnmark have lower levels than average.

Fresh water biota

Levels in burbot (*Lota lota*) liver in six lakes have been screened; concentrations are not very high compared to concentration in marine biota.

Hotspots

Marinas and shipyards are typical hotspots for TBT.

Need for further screening and monitoring

There is no need for further screening of TBT in Norway, but the use has been extensive and levels in the Norwegian marine environment are stable high and stable. Continued monitoring of TBT is therefore necessary.

Analysis

Analysis of tributyltin is well developed and often part of packages with other organotin compounds.

Methods
The methods are based on extraction, derivatisation, clean-up and chromatographic separation. For separation and quantification both GC- and LC-methods are used: GC/MS, GC/AED and HPLC/ICP-MS.

Synergy with other analyses
Sample extraction, clean-up and quantification can be performed together with other organotin compounds.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, TBT, Final version 31 January 2001.
- Miljøgifter i fisk, skalldyr og sediment i havneområder og fjorder i Rogaland 1999-2000. TA-1843/2001.
- Miljøgifter i havneområder i Nordland (TA-1967/2003).
- Miljøgifter i marine sediment og organismer i havneområdene ved Harstad, Tromsø, Hammerfest og Honningsvåg 1997-98, TA-1697/2000.
- Miljøgifter og radioaktivitet i norsk fauna - inkludert Arktis og Antarktis, utredning for DN nr. 1999-5.
- Miljøgiftundersøkelse i havner i Telemark, Vestfold, Akershus og Østfold 1999. TA-1885-2002.
- Miljøovervåkning i Sandefjordsfjorden og indre Mefjorden, 1997-1998. Delrapport 2. Miljøgifter i sedimenter. TA-1585/1998.
- Miljøstatus, TBT og TFT .
- Miljøundersøkelse ved skipsverft i Eidkjosen og Grovfjord, Troms fylke. Akvaplan-niva APN-411.02.2539.
- National Comments regarding the Norwegian data for 2003. Joint Assessment and Monitoring Programme (JAMP), rapport 921/2004.
- PCB, tungmetaller i TBT i sedimenter og organismer. Rapport 799/00, TA-1728/2000.
- SFT Miljøgifter i produkter Data for 2002.
- SFT: Tributyl-, trifenyltinnforbindelser.
- Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 1. Miljøgifter i sedimenter på strekningen Narvik-Kragerø. TA-1159/1994.
- Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 2. Miljøgifter i sedimenter på strekningen Stavern-Hvitsten. TA-1160/1994.
- Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 3. Miljøgifter i sedimenter på strekningen Ramsund-Kirkenes. TA-1215/1995.

31 Trichlorobenzene

■ **Trichlorobenzene is a group of substances. Commercial TCB was historically normally a mixture, containing mostly the 1,2,4 isomer, now purity is 99,8 %.**
■ **There is no registered use in Norway after 1995.**
■ **A screening of trichlorobenzene should be done, in order to get an estimate of environmental levels and potential risks.**

Production and use

Globally, commercial trichlorobenzene is a high volume chemical, it generally comprises of a mixture of various isomers, mainly 1,2,4- isomer (80-100 %). It has been used as intermediate in the production of herbicides, as a solvent or dye carrier, as additive to PCB and as anti-corrosive agent. No emissions "of significance" are registered in Norway (Miljøstatus), about 20 kilos in 2002 (SFT). A 20 % drop in emissions has been estimated since 1995. Trichlorobenzene is not registered in the Norwegian Product Register after 1995, and there is little knowledge on earlier use.

Emissions, discharges, distribution and hot-spots

There are too few data on trichlorobenzene in Norway to estimate emissions. The substance has a long-range transport potential. Trichlorobenzene has not been found in any studies in Norway, but it has not been possible to establish whether any study actually looked for the substance.

Need for further screening and monitoring

Trichlorobenzene is probably not a problem in Norway. However, a screening should be done to establish levels in the environment.

Localities for further screening and monitoring

Trichlorobenzene should be screened in marine and fresh water sediment and biota.

Analysis

The analysis of trichlorobenzenes is often part of packages with several other volatile organic compounds (VOC) or other chlorobenzenes.

FACTS

Cas no.: 12002-48-1

87-61-6 (1,2,3-trichlorobenzene)

120-82-1 (1,2,4-trichlorobenzene)

108-70-3 (1,3,5-trichlorobenzene)

Synonyms: TCB, Trichlorobenzol, Hostetex L-PEC.

Properties: Colourless liquid or crystalline, solid below 17°C.

Toxic effects: 1,2,4-trichlorobenzene is slightly toxic, LD50 (rat oral) is 756 mg/kg. TCB is also an irritant, and it is very toxic to aquatic organisms (LC50 rainbow trout (*Oncorhynchus mykiss*) is 1,95 mg/l/48 hour).

Log Kow: 3,93 - 4,2

Persistence: 1,2,4-trichlorobenzene has an atmospheric half-life of 30 days and half life ranging from several weeks to a few months in soil and water. Bioaccumulation in aquatic life forms is high.

Water solubility: 48-100 mg/l

Molecular formula: $C_6H_3Cl_3$

Metabolites: Dichlorobenzenes, monochlorobenzene via chlorinated phenols and catechols.

Methods

The methods are based on purge-and-trap, or head-space analysis, or based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses

Sample preparation and quantification can be co-ordinated with the analysis of other VOC like compounds or other chlorobenzenes.

References

■ HSDB: Trichlorobenzene.
■ Miljøstatus: TCB.
■ ClassLab, Trichlorobenzene.
■ CIRCA, Royal Haskoning Fact sheets on production, use and release of priority substances in the WFD, Pentachlorophenol, Final version 31 January 2001
■ SFT TCB 1995-2002.
■ US EPA: Consumer Factsheet on 1,2,4-trichlorobenzene.

32 Trichloromethane/chloroform

■ **Trichloromethane (chloroform) is a toxic volatile liquid.**
■ **It has mainly been used as a solvent and intermediate.**
■ **Use is to be stopped in Norway from 2005. Emissions in Norway have been small, and the substance does not bioaccumulate.**
■ **No further screening is regarded necessary.**

Production and use

Globally, trichloromethane (chloroform) has been used as a solvent and as a chemical intermediate in the manufacture of dyes and pesticides. It has also been used in human drugs/proprietary medicines and in cosmetic products. 4,25 tons were sold in Norway in 2000, 2,24 tons in 2001 and 3 tons in 2002. Sales have seen a drop from 12 tonnes in 1990 and it is mostly used in laboratories. There were no listings of trichloromethane in the Norwegian Product Register in 2003.

Emissions, discharges, distribution and hot-spots

There may be diffuse emissions of trichloromethane from Norsk Hydro at Rafnes. Norway has stated that emissions of trichloromethane are to be significantly reduced by 2000 and stopped by 2005.

Monitoring

There is one study of trichloromethane in effluents from a bleaching process/plant Halden in Østfold County (bleaching) where trichloromethane was detected.

Need for further screening and monitoring

Chloroform is volatile, does not bioaccumulate and is not considered a problem in Norway today. No further screening is considered necessary.

Analysis

The analysis of trichloromethane is often part of packages with several other volatile organic compounds (VOC).

Methods

The methods are based on purge-and-trap, or head-space analysis and separation and quantification with GC-based methods: GC/MS or GC/ECD.

Synergy with other analyses

Sample preparation and quantification can be co-ordinated with the analysis of other VOC like other halogenated and non-halogenated solvents.

FACTS

Cas no.: 67-66-3

Synonyms: Chloroform, triklormetan, trichloroform, methyl trichloride, methenyl trichloride, freon 20, HCC 20, R 20, TCM.

Properties: Clear, colourless, volatile liquid with a characteristic odour and a burning, sweet taste.

Toxic effects: Trichloromethane can cause discomfort at levels below 249 mg/m3 (50 ppm) in humans. The substance is a skin irritant and acute toxic, LD50 for rat (oral) is 450 - 2000 mg/kg. LC50 rat (inhalation) is 47,7 mg/m3/4 hour. Trichloromethane is moderately toxic to Daphnia magna (LC50 = 29 mg/litre). LC50 for rainbow trout (*Oncorhynchus mykiss*) is 43 800 µg/l/96 h. The substance is a possible carcinogen (ClassLab/WHO/HSDB).

Log Kow: 1,97

Persistence: Trichloromethane biodegrades very slowly in water and soil, but it is very volatile. Half-life in air is estimated to be 151 days and half life water is up to 4,4 days (volatilization). Trichloromethane does not bio-accumulate (HSDB). DT50 in water is 15 months at 25 °C, max. 3500 years, DT50 in air is 70-79 d (CIRCA).

Water solubility: 7,5-9,3 g/l

Molecular formula: $CHCl_3$

Metabolites: Phosgene, hydrochloric acid

References

■ CIRCA, Royal Haskoning Fact sheets on production, use and release of priority substances in the WFD, Trichloromethane, Final version 31 January 2001.
■ HSDB: Trichloromethane.
■ WHO 1994. International programme on chemical safety. Environmental health criteria 163, CHLOROFORM.

■ SFT: Miljøgifter i produkter; 2000 and 2001 and 2002 and 2003.
■ Källqvist, T., Carlberg, G. (SI): Økotoksikologisk karakterisering av miljøgifter. Fagrapport 1/87: Innledende karakterisering av avløpsvann fra sulfittcelluloseindustri med klorblekeri (Saugbruksforeningen i Halden). Norsk institutt for vannforskning (NIVA); 1987; 48 s.

33 Trifluralin

■ **Trifluralin is an herbicide, mainly used as pre-emergence for grasses and broadleaves.**
■ **The sales of trifluralin as herbicide in Norway stopped in 1993.**
■ **The substance has been monitored but not found in marine or fresh water environments on Norwegian Mainland.**
■ **No further screening or monitoring is considered necessary.**

Production and use

The main worldwide use of trifluralin is on soy beans and cotton. In EU use on horticulture, fruit, vegetables, vineyards have been dominant. Trifluralin is a key herbicide in oil seed rape and sunflower, and in fodder peas and small grains. Almost all use is preventive.

In Norway trifluralin has been used against weed in Brassicaceae (crosswort, cabbage), peas and beans production. In 1974, 17 322 kilos of nitropreparates were imported (trifluralin beeing one of five nitropreparates). Between 1975 and 1978 53 566 kilos of anilines and uraciles were sold (probably 2 000 to 3 000 kg of trifluralin annually). Between 1979 and 1992 35 593 kilos of trifluralin were sold. Sales of trifluralin as herbicide were stopped in 1992-1993 by Norwegian authorities due to high persistence and bio-accumulation in aquatic organisms.

Emissions, discharges, distribution and hot-spots

Trifluralin emission has mainly been from agricultural use.

Monitoring

Trifluralin has been monitored in one study (Heavy metals and persistent organic pollutants in sediments and fish from lakes in Northern and Arctic regions of Norway).

Fresh water biota

Fish in Northern Regions of Norway have been investigated. Trifluralin was not quantifiable in any of the samples analysed.

Need for further screening and monitoring

Trifluralin has not been used in Norway since 1993 and it has not been detected on Norwegian Mainland. There is no further need for screening or monitoring.

FACTS

Cas no.: 1582-09-8

Synonyms: 2,6-Dinitro-N,N-dipropyl-4-trifluoromethyl benzenamine; 2,6-Dinitro-N,N-dipropyl-4-trifluoromethyl anilinea; a,a-trifluoro-2,6-dinitro-N.N-dipropyl-p-toluidine. Crisalin, Elancolan, Flurene SE, Ipersan, L-36352, M.T.F., Su Seguro Carpidor, TR-10, Trefanocide, Treficon, Treflan, Tri-4, Trifluralina 600, Triflurex Trim, and Trust.

Properties: Odourless, yellow-orange crystalline solid.

Toxic effects: Trifluralin is not considered acutely toxic to animals. Oral LD50 for rat >10 000 mg/kg. Inhalation may cause irritation, and it is irritating for eyes. Prolonged skin contact may cause allergies. The formulation may be more toxic than trifluralin. Chronic toxicity for dogs is 18,75 mg/kg/day. Trifluralin has very high toxicity to fish and other aquatic organisms. The 96-hour LC50 is 0,02 to 0,06 mg/l in rainbow trout (*Oncorhynchus mykiss*) Trifluralin is also toxic to earthworms in large concentrations. (HSDB and EXTOXNET) The substance is a possible human carcinogen (IRIS) but it's not on the EU list of suspected endocrine disruptors. Concern has been raised about this effect and possible adverse effects on reproduction.

Log Kow: 5,31

Persistence: Reported half-life is 45 days to 8 months in soil. Trifluralin is practically insoluble in water and has moderate tendency to bio-accumulate in aquatic life forms. (EXTOXNET)

Half-life <1 hour (surface water/photodecomp./evapor.) 51 min. (water/photodecomposition) 3-18 weeks (CIRCA)

Water solubility: <1 to 0,184 mg/l at 20°C

Molecular formula: C_{13}-H_{16}-F_3-N_3-O_4

Metabolites: Several routes of degradation. Insufficient data on environmental effects of metabolites.

Analysis

The analysis of trifluralin is often part of multi pesticide packages offered by several laboratories.

Methods
The methods are based on direct extraction with an organic solvent (sediment and biota) or solid phase extraction (SPE), chromatographic clean-up and separation and quantification with GC-based methods: GC/MS.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other pesticides which can be analysed by GC/MS as other organochloro insecticides or especially other dinitroanilines like ethalfluralin and pendimethalin.

References

- CIRCA, Royal Haskoning: Fact sheets on production, use and release of priority substances in the WFD, Trifluralin, Final version 31 January 2001.
- HSDB: Trifluralin.
- EXTOXNET Pesticide Information Profiles Trifluralin, revised 1996
- Mattilsynet: Email from Merethe Dæhli 14.10.2005.
- Heavy metals and persistent organic pollutants in sediments and fish from lakes in Northern and Arctic regions of Norway, rapportnr. 688/97.

SUBSTANCES WITH SPECIAL INTEREST FOR NORWAY

a Copper

■ **Copper is very toxic to aquatic organisms.**
■ **There are several areas already affected by copper pollution in Norway, reductions in emissions are small.**
■ **Further screening is not considered necessary, but monitoring should continue.**

Production and use

Copper is used as a biocidal active substance in insecticides, paint, pigments and wood preservation and anti-fouling. Metallic copper is used in electric appliances, coins, building materials etc. Several compounds used in chemical industries.

Emissions, discharges, distribution and hot-spots

The largest releases of copper to water in Norway are anti fouling in aquaculture. Emissions from preserved wood are rapidly increasing. Emissions has dropped from to 748 tons in 1995 tons in 2002. Discharges to water has dropped from 674 tons to 585 tons in the same period.

Monitoring

Monitoring of copper has been part of JAMP and RID, and time trends exist here. Copper has also been investigated in other studies (see references).

Marine sediment

Several harbours are polluted by copper.

Marine biota

Shellfish in Nordland are screened; levels were highest in Svolvær. Blue mussels have shown effects from copper pollution in Ranfjorden in Nordland County, Orkdalsfjorden in Sør-Trøndelag County and Sørfjorden in Hordaland County.

Fresh water

10 rivers are investigated; in Orkla samples in Class V have been found, but concentrations vary. No other samples have shown concentrations above class III.

Fresh water sediment

Lakes affected by mining are polluted, see hotspots. In other lakes concentrations are low.

FACTS

Copper is a metal which is essential to life. Copper compounds may however be toxic to humans in too high concentrations, but it is not considered carcinogenic. To aquatic organisms, copper is very toxic, partly due to high mobility and high bioconcentration.

Fresh water biota

Insect larvae, especially mayfly, living downstream mines are shown to have increased body copper concentration.

Hotspots

Copper mines and areas for wood preservation are hotspots for copper pollution. Major copper maining has taken place in Røros, Grong, Sulitjelma, Folldal, Løkken and Karmøy. Copper has been mined in at least 100 different locations from approx. 1700 and onwards. The use of copper for wood preservation takes place in about 15 different plants nationally

Need for further screening and monitoring

Copper is thoroughly screened, and no further screening is considered necessary. However, monitoring should continue, as concentrations are high in the environment, combined with an increase in the use for anti fouling and wood preservation.

Analysis

There are several well-established techniques for determination of Cu. Several companies offer this service in Norway and Europe. The most frequently techniques are Inductively coupled plasma mass spectrometry (ICP-MS), Inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods

Water samples are acidified with 1 - 10 % nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen

peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of copper can also be used for determination of Pb, Hg, Ni, Zn, Cr, As and Ni.

References

- Bergfald & Co as: Kobber - bruk og utslipp i Norge og Nordsjølandene. December 2003.
- Fylkesvise tiltaksplaner for forurensede sedimenter, Rapport fra fase 1 for Farsundsområdet med Lyngdalsfjorden, Vest-Agder.
- Heavy metals and persistent organic pollutants in sediments and fish from lakes in Northern and Arctic regions of Norway, rapportnr. 688/97:
- Miljøgifter i fisk, skalldyr og sediment i havneområder og fjorder i Rogaland 1999-2000. TA-1843/2001.
- Miljøgifter i havneområder i Nordland, TA-1967-2003:
- Miljøgifter i marine sediment og organismer i havneområdene ved Harstad, Tromsø, Hammerfest og Honningsvåg 1997-98, TA-1697/2000.
- Miljøgifter og radioaktivitet i norsk fauna - inkludert Arktis og Antarktis, utredning for DN nr. 1999-5
- Miljøstatus: Kobber.
- SFT Tiltaksplan 1995-2002
- Miljøundersøkelse ved skipsverft i Eidkjosen og Grovfjord, Troms fylke. Akvaplan-niva APN-411.02.2539.
- Overvåking av miljøgifter i marine sedimenter og organismer, 1981-1999. Joint Assessment and Monitoring Programme (JAMP), TA-1797-2001.
- PCB, tungmetaller i TBT i sedimenter og organismer. Rapport 799/00, TA-1728/2000.
- Regional undersøkelse av miljøgifter i innsjøsedimenter. Delrapport 2. Tungmetaller og andre sporelementer. Rapportnr. 713/97.
- Riverine inputs and direct discharges to Norwegian coastal waters - 2003. Part B: Data report.
- Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 2. Miljøgifter i sedimenter på strekningen Stavern-Hvitsten. TA-1160/1994.
- Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 1. Miljøgifter i sedimenter på strekningen Narvik-Kragerø. TA-1159/1994.
- Nasjonalt folkehelseinstitutt: Miljø og helse - en forskningsbasert kunnskapsbase. Revisjon 2003. Rapport 2003:9.

b Zinc

■ **Zinc is a metal with acute and chronic toxicity for aquatic organisms.**
■ **No further screening is necessary.**

Production and use
Zinc compounds are used as active substances in biocidal products, as surface protector for other metals and as a stabilizer in plastic. Metallic zinc is used in electric appliances, coins, building materials, sinks, buckets, roofing etc.

Emissions, discharges, distribution and hot-spots
Main emissions of zinc comes from industry, mining, waste incineration and products.

Monitoring
Monitoring of zinc has been part of JAMP and RID and time trends exist here. Zinc has also been investigated in other studies (see references).

Marine sediment
High zinc levels in sediments are found in connection with mining or shipyards.

Marine biota
Shellfish in harbours in Nordland has been screened. Narvik and Svolvær are highly polluted.

Fresh water
10 rives have been monitored, but concentrations are generally low; the samples with highest concentrations have been Class III.

Fresh water sediment
Lakes affected by mining, are polluted. In other lakes concentrations are low.

Fresh water biota
Insect larvae, especially mayfly, living downstream mines are shown to have increased body zink concentration.

Hotspots
Lakes, rivers and streams affected by mining are hotspots for zinc pollution. These are being monitored today.

FACTS

Zinc is a metal which is essential to all organisms, but high concentrations have adverse effects, especially in aquatic organisms. Zinc also has chronic toxicity for aquatic organisms. There is some bioaccumulation, but negligible biomagnification. Very high levels are required to cause adverse health effects, but as zinc is associated with cadmium, high zinc levels may indicate other effects.

Need for further screening and monitoring
Zinc is thoroughly screened. No further screening is necessary.

Analysis
There are several well-established techniques for determination of Zn. Several companies offer this service in Norway and Europe. The most frequently techniques are Inductively coupled plasma mass spectrometry (ICP-MS), Inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods
Water samples are acidified with 1-10% nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of zinc can also be used for determination of Pb, Hg, Ni, Cu, Cr, As and Ni.

References
■ Heavy metals and persistent organic pollutants in sediments and fish from lakes in Northern and Arctic regions of Norway, rapportnr. 688/97
■ Miljøgifter i fisk, skalldyr og sediment i havneområder og fjorder i Rogaland 1999-2000. TA-1843/2001.
■ Miljøgifter i havneområder i Nordland, TA-1967-2003

■ Miljøgifter i marine sediment og organismer i havneområdene ved Harstad, Tromsø, Hammerfest og Honningsvåg 1997-98, TA-1697/2000.
■ Miljøgifter og radioaktivitet i norsk fauna - inkludert Arktis og Antarktis, utredning for DN nr. 1999-5
■ Miljøundersøkelse ved skipsverft i Eidkjosen og Grovfjord, Troms fylke. Akvaplan-niva APN-411.02.2539.
■ Overvåking av miljøgifter i marine sedimenter og organismer, 1981-1999. Joint Assessment and Monitoring Programme (JAMP), TA-1797-2001.
■ Regional undersøkelse av miljøgifter i innsjøsedimenter. Delrapport 2. Tungmetaller og andre sporelementer. Rapportnr. 713/97.
■ Riverine inputs and direct discharges to Norwegian coastal waters - 2003. Part B: Data report.
■ SFT: Miljøgifter i norske fjorder. Ambisjonsnivåer og strategi for arbeidet med forurenset sjøbunn, http://www.sft.no/publikasjoner/kjemikalier/1774/TA1774.pdf
■ SFT: Miljøgifter i produkter Data for 2002
■ Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 2. Miljøgifter i sedimenter på strekningen Stavern-Hvitsten. TA-1160/1994.
■ Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 1. Miljøgifter i sedimenter på strekningen Narvik-Kragerø. TA-1159/1994.
■ Nasjonalt folkehelseinstitutt: Miljø og helse - en forskningsbasert kunnskapsbase. Revisjon 2003. Rapport 2003:9.

c Chromium

■ **Chromium is a metal which is carcinogenic and very toxic to aquatic organisms.**
■ **Chromium should be screened in marine sediments.**
■ **Hexavalent chromium is more toxic than trivalent chromium.**

Production and use

Chromium is used as pigment, in dyes and tanning, wood preservation and surface treatment of metals and in steel alloys.

Emissions, discharges, distribution and hot-spots

Norwegian emissions of chromium have increased by approx. 5 % from 1995 to 2002, from 60 to 63 tons. In the same period discharges to water have dropped from 14 tons to 11.5 tons. The increase was mainly due to an increase in the use of chromium in paints for marine purposes, partly due to the phasing out of other substances.

Monitoring

Monitoring of chromium has been part of RID (time trend). Chromium has also been investigated in a few other studies (see references).

Marine sediment

Chromium is found in too high concentrations in Kristiansandsfjorden and Grisefjorden (near Flekkefjord) in Vest-Agder County and in Osterfjorden in Hordaland County.

Marine biota

Blue mussels (*Mytilus edulis*) and Horse mussels (*Modiolus modiolus*) in Nordland County had low chromium concentrations.

Fresh water

Chromium levels in rivers have been monitored, but concentrations are generally low, there are no samples above Class II.

Fresh water sediment

Lake Kornsjø in Østfold county has very high chromium concentrations caused by effluents from tanning of hides. Austlandsvatn in Lillesand in Aust-Agder county and Ulgjelvatn at Lista in Vest-Agder county were moderately polluted. 106 lakes were investigated in a study published in 1997.

FACTS

Chromium is a metal which is essential to all organisms, but high concentrations have adverse effects, especially in aquatic organisms. Some chromium compounds are also carcinogenic, and some compounds bioaccumulate. Mobility in water is relatively high.

Fresh water biota

There are no specific data on chromium problems in fresh water biota.

Hotspots

Lake Kornsjø is a hotspot. Paint producers, shipyards and wood preservation are other probable hotspots. Tanning or landfills may be hotspots.

Need for further screening and monitoring

Chromium has high mobility in water and its use is increasing. Screening should be initiated.

Localities for further screening and monitoring

Chromium should be screened in marine sediments.

Analysis

There are several well-established techniques for determination of Cr. Several companies offer this service in Norway and Europe. The most frequently techniques are Inductively coupled plasma mass spectrometry (ICP-MS), Inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods

Water samples are acidified with 1-10% nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of chromium can also be used for determination of Pb, Hg, Ni, Zn, Cu, As and Ni.

References

- Miljøstatus: Krom
- Fylkesvise tiltaksplaner for forurensede sedimenter, Rapport fra fase 1 for Farsundsområdet med Lyngdalsfjorden, Vest-Agder.
- SFT Tiltaksplan 1995-2002.
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- Miljøgifter og radioaktivitet i norsk fauna - inkludert Arktis og Antarktis, utredning for DN nr. 1999-5

d Arsenic

- **Arsenic is a carcinogen and it bioaccumulates.**
- **Main use has been wood preservation.**
- **There are few data on marine pollution of arsenic.**
- **There is a need for screening of arsenic.**

Production and use
Arsenic has mainly been used as a wood preservative, but this use is now prohibited.

Emissions, discharges, distribution and hot-spots
Norwegian emissions in 2002 are estimated to 7 tons, down from more than 350 tons in 1985 via 14 tons in 1995. Discharges to water have increased from about 1 ton in 1995 to 1,4 tons in 2002.

Monitoring
Monitoring of arsenic has been part of RID (time trend exists). Arsenic has also been investigated in a few other studies (see references).

Marine sediment
Increased levels are found in Kristiansandsfjorden and Ballangsfjorden. No effects are known.

Fresh water
Several rivers have been monitored on a yearly basis since 1990. Arsenic levels have been generally low.

Fresh water sediment
Concentrations of arsenic are generally low in lakes, standards for drinking water are being kept.

Fresh water biota
Low levels of arsenic are found in fish.

Hotspots
Hotspots for arsenic are in particular manufacturing sites for preservation of wood.

Need for further screening and monitoring
There are few data on arsenic concentrations in the environment. A thorough screening should be made in order to estimate the effectiveness of the policies and measures taken to reduce emissions.

FACTS

Arsenic is a human carcinogen, and some arsenic compounds are highly toxic. Arsenic accumulates in aquatic organisms and organic arsenic compounds can bioaccumulate.

Localities for further screening and monitoring
Arsenic should be screened in marine sediments and in marine biota. It should also be screened in fresh water biota.

Analysis
There are several well-established techniques for determination of As. Several companies offer this service in Norway and Europe. The most frequently techniques are Inductively coupled plasma mass spectrometry (ICP-MS), Inductively coupled Plasma Atomic Emission Spectroscopy (ICP-AES), Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) and Flame Atomic Absorption Spectroscopy (F-AAS).

Methods
Water samples are acidified with 1-10% nitric acid.

For analysis of solid samples, the methods are based on digestion with nitric acid / hydrogen peroxide in sealed containers using microwave system.

Synergy with other analyses
The sample digestion method used for determination of arsenic can also be used for determination of Pb, Hg, Ni, Zn, Cr, Cu and Ni.

References

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■ Regional undersøkelse av miljøgifter i innsjøsedimenter. Delrapport2. Tungmetaller og andre sporelementer. Rapportnr. 713/97.

■ Miljøgifter og radioaktivitet i norsk fauna - inkludert Arktis og Antarktis, utredning for DN nr. 1999-5

e PCB

■ **PCB is toxic and a carcinogen. Damages immune, nervous, reproductive and endocrine systems.**
■ **PCB is a well known pollutant in Norway.**
■ **The distribution of the chemical is among the best mapped in Norway.**

Production and use

PCB has been used in transformers and in capacitors in electric appliances and as additive in paint, sealants and concrete, as pesticides (no known use in Norway), as heat transfer oils in heat exchangers, as lubricants in vacuum pumps and as plasticiser. It is estimated that 1185 tonnes of PCB have been imported, sold and used in Norway. Import has been banned since 1980. Production was stopped in most European countries around 1980. Some use of existing products with PCB is banned from 2005 (capacitors, lightning fixtures). It is estimated that about 280 tons is still in use in old products (prior to 1980), and that 280 tons has been destroyed per December 2004. PCB is a trans-boundary pollutant. Norwegian Ministry of Environment has published an action plan for the reduction of PCB in St. meld. nr. 25 (2002-2003). The ban on use of products with PCB and regulations regarding dismantling of buildings with PCB will cause more PCBs to be taken out of use and destroyed.

Emissions, discharges, distribution and hot-spots

High levels of PCB are found around certain old industrial sites, on navy sites and shipyards, around landfills and in marine sediments. According to Norwegian Pollution Control Authority, 397 tons has been landfilled, dumped or otherwise leaked into the environment. Emissions has dropped from 3,3 tons in 1995 to 0,8 tons in 2001. Discharges to water has dropped from 0,03 tons in 1995 to about zero in 2002.

PCB has been monitored in several programmes and time trends exist.

Marine sediment
Several Norwegian harbours have high PCB contamination.

FACTS

Cas no.: 1336-36-3 (and several more)

Synonyms: Clophen, arochlor, 1,1 biphenyl, dikanol, chlorextol, kanechlor, pyralene and many more.

Properties: Approx. 200 congeners of polychlorinated biphenyls (PCB). These appear as oily liquids, white crystalline solids and hard non-crystalline resins. PCB has been manufactured for specific purposes, but they may also form in incineration processes.

Toxic effects: PCB is acutely toxic to marine organisms and carcinogenic to mammals. PCB damages the immune, nervous and reproductive systems, and causes damage to reproductive organs and is a possible human carcinogen. PCB also inhibits learning and development. PCB is on the EU list of substances with documented endocrine-disrupting effects.

Log Kow: 6,34 (estimate)

Persistence: Classified as POP in Stockholm convention

Water solubility: 0,002 - 7,5 mg/l at 20 °C (depending on isomer)

Molecular formula: C12- H (10-n) Cl

Metabolites: Phenolic products, methylthio derivative

Marine biota
15 harbours and fjords have restrictions on sales and consumption of seafood due to PCB pollution. General advice is given on consumption of fish liver and gull eggs to the whole population and on consumption of crabs to young women and children.

Fresh water sediment
Several lakes are investigated. Tveitavann in Bergen is strongly polluted. Other lakes close to heavy industry and larger urban areas have higher concentrations.

Fresh water biota
General advice to the population is not to use burbot liver (*Lota lota*) from Furnesfjorden or main basin Mjøsa, nor from Hurdalssjøen. Trout (*Salmo trutta*) from Mjøsa and Vorma should not be consumed more than once a month, young women and children should avoid it totally.

Need for further screening and monitoring

PCBs are quite well mapped in Norway, but data is lacking in some areas. Data on PCB pollution in groundwater are limited.

Analysis

PCB-analysis is well developed. Non-ortho and mono-ortho PCB are used to calculate the contribution of the PCBs (toxic equivalents (TEQ) to the total dioxin-like toxicity of a sample. "Seven Dutch" which means the sum of PCB-28, 52, 101, 118, 138, 153 and 180 is not suitable for estimation of effect on human health, but gives a good indication on amounts in the environment.

Methods

The methods are based on extraction with an organic solvent, chromatographic clean-up and separation and quantification with GC-based methods: normally GC/ECD or GC/MS. Quantification of the most advanced methods is based on the use of 13C-labelled internal standards.

Synergy with other analyses

Sample extraction and clean-up can be co-ordinated with the analysis of other persistent organic pollutants as PBDE, HCH, and SCCP/MCCP. The analysis of non-ortho PCB is performed together with dioxins.

References

- Environmental Review no. 15, 2004: List of Undesirable Substances 2004, Appendix B - Substances on the EU list of substances with documented endocrine-disrupting effects
- Fylkesvise tiltaksplaner for forurensede sedimenter, Rapport fra fase 1 for Farsundsområdet med Lyngdalsfjorden, Vest-Agder.
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- Miljøovervåkning i Sandefjordsfjorden og indre Mefjorden, 1997-1998. Delrapport 2. Miljøgifter i sedimenter. TA-1585/1998.
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- Sonderende undersøkelser i norske havner og utvalgte kystområder. Fase 3. Miljøgifter i sedimenter på strekningen Ramsund-Kirkenes. TA-1215/1995.

■ St. meld. nr. 12 (2001-2002).
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■ Økland, T. E., Wilhelmsen, E.: Kostholdsråd i norske havner og fjorder. Bergfald & Co as, 2005.
■ Tatiana Savinova, Vladimir Savinov, Guttorm Christensen, Galina Chernik, Lyudmila Alexeeva, Dmitry Samsonov and Nikolay Kashulin: Screening studies on POP levels in freshwater environment within the joint Russian-Norwegian border area.

f Polychlorinated dibenzodioxins and dibenzofurans (dioxins)

■ **Dioxins are toxic, carcinogenic, damage the immune system and nervous system, cause damage to reproductive organs and are endocrine disrupters.**
■ **Dioxins are well known pollutants in Norway, and they have received much attention from the authorities and the general public.**
■ **General screening is not considered necessary, but monitoring should continue.**

Production and use

Dioxins are formed as by-products naturally or in man made processes. No commercial use is known.

Emissions, discharges, distribution and hot-spots

Emissions in Norway in 2002 have dropped from 72 g I-TEQ (toxicity equivalents) in 1995 to 30 g I-TEQ in 2003. Discharges to water have dropped from to 1,9 g I-TEQ to about 1,2 g I-TEQ.

Monitoring

Dioxins have also been investigated in several studies, see references. Time trends exist in Grenlandsfjordene in Telemark.

Marine sediment

Grenlandsfjorden and Kristiansandsfjorden have high dioxin concentrations.

Marine biota

3 harbours and fjords have restrictions on sales and consumption of seafood due to dioxin pollution. Two of these, Grenlandsfjorden and Kragerøfjorden are due to the same source, due to the local costal current moving inshore from the Island of Jomfruland. General advice is given on consumption of gull eggs to the whole population and on consumption of crabs to young women and children.

Fresh water sediment

Sediments from ten lakes around the iron sinter company Aktieselskapet Sydvaranger are classified as extremely polluted.

FACTS

Chlorinated dioxins and furans form 210 congeners, which are formed in chemical and combustion processes. Dioxins are toxic, carcinogenic, damage the immune system and nervous system, cause damage to reproductive organs and are endocrine disrupters.

Lakes around "Finnfjord smelteverk "and "Senja avfallsselskap" was shown to be polluted by dioxins.

Fresh water biota

Young women and children should avoid fresh water fish from lakes due north of in Sør-Varanger including Tredjevatnt in Finnmark County. High concentrations have been found in burbot liver in Mjøsa, Hurdalssjøen and Femsjøen.

Need for further screening and monitoring

Dioxins are quite well mapped in Norway. There is no further need for screening, but monitoring should continue.

Analysis

The analysis of dioxins is well developed. Normally, 17 different congeners are quantified and a total dioxin-like toxicity of a sample (toxic equivalents (TEQ)) is calculated.

Methods

The methods are based on extraction with an organic solvent, multi-chromatographic clean-up and separation and quantification with GC-based methods: normally GC/HRMS. All accepted methods use 13C-labelled internal standards for quantification.

Synergy with other analyses

Sample extraction can be co-ordinated with the analysis of other organic semivolatile pollutants as PAH, PCB, PBDE, HCH, and SCCP/MCCP. However, the clean-up and analysis of dioxins is different from the other compounds and is normally performed as a separate method.

References

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g C14-C17 chloroalkanes (MCCP)

■ **MCCP is medium chained chloroalkanes.**
■ **MCCP should be screened in the environment.**

Production and use
MCCP are mainly used as plasticisers and flame retardants in paints, plastics and cutting fluids. When SCCP was banned for most purposes, the use of MCCP increased. In 1995 50 tons MCCP were used in Norway; in 2002 1100 tons were used.

Emissions, discharges, distribution and hot-spots
The main emission source is products containing MCCP. Emissions for 1995 are not known. Emissions in 2002 are larger than 12 tons.

Monitoring
MCCP were screened in 2003.

Marine sediment
MCCP were screened in Drammensfjorden in Buskerud County and four other areas from Tønsberg in Vestfold County to Tromsø in Troms County. The highest levels, 7500 ng/g dry weight, were found in Drammensfjorden.

Marine biota
MCCP were found cod liver (*Gadus morhua*), but levels are generally lower than for SCCP. In blue mussels (*Mytilus edulis*), levels were similar to SCCP concentrations.

Fresh water sediments
MCCP in Mjøsa have been measured to 150-410 ng/g dry weight. The lower parts of Drammenselva have four - ten times higher concentrations.

Fresh water biota
MCCP were found in the same concentrations as SCCP.

Other
Sediments from leakage systems for municipal landfills were investigated.

Hotspots
Paint producers and shipyards are probable hotspots.

FACTS

MCCP are oily liquids. They are persistent, bioaccumulate in the food chain, and they are toxic to aquatic organisms. It is uncertain whether MCCP is carcinogenic.

Need for further screening and monitoring
The use of MCCP is rapidly increasing. The screening in 2003 has shown high levels. This screening should be repeated within a few years, in order to show trends.

Localities for further screening and monitoring
The screening should be compatible with the screening in 2003.

Analysis
With the growing interest of the analysis of SCCP, the focus on MCCP has also increased. The use of SCCP has in many cases been substituted with MCCP. As for SCCP the huge amount of compounds in this group and the lack of 13C-labelled internal standards is the main reason that this method has not reached the same standard of analytical quality as for example the analysis of dioxins or PCB.

Methods
The methods are based on extraction with an organic solvent, chromatographic clean-up and separation and quantification with GC-based methods: normally GC/MS with different modes of ionization. The most prominent GC/MS methods for SCCP analyses are based on electron capture negative ion (ECNI) mode with both high- and low resolution MS. A more extensive sample clean up is necessary when using low resolution MS to remove closely related and interfering compounds. With the more sophisticated and expensive high resolution MS instruments, interferences are almost negligible.

Synergy with other analyses
Sample extraction and clean-up can be co-ordinated with the analysis of other persistent organic pollutants as PCB, HCH, PBDE and SCCP.

References

- Miljøstatus: Klorerte parafiner
- SFT: Kartlegging av bromerte flammehemmere og klorerte parafiner, NILU 62/2002, TA-1924/2002.
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- SFT: Tiltaksanalyse 1995 - 2002.

h Perfluoroalkyl compounds (PFAS)

■ **PFAS are very persistent and may harm reproduction.**
■ **General screening is not considered necessary, but monitoring and screening of specific localities should continue.**

Production and use

The use in Norway was estimated to 23 - 26 tons in 2002. Historical data are lacking. PFAS are mainly used as surfactants, in fire extinguishers and preservatives in textiles.

Emissions, discharges, distribution and hot-spots

Emissions in Norway in 2002 are estimated to 13 - 15 tons, but these estimates are very rough. PFAS may have been used in specific paper productions. The compound Cera-F may form perfluoroalkyl compounds. Cera F is used widely in ski waxes (glider and wax). Possible hotspots are start areas / ski preparation areas of ski tracks.

Monitoring

PFAS have been screened in the program: "Kartlegging av utvalgte nye organiske miljøgifter i 2004. Bromerte flammehemmere, perfluoralkylstoffer, irgarol, diuron, BHT og dicofol" and in a common screening in the Nordic environment 2003. There has also been a Nordic screening related to water resources affected by landfills or municipal waste water plants.

Marine sediment
High concentrations are found at Rubbestadneset in Bømlo.

Marine biota
Concentrations in cod liver (*Gadus morhua*) were found to be higher than in an earlier Nordic screening.

Fresh water
PFAS concentrations in water were low compared to studies in Germany and USA.

Fresh water sediment
PFAS levels in fresh water sediments were low compared to levels from the Netherlands.

FACTS

PFAS are a class of compounds. SFT has shown particular interest in the compounds PFBS, PFHxS, PFOS, PFDS, PFHpA, PFOA, PFNA and PFOSA. They are highly persistent and may harm reproduction.

Fresh water biota
The highest levels were found in perch (*Perca fluriatilis*) from Hurdalssjøen.

Other
In a Nordic screening, high PFAS concentrations were found in water affected by municipal waste water plants.

Need for further screening and monitoring

PFAS were screened in 2004. There is no further need for general screening at the moment, but monitoring should continue. Screening should be performed downstream of specific paper mills as PFAS may have been in former use at these sites.

Analysis

The methods for analysis of PFAS have been improved through the last years. However, this group of compounds possess exceptional chemical properties (hydrophobic and lipophobic at the same time) which require other techniques for sampling, extraction, clean-up and quantification.

Methods
The methods are based on extraction with an organic solvent or ion-pair extraction, a very short clean-up and separation and quantification with LC/MS. During sampling and analysis adsorption to surfaces must be avoided. During production of fluorinated polymers like Teflon PFAS has been used. Therefore the contact with Teflon or other fluorinated polymers can cause contamination of the sample during sampling, storage or analysis.

Synergy with other analyses
The special character of the requirements for PFAS sampling and analysis reduce the chance for synergy with the sampling and analysis of other compounds.

References

■ Miljøstatus: PFOS

■ Kartlegging av utvalgte nye organiske miljøgifter i 2004. Bromerte flammehemmere, perfluoralkylstoffer, irgarol, diuron, BHT og dicofol (TA-2096/2005).

■ Roland Kallenborn, Urs Berger and Ulf Järnberg: Perfluorinated Alkylated Substances (PFAS) in the Nordic Environment. TemaNord 2004.

APPENDIX A

Detection limits and measurement uncertainty

Detection limits and measurement uncertainty for all substances in the different relevant sample matrices are given in the table below. The lower limit of detection is determined by several factors. The most important are sample amount, clean-up method and instrument sensitivity. These factors can vary between the different laboratories, matrix types, and even between different samples of the same type. The detection limits given in the table below are therefore a rough estimate. The measurement uncertainty of a method is determined by the used method, the experience of the laboratory executing the method, the availability and results of intercalibrations and certified reference materials. Since there are several different methods for quantifying measurement uncertainties, the uncertainty is given as rough categories only: *good:* well established method with a high frequency of intercalibrations and relevant certified materials available; *fair:* established method only infrequent intercalibrations, no major analytical problems; *poor:* new method not all analytical problems solved.

SUBSTANCE	Detection limit			Uncertainty
	Water ng/L	Sediment g/kg d.w.	Biota g/kg f.w.	
WFD SUBSTANCES:				
Alachlor	2-200	1-10	1-10	fair
Atrazine	1-200	1-10	1-10	fair
Benzene	20-200	10-100	10-100	fair
Brominated diphenylethers	0,1-50	0,1-50	0,2-100	fair
Cadmium and its compounds	2-10000	30-10000	2-1000	good
C10-13-chloroalkanes (Sum)	1-500	0,3-50	0,3-50	poor
Chlorfenvinphos	4-200	1-10	1-10	fair
Chlorpyrifos	4-200	1-10	1-10	fair
1,2-Dichloroethane	20-200	10-100	10-100	fair
Dichloromethane	20-200	10-100	10-100	fair
Di(2-ethylhexyl)phthalate	50	20	40	poor
Diuron	1-20	1-20	1-20	fair
Endosulfan	0,05-10	0,05-10	0,05-10	good
Hexachlorobenzene	0,05-10	0,05-10	0,05-10	good
Hexachlorobutadiene	20-200	10-100	10-100	fair
Hexachlorocyclohexane	0,05-10	0,05-10	0,05-10	good
Isoproturon	1-20	1-20	1-20	fair
Lead and its compounds	10-10000	85-10000	9-10000	good
Mercury and its compounds	2-200	5-200	5-200	good
Nickel and its compounds	50-10000	40-10000	40-10000	good
Nonylphenols	10-20	10-50	10-50	fair
Octylphenols	1-20	1-50	1-50	fair
Pentachlorobenzene	0,05-10	0,05-10	0,05-10	good
Pentachlorophenol	1-20	1-50	1-50	fair
Polycyclic aromatic hydrocarbons	0,1-300	0,3-100	0,1-100	good
Anthracene	0,1-300	0,3-100	0,1-100	good
Benzo(a)pyrene	0,1-300	0,3-100	0,1-100	good
Benzo(b)fluoranthene	0,1-300	0,3-100	0,1-100	good

(continued on page 98)

(continued from page 97)

SUBSTANCE	Detection limit			Uncertainty
	Water ng/L	Sediment g/kg d.w.	Biota g/kg f.w.	
WFD SUBSTANCES:				
Benzo(k)fluoranthene	0,1-300	0,3-100	0,1-100	good
Benzo(g,h,i)perylene	0,1-300	0,3-100	0,1-100	good
Fluoranthene	0,1-300	0,3-100	0,1-100	good
Indeno(1,2,3-cd)pyrene	0,1-300	0,3-100	0,1-100	good
Naphthalene	0,1-300	0,3-100	0,1-100	good
Simazine	5-200	5-10	5-10	fair
Tributyltin	1-100	1-1000	1-1000	good
Trichlorobenzenes	20-200	10-100	10-100	fair
Trichloromethane	20-200	10-100	10-100	fair
Trifluralin	0,05-10	0,05-10	0,05-10	good
NATIONAL SUBSTANCES:				
Copper and its compounds	500-10000	60-10000	33-10000	good
Zinc and its compounds	200-10000	800-20000	200-10000	good
Chromium and its compounds	100-20000	80-8000	10-10000	good
Arsen and its compounds	50-10000	100-10000	15-10000	good
Sum PCB-7 (Seven Dutch)	0,1-7	0,1-25	0,1-30	good
PCB (single congener)	0,01-1	0,01-3	0,01-4	good
MCCP	1-500	0,3-50	0,3-50	poor
PFAS	0,1-10	0,01-1	0,01-1	poor
Dioxins	0,5-100 pg/L	0,05-10 ng/kg d.w.	0,05-10 ng/kg f.w.	good

APPENDIX B

SFT's classification system for water, sediment and biota in fresh and salt water

Classification of fresh water, fresh water sediments and fresh water fish (SFT veiledning 97:04)

CLASSES	I "Slightly polluted"	II "Moderately polluted"	III "Markedly polluted"	IV "Severely polluted"	V "Extremely polluted"
FRESH WATER					
Copper (µg/l)	<0,6	0,6-1,5	0,5-3	3-6	>6
Zinc (µg/l)	<5	5-20	20-50	50-100	>100
Cadmium (µg/l)	<0,04	0,04-0,1	0,1-0,2	0,2-0,4	>0,4
Lead (µg/l)	<0,5	0,5-1,2	1,2-2,5	2,5-5	>5
Nickel (µg/l)	<0,5	0,5-2,5	2,5-5	5-10	>10
Chromium (µg/l)	<0,2	0,2-2,5	2,5-10	10-50	>50
Mercury (µg/l)	<0,002	0,002-0,005	0,005-0,01	0,01-0,02	>0,02
FRESH WATER SEDIMENTS (dry weight)					
Copper (mg/kg)	<30	30-150	150-600	600-1800	>1800
Zinc (mg/kg)	<150	150-750	750-3000	3000-9000	>9000
Cadmium (mg/kg)	<0,5	0,5-2,5	2,5-10	10-20	>20
Lead (mg/kg)	<50	50-250	250-1000	1000-3000	>3000
Nickel (mg/kg)	<50	50-250	250-1000	1000-3000	>3000
Arsenic (mg/kg)	<5	5-25	25-100	100-200	>200
Mercury (mg/kg)	<0,15	0,15-0,6	0,6-1,5	1,5-3	>3
FRESH WATER FISH (dry weight)					
Mercury (mg/kg)	<0,2	0,5-0,5	0,5-1	1-2	>2

Classification of salt water and salt water sediments (SFT veiledning 97:03)

CLASSES	I "Slightly polluted"	II "Moderately polluted"	III "Markedly polluted"	IV "Severely polluted"	V "Extremely polluted"
SALT WATER					
Arsenic (µg/l)	<2	2-5	5-10	10-20	>20
Lead (µg/l)	<0,05	0,05-0,15	0,15-0,5	0,5-1	>1
Cadmium (µg/l)	<0,03	0,03-0,07	0,07-0,2	0,2-0,5	>0,5
Copper (µg/l)	<0,3	0,3-0,7	0,7-1,5	1,5-3	>3
Chromium (µg/l)	<0,2	0,2-0,5	0,5-1,5	1,5-3	>3
Mercury (µg/l)	<0,001	0,001-0,005	0,005-0,015	0,015-0,03	>0,03
Nickel (µg/l)	<0,5	0,5-2	2-5	5-10	>10
Zinc (µg/l)	<1,5	1,5-5	5-10	10-20	>20
METALS IN SEDIMENTS (dry weight)					
Arsenic (mg/kg)	<20	20-80	80-400	400-1000	>1000
Lead (mg/kg)	<30	30-120	120-600	600-1500	>1500
Cadmium (mg/kg)	<0,25	0,25-1	1-5	5-10	>10
Copper (mg/kg)	<35	35-150	150-700	700-1500	>1500
Chromium (mg/kg)	<70	70-300	300-1500	1500-5000	>5000
Mercury (mg/kg)	<0,15	0,15-0,6	0,6-3	3-5	>5
Nickel (mg/kg)	<30	30-130	130-600	600-1500	>1500
Zinc (mg/kg)	<150	150-700	700-3000	3000-10000	>10000
TBT (mg/kg)	<0,001	0,001-0,005	0,005-0,02	0,02-0,1	>0,1
ORGANIC POLLUTANTS IN SEDIMENTS (dry weight)					
ΣPAHs (mg/kg)	<0,3	0,3-2	2-6	6-20	>20
HCB (mg/kg)	<0,0005	0,0005-0,0025	0,0025-0,01	0,01-0,05	>0,05
Σ (mg/kg)PCB(7)	<0,005	0,005-0,025	0,025-0,1	0,1-0,3	>0,3
Dioxins (TEQ PCDD/PCDF) (ng/kg)	<0,01	0,01-0,03	0,03-0,1	0,1-0,5	>0,5

Classification of salt water biota (SFT veiledning 97:03)

CLASSES	I "Slightly polluted"	II "Moderately polluted"	III "Markedly polluted"	IV "Severely polluted"	V "Extremely polluted"
BLUE MUSSELS (Mytilus edulis) SOFT BODY, METALS (dry weight)					
Arsenic (mg/kg)	<10	10-30	30-100	100-200	>200
Lead (mg/kg)	<3	3-15	15-40	40-100	>100
Cadmium (mg/kg)	<2	2-5	5-20	20-40	>40
Copper (mg/kg)	<10	10-30	30-100	100-200	>200
Chromium (mg/kg)	<3	3-10	10-30	30-60	>60
Mercury (mg/kg)	<0,2	0,2-0,5	0,5-1,5	1,5-4	>4
Nickel (mg/kg)	<5	5-20	20-50	50-100	>100
Zinc (mg/kg)	<200	200-400	400-1000	1000-2500	>2500
TBT (mg/kg)	<0,1	0,1-0,5	0,5-2	2-5	>5
BLUE MUSSELS (Mytilus edulis) SOFT BODY, ORGANIC POLLUTANTS (wet weight)					
∑PAHs (µg/kg)	<50	50-200	200-2000	2000-5000	>5000
B(a)P (µg/kg)	<1	1-3	3-10	10-30	>30
HCB (µg/kg)	<0,1	0,1-0,3	0,3-1	1,5	>5
∑HCH (µg/kg)	<1	1-3	3-10	10-30	>30
∑PCB7 (µg/kg)	<4	4-15	15-40	40-100	>100
Dioxins (TEQ PCDD/PCDF)	<0,2	0,2-0,5	0,5-1,5	1,5-3	>3
COD (Gadus morhua), LIVER (wet weight)					
HCB (µg/kg)	<20	20-50	50-200	200-400	>400
∑HCH (µg/kg)	<50	50-200	200-500	500-1000	>1000
∑PCB7 (µg/kg)	<500	500-1500	1500-4000	4000-10000	>10000
Dioxins (TEQ PCDD/PCDF)	<15	15-40	40-100	100-300	>300
COD (Gadus morhua), MUSCLE (wet weight)					
HCB (µg/kg)	<0,2	0,2-0,5	0,5-2	2-5	>5
∑HCH (µg/kg)	<0,5	0,5-2	2-5	5-15	>15
∑PCB7 (µg/kg)	<5	5-20	20-50	50-150	>150
Dioxins (TEQ PCDD/PCDF) (ng/kg)	<0,1	0,1-0,3	0,3-1	1-2	>2
Mercury (µg/kg)	<0,1	0,1-0,3	0,3-0,5	0,5-1	>1

APPENDIX C

Short list of words and terms

Acute oral LD50: Acute lethal dose for 50 percent of a group of test animals (rats) within a defined period of time, often 24 hours. The dose is normally given in micrograms per gram body weight.

BCF: Bio-concentration factor. Defined as the concentration of a chemical in an organism (divided by the concentration in a reference compartment (e.g. food, surrounding water)).

ClassLab: "Harmonised Classifications and Labelling for Substances, refers to the Norwegian Stofflisten. Stofflisten has some information that is specific to Norway.

EC50: Effect concentration. The concentration that gives effects on 50 percent of test animals within a given period of time.

Half life: Half life (or DT50) is the time it takes for half the amount of a chemical to disappear. This may happen due to evaporation, hydrolysis, photo degradation, chemical degradation, degradation by bacteria etc. When using values for half life it should be taken into consideration that chemicals which are easily degraded by for instance sunlight may be very persistent in groundwater or sediments, and that a chemical may be degraded via several routes simultaneously.

Thus different half life values are given for each substance for depending on where the chemical is released and type of degradation.

LC50: Lethal concentration (usually in water) for fish or invertebrates, the concentration required to kill 50 percent of a group of fish or invertebrates in a given time (normally 24 - 96 hours)

Log Kow: Log Octanol-Water Partitioning Coefficient. High Log Kow indicates a compound which will preferentially partition into soil organic matter rather than water.

NOEL/NOAEL: No observed effect level / No observed adverse effects level. The highest amount of a substance that can be administered without any effects on the test animals.

APPENDIX D

Map over Norway with counties



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Oppdragstakers prosjektansvarlig	År	Sidetall	SFTs kontraktnummer
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Utgiver	Prosjektet er finansiert av
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Tittel

A study of the priority substances of the Water Framework Directive

Monitoring and need for screening

Sammendrag – summary

Dette er et litteraturstudie av 33 prioriterte stoffer i EUs vannrammedirektiv, og 8 stoffer med spesiell interesse for Norge. Litteraturstudiet viser stoffenes fysiske egenskaper, bruk og utslipp i Norge samt status for overvåking. Studiet konkluderer med at det er behov for ytterligere screening for 15 av de 42 stoffene.

This is a desk study of the 33 priority substances in the Water Framework Directive (WFD), and 8 substances with special interest for Norway. The study lists the substances physical properties, use and emissions/discharges in Norway and monitoring status. The desk study concludes that 15 out of the 42 substances should be screened. .

4 emneord	4 subject words
Prioriterte stoffer	Priority Substances
EUs vannrammedirektiv	Water Framework directive
Overvåking	Monitoring
Behov for screening	Need for screening

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