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Inventory of Biocides used in Denmark

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Table of Contents

Summary

Background and objective

The European Parliament and the Council adopted in 1998 a directive on the placing of biocidal products on the market (the Biocide Directive). The background for the directive is a need for harmonisation of the legislation of the Member States regarding this type of industrial chemicals.

As a consequence of the adoption of the Biocide Directive and reflecting a general intention to strengthen the work on chemicals in the Danish environmental administration, the Danish Environmental Protection Agency has in the spring 2000 established a division for Biocides and Chemicals Assessment. This division will be in charge of the implementation of the Biocide Directive in the Danish legislation and administrative provisions.

The object of this study is to establish a comprehensive view of the use of biocidal products in Denmark and develop models for assessments of human and environmental exposure to biocides.

The study

The present study, carried out in 1999/2000, consists of two phases. Phase one, reported here, includes an inventory of biocides used in Denmark. Phase two, reported in a separate report, includes the development of preliminary models for assessments of human and environmental exposure to biocides.

In the Biocide Directive, biocidal products are organised into 23 product-types, which may be further organised into a number of sub-types or application areas. For each product-type the application and consumption of biocides have been surveyed. For some application areas, specific information on the consumption of each biocide has been available, whereas for other application areas it has only been possible to roughly estimate the total consumption of biocides within the area.

The inventory has been drawn up on the basis of information from the Danish Pesticide Statistics, the database of the Danish Productregister (PROBAS), trade organisations, private companies, Statistics Denmark, and research institutions. For a number of application areas, questionnaire surveys have been conducted, either via the branch organisations SPT (soap, perfume and toiletware) and FDLF (lacquer and paint) or by direct enquiries to private companies.

Some of the collected information is considered confidential, and for some application areas consumption figures for each biocide are in the published report treated in such a way that only aggregated consumption figures are presented.

The study was carried out by COWI Consulting Engineers and Planners in cooperation with DTC and DHI Water and Environment. The project was launched in the autumn 1999 and has thus run for about a year.

Results

For each application area, the report includes a description of

- application of the biocides
- actors on the market
- biocides (active substances) used in Denmark
- consumption of biocides with finished products.

A large number of biocides are used in Denmark, and more than 600 of the compounds listed at the 'List of biocidal substances' from the European Chemical Bureau are registered in PROBAS as used in Denmark. It is, however, not registered in PROBAS for all compounds whether the compounds are actually used as biocides in the products. About 300 compounds were registered as used as preservative, disinfectant or antifouling agent. Some of the registered agents may actually not be present in products marketed today, but have not been cancelled by the suppliers in the Register.

The total consumption of biocides with finished products by product-types is summarised in Table 1. Only application areas not covered by other EU instruments than the Biocide Directive are included. For some application areas, e.g. food and feed area disinfectants, the delimitation is not clear, and some of the application areas included in the table may be covered by other regulative instruments and should consequently not be included here (indicated by * in the table).

For each product-type or application area, the percentage of the total consumption of biocides represented by the application area is indicated.

As it appears from the table the main application areas of biocides in terms of quantities are as follows (arranged in order of magnitude):

- Disinfectants for public areas (professional cleaning and industrial use)
- Disinfectants for swimming pools
- Food and feed area disinfectants (mainly for the food processing industry)
- Disinfectants for private areas
- Wood preservatives for vacuum and pressure preservation
- Disinfectants for laundries
- Antifouling paints for large vessels
- In-can preservatives for cleaning materials
- Preservatives for insulating materials of organic fibres
- Slimicides and other biocides used by oil extraction and fuel storage

Table 1
Consumption of biocides (active substance) with finished products in Denmark 1998/99 [2]. The assessment only includes applications not covered by other EU regulation

Product-type	Sub-type	Total consumption (tonnes/year)	% of total consumption
1: HUMAN HYGIENE BIOCIDAL PRODUCTS *	Skin disinfectants 4)	51-101	1.7
2: PRIVATE AREA AND PUBLIC HEALTH AREA BIOCIDAL PRODUCTS	Disinfectants for private areas	390-420	8.9
	Disinfectants for public areas	710-1,150	20
	Disinfectants for medical equipment	0.1-1	0.01
	Disinfectants for laundries	277	6.1
	Disinfectants for chemical toilets	3-15	0.2
	Disinfectants for swimming pools	500-1,000	16
	Disinfectants for wastewater and hospital waste	0	0
3: VETERINARY HYGIENE BIOCIDAL PRODUCTS	Disinfectants applied directly to animals	7-9	0.2
	Disinfectants applied around animals	4-5	0.1
	Disinfectants for milking machines	71-83	1.7
4: FOOD AND FEED AREA DISINFECTANTS *		530-620	13
5: DRINKING WATER DISINFECTANTS		31-51	0.9
6: IN-CAN PRESERVATIVES	In-can preservatives for paints	29-118	1.6
	In-can preservatives for inks, fountain water, sealants and adhesives	1.2-3.7	0.05
	In-can preservatives for cleaning materials	24-180	2.2
	In-can preservatives for other products	10-100	1.2
7: FILM PRESERVATIVES	Film preservatives for paints	27-158	2
	Film preservatives for plastics	0.7-3.1	0.04
	Film preservatives for sealant, fillers and other products	0.2-4	0.05
8: WOOD PRESERVATIVES	Vacuum and pressure preservatives	377-453	9.1
	Preservatives for surface treatment	16-21	0.4
9: FIBRE, LEATHER, RUBBER AND POLYMERISED MATERIALS PRESERVATIVES	Preservatives for textiles	0.8-3.2	0.04
	Preservatives for leather	0.6-2.4	0.03
	Preservatives for rubber	3)	
	Preservatives for insulating materials of organic fibres	48-137	2
	Preservatives for paper and other polymeric materials	3)	
10: MASONRY PRESERVATIVES		11-25	0.4
11: PRESERVATIVES FOR LIQUID-COOLING AND PROCESSING SYSTEMS		11-14	0.3
12: SLIMICIDES	Slimicides for wood and paper pulp	33	0.7
	Slimicides and other biocides used by oil extraction and fuel storage	91	2
13: METALWORKING-FLUID PRESERVATIVES		10-13	0.3
14: RODENTICIDES *		4.1	0.09
15: AVICIDES		0	0
16: MOLLUSCICIDES		0	0
17: PISCICIDES		0	0
18: INSECTICIDES AND PRODUCTS TO CONTROL OTHER ARTHROPODS		9.4	0.2
19: REPELLENTS AND ATTRACTANTS	Repellents and attractants for control of gnat and fleas	1.1	0.02
	Repellents and attractants for control of game and birds	2.6	0.06
20: PRESERVATIVES FOR FOOD OR FEEDSTOCK		5)	-
21: ANTIFOULING PRODUCTS	Antifouling paints for vessels < 25 m.	53	1.2
	Antifouling paints for vessels >= 25 m.	250-340	6.5
	Antifouling paints for other uses	5-10	0.2
22: EMBALMING AND TAXIDERMIST FLUIDS	Embalming fluids for humans	9-12	0.2
	Embalming and taxidermist fluids for animals.	3-6	0.1
23: CONTROL OF OTHER VERTEBRATES		3.9 1)	0.09

Total (rounded)	3,600-5,530	100

1) The 3.9 tonnes used for control of other vertebrates are also included in product-type 14 Rodenticides, as it is not clear how much of the total is used for other vertebrates (moles). In the total sum, the amount is only included once.
2) Only biocides not covered by other EU regulation are included. Application areas where the delineation is not clear are indicated by a *. All figures represent the consumption of active substances and are represented by the range within which the authors estimate the 'true' value can be found at an 80% certainty level.
3) It has not been possible to confirm any use of biocides in rubber, paper (apart from paper insulation materials) and 'other polymeric materials' in Denmark, but it is expected that some minor uses take place.
4) Only skin disinfectants used in the health care sector and in antibacterial soap are included.
5) Preservatives for food and feedstock are in general covered by other regulation, but there are a few exemptions, for example preservatives in cheese rind. Within this project, there has not been made any attempt to assess the consumption of biocides for these exemptions.

Dansk sammenfatning

Baggrund og formål

Europa-Parlamentet og Rådet vedtog i 1998 et Direktiv om markedsføring af biocidholdige produkter (Biociddirektivet). Direktivet er blevet til på baggrund af et behov for ensartede regler i fællesskabets medlemsstater for godkendelse og brug af denne type af industrielle kemikalier.

Som konsekvens af Biociddirektivets vedtagelse - og som udtryk for et generelt ønske om at styrke kemikalieområdet i den danske miljøadministration - har Miljøstyrelsen i foråret 1999 etableret et kontor for Biocid- og Kemikalievurdering. Dette kontor skal fremover forestå implementeringen af Biociddirektivet i lovgivning og administrativ praksis.

Formålet med dette projekt er at etablere et overblik over anvendelsen af biocidmidler i Danmark, og udvikle modeller til kvantificering af eksponeringen af mennesker og miljø ved brugen af biocidmidler.

Undersøgelsen

Undersøgelsen, som er gennemført i 1999-2000, består af to faser. I fase I, hvis resultater fremlægges i denne rapport, er der foretaget en kortlægning af brugen af biocider med færdigvarer i Danmark. I projektets fase II, hvis resultater fremlægges i en selvstændig rapport, er der for en række udvalgte produktgrupper udarbejdet indledende modeller til vurdering af eksponeringen af mennesker og miljø ved brug af biocidmidler.

Biocidholdige produkter er i Biociddirektivet inddelt i 23 produkttyper, som igen kan inddeles i en række undertyper eller anvendelsesområder. For hver produkttype er det i projektet undersøgt, hvilke biocider der anvendes i Danmark, og i hvor store mængder de omsættes. For en række anvendelsesområder har der været detaljerede oplysninger om forbruget af hvert enkelt biocid til rådighed, mens det for andre anvendelsesområder kun har været muligt groft at estimere den samlede omsætning af biocider.

Kortlægningen er foretaget på grundlag af oplysninger fra Bekæmpelsesmiddelstatistikken, Kontoret for Produktdatas database (PROBAS, tidligere Produktregistret), brancheforeninger, enkeltvirksomheder, Danmarks Statistik og forskningsinstitutioner. For en række produkttyper er der gennemført spørgeskemaundersøgelser; enten via brancheforeningerne SPT og FDLF eller med henvendelse direkte til virksomhederne.

Der er i EU-sammenhæng af European Chemical Bureau udarbejdet en liste med mere end 1.300 kemiske stoffer, der anvendes som biocider i EUs medlemslande. Denne liste har været anvendt som udgangspunkt for et udtræk i PROBAS. Udtrækket fra PROBAS har primært været anvendt til udarbejdelse af bruttolister over biocider, som anvendes inden for de forskellige anvendelsesområder, mens estimater på omsætningsvolumen primært er baseret på oplysninger indhentet fra virksomheder eller fra Bekæmpelsesmiddelstatistikken.

En del af de tilvejebragte oplysninger betragtes som fortrolige, og mængdeoplysninger er i den offentliggjorte rapport for en række anvendelsesområder bearbejdet, så kun forbrugstal for grupper bestående af flere biocider er angivet.

Undersøgelsen er gennemført af COWI Rådgivende Ingeniører AS i samarbejde med DTC og DHI Vand og Miljø.

Resultater

For hvert anvendelsesområde indeholder rapporten en beskrivelse af

- anvendelse og funktion af biociderne
- markedsaktører
- biocider (aktivstoffer) anvendt i Danmark
- forbrug af biociderne med færdigvarer.

Der anvendes et stort antal biocider i Danmark, og i Produktregistret er mere end 600 af stofferne på EUs biocidliste registreret med et forbrug i Danmark. Det fremgår dog ikke i alle tilfælde, om stofferne anvendes som biocid eller har en anden funktion i produkterne. Omkring 300 stoffer er specifikt registreret som anvendt som konserveringsmiddel, desinfektionsmiddel eller antifoulingmiddel. Nogle af disse stoffer indgår muligvis ikke længere i produkter på markedet, men er af leverandørerne ikke blevet slettet i registret.

Det samlede forbrug af biocider opdelt på produkttyper og anvendelsesområder i 1998/99 fremgår af tabel 1. Tabellen indeholder kun oplysninger om anvendelsesområder, som ikke er omfattet af anden regulering. For nogle anvendelsesområder, eksempelvis desinfektionsmidler anvendt inden for fødevareindustrien, har afgrænsningen mellem Biociddirektivet og anden regulering imidlertid ikke været klar på det tidspunkt, da denne opgørelse blev foretaget (markeret med *). Disse områder vil muligvis være dækket af anden regulering og skulle i så fald ikke være med her. Forbruget inden for hver produkttype eller anvendelsesområde er angivet som procent af det samlede forbrug.

De væsentligste anvendelsesområder for biocider udtrykt i omsætningsvolumen (angivet med de største først) er følgende:

- Desinfektionsmidler brugt på offentlige områder (professionel rengøring)
- Desinfektionsmidler til svømmehaller
- Desinfektionsmidler til områder, hvor der håndteres fødevarer og foderstoffer (hovedsageligt fødevareindustrien)
- Desinfektionsmidler til private områder
- Træbeskyttelsesmidler til industriel træbeskyttelse (tryk- og vakuumimprægnering)
- Vaskerier
- Antifoulingmaling til store skibe (>25 m)
- Konserveringsmidler til rengøringsmidler
- Konserveringsmidler til isoleringsmaterialer af organiske fibre (hovedsageligt papir)
- Slimbekæmpelsesmidler og andre biocider anvendt ved udvinding og transport af olie

Tabel 1
Forbrug af biocider med færdigvarer i Danmark 1998/99 [2]. Opgørelsen omfatter kun anvendelser, som ikke er dækket at anden regulering.

Produkttype	Undertype	Totalt forbrug aktivstof (tons/år)	% af samlet forbrug
1: HYGIEJNEPRODUKTER *	Desinfektion af hud 4)	51-101	1,7
2: DESINFEKTIONSMIDLER TIL PRIVATE OG OFFENTLIGE OMRÅDER	Private områder	390-420	8,9
	Offentlige områder	710-1.150	20
	Medicinsk udstyr	0,1-1	0,01
	Vaskerier	277	6,1
	Kemiske toiletter	3-15	0,2
	Svømmehaller	500-1.000	16
	Spildevand og hospitalsaffald	0	0
3: BIOCIDPRODUKTER TIL VETERINÆR HYGIEJNE	Direkte på dyr	7-9	0,2
	Omkring dyr	4-5	0,1
	Malkemaskiner	71-83	1,7
4: OMRÅDER OG UDSTYR TIL BEVARING AF FØDEVARER OG FODERSTOFFER *		530-620	13
5: DESINFEKTIONSMIDLER TIL DRIKKEVAND		31-51	0,9
6: KONSERVERINGSMIDLER TIL TEKNISKE PRODUKTER I BEHOLDERE	Maling	29-118	1,6
	Trykfarver, fugtevand, fugemasser og klæbemidler	1,2-3,7	0,05
	Rengøringsmidler	24-180	2,2
	Andre produkter	10-100	1,2
7: KONSERVERINGSMIDLER MOD BEGRONING AF OVERFLADEFILM	Maling	27-158	2
	Plastik	0,7-3,1	0,04
	Fugemasser, klæbemidler og andre produkter	0,2-4	0,05
8: TRÆBESKYTTELSESMIDLER	Vakuum- og trykimprægnering	377-453	9,1
	Overfladebehandling	16-21	0,4
9: KONSERVERINSMIDLER TIL FIBRE, LÆDER, GUMMI OG POLYMERISEREDE MATERIALER	Tekstiler	0,8-3,2	0,04
	Læder	0,6-2,4	0,03
	Gummi	3)	
	Isoleringsmaterialer af organiske fibre	48-137	2
	Polymeriserede produkter	3)	
10: KONSERVERINGSMIDLER TIL BESKYTTELSE AF MURVÆRK		11-25	0,4
11: KONSERVERINGSMIDLER TIL KØLE- OG PROCESVAND		11-14	0,3
12: SLIMBEKÆMPELSESMIDLER	Papir og papirmasse	33	0,7
	Olieudvinding og -opbevaring	91	2
13: KONSERVERINGSMIDLER TIL VÆSKER TIL METALFORARBEJDNING		10-13	0,3
14: ROTTEBEKÆMPELSESMIDLER *		4,1	0,09
15: FUGLEBEKÆMPELSESMIDLER		0	0
16: SNEGLEBEKÆMPELSESMIDLER		0	0
17: FISKEBEKÆMPELSESMIDLER		0	0
18: INSEKTICIDER		9,4	0,2
19: AFSKRÆKNINGS- OG TILTRÆKNINGSMIDLER	Myg og fluer	1,1	0,02
	Vildt og fugle	2,6	0,06
20: KONSERVERINGSMIDLER TIL FØDEVARER OG FODERSTOFFER		5)	-
21: ANTIFOULINGMIDLER	Skibe <25 m	53	1,2
	Skibe >= 25 m	250-340	6,5
	Andre anvendelser	5-10	0,2
22: BALSAMERINGS- OG PRÆSERVERINGSVÆSKER	Mennesker	9-12	0,2
	Dyr	3-6	0,1
23: MIDLER TIL KONTROL AF ANDRE HVIRVELDYR		3,9 1)	0,09
Samlet mængde (afrundet)		3.600-5.530	100

1) De 3,9 tons, som anvendes til kontrol af andre hvirveldyr, er også inkluderet i produkttype 14: Rottebekæmpelsesmidler. I totalen er mængden kun medregnet én gang.

2) Tabellen omfatter kun biocider, som ikke er omfattet af anden EU regulering. For en række anvendelsesområder har grænsefladerne, på det tidspunkt hvor opgørelsen er foretaget, ikke

været helt klare (markeret med *). Mængder er angivet som mængde aktivstof i færdigvarer, som sælges på det danske marked. Alle mængder er angivet med det interval, som forfatterne vurderer den rigtige værdi med 80% sikkerhed vil være inden for.

3) Det har ikke være muligt at identificere nogen brug af biocider i gummi, papir (færdigt papir bortset fra papir isolering) og 'andre polymeriserede materialer', men det formodes, at der vil finde en begrænset anvendelse sted.

4) Kun huddisinfektionsmidler brugt i sundhedssektoren og antibakterielle sæber er inkluderet.

5) Konserveringsmidler til fødevarer og foderstoffer er generelt omfattet af anden regulering, men der er få undtagelser bl.a. konserveringsmidler til osteskorper. Det har inden for dette projekt ikke været forsøgt at estimere forbruget til disse alternativer.

1 Introduction

In the present report the outcome of phase 1 of the project 'Description of use of biocidal products in Denmark' is presented.

The aim of phase 1 of the project is to establish a comprehensive view of the use of biocides and biocidal products in Denmark.

In phase II, the potential exposure of man and the environment from the use of biocidal products is estimated for selected applications of biocidal products. The lists of potential exposure routes are not included in the present report, but are part of the phase II report.

The direct cause of the initiation of the project is the adoption of the 'Directive of the European Parliament and of the Council No 98/8/EC of 16 February 1998 on the placing of biocidal products on the market'; in the following designated 'the Biocide Directive'.

The report is structured in accordance with the Biocide Directive with 4 main groups organised into 23 product-types. The four main groups are:

1. Disinfectants and general biocidal products
2. Preservatives
3. Pest control
4. Other biocidal products

Each of the 23 product-types is organised into one or more sub-types each covering a specific application area. The application areas are defined by specific market or exposure conditions. The hierarchic grouping of the biocidal products in 'main groups', 'product-types' and 'sub-types' appears directly from the Table of Contents of the report.

The Biocide Directive only applies to the biocidal products used within specific application areas to the extent these areas are not defined by or within the scope of other EU instruments. The main exceptions are biocides used for food and feed, toys, cosmetics, human hygiene products and medical products. The exceptions are in the present report mentioned for each of the application areas to which they apply.

The year of reference of the assessment is 1998, but for some application areas, the consumption assessments refer to other years, if 1998-data were not available.

The chemical names used in the report refer to the chemical names used in the 'List of biocidal substances' of July 1999 from the European Chemical Bureau.

The project was followed by a steering committee consisting of:

Jørgen Larsen, The Danish Environmental Protection Agency (chair)
Jesper Preuss Justesen, SPT (Trade Organisation for Soap, Perfume and Toiletware)

Hans Jørgen Andresen, Colgate-Palmolive A/S, Representing SPT
Marianne Peirera, J.C. Hempel's Skibsfarvefabrik AS, representing the Danish Paintmakers Association
Per Langholdt, S. Dyrup & Co. AS, representing the Danish Paintmakers Association
Michael Jørgensen, CO-Industri
Poul Erik Andersen, National Working Environment Authority
Sonja Hagen Mikkelsen, COWI Consulting Engineers and Planners AS

The report was prepared by a working group consisting of Carsten Lassen, Sonja Hagen Mikkelsen, Susanne Skaarup and Jesper Kjølholt (COWI); Pia Juul Nielsen (DTC); Dorte Rasmussen and Lise Samsoe-Petersen (DHI Water and Environment).

2 Methodology

According to the Biocide Directive biocidal products are defined as:

'Active substances and preparations containing one or more active substances, put up in the form in which they are supplied to the user, intended to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect on any harmful organism by chemical or biological means.'

For the transparency of the present assessment it is, however, expedient to distinguish between the active substances and preparations and products containing these substances.

The following terms will be used:

- *Biocides*: The active substances (or active agents) with a biocidal effect. The biocides are specific chemical compounds.
- *Biocidal chemicals*: Biocide-containing chemicals used for production of biocidal products. In many instances, the biocidal chemical only consists of the biocide.
- *Biocidal products:* Manufactured products with an explicit biocidal function.
- *Other products containing biocides*: Manufactured products without an explicit biocidal function to which biocides are added for protection of the product itself.

There are a number of substances whose major use is non-biocidal, but which has some minor use as a biocide. These substances are in the Biocide Directive designated 'Basic substances'. In the assessment in the present report, only the consumption of these substances as a biocide is included.

The flow of biocides from production of biocidal chemicals to consumption of finished goods is illustrated in Figure 2.1.

The flow of the biocides subsequent to the use of the products and the possible exposure of man and the environment will be discussed more within Phase 2 of this project.

The emphasis of the assessment is on the use-phase and the *consumption of biocides with finished biocidal products and other products containing biocides.* The consumption of biocides for a specific application indicated in the tables in the following sections thus represents the total content of the biocides in finished goods sold on the Danish market in 1998, if nothing else is explicitly indicated.

Figures for the volume of biocidal chemicals used for production of finished goods in Denmark are not represented in the report, except for wood-preservatives, for which the consumption for production in Denmark is registered in the Pesticide Statistics.

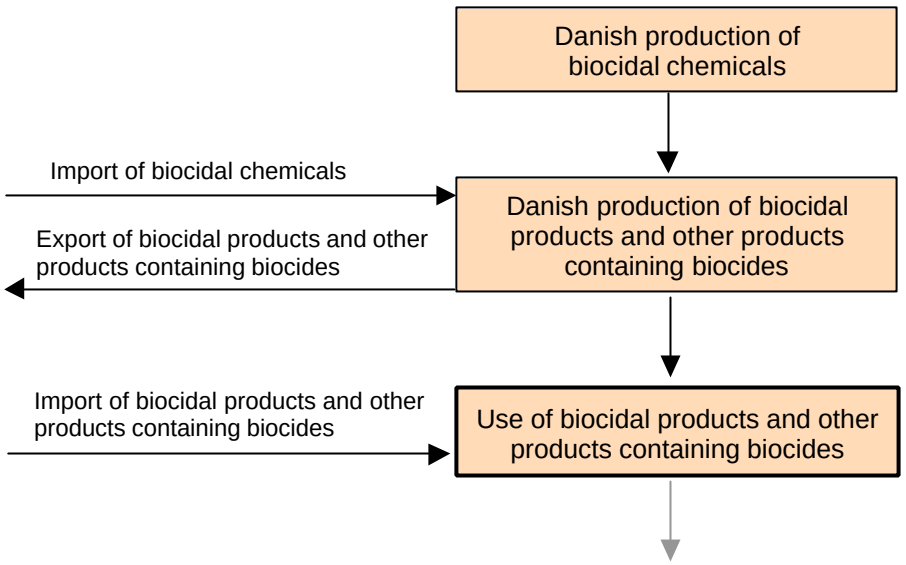

Figure 2.1
Initial part of the flow of the biocides through the society

The consumption volumes for the biocides are estimated on the basis of information from the Danish Product Register Database PROBAS, the Danish Pesticide Statistics, Statistics Denmark, the Danish EPA, trade organisations, consumers, and companies producing or trading the products.

Initially a retrieval of biocidal substances registered in PROBAS, the database of the Danish Productregister was carried out. The retrieval was based on the 'List of biocidal substances' of July 1999 from the European Chemical Bureau. The list comprised 1,336 substances with CAS No. Of these, 607 substances were registered in PROBAS as used in Denmark.

For these substances, a more extensive retrieval of turnover by application areas was carried out. The application areas registered in PROBAS are, however, not identical with the application areas defined in this work, and the data from PROBAS are not immediately applicable. In addition, only a part of the biocidal products is registered. Companies only have the obligation to submit information on the turnover of products to PROBAS if the products contain substances classified dangerous (Bek 540). If the products contain dangerous substances, however, all constituents of the products are registered.

As all products are not registered, the data from PROBAS cannot be used directly to estimate the consumption of the biocidal products in Denmark, but the information from the database has been used in combination with information received from the relevant branches of trade. Producers and importers have to submit information on the expected turnover of the products and any changes in this respect. By experience, the turnover volumes are often not updated frequently, and the registered turnover may be quite far from the actual volumes.

The data from PROBAS have been most useful as regards applications within Main Group 2: ‘Preservatives’ and product-type 21: ‘Antifouling products’. For antifouling products, the registering in PROBAS was updated and quality assessed, and turnover volumes have been applied directly in this study.

A total of 144 different compounds are registered in PROBAS as used as preservatives in various products. The PROBAS data supplement the information obtained from the industry, as the information from the industry for most application areas focus on the compounds typically used. The information in PROBAS regarding the specific use of the substances is considered confidential, if the number of registered products and registered users is below three. The detailed lists of preservatives used for different application areas are consequently only included in a confidential unpublished version of this report.

Until now the biocides included in the product-types 8, 10 (partly), 12 (partly), 14, 18, 19 (partly) and 23 have been covered by the Danish Statutory Order No. 241 of 27 April 1998 on Pesticides (Bek 241). According to the regulation only pesticides approved by the Danish EPA are allowed in Denmark, and information about the content of active agents of the approved pesticides is included in 'Survey of approved pesticides' published by the Danish EPA (Danish EPA. 1999 A). The total sale of the pesticides and active agents are registered by the Danish EPA and reported annually in the 'Pesticide Statistics' (Danish EPA. 1999 B). In the tables in this report, the number of approved products for each application area is indicated, but the turnover of some of the approved products on the Danish marked for the year of reference may actually be zero.

The total consumption of biocides for these application areas is estimated on the basis of the Pesticide Statistics. In these instances when the active agents are used for more than one application area, the distribution of the registered biocides on product-types and sub-types is based on information retrieved from the pesticide register of the Danish EPA. In one instance, wood preservatives, the biocidal products are used for production of products containing biocides, and both the Danish consumption of biocidal products for manufacturing of products and the consumption with finished goods are assessed.

For application areas where the biocides are not covered by the Pesticide Statistics, the total consumption of the biocides are predominantly estimated on the basis of information from consumers, trade organisations and companies producing or trading the finished goods. As mentioned above, this information is combined with information retrieved from PROBAS.

For most of the biocides, it is not possible to assess the exact sale of the biocide with finished goods in 1998. The consumption figures will consequently be represented by ranges based on more or less uncertain 'expert judgements'. The basis for the judgements is indicated in the text or notes to the tables. In order to limit the extent of the ranges , the indicated ranges represent a 80% certainty level or in other words: The figures are represented by the range, within which the authors estimate the 'true value' with a 80% certainty can be found. In this way, there is a direct correlation between the uncertainty of the estimates and the width of the ranges. It should be noted that the ‘true value’ of about 20% of the estimates accordingly could be outside the indicated range.

The content of active agents in the products is represented as (weight/weight), if nothing else is indicated.

3 Main group 1: Disinfectants and general biocidal products

The group includes biocidal products for disinfection and general biocidal products used for human and veterinary hygiene.

These product-types exclude cleaning products that are not intended to have a biocidal effect, such as washing preparations, powders and similar products.

Producers and suppliers of products for disinfection in Denmark are organised in the trade organisation SPT (Trade Organisation for Soap, Perfume and Toiletries). As part of this project SPT has carried out an inventory of disinfectants in products traded on the Danish market by the members of the organisation. The following chapter is to a large extent based on the results of this inventory. As the members of the trade organisation do not cover 100% of the market, additional information has been gathered from other suppliers, or the total consumption in Denmark is estimated by extrapolation of the SPT inventory results.

It has been attempted to base the estimates of the total consumption on extrapolations of the SPT inventory. The lists of used active agents in the following sections are mainly based on the SPT inventory, and the lists are most likely not comprehensive. The information on the consumption of specific compounds is in the publishedreport only indicated for agents for which the consumption volumes is based on information from more than two suppliers.

The confidential version of this report contains in addition a list of substances registered in PROBAS as used as disinfectants.

3.1 Product-type 1: Human hygiene biocidal products

Products in this group are biocidal products used for human hygiene purposes. Human hygiene biocidal products are mainly used in relation to care, examination and treatment of patients in the public health service sector, in private medical and dental clinics, nursing homes, in the food processing industry and other food handling areas. A limited number of products are used in private homes and workplaces with the purpose of avoiding contamination and preventing infections in relation to cuts, abrasions and the like. Human biocidal products have until now not been covered by any statutory approval procedure.

The product-type includes only one sub-type:

- Skin disinfectants (antiseptics), covering both liquid disinfectants and antibacterial soaps.

Biocides in cosmetic products and products specifically intended for medicinal purposes are not covered by the Biocide Directive and are consequently excluded from this assessment. Antibacterial soaps were at first left out of the assessment, as they were not considered to be biocidal products, but were

later included as a result of the borderline discussions and also in order to cover triclosan-containing soaps.

When the identified suppliers were approached in relation to this project, the understanding was, in accordance with the available borderline documents from the Commission, that human hygiene biocidal products covered by the directive were products mainly intended for application on intact skin or for general hygiene purposes, which are not defined as 'medicinal' use. At a later meeting in a working group discussing the borderline with other legislation, it was decided to replace this border by a border based on the purpose and the use of the products instead. This was because it appeared impossible to draw a line on the basis of intact/wounded skin only. 'Medicinal use' in relation to disinfectants also still needs to be clarified. A written proposal from the Commission defining the borderline was planned to be distributed to the contact points and the medicinal authorities in the Member States. The main problem with regard to the borderline between the Medicinal Products Directive (65/65/EEC as last amended by Directive 93/93/EEC) and the Biocides Directive is that the medicinal authorities have a different understanding of what is covered by the Medicinal products Directive.

Products for treatment of acne and shampoos to control dandruff are considered to be cosmetic products covered by the Cosmetics Directive (76/768/EEC) or in special cases to be medicinal products and covered by the Medicinal Products Directive, when a therapeutic claim is made. Suntan products containing antimicrobial ingredients, antiperspirants, deodorants, and mouth and denture products are considered to be cosmetic products. This demarcation is based on the current discussions in the available borderline documents from the Commission and may change in the future. Some of the products excluded on this basis are included in other projects identifying biocidal products in use in different European countries.

3.1.1 Skin disinfectants

Skin disinfectants or antiseptics are used for human hygiene purposes in order to destroy microorganisms that could cause infections or have a detrimental effect on human activities, for example spoiling or contaminating food or for general hygiene purposes in the health care sector. Skin disinfectants either inhibit the growth (microbiostatic effect) or kill microorganisms (microbiocidal effect) on the surface of the skin. Disinfectants specifically aimed at treating or preventing disease in human beings and animals are regarded as medicinal products.

Chlorhexidine is one of the most common active ingredients used in human hygiene disinfectants for retail sale and also to a large extent for use in the health care sector. The absence of a Danish approval procedure for chemical disinfectants has resulted in a large number of different products on the market, many of them containing similar ingredients. Skin disinfectants particularly used in the health care sector are generally containing chlorhexidine, iodine or alcohols as active ingredients according to information from Statens Serum Institut (Statens Serum Institut, 1997). Triclosan is found in many antibacterial soap-formulations for both the professional and the private market. If the concentration is less than 0.3%, triclosan will act as a preservative, and the statutory order on cosmetics will apply. In order to achieve a biocidal effect the concentration must be above this limit.

Chlorhexidine is rapidly bactericidal and persistent and is recommended as a relatively non-toxic skin antiseptic for general use. It is most active against Gram-positive organisms and fairly effective against Gram-negative bacteria and many viruses. It is inactivated by soap and organic matter and is therefore used in aqueous or alcoholic solutions for topical application, hand and skin washing. Chlorohexidine and alcohol are often used together for skin disinfection.

Iodine is mostly used in solutions with water and detergents (iodophors) together with alcohol. Iodine complexes with the detergents and exists in equilibrium with a small amount in the water phase. Iodophors are slowly sporicidal but rapidly effective against vegetative organisms including fungi and Trichomonas. The microbiocidal effect, especially against viruses, is however varying.

Iodine in alcohol solutions (tincture of iodine) are powerful and efficient skin disinfectants, but also rather irritant to skin. Free iodine may cause toxic dermatitis and is easily absorbed through injured skin. Previously these tinctures were widely used.

Alcohols like isopropyl alcohol and ethanol are optimally bacteriocidal in aqueous solution at concentrations of 70 to 75%, and have very little bacteriocidal effect outside this range, e.g. when 'absolute' or diluted too much. Alcohols represent the group of substances which most rapidly and efficiently reduces the number of microorganisms on the skin. They are microbiocidal against bacteria including mycobacteria, fungi and especially lipid containing virus. They are not active against spores and non-lipid containing viruses.

Triclosan has been widely used as an antimicrobial agent in consumer goods including cosmetics for many years. Recently it was discovered that triclosan has a very specific mode of action, as is the case for antibiotics. Triclosan is fat-soluble and crosses easily cell-membranes. Once inside the cell, triclosan blocks the active site of an enzyme called enoyl-acyl carrier-protein reductase, preventing the bacteria from producing fatty acids needed for building cell membranes and other vital functions. As a preservative in soaps, triclosan is added in low concentrations (<0.3%). In order to obtain an antiseptic effect, the concentration must typically be up to 3%.

3.1.1.1 Actors on the market

The Danish main suppliers or wholesalers of disinfectants to the pharmacies are Nomeco which is the largest, K.V. Tjellesen A/S and the joint-stock company Max Jenne which is the main supplier in Jutland. Among suppliers to the wholesalers are Medicteam, ScanMedic and Unichem in Denmark and Galderma in Sweden.

In addition, there is a number of smaller and larger companies supplying disinfectants to the health care sector. A number of these companies has registered their products by Statens Serum Institut (SSI). This registration is voluntary and is not to be mistaken for an approval process. A product, which is registered by SSI, will however more easily be introduced in the hospital and health care sector. The names of these companies and their products appear in a booklet on disinfection in the health care sector published by SSI (Statens Serum Institut, 1997).

The main suppliers for the professional market are Henkel Ecolab A/S, Novadan A/S and Diversey Lever A/S and the main suppliers to the retail market are Matas A/S, the pharmacies and to a lesser extent supermarkets and department stores.

3.1.1.2 Biocides used in Denmark for the application area

According to information from major Danish hospitals, Statens Seruminstitut and SPT, the most frequently used biocides for skin disinfection are those listed in Table 3.1.

Table 3.1
Biocides used for skin disinfectants in Denmark[1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
2,4,11,13-tetraazatetradecanediimidamide, N,N''-bis(4-chlorophenyl)-3,12-diimino, diacetate	chlorhexidine diacetate	56-95-1	0,2
Ethyl alcohol	surgical spirit	64-17-5	70-85
Phenol, 5-chloro-2-(2,4-dichloropnenoxy)-	triclosan	3380-34-5	0,3-3[2)]
Iodine		7553-56-2	0.01-5
D-gluconic acid, compound with N,N''-bis(4-chlorophenyl)-3,12-diimino-2, 4,11,13-tetraaza-tetradecanediimidamide (2 :1)	chlorhexidine-digluconate	18472-51-0	0,5

1) Information from 'Desinfektion i Sundhedssektoren', (Statens Serum Institut, 1997).
2) Information from suppliers.

3.1.1.3 Consumption of biocides with finished products

Skin disinfectants are used in the primary health care sector, the hospital sector, in industry and institutions and in private homes.

According to the Danish Medicines Agency it is not possible to get the full picture of the use of skin disinfectants in the primary health care sector and the hospital sector from the Medicinal Products Statistics in 1998. This statistics includes data submitted by high street (private) pharmacies, hospital pharmacies and Statens Seruminstitut. As of 1 July 1995, it became compulsory for pharmacies to install a special point-of-sale terminal to enable recording of over-the-counter (OTC) sales. Based on this recording the sales of chlorhexidine in 1998 in the primary health care sector amounts to DKK 1,600,000 (pharmacy retail price) and DKK 220,000 in the hospital sector (settling price).

Information from the County Medicine Registration Office in Denmark, which is an office belonging to the Association of County Councils in Denmark, provides an overview of the consumption of SAD (Sygehusapotekerne i Danmark) skin disinfectants in the hospital sector in 1999. The County Medicine Registration Office in Denmark is responsible for registration of SAD-medicines in the Danish Medicines Agency's speciality register and for maintenance of the documentation for medicinal products produced by the hospital pharmacies in Denmark. Apart from the SAD products, which are produced by the hospital pharmacies, the hospitals also purchase skin disinfectants from wholesalers and other companies supplying products to the health care sector. SAD products are estimated to account for only a small fraction of the consumption in the hospital sector according to some of the hospital pharmacies.

Information about the consumption of skin disinfectants in the hospital sector in Copenhagen County was therefore obtained in order to estimate the total consumption of skin disinfectants in this sector in Denmark. Using the number of inhabitants in Copenhagen County and in Denmark, the total consumption of skin disinfectants in Denmark is estimated to be approximately eight times the consumption in Copenhagen County. The same extrapolation is used in relation to the consumption of medicinal products in general (L. Nielsen, 2000). In order to include also the primary health care sector, the amount of skin disinfectants used in Copenhagen County is estimated at 5-10% of the total consumption.

In Table 3.2 the consumption of chlorhexidine, surgical spirit and iodine in the health care sector and triclosan in antibacterial soaps is shown. The table does not provide a full picture of the consumption of skin disinfectants in Denmark, as the private sector is only partly included. Due to a change in the demarcation between the Medicinal Products Directive, the Cosmetics Directive and the Biocides Directive, it has not been possible to provide a full overview within the timeframe of the project.

Table 3.2
Consumption of biocides with skin disinfectants in the health care sector and in antiseptic soap in Denmark 1999

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Chlorhexidine diacetate	0.013-0.025	Skin disinfectant	0.2	1
Ethanol	50-100	Skin disinfectant	80	1
Triclosan	0.5-1	Skin disinfectant	0.3-3	2
Iodine	0.032-0.063	Skin disinfectant	2.5	1
Chlorhexidine digluconate	0.2-0.4	Skin disinfectant	0.5	1
Total	51-101			

1) Consumption of skin disinfectants in the primary health care and hospitals sector in 1999. Figures are extrapolated from the consumption of skin disinfectants in the hospitals in Copenhagen County. Retail sales are not included.

2) According to a specific assessment of triclosan in products carried out by the trade organisation SPT, the total content of triclosan in antiseptic soaps on the professional market in 1999 was about 0.5 tonne. The private market of antibacterial soaps is here estimated to be smaller than the professional market and the total consumption of triclosan is estimated at 0.5-1 tonne.

Due to rising concerns about the possible consequences of the increasing use of triclosan, many suppliers are phasing out this substance. . In the mid nineties the industry decided to phase out triclosan in 'high-volume down-the-drain-products'. This decision was taken through their organisation AISE (Association Internationale de la Savonnerie, de la Détergence et des Produits d'Entretien) of which SPT is the Danish division. This resulted in a reduction of triclosan-containing cleaning products for private use. According to members of SPT, it can also be expected that triclosan will be phased out in antibacterial soaps, and several suppliers have already substituted soaps containing e.g. chlorhexidine for these soaps on a voluntary basis.

3.2 Product-type 2: Private area and public health area disinfectants and other biocidal products

Products in this group are used for the disinfection of air, surfaces, materials, equipment and furniture which are not used for direct food or feed contact in private, public and industrial areas, including hospitals. The product-type also includes products used as algicides in these areas.

The product-type is organised into the following sub-types:

- Disinfectants for private areas
- Disinfectants for professional cleaning and industrial areas
- Disinfectants for medical equipment
- Disinfectants for laundries
- Disinfectants for air-conditioning systems
- Disinfectants for chemical toilets
- Disinfectants for swimming pools
- Disinfectants for wastewater and hospital waste

3.2.1 Disinfectants for private areas

Disinfectants for private areas primarily include chlorine containing products for bleaching, surface disinfection and automatic dishwashing and furthermore disinfectants for toilets.

Information about the active ingredients and the consumption of biocidal products was obtained from the trade organisation SPT, based on both available information about the sodium hypochlorite consumption in Denmark a few years ago and responses to questionnaires sent out by SPT to their members specifically in relation to this project. SPT estimates that their members cover 80-90% of the market for disinfection in Denmark.

As disinfectants for private use do not have to be registered with the Danish Product Register, no relevant information is available from PROBAS.

3.2.1.1 Actors on the market

The main suppliers of disinfectants for private areas are Reckitt Benckiser A/S, A/S Blumøller, Colgate Palmolive and Lever Fabergé Danmark A/S. Only A/S Blumøller and Colgate Palmolive have production in Denmark.

One of the larger supermarkets in Denmark markets disinfectants for toilets under their own branding. Their supplier, Nopa, is not a member of SPT, and the consumption of their products is not included in the assessment.

3.2.1.2 Biocides used in Denmark for the application area

The identified biocides used for toilet disinfection and other private household disinfection are shown in Table 3.3. The total number of different products for toilet disinfection included in the assessment is about 12.

Table 3.3
Biocides used for private areas in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Formic acid, 86%		64-18-6	2.5
Acetic acid		64-19-7	0.8-1
Citric acid		77-92-9	2-2.5
Sodium benzoate		532-32-1	0.1
Sodium hydroxide	Caustic soda	1310-73-2	2.5
Sulfamidic acid	Sulfamic acid	5329-14-6	4
Hydrochloric acid, 36 %	Muriatic acid	7647-01-0	7.5
Ortophosphoric acid	Phosphoric acid	7664-38-2	6
Sodium hypochlorite		7681-52-9	1-4
Benzenesulfonic acid, mono-C10-13-sec-alkyl-derivatives	Dodecylbenzene sulphonic acid	27176-87-0	4.5
Quaternary ammonium compounds, benzyl-C12-16 alkyldimethyl, chlorides (80%)		68424-85-1	2.5
Quaternary ammonium compounds, benzyl-C12-14 -alkyldimethyl, chlorides		85409-22-9	0.05

3.2.1.3 Consumption of biocides with finished products

The consumption of biocidal active agents with these product groups - based on the information from SPT - is shown in Table 3.4. Main agents for the application area are sodium hypochlorite, phosphoric and sulfamic acid.

Table 3.4
Consumption of biocides for private areas in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Orthophosphoric acid	74	Disinfectant for toilets	6-14.2	1
Sodium hypochlorite	170	Bleaching and automatic dishwashing	1-4	1,2
Other agents for toilet disinfection	124	Disinfectant for toilets	0.8-7.5	1
Total	390-420			3

1) Consumption according to an assessment carried out by the trade organisation SPT. The assessment is estimated to cover about 90% of the total market, but for the individual agents the coverage of the assessment may vary between 100% and 50% and even lower.

2) The consumption assessment of sodium hypochlorite covers all Danish suppliers including those who are not members of SPT. The consumption of neat sodium hypochlorite based on information about the active chlorine content in the finished products is calculated as follows (AISE, 1997): Conversion between Av.Cl2(FAC) and NaOCl concentration: 1.05 x Av.Cl2 (%) = NaOCl (%). (FAC = Free Available Chlorine (active chlorine))

3) The uncertainty on the consumption of the individual agents is not indicated in the table. To take the uncertainty on the coverage into account the total (except for sodium hypochlorite) is multiplied by 1.1 to 1.3.

3.2.2 Disinfectants for professional cleaning and industrial use

Professional and industrial use in this context includes industry, institutions, the primary health care sector and the hospital sector. The primary health care sector is here defined as general practitioners (medical and dental clinics), nursing homes and similar institutions.

Disinfectants for professional and industrial use include products for disinfecting surfaces like floors and walls as well as larger pieces of portable equipment and furniture. Disinfectants for food handling areas are not included, as they are covered by product-type 4.

The efficiency of the disinfectant depends on the direct contact between the disinfectant and the surface that need to be disinfected, the concentration of the active ingredient, duration of the contact and on the pH and the temperature of the solution. As most disinfectants act by denaturing or altering proteins or lipids in the cytoplasmic membrane, they will need time to penetrate the outer surface of the microorganisms. The time it takes to kill a certain microorganism depends on the specific biocide.

3.2.2.1 Actors on the market

The main suppliers of biocidal products in Denmark for professionel and industrial use are Henkel Ecolab A/S, Novadan A/S and Diversey Lever A/S.

Suppliers to the primary health care and hospital sector are wholesalers of disinfectants to the pharmacies including Nomeco, K.V. Tjellesen A/S and the joint-stock company Max Jenne. Among suppliers to the wholesalers are Medicteam, ScanMedic and Unichem in Denmark and Galderma in Sweden.

3.2.2.2 Biocides used in Denmark for the application area

In Denmark, there has been no legal demand for approval of chemical disinfectants for professional and industrial use as defined here. This has resulted in quite a considerable number of different products on the market. Many of these are variations of the same basic constituents. Disinfectants for professional use which are defined as hazardous according to Statutory Order no. 540 on substances and materials from the Danish Working Environment Authority must be notified with the Product Register.

For disinfection of surfaces, the main active ingredients include chlorinated compounds, acids and quaternary ammonium compounds. Quaternary ammonium compounds are not always considered real disinfectants as soap and organic material easily inactivate them, and because they are not very effective against gram-negative bacteria like *Pseudomonas*. They are also not very efficient against virus. They do however have very god surface active properties and are therefore often used as auxiliary substance in disinfectants with the purpose of dissolving dirt.

Contact to some of the major hospitals in Denmark confirmed that very few chemical disinfectants are used for cleaning of surfaces. In the 'Hygiene principles' for the hospitals in Copenhagen County, it is stated that surfaces should be cleaned with surgical spirits (70% v/v). Mixtures of surgical spirits and chlorhexidine are also used for some cleaning tasks, especially for portable equipment. Products based on buffered and stabilised peracid are used only in extreme cases, e.g. when the operating room is heavily contaminated.

Table 3.5
Biocides used for professional cleaning and industrial use in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Propanoic acid, 2-hydroxy-	Lactic acid	50-21-5	2.5
Ethanol	(Surgical) spirit	64-17-5	80
1,2,3-propanetricarboxylic acid, 2-hydroxy-	Citric acid	77-92-9	2.5-15.5
Bromoacetic acid		79-08-3	10
Hydroxy acetic acid		79-14-1	2.5
Biphenyl-2-ol		90-43-7	2
Benzyl dimethyl tetradecyl ammonium chloride	Myristalkonium chloride	139-08-2	3
Methyl salicylate		199-36-8	0.5
Sodium hydroxide		1310-73-2	2.5
N-(3-aminopropyl)-N-dodecylpropane-1,3-diamine		2372-82-9	2.5
1,3,5 triazine-2,4,6-(1H,3H,5H)-trione, 1,3-dichloro-, sodium salt, dihydrate		2893-78-9	30
Sulfamic acid		5329-14-6	7
1,2,3-propanetricarboxylic acid, 2-hydroxy, monohydrate	Citric acid monohydrate	5949-29-1	0.5
Didecyldimethylammonium chloride		7173-51-5	2.5
Sodium hypochlorite		7681-52-9	1-15
Phosphoric acid		7664-38-2	4-19
Hydrogen peroxide		7722-84-1	37.5
Sodium chlorite		7758-19-2	2.5
Hexanediamine. polymer with N,N'''-1,6-hexanediylbis {N''-cyanoguanidine} hydrochloride		27083-27-8	20
Quaternary ammonium compounds. benzylcoco alkyldimethyl, chlorides		61789-71-7	1
Quaternary ammonium compounds. benzylcoco alkyldimethyl, chlorides		61789-71-7	6-10
Quaternary ammonium compounds, benzyl-C8-18-alkyldimethyl, chlorides		63449-41-2	2.5-10
Quaternary ammonium compounds, di-C8-10-alkyldimethyl, chlorides		68424-95-3	2.5
Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides		68424-85-1	3-8.95
Pentapotassium bis(peroxymonosulphate) bis(sulphate)		70693-62-8	10
Quaternary ammonium compounds, benzyl-C12-14-alkyldimethyl, chlorides		85409-22-9	0.5-20

3.2.2.3 Consumption of biocides with finished products

The total consumption of disinfectants for the professional and industrial area is estimated at 710-1,140 tonnes based on an assessment carried out by the trade organisation SPT. This estimate is based on answers to questionnaires sent out to all members of the trade organisation, who are expected to cover about 80% of the market.

It should be noted that surgical spirit, which is widely used for mild disinfection in the health care and hospital sector, is not mentioned in the list of biocides. This is probably because surgical spirits are supplied by companies

which are not members of SPT. According to information from the hospitals in Copenhagen County, the consumption of surgical spirit in 1998 at these hospitals was 17,500 l (14 tonnes) in 1998. Assuming this amount corresponds to 5-10% of the consumption in the health care sector as a whole, the total consumption of finished product would be 140-280 tonnes. This assumption is based on the same principles for extrapolation as was used for the skin disinfectants.

In PROBAS, there are 64 different active ingredients registered as 'disinfectants' in the products. Of these 64 active ingredients, 13 are also included in Table 3.5.

Two products for toilet disinfection containing sodium hypochlorite are registered in PROBAS and 23 products in total for toilet cleaning.

Table 3.6
Consumption of biocides for professional cleaning and industrial use in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in %	Note
Ethanol	140-240	Disinfection	80	3
Citric acid	6.6	Disinfectant for toilets	0.5-18	1
Phosphoric acid	27	Disinfectant for toilets	4-19	1
Other acids	0.8	Disinfectant for toilets	1.5-10	1
Sodium hypochlorite	498-819	Disinfection	1-16	1, 2
Hydrogen peroxide	6-16	Disinfection	37.5	1
Quaternary ammonium compounds	9.8	Disinfection	1-20	1
Other agents	11	Disinfection	2-30	1
Total 4)	710-1,150			

1) Consumption according to an inventory carried out by trade organisation SPT. The inventory is estimated to cover about 80% of the total market, but for the individual agents the coverage of the inventory may vary between 100% and 50% or even lover. The uncertainty of the consumption of the individual agents is not indicated in the table.
2) Based on a few year old assessment by the trade organisation SPT, covering all suppliers. Agents for disinfection in laboratories and the hospital sector are included.
3) Based on an extrapolation of the consumption in the hospitals in Copenhagen Country, which is estimated to account for 5-10% of the consumption in the health care sector in Denmark.
4) The inventory (except for sodium hypochlorite and ethyl alcohol) is estimated to cover about 80% of the market. To take the uncertainty on the coverage into account the total (except for sodium hypochlorite and ethyl alcohol) is multiplied by 1.1-1.3.

3.2.3 Disinfectants for medical equipment

Multipurpose disinfectants or sterilisation agents are covered by this product group.

Disinfectants specifically intended for use with medical devices (e.g. contact lens care products for disinfecting) fall under the definition 'accessory' and are covered by the Medical Devices Directive (93/42/EEC) according to a document from the European Commission, DGIII (The European Commission, March 1998). The document determines the demarcation between Medical Devices Directives and Medicinal Products Directives. These disinfectants are used to enable the device to be used in accordance with its intended purpose or to enhance the performance of the device. This demarca-

tion may however also be changed, so that this type of products will be covered by the Biocides Directive in the furture.

The method for sterilisation, which means that the medical equipment is freed from all living organisms, including viruses, bacteria and their spores and fungi and their spores, both pathogenic and non-pathogenic, is mainly heat. But for disinfecting equipment, which is heat-sensitive, chemical disinfectants are used.

3.2.3.1 Actors on the market

Henkel Ecolab A/S, Novadan A/S, Diversey Lever A/S, Johnson and Johnson and Superfos Biosector are among the main suppliers who are also members of SPT. According to the disinfection booklet from Statens Serum Institut, products are also marketed by a number of other suppliers, who are listed in the booklet.

3.2.3.2 Biocides used in Denmark for the application area

A typical biocide for chemical disinfection is buffered glutaraldehyde. The efficiency of glutaraldehyde solutions is highly dependent on the correct pH, and they are therefore supplied together with a separate alkaline buffer, which is added before use. The efficiency increases with increasing pH, which at the same time decreases the stability of the disinfectant.

A number of biocides for this application area is listed in the booklet from Statens Seruminstitut giving advice and instructions about disinfection in the health care sector. These suggestions include hypochlorite, chlorine dioxide, chloramine and dichloro isocyanurate. A consumption of these has not been revealed by the assessment carried out by SPT.

Contact to some of the major hospitals in Denmark confirmed that very few chemical disinfectants are used for medical equipment. In the 'Hygiene principles' for the hospitals in Copenhagen County, it is stated that heat should be used whenever possible. Glutaraldehyde in a concentration of 2% is used for flexible endoscopes, and heat-sensitive equipment is soaked 60 minutes in a solution containing chlorine and potassium bromide. A typical biocide for chemical disinfection is buffered glutaraldehyde. The efficiency of glutaraldehyde solutions is highly dependent on the correct pH, and they are therefore supplied together with a separate alkaline buffer, which is added before use. The efficiency increases with increasing pH, which at the same time decreases the stability of the disinfectant. Glutaraldehyde is not significantly inactivated by organic material and is active against spores. Aldehydes, including glutaraldehyde, are among the more toxic disinfectants and gluteraldehyde is both irritant and sensitising.

Table 3.7
Identified biocides used for disinfection of medical equipment in Denmark 1998

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Pentanedial	gluteraldehyde	111-30-8	2-20
Perboric acid, sodium salt		10332-33-9	20
Tetraacetylethylenediamine	TAED	10543-57-4	15

3.2.3.3 Consumption of biocides with finished products

Information about the consumption of biocides with finished products received from SPT only contains data from one of their member companies. The estimated consumption is therefore subject to quite some uncertainty.

Table 3.8
Consumption of biocides for medical equipment Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Miscellaneous	0.1-1	Disinfectant for medical equipment	15-20	1

1) The inventory carried out by trade organisation SPT covering only one supplier revealed a turnover of about 0.08 tons. Several of the main suppliers are not members of the trade organisation, and the inventory presumably only covers a part of the market. The total consumption is roughly estimated to be within 0.1- 1 tonnes.

3.2.4 Disinfectants for laundries

Laundry disinfectants can be used for laundry from the primary and secondary health care sector, hotels, nursing homes and other areas where disinfection is needed.

Typical biocides for this application area are chlorine, hypochlorite, peroxide and peracetic acid. The disinfectants which are used have a combined effect as both disinfectants and bleaching agents.

3.2.4.1 Actors on the market

Main suppliers of bleaching agents and disinfectants are Henkel Ecolab A/S, Diversey Lever A/S and Novadan A/S (Larsen et al., 1998).

3.2.4.2 Biocides used in Denmark for the application area

Table 3.9
Biocides used for laundry disinfection in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Acetic acid		69-19-7	10
Peracetic acid		79-21-0	5
Sodium hypochlorite		7681-52-9	1-15
Hydrogen peroxide		7722-84-1	30
Calcium hypochlorite		7778-54-3	1-15
Potassium hypochlorite		7778-66-7	1-15

3.2.4.3 Consumption of biocides with finished products

Estimates of the consumption from Larsen, 1998, is shown in Table 3.10. The total consumption is estimated at 277 tonnes.

Table 3.10
Consumption of biocides disinfectants for laundries in Denmark 1996

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Acetic acid	209	Bleaching	5-10	1, 3
Chlorine based bleaching agents (hypochlorite)	50	Bleaching	1-15	2,3
Hydrogen peroxide based bleaching	18.4	Bleaching	30	2
Total	277			

1) Based on an assessment from 1996 (Larsen, 1998). The chlorine based bleaching agents are in the report indicated as sodium, potassium and calcium hypochlorite. The hypochlorite is most likely also included in the amount of sodium hypochlorite estimated under disinfectants for professional cleaning and industrial area. The content of active ingredient is estimated to be as indicated by SPT.
2) According to an assessment carried out by the trade organisation SPT the consumption of hydrogen peroxide is estimated at 4 tonnes product with an average content of biocide of 30%. As this figure seems very low, the figure from 1996 from the report (Larsen, 1998) is used.
3) According to an assessment carried out by the trade organisation SPT the consumption of acetic acid is estimated at 4 tonnes product with an average content of biocide of 10%. As this figure seems very low, the figure from 1996 from the report (Larsen, 1998) is used.

3.2.5 Disinfectants for air-conditioning system

Disinfectants can be applied to air-conditioning systems with the purpose of preserving the cooling liquid or disinfecting the system. Contamination of the cooling liquid is most likely to happen in open or semi-open systems, e.g. for control of *Legionella* and other pathogenic bacteria in cooling water in hospitals.

Contact to suppliers of cooling liquids showed that biocides used for liquid-cooling and processing systems and biocides for air-conditioning systems were very much the same. In this report, the biocides used for air-conditioning systems are therefore included in the description of product-type 11, preservatives for liquid-cooling and processing systems.

3.2.6 Disinfectants for chemical toilets

Disinfectants for chemical toilets are added with the purpose of cleaning and controlling possible growth of bacteria.

Chemical toilets are typically mobile and mostly found in boats, busses and campers with no connection to the sewer system.

3.2.6.1 Actors on the market

Main importers and suppliers of biocides for chemical toilets in Denmark are Camper and DCT, both located in Jutland. Camper markets Thetford products and DCT markets Italian products. Neither of these companies are members of the trade-organisation SPT.

Among the SPT members only one company is registered.

3.2.6.2 Biocides used in Denmark for the application area

A large number of biocides for toilet cleaning and disinfection is registered in the Product Register. It is however not possible to distinguish between ordi-

nary toilet disinfectants and disinfectants for chemical toilets, but most likely some of the registered products are for chemical toilets.

According to a main supplier, who is not a member of SPT, his products only contain biocides as preservation and only in very small amounts (<0.1%). Table 3.11 therefore only contains data from SPT and cannot be considered representative to all biocides for this application area.

Table 3.11
Identified biocides used for chemical toilets in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Quaternary ammonium compounds	Benzalkonium chloride	85409-22-9	10-15

3.2.6.3 Consumption of biocides with finished products

According to the assessment carried out by SPT about 15 tonnes biocidal products was used for chemical toilets in 1998. The assessment, however, is estimated only to cover a part of the market, as the main suppliers are not members of the organisation.

It has not been possible to obtain detailed information of the rest of the market, and the total consumption will here be roughly estimated on the basis of the following assumptions.

According to the Statistics Denmark, the number of registered caravans is around 100,000. Most caravans have a toilet, but not all of the toilets are used regularly. Typically, 150 ml of the biocidal product is used for 20 l of water. Based on the experience of a few interviewed campers, it is assumed that on average 0.3-1.5 litres of biocidal product are used per caravan per year.

The total consumption will based on these assumptions be approximately 30-150 tonnes. Quaternary ammonium compounds seem to be the biocides of choice in concentrations around 10%.

Table 3.12
Consumption of biocides for chemical toilets in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in %	Note
Biocides (mainly quaternary ammonium compounds)	3-15	Disinfectants	10	1

1) See the body text for the assumptions on which the estimate is based.

3.2.7 Disinfectants for swimming pools

The quality of water in swimming pools is regulated through the Statutory Order No. 195 of 5 April 1998 that is under revision. This order covers swimming pools, which are intended to be used by a larger number of people, e.g. in schools, hotels, camping grounds, holiday camps, etc.

In order to ensure a low level of microbes and thereby protect the bathers from getting sick, swimming pool water is disinfected with chlorine gas or hypochlorite. Sodium hypochlorite is the main disinfectant for this application

area, whereas calcium hypochlorite and chlorine gas are only used in smaller amounts and not very often.

3.2.7.1 Actors on the market

Main suppliers of sodium hypochlorite for swimming pools include Henkel Ecolab A/S, Novadan A/S, and Diversey Lever A/S.

3.2.7.2 Biocides used in Denmark for the application area

Table 3.13
Biocides used for swimming pools in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Sodium hypochlorite		7681-52-9	15
Calcium hypochlorite		7778-54-3	15
Chlorine gas		7782-50-5	

3.2.7.3 Consumption of biocides with finished products

In 1981 the consumption of disinfectants for swimming pools was estimated in a report from the Danish Environmental Protection Agency /Bidsted et al, 1981/. At that time, the consumption of sodium hypochlorite was estimated at 3,250 tonnes, the consumption of chlorine gas at 5 tonnes and the consumption of calcium hypochlorite at 13 tonnes. Since 1981 the number of swimming pools has increased but the consumption of disinfectants has decreased at the same time. According to the Danish Techological Instute, Swimming Pool Technology /Ole Bidsted, 2000/ it must be expected that the consumption of sodium hypochlorite in 1998 should be lower than in 1981.

Based on an assessment made by SPT a few years ago, the consumption of sodium hypochlorite for swimming pools is estimated at 500-1,000 tonnes (Table 3.14).

Table 3.14
Consumption of biocides for swimming pools in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Sodium hypochlorite	500-1,000	Disinfectant	16	1

1) According to a few year old assessment by the trade organisation SPT, covering all suppliers, the consumption of sodium hypochlorite for swimming pools was 630 tonnes (as active sodium hypochlorite, 4000 tonnes hypochlorite solution with 15% active chlorine). Considering the uncertainty and possible changes in consumption, the consumption in 1998 is estimated at 500-1000 tonnes.

3.2.8 Disinfectants for wastewater and hospital waste

Five major hospitals in Denmark, including the hospitals in Copenhagen County, have been asked about the use of disinfectants for waste and wastewater. None of the hospitals used disinfectants for this purpose, and it is assumed that this is the general picture all over the country.

There are no longer any approved products for soil disinfection on the Danish market according to the Danish Plant Protection Association.

Based on this information, the total consumption for these application areas is estimated to be zero.

3.3 Product-type 3: Veterinary hygiene biocidal products

Veterinary hygiene biocidal products are biocidal products used for veterinary hygiene purposes including products used in areas in which animals are housed, kept or transported.

The product-type can be subdivided into the following sub-types:

- Disinfectants applied directly to domestic animals
- Disinfectants for areas in which animals are housed, kept or transported
- Disinfectants for milking equipment

Biocidal products used for cleaning of teats and udder, for animals' footbaths, for disinfection of equipment for feeding and feed areas as well as products for disinfection of milking equipment are included in this section.

The estimates of consumption in this section include entries in the inventory from SPT, which could be positively correlated to use for veterinary purposes, i.e. entries like 'udder cleaning', 'animal stables' and 'milking machines'. Entries in the inventory, which are described solely by wording like 'cleaning', 'disinfection', 'surfaces', 'equipment', 'tubing' or 'containers', are included in section 3.2.

3.3.1 Disinfectants applied directly to domestic animals

Disinfectants applied directly to domestic animals are used for the control or prevention of diseases, for cleaning the animals' feet and for udder cleaning. The substances used for disease control or prevention are covered by the Veterinary Medicinal Products Directive (81/851/EEC as last amended by Directive 93/40/EEC). Products used to kill and/or repel arthropods are included in Main Group 3: Pest Control, product-type 18.

Disinfectants in products for cleaning the animals' feet are considered biocides. Products used for teats and udder cleaning are considered biocides in the EU regulation (EU Biocidal Group, 1999). In Denmark, these products are covered by the Veterinary and Food legislation, but results regarding their use are included in Table 3.15 and Table 3.16.

For stocks of cattle, pigs and sheep, in which infectious skin diseases are a problem (e.g. digital dermatitis), disinfectants may be used in hoof baths, which the animals are forced to walk through regularly, e.g. on their way to the stable in which the milking takes place. According to the Danish advisory service for cattle (Landskontoret for Kvæg), the main use of disinfectants for cleaning the animals' feet takes place in cattle farms and is at present increasing due to an increase in the problems.

Disinfectants for teats and udder are used before milking and for teats after milking. The products may be applied by means of cloths, by dipping or as sprays.

3.3.1.1 Actors on the market

Two *Danish suppliers* of products for disinfection of animals' feet have been identified: Vittfoss and Danish Genetics. The main suppliers of agricultural chemicals in general are not marketing products, specifically for hoof baths, but they state that some of the products sold for general disinfection in stables are also used for this purpose. The amounts should thus be included in section 3.3.2.

Danish producers and suppliers of disinfecting products for cleaning of teats and udder are Alfa Laval Agri, Ciba Geigy A/S, DiverseyLever, Medimerc A/S, Novadan A/S, Henkel-Ecolab A/S, Hypred Danmark A/S, Superfos Biosector A/S, B.S. ApS, S.A. Christensen, Danish Genetics A/S, J.P. Hansen Ltd., Jettadam Fabrikker A/S, Linds Handelsselskab, Manus Agroteknik, MW-cleantrade ApS, Nardos og S. Sørensen. Among these, Alfa Laval Agri, DiverseyLever, Novadan A/S and Henkel-Ecolab A/S are the dominating suppliers.

3.3.1.2 Biocides used in Denmark for application directly to domestic animals for disinfecting the animals' feet and for udder and teats

Biocides used for the application area are shown in Table 3.15. The list is based on the inventory of SPT supplemented by additional information ($CuSO_4$, chlorhexidine-digluconate and isopropanol)

The disinfectants used for hoofs are formaldehyde and $CuSO_4$. Due to the strong irritant and carcinogenic properties of formaldehyde, products containing this substance are not recommended by the advisory service. No information is available regarding the use of this substance for this purpose. Possible use of formaldehyde for hoof baths may be included in the consumption for stables, i.e. in section 3.2.2. According to the advisory service, the consumption of products for hoof baths is very limited, and it is not included in the consumption volumes below.

One of the biocides used for udder and teats cleaning is dodecylbenzene sulfonic acid (LAS). However, even if LAS is included in the EU-list of biocides for type 3 products, its classification as a biocide may be questioned, as it is mainly used as a detergent.

Sodium dichloroisocyanurat, which is frequently used for the cleaning of teats, is not mentioned for this use in the SPT-inventory. However, it is included under the heading 'milking equipment', and the use for cleaning of teats is supposedly covered by the consumption described in section 3.3.3.

Table 3.15
Biocides used for application directly to domestic animals (udder and teats) in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Lactic acid		50-21-5	1.5
Isopropanol		67-63-0	3.6-4.3
Benzylalkohol		100-51-6	4
Bis-3-aminopropyl dodecylamine	Lauryl propylentriamine	2372-82-9	1.5
Hydrogen peroxide		7722-84-1	0.5
Sulfuric acid copper (2+) salt (1:1)	Copper sulphate	7758-98-7	
Chlorodioxide		10049-04-4	2.6
Chlorhexidine-digluconate		18472-51-0	0.45
2-pyrrolidinone, 1-ethenyl-, homopolymer, compound with iodine	PVP-iodine	25655-41-8	1-2.5
Guanidine, N,N"-1,6 hexanediyl-bis-[N'-cyano-, polymer with 1,6-hexandiamine, hydrochloride	Biquanid	27083-27-8	0.2
Dodecylbenzene sulfonic acid	LAS	27176-87-0	2

3.3.1.3 Consumption of biocides with finished products

The total consumption of biocides for cleaning udder and teats in Denmark is estimated to be 19-22 tonnes per year (Table 3.16)

Table 3.16
Consumption of disinfectants applied directly to domestic animals in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
PVP-iodine	3.2	Disinfectants for udder cleaning	2.3	2
Others	14	Disinfectants for 'hoof baths'		2
Total 3)	19-22			

1) Average concentration of the biocides in the applied products.
2) Consumption according to an inventory carried out by trade organisation SPT supplied with information from suppliers of products for animals' hoof baths. The inventory is estimated to cover about 80% of the total market, but for the individual agents the coverage of the inventory may vary between 100% and 50% or even lover. The uncertainty on the consumption of the individual agents is not indicated in the table.
3) The consumption inventory is estimated to cover about 80% of the market. To take the uncertainty on the coverage into account the total is multiplied by 1.1-1.3.

3.3.2 Disinfectants for areas in which animals are housed, kept or transported

Areas in which animals are housed, kept and transported are most often cleaned and disinfected on a regular basis in order to prevent the build up and/or dispersal of pests and/or diseases among the animals.

'Disinfectants for areas in which animals are housed' are used for disinfection of the entire stable, including disinfection of containers, consumption utensils, surfaces and pipe work for transport, storage and consumption of feed and drinking water. Such disinfection may be carried out, when a section of a stable is closed down, e.g. every 6 weeks by slaughtering of chickens, in case of heavy infections with e.g. salmonella, or occasionally after emptying the sta-

bles. Normally, a disinfection process is very extensive and comprises the whole interior of the building, including all equipment.

Furthermore, disinfectants may be used for the footwear of people working in the stables in the form of containers in which the footwear is cleaned before entering into the stables. According to the Danish advisory service, this practise is limited in Denmark, and the consumption is not included in the assessment.

The number of disinfectants used in pig and cattle farming is limited, as most cleaning is based on the use of high-pressure water and lime.

3.3.2.1 Actors on the market

The principal Danish producers and suppliers are Alfa Laval Agri, Diversey-Lever, Novadan A/S and Henkel-Ecolab A/S.

3.3.2.2 Biocides used in Denmark for application in areas in which animals are housed, kept or transported including feed areas

Disinfectants used for cleaning areas in which animals are housed, kept and transported are shown in table 3.17.

Table 3.17
Biocides used for application in areas in which animals are housed, kept or transported, including feed areas in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Formaldehyde		50-00-0	18
Ethaneperoxoic acid	Peracetic acid, peroxy acetic acid	79-21-0	6
Pentanedial	Glutaric aldehyde	111-30-8	13
Benzenesulfonamide, N-chloro-4-methyl-,sodium salt	Na-p-toluen-sulfonchloroamide	127-65-1	2.5
1-decanaminium, N-decyl-N,N-dimethyl-, chloride	Didecyl dimethyl ammonium chloride	7173-51-5	1.0
Hydrogen peroxide		7722-84-1	26
1,3,5-triazine-2,4,6(1H,3H,5H)-trione, 1,3-dichloro, sodium salt	Sodium dichloroisocyanurate	2893-78-9 51580-86-0	-
Alkylbenzyldimethyl benzalkonium chloride	Quaternary ammonium compound	61789-71-7	3.6

3.3.2.3 Consumption of biocides with finished products

The total consumption of biocides for areas in which animals are housed, kept or transported in Denmark amounts to 4-5 tonnes per year, of which formaldehyde, glutaraldehyde and hydrogen peroxide are the dominant, sold in amounts of one tonne per year of each.

Sodium dichloroisocyanurate is not mentioned for this use in the inventory of SPT, but the use for disinfection in stables is expected to be covered by the consumption volumes in section 3.3.1.

Table 3.18
Consumption of biocides for disinfection around domestic animals in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Glutaric aldehyde	1	Disinfectants for animal stables	13	2
Others	2.7	Disinfectants for animal stables	6	2
Total 3)	4-5			

1) Average concentration of the biocides in the applied products.
2) Consumption according to an inventory carried out by trade organisation SPT. The inventory is estimated to cover about 80% of the total market, but for the individual agents the coverage of the inventory may vary between 100% and 50% or even lover. The uncertainty on the consumption of the individual agents is not indicated in the table.
3) The inventory is estimated to cover about 80% of the market. Considering the uncertainty on the coverage the total is multiplied by 1.1-1.3.

3.3.3 Disinfectants for milking equipment

Disinfectants for milking equipment may be covered by Directive 92/46/EEC (production and placing on the market of milk). However, as the products used for this purpose are used in the same production process as the remaining veterinary products, the available data on the use of disinfectants for milking equipment are presented here.

Disinfection of milking equipment includes the milking machines, pipework and containers used for the milk. Typically, these are disinfected after each batch of milk by flushing the system with the disinfectant followed by clean water to remove possible residues of the product.

3.3.3.1 Actors on the market

The Danish market for agricultural, biocidal products is dominated by four producers and suppliers: Alfa Laval Agri, DiverseyLever, Novadan A/S and Henkel-Ecolab A/S.

3.3.3.2 Biocides used in Denmark for the application area milking equipment

The use of disinfectants for milking equipment is dominated by chloride and acid compounds.

Table 3.19
Biocides used for the application area milking equipment in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Ethaneperoxoic acid	Peracetic acid, peroxy acetic acid	79-21-0	10
1-octanaminium, N,N-dimethyl-N-octyl-, chloride	Dioctyldimethyl ammoniumchloride	5538-94-3	0.75-0.9
Sulfuric acid		7664-93-9	10
Sodium hydrogen sulfate		7681-38-1	18
Hypochlorous acid, sodium salt	Sodium hypochlorite	7681-52-9	5-6.5
Hydrogen peroxide		7722-84-1	1.0
1,3,5-triazine-2,4,6(1H,3H,5H)-trione, 1,3-dichloro, sodium salt	Sodium dichloroisocyanurate	2893-78-9 51580-86-0	57
Alkylbenzyldimethyl benzalkonium chloride	Quaternary ammonium compound	8001-54-5 61789-71-7	0.2

3.3.3.3 Consumption of biocides with finished products

The total, annual consumption of disinfectants for milking equipment in Denmark is estimated to be 71-83 tonnes of which the chloride compounds account for 25-30 tonnes and the acid compounds for 43-51 tonnes.

Table 3.20
Consumption of disinfectants for milking equipment in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Sodium dichloro isocyanurate	17	Disinfect. for milking machines	60	2
Others	47	Disinfect. for milking machines	10	2
Total 3)	71-83			

1) Average concentration of the biocides in the applied products.
2) Consumption according to an inventory carried out by trade organisation SPT. The inventory is estimated to cover about 80% of the total market, but for the individual agents the coverage of the inventory may vary between 100% and 50% or even lover. The uncertainty on the consumption of the individual agents is not indicated in the table.
3) The inventory is estimated to cover about 80% of the market. To take the uncertainty on the coverage into account the total is multiplied by 1.1-1.3.

3.4 Product-type 4: Food and feed area disinfectants

Food and feed area disinfectants are used for disinfection of equipment, containers, consumption utensils, surfaces or pipe work associated with production, transport, storage or consumption of food, feed or drink (including drinking water) for humans and animals.

The product-type can be organised into the following application areas:

- Food and feed area disinfectants used in agriculture
- Disinfectants used in the food-processing industry
- Disinfectants used for food handling in retail shops or other food handling areas

Food and feed area disinfectants are used to secure a high standard of hygiene in order to interrupt potential sources of infection and contamination of food and feed, and thereby minimising the risk of foodborne diseases.

3.4.1 Food and feed area disinfectants used in agriculture

Disinfectants are used in agriculture for disinfection of containers, consumption utensils, surfaces and pipe work for transport, storage and consumption of feed and drinking water. Feed area disinfectants are not used on a routine basis. Disinfection may be carried out when a section of a stable is closed down, e.g. every 6 weeks by chicken slaughtering, in case of heavy infections with e.g. salmonella, or occasionally after emptying the equipment. The feed system will not be disinfected separately. In practice, a disinfection process is very extensive and comprises the complete interior of the building including all equipment.

Disinfection of the feed system is therefore integrated in the disinfection process for veterinarian hygiene purposes. It is not possible to estimate the biocide consumption specifically with regard to disinfection of feed systems. The biocides used for this application are the same as used for veterinarian hygiene purposes. According to the industry, the consumption is included in the figures for veterinarian hygiene purposes (in section 3.3).

Under certain circumstances, e.g. by private well-borings with varying water quality, or when drinking water is stored in open systems, biocides are used for disinfection of drinking water. In these cases, disinfectants approved for the food industry are used. According to the industry, the consumption for this application is included in the figures for the food-processing industry (section 3.4.2.).

3.4.2 Disinfectants used in the food-processing industry

Disinfectants intended for use in the food-processing industry are mainly defined or within the scope of other directives e.g. 89/109/EEC (materials and articles intended to come into contact with foodstuffs), 92/46/EEC (production and placing on the market of milk), 89/437/EEC (production and placing on the market of egg products), 89/1107/EEC, 88/388/EEC and 95/2EC (food additives and flavourings), 91/493/EEC (production and placing on the market of fishery products), 95/5/EC (production and marketing of certain products of animal origin). This means that products comprised by these directives are excluded from the Biocide Directive.

The Biocide Directive applies to products intended for hand disinfection. The Biocide Directive also applies to products intended for disinfection in food retail shops and other food handling areas, e.g. cafeterias and canteens.

In Denmark, the national legislation does not discriminate between disinfectants used in the food-processing industry or in retail shops and other food handling areas. This means that all disinfectants, which may come into contact with foodstuffs, must be approved by the Danish Veterinary and Food Administration. The suppliers do not categorise the consumption of disinfectants, and in the light of this, it is not possible to estimate the consumption exclusively for the retail area and other food handling areas.

The estimate of consumption covers disinfectants used for the whole food handling area in Denmark.

Disinfectants are typically used after clean-up processes for disinfection of equipment, containers, consumption utensils, surfaces or pipework associated with the production, transport, storage or consumption of food or beverages. After application of the disinfectant, the treated area/equipment is washed with water.

3.4.2.1 Actors on the market

The Danish main producers of disinfectants or the food industry are Henkel-Ecolab and Novadan, and the main suppliers are Henkel-Ecolab, Diversey-Lever, Novadan, SFK a.m.b.a. and Nopa-Nordisk Parfumerivarefabrik A/S.

Producers and suppliers of disinfectants for foodstuffs are organised in the trade organisation SPT (Soap, Perfume and Toiletware).

3.4.2.2 Biocides used in Denmark for the application area

All disinfectants, which may come into contact with foodstuffs, must be approved by the Danish Veterinary and Food Administration. The identity of active biocidal compounds is therefore well known. The approval is based on the concept that residues do not cause acute or chronically harmful effects to the consumer. Furthermore, in order to secure that food will not be contaminated by biocides, all disinfected equipment must be washed with water before use.

A list of approved active ingredients in disinfectants (of 9 October 1998) is shown in the table.

Table 3.21
Biocides approved by the Danish Veterinary and Food Administration [1)]

Chemical name (active agent)	CAS No
Potassium sulfate triple salt	-
Polymeric biguanide hydrochloride	-
2-Propanol	67-63-0
Citric acid	77-92-9
Methyl-4-hydroxybenzoate	99-76-3
Acetic acid	64-19-7
Ethanol	64-17-5
Peracetic acid	79-21-0
Propyl-4-hydroxybenzoate	94-13-3
n-Caprylic acid	124-07-2
Lauryl betaine	683-10-3
Sodium tetraborate decahydrate	1303-96-4
Sodium hydroxide	1310-73-2
2,4-Dichlorobenzyl alcohol	1777-82-8
Bis-3-aminopropyl dodecylamine	2372-82-9
Sodium dichloroisocyanurate	2893-78-9
Sulfamic acid	5329-14-6
Malic acid	6915-15-7
Didecyl dimethyl ammonium chloride	7173-51-5
Potassium hydrogen sulfate	7647-93-7
Phosphoric acid	7664-38-2
Sodium hypochlorite	7681-52-9
Nitric acid	7697-37-2
Hydrogen peroxide	7722-84-1
Pentasodium triphosphate	7758-29-4
Sodium hexametaphosphate	10124-56-8
Potassium monopersulfate	37222-66-5
Bensylcoco alkyldimethylammonium chlorides	61789-71-7
Alkyl dimethylbenzyl ammonium chloride	63449-41-2

1) List of approved active ingredients in disinfectants for the food area, 9 October 1998

Approximately 200 biocides are registered as disinfectants in PROBAS. The application areas are not indicated, and consequently it is not possible to pick out those intended for the food and feed area. According to the industry, only a limited number of the biocides accounts for the main part of the consumption for food area disinfection.

Chlorine in the form of liquid Sodium hypochlorite is the most well-known and used disinfectant in the food industry. Sodium hypochlorite causes irreversible oxidative attacks on the cells in microorganisms. A powdered organic chlorine-releasing compound like sodium dichloroisocyanurate is used in small amounts. Chlorine itself is very sensitive to organic material and will suddenly be reduced by 'dirt' leading to ineffectiveness.

Hydrogen peroxide and peracetic acid are oxidising disinfectants like chlorine.

Quaternary ammonium compounds (benzalkonium chloride and didecyl dimethyl ammonium chloride) are surfactants that disturb the permeability of the cell membrane resulting in cell death.

Table 3.22
Identified biocides used as disinfectants for food handling areas [1)]

Chemical name 1) (active agent)	Trivial name	CAS No	% active agent in biocidal products
Ethanol		64-17-5	70-80
Bromo acetic acid		79-08-3	12
Peracetic acid	Desoxon 1	79-21-0	5-10
Pentanedial	Glutaraldehyde	111-30-8	20
N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine		2372-82-9	5-10
Sodium dichloroisocyanurate		2893-78-9	88
1-octanaminium, N,N-dimethyl-N-octyl-, chloride		5538-94-3	1
Didecyl dimethyl ammonium chloride	Bardac 22, Arquat 10	7173-51-5	3-25
Sodium hypochlorite	Dakin's solution	7681-52-9	1-15
Hydrogen peroxide	-	7722-84-1	7-45
Chlorous acid, sodium salt		7758-19-2	10-23
Quaternary ammonium compounds, alkylbenzyldimethyl, chlorides	Rodalon, Parasterol	8001-54-5	10-50
2-pyrrolidinone, 1-ethenyl-, homo-polymer, compound with iodine	PVP-iodine	25655-41-8	10
2-Octenyl succinic anhydride		26680-54-6	10
Guanidine, N,N"-1,6 hexanediyl-bis-[N'-cyano-, polymer with 1,6-hexandiamine, hydrochloride		27083-27-8	3
Poly(iminocarbonimidoyliminocarbon i-midoylimino-1,6-hexanediyl, hydro-chloride)		32289-58-0	10
1,3,5 triazine-2,4,6-(1H,3H,5H)-trione, 1,3-dichloro-, sodium salt, dihydrate	Sodium dichloro tri-azinetrione dihydrate	51580-86-0	2-9
3(2H) - isothiazolone, 5-chloro-2-methyl-, mixt. with 2 methyl-3(2H) isothiazolone	2-methyl-3(2H)-Isothiazolone,	55965-84-9	14
Chlorinated trisodium phosphate	phosphoric acid	56802-99-4	20-93
Quaternary ammonium compounds, benzylcoco alkyldimethyl, chlorides	Alkylbenzyldimethyl-ammonium chlorides	61789-71-7	4-35
Quaternary ammonium compounds, benzyl-C8-C18-alkyldimethyl, chloride	Benzalkoniumchloride	63449-41-2	3

1) Biocides that are used for food area disinfection according to the industry.

3.4.2.3 Consumption of biocides with finished products

The total consumption of disinfectants for the food handling area is shown in Table 3.23 based on an inventory carried out by the trade organisation SPT. This estimate is subject to some uncertainty, because the figures do not include the total consumption of disinfectants used in other food handling areas than the food-processing industry. Some companies have divisions for the industrial market and the retail market. The consumption of disinfectants for other food handling areas, e.g. cafeterias and canteens will often be regarded as a part of the retail market, and as such reported under product-type 2: Private area and public health area disinfectants and other biocidal products.

Table 3.23
Consumption of biocides for disinfection of food handling areas in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Ethanol	2.9	Disinfection of tanks and equipment	70	1
Peracetic acid	43	"-"	5	1
N-(3-Aminopropyl)-N-dodecylpropane-1,3-diamine	1.5	"-"	5-10	1
Sodium dichloro isocyanurate	1.3	"-"	88	1
Didecyl dimethyl ammonium chloride	8	"-"	25	1
Sodium hypochlorite	182	"-"	10-15	1
Hydrogen peroxide	193	"-"	25-30	1
Chlorous acid, sodium salt	9.7	"-"	18	1
PVP-iodine	20	"-"	20	1
Quarternary ammonium compounds	11	"-"	10-50	1
Others	8	"-"		1
Total 2)	530-620			

1) Consumption according to an inventory carried out by trade organisation SPT. The inventory is estimated to cover about 80% of the total market, but for the individual agents the coverage of the inventory may vary between 100% and 50% or even lower. The uncertainty on the consumption of the individual agents is not indicated in the table.
2) The inventory is estimated to cover about 80% of the market. To take the uncertainty on the coverage into account the total is multiplied by 1.1-1.3.

3.4.3 Disinfectants used for food handling in retail shops or other food handling areas

Disinfectant are used for food handling areas other than the food-processing industry, e.g. retail shops as butchers, bakeries, cafeterias, canteens and other catering activities to secure a satisfactory hygienic standard. As mentioned in section 3.4.2, the biocides for these application areas must be approved in Denmark by the authorities. In the light of this, the suppliers do not split the consumption of biocides for the food-processing industry and other food handling areas. The consumption for other food handling areas than the food-processing industry is included in the figures shown in section 3.4.2 and in some cases reported under product-type 2: Private area and public health area disinfectants and other biocidal products. The estimate of the consumption is subject to some uncertainty, because disinfectants intended for other applications, e.g. private cleaning, may be used professionally for disinfection in food handling areas.

Disinfectants are typically used after clean-up processes for the disinfection of equipment, containers, consumption utensils, surfaces or pipework associated with production, transport, storage or consumption of food or beverages in food handling retail shops or other food handling areas, e.g. cafeterias and canteens. After application of the disinfectant, the treated area/equipment is washed with water.

Actors of the market will also be covered by the description in section 1.2.2.

3.5 Product-type 5: Drinking water disinfectants

Drinking water disinfectants are primarily used for the disinfection of drinking water at the waterworks. The product-type includes disinfectants used by the waterworks and disinfectants used locally by the user before drinking low quality water.

Drinking water disinfectants are used at the waterworks to control the microbiological quality of the water before it is supplied to the distribution network. The intention is to destroy pathogenic and infectious micro-organisms and to reduce the total counts of micro-organisms to an acceptable level.

Disinfectants for cleaning of the drinking water distribution network are used only occasionally when laying down new drinking water mains, and only if flushing with drinking water is not sufficient to secure low content of germs.

Drinking water disinfectants can be used locally for disinfection of drinking water in case of bad sanitary conditions, e.g. during travelling and temporary stays in developing countries. These products are not used in Denmark.

3.5.1.1 Actors on the market

Chlorine for disinfection of drinking water at the waterworks is supplied by common suppliers of industrial chemical compounds.

The chlorine is also used as ingredient for site production of monochloroamine disinfectants by the waterworks themselves.

3.5.1.2 Biocides used in Denmark for the application area

Harmful microorganisms are not allowed in water for human consumption. The content of total microorganisms, measured as total count at 22 and 37°C, must be below 50 and 5 per ml, respectively.

In Denmark, it is not the drinking water policy to add disinfectants except in areas where ground water of good bacteriological quality cannot be achieved, or in areas where surface water is used for drinking water.

Addition of disinfectants to drinking water can only be carried out at a waterworks, if the Regional County finds it acceptable and intends to approve the disinfection product according to the § 21 in the Water Supply Act. Normally, the Danish EPA is asked to carry out an assessment of the disinfection product and to set up purity criteria for the product.

Until now, only chlorine products like chlorine and sodium hypochlorite and substances produced from them, e.g. monochloroamine, are used as disinfectants for drinking water. The same disinfectants are used for surface water during the treatment process at present, but ozone has been used in a newly closed plant. Disinfection must be carried out in such a way that formation of disinfection by-products is minimised. Therefore, chlorination is only accepted after the flocculation and sedimentation step of the water treatment process.

The biocidal properties are based on the strong oxidizing effect of the chlorine and chlorinated compounds.

Disinfection at drinking water supply plants is primarily carried out when drinking water production is based on surface water. Only one of Copenhagen's seven waterworks produces water from surface waters and only in short periods of the year - mainly the summer season.

The Copenhagen Water Supply uses chlorine as a third step in the surface water treatment process in amounts of approximately 18 mg/l. The fourth step is to remove all residual chlorine. The last step before the water leaves the waterworks is to add monochloroamine in amounts of approximately 0.35 mg monochloro-amine/litre drinking water.

Gentofte Water Services has stopped using surface water, but treats the ground water with monochloroamine to secure the biological quality of the water, before it leaves the waterworks. The dosing of 0.20 mg/l results in approximately 0.15 mg monochloroamine/litre drinking water leaving the plant.

The waterworks prepare the monochloroamine by adding hypochlorite to an aqueous solution of ammonium sulphate at adequate pH.

Some minor waterworks, Christiansø, Skagen and Rørvig treat their drinking water with sodium hypochlorite before supplying water to the pipe system. The resulting concentration of free chlorine for Skagen is below 0.05 mg/litre drinking water and for Christiansø approximately 0.1 mg/litre drinking water.

Table 3.24
Biocides used for water disinfection in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Chlorine gas	Chlorine	7782-50-5	100
Hypochlorous acid, sodium salt	Sodium hypochlorite	7681-52-9	15
Monochloroamine	Chloroamide	10599-90-3	0.1-0.15

3.5.1.3 Consumption of biocides with finished products

The total consumption of biocides for this application area is based on information from the waterworks. The annual consumption of drinking water disinfectants in 1998 is shown in table Table 3.25. Even though detailed figures from Skagen and Rørvig waterworks are not included, the estimate is assessed to cover 95% of the consumption. The great variation in annual consumption is caused by the fluctuating amount of surface water used for production of drinking water each year.

Table 3.25
Consumption of biocides for drinking water disinfection in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in %	Note
Chlorine gas	20-40	Drinking water disinfectants	100	1
Sodium Hypochlorite	11	Drinking water disinfectants	15	2
Monochloroamine		Drinking water disinfectants	0.1-0.15	3
Total	31-51			

1) Chlorination of surface water. Consumption according to Copenhagen, Gentofte, Christiansø, Skagen and Rørvig waterworks.
2) Consumption according to Copenhagen, Gentofte, Christiansø, Skagen and Rørvig waterworks.
3) Consumption 6.7- 8.3 tonnes per year according to Copenhagen and Gentofte waterworks. The consumption is covered by the figures for Sodium Hypochlorite which is used for the production of Monochloroamine at the waterworks.

4 Main group 2: Preservatives

4.1 Product-type 6: In-can preservatives

In-can preservatives are biocidal-products used for the preservation of manufactured products, other than foodstuff or feedingstuff, in containers by the control of microbial deterioration to ensure their shelf life.

In-can preservatives are used in virtually all water-based non-food products.

The product-type can based on application areas be organised into four application areas:

- In-can preservatives for paints
- In-can preservatives for inks, fountain water, adhesives and sealants
- In-can preservatives for cleaning materials
- In-can preservatives for other products

In-can preservatives for medicine, toys, cosmetics and human hygiene products are not included, as these products are covered by other directives.

There is a large number of in-can preservatives in use in many different products, and in this project it has not been possible to carry out a comprehensive assessment of all preservatives and applications.

In PROBAS, 236 different CAS No's are registered as used as preservatives. As many of the water-based products are not registered in PROBAS, the actual number of preservatives may be higher.

It is in PROBAS not possible to distinguish between in-can preservatives and other preservatives. In total, 144 CAS No's are registered as preservatives in the following product groups: Paint, inks, dyes, binders, adhesives, maintenance products, photographic products, cleaning agents and sealants. The preservatives in these products will either be in-can preservatives covered by this section or film preservatives covered by the next section. In-can preservatives may also be used in other product groups, and the list is consequently not comprehensive.

Of the 144 CAS No's, 75 is used in less than 3 registered products and are not shown due to confidentiality. The remaining 68 preservatives are shown in Table 4.1 with the number of registered products indicated.

It should be noted that the preservatives registered in a large number of products are not necessarily the preservatives used in largest quantities. As mentioned, most water-based products as paint and cleaning agents are not registered in PROBAS.

The table, however, gives an indication of the large number of preservatives in use, and indicates some of the most widespread. Of the upper 12 compounds as regards product groups, the isothiazolones(4), 1,3-,2-bromo-2-nitro-

propanediol and quaternary ammonium compounds (2) are some of the preservatives estimated to account for the major part of the consumption. As regards formaldehyde, the current inventory indicates that formaldehyde is not very widespread as in-can preservative today.

The consumption figures for the different application areas are assessed in the following sections.

Table 4.1
Preservatives registered in >2 products in PROBAS under the product groups: Paint, inks, dyes, binders, adhesives, maintenance products, photographic products, cleaning agents and sealants

CAS No	Chemical name	Number of registered products
50-00-0	formaldehyde	111
52-51-7	1,3-propanediol,2-bromo-2-nitro-	40
57-13-6	urea	7
65-85-0	benzoic acid	11
67-56-1	methanol	4
77-92-9	1,2,3-propanetricarboxylic acid, 2-hydroxy-	3
79-07-2	acetamide, 2-chloro-	15
88-04-0	phenol, 4-chloro-3,5-dimethyl-	3
90-43-7	(1,1'-biphenyl)-2-ol-	6
94-13-3	benzoic acid, 4-hydroxy-, propyl ester	12
95-14-7	1H-benzotriazole	26
99-76-3	benzoic acid, 4-hydroxy-, methyl ester	5
100-51-6	benzenemethanol	12
102-30-7	benzenemethanaminium, 3,4-dichloro-N-dodecyl-N,N-dimethyl-, chloride	3
107-22-2	ethanedial	4
110-90-7	hexahydro-1,3,5-triazine	4
110-91-8	morpholine	7
111-30-8	pentanedial	21
119-36-8	benzoic acid, 2-hydroxy-,methyl ester	3
122-99-6	ethanol, 2-phenoxy	7
127-65-1	benzenesulfonamide, N-chloro-4-methyl-,sodium salt	3
128-04-1	carbamodithioic acid, dimethyl-, sodium salt	3
128-37-0	2,6-di-tert-butyl-p-cresol	7
132-27-4	[1,1'-biphenyl]-2-ol, sodium salt	4
139-07-1	benzenemethanaminium, N-dodecyl-N,N-dimethyl-, chloride	3
149-30-4	2(3H)-benzothiazolethione	3
330-54-1	urea, N'-(3,4-dichlorophenyl)-N,N-dimethyl-	11
1085-98-9	methanesulfenamide, 1,1-dichloro-N-[(dimethyl-amino)sulfonyl]-1 -fluoro-N-phenyl	29
1303-96-4	Borax decahydrate	4
1317-39-1	copper oxide	4
2492-26-4	2(3H)-benzothiazolethione, sodium salt	32
2634-33-5	1,2-benzisothiazol-3-(2H)-on	65
2682-20-4	3(2H)-isothiazolone, 2-methyl-	68
2832-19-1	acetamide, 2-chloro-N-(hydroxymethyl)-	14
3586-55-8	methanol, [1,2-ethanediylbis(oxy)]bis-	3
3734-33-6	denatonium benzoate	7
3811-73-2	9-octadecen-1-amine, acetate	7
4080-31-3	3,5,7-triaza-1-azoniatricyclo[3.3.1.13,7] decane, 1-(3-chloro-2-propenyl)-chloride	6
4719-04-4	Hexahydro-1,3,5-tris(hydroxyethyl)-s-triazine	21

CAS No	Chemical name	Number of registered products
5395-50-6	Imidazo[4,5-d]imidazole-2,5(1H,3H)-dione, tetrahydro-1,3,4,6-tetrakishydroxymethyl	4
7005-47-2	2-(dimethylamino)-2-methylpropan-1-ol	39
7631-99-4	sodium nitrate	5
7681-57-4	disulfurous acid, disodium salt	5
7681-49-4	sodium flouride	6
7632-00-0	sodium nitrite	48
7757-79-1	potassium nitrate	3
7757-83-7	sulfurous acid, disodium salt	41
8001-54-5	Quaternary ammonium compounds, alkylbenzyldimethyl, chlorides	33
10605-21-7	carbamic acid, 1H-benzimidazol-2-yl, methyl ester	4
14548-60-8	methanol, (phenylmethoxy)-	3
15733-22-9	phenol, 4 chloro-3-methyl-, sodium salt	5
21564-17-0	thiocyanic acid, (2-benzothiazolylthio)methyl ester	4
26172-55-4	3(2H)-Isothiazolone, 5-chloro-2methyl-	156
26172-54-3	2-methyl-2H-isothiazol-3-one hydrochloride	4
26530-20-1	3(2H)-isothiazolone, 2-octyl-	5
26530-03-0	3(2H)-Isothiazolone, 5-chloro-2methyl-, hydrochloride	3
35691-65-7	Pentanedinitrile, 2-bromo-2(bromomethyl)-	10
51200-87-4	oxazolidine, 4,4-dimethyl-	5
55406-53-6	carbamic acid, butyl-, 3-iodo-2-propynyl ester	14
55965-84-9	3(2H) - isothiazolone, 5-chloro-2-methyl-, mixt. with 2 methyl-3(2H) isothiazolone	36
58249-25-5	1,2-benzisothiazol-3(2H)-one, sodium salt	21
61791-10-4	Quaternary Ammonium Compounds, Coco Alkyl-bis(Hydroxyethyl)methyl, Ethoxylated, Chlorides	35
68424-85-1	quaternary ammonium compounds, benzyl-C12-16 alkyldi-methyl, chlorides	4
68391-01-5	quaternary ammonium compounds, benzyl-C12-C18 -alkyldimethyl, chlorides.	3
68956-79-6	quaternary ammonium compounds, C12-18-alkyl [(ethyl-phenyl)methyl]dimethyl,chlorides	4
68937-41-7	Phenol, isopropylated, phosphate (3:1)	6
70750-47-9	quaternary ammonium compounds, coco alkyl-bis(hydroxyethyl)methyl, chlorides	19
85409-22-9	quaternary ammonium compounds, benzyl-C12-14 -alkyldimethyl, chlorides	4

4.1.1 In-can preservatives for paints

In-can preservatives are used for preservation of all types of water-based paints.

4.1.1.1 Actors on the market

There is no Danish production of in-can preservatives for paints. The main suppliers of the preservatives are Thor Chemie GmbH and Rohm & Haas; both without Danish offices.

Producers and suppliers of paints containing in-can preservatives are organised in the trade organisation 'The Danish Paintmakers Association' ('Foreningen for Danmarks Lak- og Farveindustri').

4.1.1.2 Biocides used in Denmark for the application area

The content of biocides in paints has as a part of another ongoing project supported by the Danish EPA been assessed by a panel of experts from the paint industry. The following information on in-can preservatives in paint is based on this work, if nothing else is mentioned.

The main biocides registered in PROBAS for the application is listed in Table 4.2. According to the industry only a limited number of the biocides (indicated in the table) accounts for the main part of the consumption. Basically, the same biocides are used for both indoor and outdoor water-based paints for both masonry and wood.

There are more than 39 biocides registered as preservatives in paints in PROBAS. The list of preservatives is not shown due to confidentiality. For most water-based paints, there is no obligation to declare the products to PROBAS, and the register cannot be used for estimation of the total content of biocides in paint.

Table 4.2
Main biocides used as in-can preservatives for paint in Denmark [1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in products 2)
Most common:			
2-bromo-2-nitro- 1,3-propanediol	Bronopol	52-51-7	0-0.5
1,2-benzisothiazol-3(2H)-one	BIT	2634-33-5	0-0.5
3(2H) - isothiazolone, 5-chloro-2-methyl-, mixt. with 2 methyl-3(2H) isothiazolone	CIT/MIT	55965-84-9	0-0.1
Less common:			
benzoic acid, sodium salt	Sodium benzoate	532-32-1	0.1-1
3(2H)-isothiazolone, 2-methyl-	MIT	2682-20-4	0-0.1
acetamide, 2-chloro-N-(hydroxymethyl)-		2832-19-1	0.1-0.5
Sodium nitrite		7632-00-0	0.1-0.5
3(2H)-Isothiazolone, 5-chloro-2methyl-	CIT	26172-55-4	00.1

1) The list includes the main biocides registered in PROBAS for the application. Some of the biocides may, however, not be in use today. According to the industry a limited number of biocides accounts for the main part of the consumption (indicated as most common).

2) Concentrations in the paint according to PROBAS. The average concentrations in common products are shown in the next table.

4.1.1.3 Consumption of biocides with finished products

The total consumption of water-based paints in Denmark is 33,000-36,300 tonnes. The estimated total consumption of in-can preservatives with paint is shown in Table 4.3. The estimate is based on the typical content of the preservatives and the consumption of the relevant types of paint. The basis for the estimate is indicated in the notes to the table. According to the industry a typical water-based paint contain either 200 ppm BIT, 30 ppm CIT/MIT or 0,1% Bronopol. The biocides may be used in combination and if so used in proportionally lower concentrations.

Table 4.3
Consumption of in-can preservatives with paint in Denmark 1998

Biocides (active agents)	Consumption tonnes 1)	Product group	Average content of agent in %	Note
Bronopol	26-87	Waterbased paints	0.8-1.2	2
BIT	1-2.7	Waterbased paints	0.015-0.025	2
CIT/MIT	0.4-0.9	Waterbased paints	0.0025-0.0035	2
Other	1.7-27	Waterbased paints	0.1-0.5	2,3
Total	29-118			

1) The total sale of water-based paints in Denmark in 1998 is by the trade organisation estimated at 33,000-36,300 tonnes (assuming a density of 1.1 kg/l). It is roughly estimated that CIT/MIT is used in about 50-70% of the paint, BIT in 20-30%, Bronopol in 10-20% and other preservatives in the rest. It should be noted that the values are mutually dependent so a high value for some of the biocides is correlated with low values for other. This has not been taken into account by calculating the sum total.
2) The average content is based on data provided by an industry expert panel.
3) The average content is roughly estimated on basis of data from PROBAS.

4.1.2 In-can preservatives for inks, fountain water, sealants and adhesives

In-can preservatives are used in water-based inks, fountain water for offset printing, and water-based sealants and adhesives.

Concerning adhesives, in-can preservatives are present in most types; among others: Adhesives based on natural polymers, polymer dispersions/emulsions and adhesives based on water-soluble polymers. In sealants, preservatives are used in latex acrylic sealants that only account for a small part of the total consumption of sealants.

4.1.2.1 Actors on the market

Producers and suppliers of inks, sealant and adhesives are organised in the trade organisation 'The Danish Paintmakers Association' ('Foreningen for Danmarks Lak- og Farveindustri'). Fountain water is usually supplied by the same business as supply the inks.

The main suppliers of inks are Akzo Nobel Inks A/S, BASF Tryksystemer A/S, Coates Lorilleux A/S, Zeller & Gmelin A/S, Resino Trykfarver A/S, Sicpa Denmark A/S, Sun Chemical Hartmann A/S.

Main suppliers of adhesives and sealant are Casco A/S, Aaffa A/S, Bostik A/S, Dana Lim A/S, Wacker-hemie Danmark, C Ljungdal A/S, Sika Danmark A/S, Dafa A/S, but there are several other actors on the market.

4.1.2.2 Biocides used in Denmark for the application area

Identified biocides used for preservation of inks, fountain water, sealants and adhesives in Denmark are shown in Table 4.4. A large number of different products are marketed and the list is probably not comprehensive. The data are based on an inventory carried out by the Danish Paintmakers Association concerning sealant and adhesives, in combination with information obtained by means of a questionnaire to suppliers of inks and fountain water. Less than half of the suppliers answered the questionnaire.

Table 4.4
Preservatives used for inks, fountain water, sealants and adhesives in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products 1)
1,3-propanediol,2-bromo-2-nitro-	Bronopol	52-51-7	0.02-0.04
Salicylanilide		87-17-2	1-10
benzoic acid, sodium salt	sodium benzoate	532-32-1	
N-methyl-2-pyrrolidon		872-50-4	1-10
1,2-benzisothiazol-3(2H)-one	BIT	2634-33-5	0,02
2-methyl-2H-isothiazol-3-one	MIT 2)	2682-20-4	0,005-0,1
Methane, sulfonylbis[trichloro-	hexachlormethylsulfon	3064-70-8	1-10
methanol, [1,2-ethanediylbis(oxy)]bis-		3586-55-8	0,05-0,1
Methylene dithiocyanate	thiocyanic acid, methyl-ene ester	6317-18-6	0,1-1
5-chloro-2-methyl-2H-isothiazol-3-one	CIT 2)	26172-55-4	0,005-0,1
3(2H) - isothiazolone, 5-chloro-2-methyl-, mixt. with 2 methyl-3(2H) isothiazolone	CIT/MIT	55965-84-9	0,04
methanol, (2-(2-butoxyethoxy)ethoxy]-		56289-76-0	0,05-0,1

1) Typical concentration in the products. The agents are often used in combinations.
2) In some semi-manufactures for adhesives the compounds exist on hydrochloride form in acid solution as 3(2H)-Isothiazolone, 5-chloro-2methyl-, hydrochloride (CAS No. 26530-03-0) and 2-methyl-2H-isothiazol-3-one hydrochloride (CAS No. 26172-54-3).

In PROBAS, there are 29 biocides registered as preservatives in dyes, 13 in dyes, 17 in sealants and 25 in adhesives. The list of preservatives is not shown due to confidentiality.

4.1.2.3 Consumption of biocides with finished products

The estimated total consumption of preservatives with these product groups is shown in Table 4.5.

According to the trade statistics from Statistics Denmark, the total consumption of inks in 1998 was 16,000 tonnes. Based on information from suppliers, it is estimated that only about 2,500 tonnes of this is water-based and contains preservatives. The consumption of fountain water containing preservatives is based on information from suppliers estimated at about 500 tonnes.

According to the trade statistics from Statistics Denmark, the total consumption of sealant and fillers in 1998 was about 34,000 tonnes. According to statistics of the trade organisation FDLP, water-based products containing preservatives only accounted for a relatively small part of this. Based on an assessment done by the organisation at the beginning of 2000 covering suppliers of sealants and fillers, it is estimated that only about 200-500 tonnes of these products should contain preservatives.

The total consumption of adhesives in 1998 was approximately 10,000 tonnes according to the trade statistics. The main part of this seems to be preserved and the assessment by the trade organisation revealed that an amount of the same magnitude was preserved with in-can preservatives.

Table 4.5
Consumption of preservatives with inks, fountain water, sealant and adhesives in Denmark 1998

Biocides (active agents)	Consumption tonnes	Product group	Average content of agent in % 1)	Note
Biocides (mainly isothiazolones).	0.2-0.6	Fountain water	0.04-0.08	2
Biocides (mainly isothiazolones).	0.5-0.2	Inks	0.008-0.015	2
Biocides (mainly bronopol and isothiozolones)	0.01-0.1	Latex-acrylic sealants	0.005-0.025	3
Biocides (mainly bronopol and isothiozolones)	0.5-2.8	Adhesives based on polymer dispersions and natural polymers	0.005-0.025	4
Total	1.2-3.7			

1) Indicates the concentration in the finished products.
2) Based on questionnaire to the main suppliers of inks. The concentration in fountain water ranges from 0.01% 0.09%. In the water-based inks the concentration ranges from 0.005 to 0.015.
3) The total consumption of sealants and fillers in 1998 was according to the trade statistics about 34,000 tonnes. An assessment carried out by the trade organisation revealed that in-can preservatives were used in only 200 tonnes sealants and filler. The concentration of the preservatives ranges from 0.0007% for some mixtures of isothiozolines to 0.04 for Bronopol. As the exact distribution between the different preservatives is not known, the total content can only be estimated with high uncertainty. It is roughly estimated that the average concentration will be within the range 0.005% and 0.025%.
4) The total consumption of adhesives in 1998 was according to the trade statistics about 11,000 tonnes. An assessment carried out by the trade organisation revealed that in-can preservatives were used in approximately 10,000 tonnes adhesives. The concentration of the preservatives ranges from 0.001% for some mixtures of isothiozolines to 0.08 for Dimethyloxazolidin. As the exact distribution between the different preservatives is not known, the total content can only be estimated with high uncertainty. It is roughly estimated that the average concentration will be within the range 0.005% to 0.025%.

4.1.3 In-can preservatives for cleaning materials

In can preservatives are added to virtually all water containing cleaning materials except cleaning materials with a very high or low pH or cleaning materials which are preserved by the content of disinfectants (see Main Group 1).

4.1.3.1 Actors on the market

The producers of cleaning materials are organised in SPT, the Trade Organisation for Soap, Perfume and Toiletware.

The Danish main producers of food area disinfectants are Henkel-Ecolab and Novadan, and the main suppliers are Henkel-Ecolab, Diversey-Lever, Novadan, SFK a.m.b.a. and Nopa-Nordisk Parfumerivarefabrik A/S. The main suppliers of disinfectants for private areas are Reckitt Benckiser A/S, A/S Blumøller, Colgate Palmolive and Lever Fabergé Danmark A/S whereas the main suppliers of biocidal products for professional and industrial use are Henkel Ecolab A/S, Novadan A/S and Diversey Lever A/S.

4.1.3.2 Biocides used in Denmark for the application area

There are 96 different biocides registered as preservatives in cleaning materials in PROBAS. The list of preservatives is not shown due to confidentiality.

It seems, however, only to be relatively few preservatives which account for the main part of the consumption. The main biocides used for preservation of

cleaning materials according to general experience of the trade organisation SPT are shown in Table 4.6.

Table 4.6
Main biocides used for preservation of cleaning materials in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products (typical)
1,3-propanediol,2-bromo-2-nitro-	Bronopol	52-51-7	0.03
Benzoic acid		65-85-0	0.3
Pentanedial	Glutaralaldehyde	111-30-8	0.07
Parabenes: benzoic acid, 4-hydroxy-, propyl ester benzoic acid, 4-hydroxy, butyl ester benzoic acid, 4-hydroxy-, methyl ester benzoic acid, 4-hydroxy-, ethyl ester ethanol, 2-phenoxy benzoic acid, 4-hydroxy,2-methylpropyl ester	Mixture of: Propylparaben Butyl-paraben Methylpara-ben Ethylparaben Phe-noxyethanol Isobutyl-paraben	 94-13-3 94-26-8 99-76-3 120-47-8 122-99-6 4247-02-31	0.7
1,3-Dioxane, 5-bromo-5-nitro-,	Bronidox	30007-47-7	0.03
Pentanedinitrile, 2-bromo-2(bromomethyl)-		35691-65-7	0.02
3(2H) - isothiazolone, 5-chloro-2-methyl-, mixt. with 2 methyl-3(2H) isothiazolone	Kathon CG	55965-84-9	0.02
Quaternary ammonium compounds, benzyl-C8-C18-alkyldimethyl, chlorides	Benzalkoniumchloride	63449-41-2	0.1

4.1.3.3 Consumption of biocides with finished products

The total consumption of water-based cleaning materials in Denmark is estimated at 40,000-60,000 tonnes based on information from the trade organisation SPT.

The exact distribution between the different preservatives is not known. As the different preservatives are used in concentrations ranging from 0.02 to 0.7%, the total consumption of preservatives with the cleaning materials can only be estimated with high uncertainties (Table 4.7).

Table 4.7
Consumption of in-can preservatives with cleaning materials in Denmark 1998

Biocides (active agents)	Consumption tonnes 1)	Product group	Average content of agent in %	Note
Preservatives	24-180	Water-based cleaning materials	0.06-0.3	1

1) The total consumption of water-based cleaning materials is estimated at 40,000-60,000 tonnes. The concentration of preservatives ranges from 0.02 to 0.7%. The average concentration is roughly estimated to be within 0.06 to 0.3%.

4.1.4 In-can preservatives for other products

In-can preservatives are used for a large number of other product types, among others:

- Dyes and textile processing fluids

- Maintenance products (polishes, wax emulsions, car maintenance agents, etc.)
- Photographic process fluids
- Additives to concrete
- Lubricants and machine oils
- Water bed fluids
- Industrial fluids (e.g enzyme solutions)

For textile processing, biocides may be used in dyes and fluids for sizing and finishing (Laursen et al., 1997). Sizing is the protection of threads during weaving because of mechanical actions. Often the protecting agent is starch, which is degradable for microorganisms. But biocides are not necessarily used for this purpose though.

4.1.4.1 Actors on the market

'Other products' covers a wide range of products, and it has not been attempted to obtain market information.

4.1.4.2 Biocides used in Denmark for the application area

It has not been possible to make a comprehensive inventory of the preservatives used in other products. Preservatives identified by direct information from suppliers are shown in Table 4.8. The preservatives are the same as used for other technical purposes.

Table 4.8
Identified in-can preservatives for other products

Chemical name (active agent)	Trivial name	CAS No	% active agent in products 1)
Formaldehyde		50-00-0	0.09
1,3-propanediol,2-bromo-2-nitro-	Bronopol	52-51-7	0.02-0.04
Benzoic acid, sodium salt	Sodium benzoate	532-32-1	0.2-0.3
1,2-benzisothiazol-3(2H)-one	BIT	2634-33-5	0.02
2-methyl-3(2H)-isothiazolone	MIT	2682-20-4	0.001-0.003
carbamic acid, 1H-benzimidazol-2-yl, methyl ester	Carbendazim	10605-21-7	
5-chloro-2methyl-3(2H)-Isothiazolone	CIT	26172-55-4	0.001-0.003
3(2H)-isothiazolone, 2-octyl-		26530-20-1	0.005-0.007
4,4-dimethyl- oxazolidine		51200-87-4	0.08

As shown in Table 4.1, the number of different biocides is very high, and it cannot based on the obtained information be concluded that the biocides shown in Table 4.8 are the most used for 'other applications'. The number of different biocides registered as preservatives in PROBAS is 36 for maintenance products (wax and polish among others) and 20 for photographic processing fluids. The list of preservatives is not shown due to confidentiality.

4.1.4.3 Consumption of biocides with finished products

The consumption of preservatives with 'other products' has not been assessed in detail, but the total consumption may be significant compared to the application areas covered by the previous chapters. For example, the total supply of wax and polish was according to the trade statistics about 6,000 tonnes of which some may not contain preservatives.

It is roughly estimated that the consumption of preservatives with 'other applications' is in the order of magnitude of 10-100 tonnes.

4.2 Product-type 7: Film preservatives

Film preservatives are used for the preservation of films or coatings by the control of microbial deterioration in order to protect the initial properties of the surface of materials or objects such as paint, plastic, sealants, adhesives, paper and art works.

The product-type can be organised into three sub-types:

- Film preservatives for paints
- Film preservatives for plastics
- Film preservatives for sealants, fillers and other products

4.2.1 Film preservatives for paints

Film preservatives are used for preservation of most types of topcoat paints used for outdoor applications by the control of microbial (mainly fungal) deterioration of the paint film.

Biocides used in priming wood-care products, for which the main function is a protection of the wood agaist microbial detoriation, are included in product-type 8: 'Wood preservatives'.

The content of biocides in paints has as a part of another ongoing project supported by the Danish EPA been assessed by a panel of experts from the paint industry. The following information on film preservatives in paint is based on this work, if nothing else is mentioned.

4.2.1.1 Actors on the market

The main suppliers of film preservatives for paint on the Danish market are Troy chemical corp. (IPBC), Bayer A/S (dichlorfluanid, tolyfluanid) and Jansen Pharmaceuticals (Propiconazol), but there a several other suppliers.

Actors on the paint market mentioned in section 4.1.1 also apply to film-preservatives in paint.

4.2.1.2 Biocides used in Denmark for the application area

Biocides registered in PROBAS for the application is listed in Table 4.9. Except for Di-butyl-p-cresol the use of the biocides has been confirmed by the industry as actually used today.

In some linseed oil paints for outdoor use an extract of grapefruit-seed, Citricidal, is used as fungicide (Henriksen, 2000). The active component of Citricidal is a quaternary ammonium chloride (a diphenol hydroxybenzene reacted with ammonium chloride) (Nutriteam, 2000). Also zinc-sulfate (7733-22-0) may be used for linseed oil paints.

Table 4.9
Main biocides used as film preservatives for paint in Denmark 1)

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products 2)
Most common:			
1H-Isoindole-1,3(2H)dione, 2-[(trichloro methyl)thio]	Folpet	133-07-3	0,1-5
methanesulfenamide, 1,1-dichloro-N-[(dimethyl-amino)sulfonyl]-1 -fluoro-N-phenyl	Dichlorfluanide	1085-98-9	0.1-1
Less common:			
2,6-di-tert-butyl-p-cresol	Di-butyl-p-crosol	128-37-0	0-0.1
methanesulfenamide, 1,1-dichloro-N-[(dimethyl-amino)sulfonyl]-1 -fluoro-N-(4-methylphenyl)-	Tolylfluanide	731-27-1	0.1-5
methanesulfenamide, 1,1-dichloro-N-[(dimethyl-amino)sulfonyl]-1 -fluoro-N-phenyl	Dichlorfluanide	1085-98-9	0.1-1
1,3-benzenedicarbonitrile, 2,4,5,6-tetrachloro-,	Chlorothalonil	1897-45-6	0.1-0.5
Carbamic acid, 1H-benzimidazol-2-yl, methyl ester	Carbendazim	10605-21-7	0-0.5
carbamic acid, butyl-, 3-iodo-2-propynyl ester	IPBC	55406-53-6	0.1-1
1H-1,2,4-triazole, 1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-	Propiconazole	60207-90-1	0.5-5

1) The list includes the main biocides registered in PROBAS for the application except bis(tributyltinoxid), which is still registered, but today not allowed for this application. Except for Di-butyl-p-cresol the use of the biocides has been confirmed by the industry.
2) Concentrations according to PROBAS. The average concentrations in common products are shown in the next table.

According to the industry, different film-preservatives are typically used for different applications as shown in Table 4.10.

Table 4.10
Typical concentration of film preservatives in outdoor paints according to the industry

Biocide	Typical concentration in the paint (%)			
	Water-based façade paint	Solvent-based façade paint	Water-based wood care products	Solvent-based wood care products
Carbendazim	0.2-1		0.2-1	
IPBC	0.5-3		0-2	
Folpet	?	0-1-5 1)		0,1-1 1)
Chlorothalonil		0-0.5	0-0.5	0-0.5
Tolylfluanide		1-3		1-3
Dichlorfluanide		1		1
Propiconazole		0-0.5	0-0.5	0-0.5

1) According to PROBAS; the concentration is not indicated by the industry.

4.2.1.3 Consumption of biocides with finished products

The estimated total consumption of film-preservatives with paint is shown in Table 4.11.

The estimate is based on the typical content of the preservatives and the consumption of the relevant types of paint. The basis for the estimate is indicated in the notes to the table.

Table 4.11
Consumption of film-preservatives with paint in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Carbendazin, IPBC chlorothalonil and propiconazole	15-98	Water-based wood care products and façade paints	0.3-1	1
Folpet, chlorothalonil, tolylfluanide, dichlorfluanide and propiconazole	12-60	Solvent-based wood care products and façade paint	0.3-1	2
Total	27-158			

1) According to industry, the annual consumption of water-based wood care products is 3,000-4,000 litres (a density of 1.1 kg/l is assumed). The consumption of water-based building paints is 30,000-33,000. It has not been possible to obtain an estimate of the share of the building paints used for facades and other out-door applications, but it is roughly estimated that 5-15 % of the paint is used for outdoor applications. The exact distribution between the biocides in products on the market is not known, but it is roughly estimated that the average concentration of fungicides in the wood care products is 0.3-1%. The most common fungicide for water-based façade paints and wood care products is estimated to be IPBC.

2) According to industry, the annual consumption of solvent-based wood care products is 4,000-5,000 litres (a density of 0.95 kg/l is assumed). The annual consumption of solvent-based building paints is 7,000-9,000 litres. It has not been possible to obtain an estimate of the share of the building paints used for facades and other outdoor applications, but it is roughly estimated that 5-15 % of the paint is used for outdoor applications. The exact distribution between the fungicides in products on the market is not known, but it is roughly estimated that the average concentration of fungicides in the wood care products is 0.3-1%. The most common fungicide for solvent-based façade paints and wood care products is considered to be dichlorofluanide.

4.2.2 Film preservatives for plastics

Plastic products are in general not preserved against microbial degradation, but biocides may be added to plastics containing plasticisers to prevent microbial growth at the surface. During use of the plastic product, the plasticiser will diffuse to the surface and in moist environment, the plasticiser will be attached by microorganisms, especially fungi, which use the plasticiser as carbon source. In some flooring products, the biocide is added for antiseptic reasons to prevent growth of undesirable bacteria at the surface.

Plasticisers and other degradable additives may be added to different plastics, but soft PVC seems to account for the main part of preserved plastic.

The main application areas for soft PVC containing fungicides are roof foils, tarpaulins, bathroom curtains and tents of PVC coated fabric or reinforced PVC foil, (see section 4.4.1) and some types of PVC flooring (vinyl flooring) for bathrooms, busses and institutions.

The range of plastic products that may be preserved with fungicides appears from catalogues from producers of biocides. The catalogues from Rohm and Haas and Ackros Chemicals, some of the leading producers of preservatives for this application, mention the following application areas: Swimming pools

(pool liners, accessories and furniture), boats (seat cushions, boat bumpers, canopies), geomembranes, grill covers, lawn furniture, wire insulation, wall coverings, kitchen products (cutting boards, countertops, cooking utensils, refrigerator and appliance gaskets), bathroom products (shower safety mats, toilet seats and covers, soap and lotion dispensers), automotive gaskets, shoes and cleaning products (trash cans, scrub and mop buckets, dustpans). According to suppliers of biocides, biocides seem not to be used in Denmark for production of these products, but imported products may contain biocides.

4.2.2.1 Actors on the market

The only identified supplier of biocides for plastic in Denmark is Akcros Chemicals Nordic A/S. The only identified Danish producer of preserved PVC is Duratex A/S.

Roofing membranes and PVC flooring are imported, mainly from other Nordic countries.

4.2.2.2 Biocides used in Denmark for the application area

It has not been possible to make a comprehensive assessment of biocides in all products within this application area, as most of the products are imported. Table 4.12 includes biocides in some of the main product groups: PVC roofing and flooring and PVC-coated fabric for tarpaulins and tents. OBPA seems to be the main biocide of choice for products produced in Northern Europe, but it has not been possible to obtain specific information on biocides in PVC produced in other parts of the world.

Table 4.12
Identified film preservatives used for plastics in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
10H-phenoxarsine,10,10-oxybis-	OBPA	58-36-6	2

4.2.2.3 Consumption of biocides with finished products

As mentioned above it has not been possible to cover all applications of biocide preserved plastics. The estimate of the total consumption of biocides with roofing membranes is based on information from one main supplier. The estimate regarding PVC flooring and PVC coated tents and tarpaulins are based on new information from suppliers of the products. It should be noted that only a minor part of PVC flooring contains biocides.

In total, these applications correspond to a PVC consumption of 2000-3000 tonnes.

The biocide consumption with PVC and other plastics for other applications has not been assessed in detail. The order of magnitude can, however, be indicated by the amount of PVC used for these other applications. It is not known to what extent biocides are used for these applications if used at all. In the most resent assessment of the PVC consumption in Denmark from 1996, the following consumption figures were estimated:

- Fenders and other maritime equipment: 65 tonnes
- Water beds: 12 tonnes
- Shower curtains <50 tonnes
- Boots and waders: 380 tonnes

- Cars: 3,160 tonnes (including PVC for undersealing which must be expected to be without biocides)

Cars could potentially account for a significant part of the film preservatives for plastic. There is no Danish production of cars, and it has been beyond the limits of this project to gather information on biocides in imported cars.

The remaining applications are estimated to account for <1000 tonnes PVC, which is significantly less than the applications covered in Table 4.13. The total content of biocides for other applications is roughly estimated to be <2 tonnes.

Table 4.13
Consumption of film preservatives with plastic products in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
OBPA	0.6-0.8	PVC roofing membranes	0,05	2
OBPA	0.04-0.1	PVC flooring	0,04-0,05	3
OBPA and other biocides	0.02-0.19	PVC tarpaulins and tents	0,04-0,05	4
Other	<2	Miscellaneous plastic products		5
Total	0.7-3.1			

1) Indicates the concentration of biocides in the finished product.
2) Based on information from suppliers the annual consumption of outdoor roofing foils is estimated at 1,400-1,800 tonnes of which about 90% is PVC. It is all imported. The PVC typically contains 500 ppm OBPA (10,10-oxybis-10H-phenoxarsine), but PVC products without biocides are also marketed. The remaining 10% of the roofing foils is made of polyolefines, which based on information from one of the main supplier is presumed not to contain fungicides. The polyolefine foils do not contain plasticisers.
3) Based on information from suppliers, the annual consumption of PVC flooring containing OBPA is estimated at 100,000-150,000 m2. The concentration of OBPA ranges from 0.25 to 1.4 g/m2 with an estimated average of 0.3-0.6 g/m2. PVC flooring without biocides is marketed for the same applications as well.
4) The total consumption of PVC with tarpaulins and tents of PVC is roughly estimated at 300-1200 tonnes. It has only been possible to obtain information on some of the biocides present in PVC tarpaulins on the Danish market.
5) The consumption of biocides with plastics for other applications is not known. Cars and other means of transport could potentially account for a significant contribution, whereas the consumption with other applications is estimated to be small compared to the applications mentioned above.

4.2.3 Film preservatives for sealant, fillers and other products

Film preservatives may also be used in sealant, fillers, glues and adhesives.

Fungicides are added as film preservatives to sealants and fillers for application in wet rooms. According to Danish suppliers sealants for outdoor use around windows, between concrete panels, around sheeting, etc. in general do not contain fungicides.

Film preservatives are in general not added to glues and adhesives. In some instances, however, they are added to prevent mould growth.

4.2.3.1 Actors on the market

Producers and suppliers of sealants are organised in the Danish Adhesives and Sealants Association and the suppliers will be the same as mentioned in section 4.1.

4.2.3.2 Biocides used in Denmark for the application area

An assessment made by the trade organisation the Danish Adhesives and Sealants Association revealed rather few film preservatives used in products on the Danish market (see Table 4.14). The list cannot be considered comprehensive, as other film preservatives may be present in products not covered by the assessment.

Table 4.14
Film preservatives used for sealants, fillers and other products in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Isothiazole		288-16-4	
1,2-benzisothiazol-3(2H)-one	BIT	2634-33-5	0.02
Carbamic acid, 1H-benzimidazol-2-yl, methyl ester	Carbendazim	10605-21-7	0-0.5
4,5-dichloro-2-octyl-3(2H)-isothiazolone	Sea Nine 211	64359-81-5	0.3-0.5%

4.2.3.3 Consumption of biocides with finished products

The total consumption of sealants and fillers was according to Statistics Denmark in 1998 about 22,000 tonnes (see section 4.1.4). According to the assessment made by the trade organisation, only a relatively small amount of oil-based fillers, solvent-based acrylic sealants, silicone sealants and 'other' sealants contain fungicides. In total these fillers and sealants account for about 111 tonnes. The assessment may not be comprehensive, and the total amount of sealants and fillers with fungicides is here roughly estimated to be 120-500 tonnes.

The exact distribution between the different film preservatives is not known. The estimated total consumption of fungicides, based on an average concentration of the fungicides of 0.2-0.4%, is shown in Table 4.15. The estimate on the total consumption is very uncertain, but compared to the consumption of film preservatives with paint, the consumption with sealant and fillers is certainly rather small.

Table 4.15
Consumption of film preservatives with sealants and other products in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Miscellaneous fungicides	0.2-2	Filler and sealants for wet rooms	0.2-0.4	1
Miscellaneous fungicides	<2	Miscellaneous products among others adhesives		2
Total	0.2-4			

1) The total amount of filler and sealants containing film preservatives (fungicides) is roughly estimated at 120-500 tonnes. The average concentration is estimated at 0.2-0.4% based on the information that the biocides are applied at concentrations from 0.08% to 0.5% with the highest amount of sealants and fillers within the high end of the interval.

2) The total consumption of film preservatives is roughly estimated to be less than 2 tonnes. Film preservatives are used on some sealants, but otherwise no specific application of film preservatives in other products has been identified.

4.3 Product-type 8: Wood preservatives

The product-type includes products used for the preservation of wood or wood products by the control of wood-destroying or wood-disfiguring organisms. The product-type includes both preventive and curative products. Treatment of wood before the sawmill stage is not covered by the Biocide Directive.

The consumption of biocides with wood preservatives for control of wood-destroying organisms is registered in the Danish Pesticide Statistics (Danish EPA, 1999 A).

The product-type can be organised into two sub-types:

- Vacuum preservatives and pressure preservatives
- Preservatives for surface treatment

The first sub-type includes preservatives used in industrial processes, whereas preservatives for surface treatment are used mainly by craftsmen and private persons.

The product-type does not include biocides for preservation of paints, where the effect of the biocide is to preserve the paint itself. These are included in product-type 6 'In-can preservatives' and product-type 7 'Film preservatives'.

It should be noted that the term ‘wood preservatives’ in Danish is often used as synonym of all ‘wood-care products’. In this context, ‘wood preservatives’ only cover wood-care products for priming.

4.3.1 Vacuum and pressure preservatives

Pressure preservatives are used for wood for exterior use with a high risk of degradation, i.e. wood in contact with water or soil. A specific method is used for preservation of poles.

Vacuum preservation is mainly used for preservation of wooden doors and window frames.

4.3.1.1 Actors on the market

Producers and suppliers of vacuum and pressure preservatives are organised in the trade organisation 'The Danish Paintmakers Association' ('Foreningen for Danmarks Lak- og Farveindustri').

Main Danish producers of these preservatives in 1998 were Rentokil Initial A/S, S.Dyrup & Co A/S, Sadolin Woodcare, A/S Hygæa, Tanaco Danmark A/S, and Akzo Nobel Industrial Coating A/S.

Main suppliers of these preservatives in 1998 were (apart from producers) BASF Danmark A/S, Beta DK Aps, Kai R. Spangenbergs Eftfl. I/S, and Hickson Timber Protection.

4.3.1.2 Biocides used in Denmark for the application area

Biocidal products used for control of wood destroying organisms of wood in Denmark have to be approved by the Danish EPA and are described in the survey of approved pesticides (Danish EPA 1999 B).

The consumption of active agent in preservatives for vacuum and pressure preservation in Denmark in 1998 is listed in Table 4.16 and Table 4.17.

Of the total consumption of pesticides in Denmark in 1998, wood preservatives accounted for 7% corresponding to 297 tonnes (Danish EPA 1999 A).

Of the total production of industrial-preserved wood in Denmark in 1998, 87.1% was preserved by a pressure process, and 12.7% by a vacuum process. The last 0.2% of the production was production of poles using CKB-agents (copper, chromium, boron). In 1998, 87 plants were approved by Danish Impregnation Control. Of these plants, 64 produced vacuum-treated wood, 21 pressure-treated wood, and 2 plants produced masts and poles (Dansk Imprægneringsstatistik, 1998).

Chromium and creosote are not approved for preservation of wood in Denmark. In 1998, one plant had an exemption to use chromium for pressure treatment, and preservation of poles still has an exemption (medio 2000).

Industrial use of creosote in Denmark stopped in 1989 (Hansen et al., 1997).

Table 4.16
Consumption of biocides for production of pressure-preserved wood in Denmark 1998 [1)]

Biocide (active agent)	Chemical name	CAS No	Consumption (tonnes active agents)	% active agent in biocidal products	Number of approved products 2)
Copper(II)HDO			23.5	2.8-6.1	3
Cupric carbonate		1184-64-1	27.9		
Copper(II) others			108.4	4.7-11.8	5 3)
Boric acid	Boric acid	10043-35-3	66.1	4-4.5	4
Sodium dichromate	chromic acid, disodium salt	10588-01-9	45.2 3)	22-28	0
Propiconazol	1H-1,2,4-triazole, 1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-	60207-90-1	0.4	0.45-3	1
Tebuconazol	1H-1,2,4-triazole-1-ethanol, .alpha.-[2-(4-chlorophenyl)ethyl]-.alpha.-(1,1-dimethylethyl)-, (+-	107534-96-3	2.7	0.45-1	2
Total			274		

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1998 (Danish EPA 1999 B). Includes only the number of products for this application.
3) Corresponds to 21.8 tonnes Cr (Hansen et al. 2000 b).

Table 4.17
Consumption of biocides for production of vacuum-preserved wood in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption (tonnes active agents)	% active agent in biocidal products	Number of approved products 2)
Bis (tributyltin) oxide (TBTO) *	distannoxane,hexabutyl-	56-35-9	1.2	0.85-2	6
Dichlofluoanide	methanesulfenamide, 1,1-dichloro-N-[(dimethyl-amino)sulfonyl]-1 -fluoro-N-phenyl	1085-98-9	0.04	0.36	1
3-iodo-2-propynyl-butyl-carbamate (IPBC)	carbamic acid, butyl-, 3-iodo-2-propynyl ester	55406-53-6	1.8	0.2	4
Propiconazol	1H-1,2,4-triazole, 1-[[2-(2,4-dichlo rophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-	60207-90-1	3.7	0.37-1.5	1
Tributyltin naphthenate *	stannate, tributyl-, mono(naphthenoyloxy) derivs.	85409-17-2	2.2	1,8	3
Tebuconazol	1H-1,2,4-triazole-1-ethanol, .alpha.-[2-(4-chlorophenyl)ethyl]-.alpha.-(1,1-dimethylethyl)-, (+-	107534-96-3	1.2	0.37	1
Total			10.1		

* The active agent was not permitted, when this edition closed for contributions (October 2000).
1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish list of approved substances 1998 (Danish EPA 1999 B). Includes only the number of products for this application.

4.3.1.3 Consumption of biocides with finished products

The consumption of biocides with finished wood products in Denmark differs from the consumption for production as import and export of preserved wood alter the figures. In Table 4.18, the estimate on the consumption of active agents in preserved wood used in Denmark in 1998 is shown.

Production, import and export of chromium and creosote with preserved wood have recently been assessed by Hansen et al. (2000 a,b), and the consumption of chromium and creosote is derived from these analyses.

Figures for production of vacuum-preserved and pressure-preserved wood were found in the Danish Statistics of Preserved Wood (Dansk Imprægneringsstatistik, 1998). Statistics Denmark has figures for import and export of different wood products, but the products are not grouped to preservation method (Statistics Denmark 1999a). The statistics on import/export seem only to include a minor part of the actual import/export of preserved wood, and figures on import/export have been derived from Hansen et al. (2000 b) (see appendix 2).

For the estimate of the total import/export of biocides with wood products, it is necessary to make some assumptions regarding the content of biocides in imported/exported products. The basis for the estimates can be found in Appendix 2.

It is by Hansen et al. (2000 b) estimated that the net import of pressure-preserved wood is about 90% of the Danish production for Cr-containing wood and about 20% for Cr-free wood (see appendix 2) thereby increasing the consumption of biocides for this purpose compared to the Danish production. The main import is from the other Nordic countries.

The consumption of biocides with vacuum-preserved wood products is slightly smaller than the consumption for production of these products in Denmark due to a net export of preserved windows and doors, but there is a considerable uncertainty regarding the biocides that are actually imported/exported.

Both production and import of wood preserved with arsenic is now prohibited, but chromium and creosote are still allowed in imported wood.

Table 4.18
Consumption of biocides with vacuum-preserved and pressure-preserved wood in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Organotin	2.1-3.3	Vacuum-preserved wood	0.04-0.09	6
Dichlofluanide	0.02-0.04	Vacuum-preserved wood	0.02	
Other organics for vacuum preservation	4.2-6.6	Vacuum-preserved wood	0.01-0.04	2
Organics for pressure preservation	3-7.3	Pressure-preserved wood	0.02-0.06	2
Copper compounds	192-240	Pressure-preserved wood	0.2-0.5	3
Boron acid	79-99	Pressure-preserved wood	0.18-0.2	
Creosote	28	Poles, railway sleepers and other wood products	9-11	4
Chromium compounds (as Cr)	69	Pressure-preserved wood	0.26	5
Total	377-453			

1) Represents the content of each biocide in the finished wood. The calculation is based on the biocide content of the preservatives (see previous tables) and the consumption of preservatives per kg treated wood. According to (Dansk Imprægneringsstatistik, 1998) the consumption of preservatives was about 25 l/m3 for pressure and vacuum preservation. The density of the wood is on average 552 kg/m3.
2) Includes IPBC, tebuconazol and propiconazol. The biocides are most often used in combination. The indicated content represents the content of each biocide in the wood.
3) Include copper II HDO, cupric carbonate and copper II (others)
4) According to Hansen et. al 2000 a. The source does not indicate the uncertainty of the estimate and no attempt has been made here to estimate it.
5) According to Hansen et. al 2000 b. Represented as chromium. In wood preserved in Denmark sodium dichromate is used, but in imported wood other chromium coumpounds, e.g. chromium trioxide (CAS No. 1333-82-0), may be present. The source does not indicate the uncertainty of the estimate, and no attempt has been made here to estimate it.
6) The active agents were not permitted in October 2000.

The range between minimum and maximum values reflects the uncertainty of the preservation method of the products covered by the different commodity numbers in the trade statistics (see appendix 2).

Organotin compounds were not permitted after October 2000.

4.3.2 Preservatives for surface treatment

Preservatives for surface treatment are used for protection of wood constructions, which are only exposed to moistness at the surface and dry easily. The biocides used and the application areas are in many ways the same as for vacuum treatment, but surface application is cheaper and more suitable for larger constructions.

The preservatives are most often used as primers and covered by one or more layers of wood grain fillers and topcoats. In-can preservatives and film preservatives in wood grain fillers and topcoats are included in product-types 6 and 7.

The methods of surface treatment can be divided into:

- Immersion of the wood products into preservative baths
- Application by machinery

- Brush painting
- Spray painting.

4.3.2.1 Actors on the market

Suppliers of approved wood preservatives are listed in (Danish EPA 1999 B).

Producers and suppliers of wood preservatives are organised in the trade organisation 'The Danish Paintmakers Association' ('Foreningen for Danmarks Lak- og Farveindustri').

Main Danish producers of these preservatives in 1998 were Rentokil Initial A/S, S. Dyrup & Co A/S, Sadolin Woodcare, A/S Hygæa, Tanaco Danmark A/S, and Akzo Nobel Industrial Coating A/S.

Main suppliers of these preservatives in 1998 were (apart from producers) BASF Danmark A/S, Beta DK Aps, Kai R. Spangenbergs Eftfl. I/S, Hickson Timber Protection. Color Dragon A/S, Profa Amba, and Borup Kemi A/S.

4.3.2.2 Biocides used in Denmark for the application area

The consumption of active agents in biocidal products used for surface preservation is shown in Table 4.19. The figures are derived from the Danish EPA. Some of the agents may as well be used for control of wood-destroying fungi in masonry.

The biocides are a very diverse group including boron, organotin, and other organic compounds. Both waterborne preservatives and preservatives based on organic solvents are used.

Table 4.19
Consumption of biocides for surface preservation of wood in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption (tonnes active agents)	% active agent in biocidal products	Number of approved products 2)
Bis (tributyltin) oxide (TBTO) *	distannoxane,hexabutyl-	56-35-9	0.5	1-1.2	4
Dichlofluanide	methanesulfenamide, 1,1-dichloro-N-[(dimethyl-amino)sulfonyl]-1 -fluoro-N-phenyl	1085-98-9	0.004	0.4-0.6	3
Disodium tetraborate decahydrate (borax)	Borax decahydrate	1303-96-4	0.1	4.5-31	2
Boric acid 3)	Boric acid	10043-35-3	1.4	1-51	3
Disodium octaborate tetrahydrate	boron sodium oxide, tetrahy-drate	12280-03-4	10.1	20-40	2
Disodium octaborate	Boron sodium oxide	12008-41-2	0.5	100	1
Permethrin	cyclopropanecarboxylic acid, 3-(2,2-dichlorovinyl)-2,2dimethyl-, (3-phenoxyphenyl) methyl ester	52645-53-1	0.2	0.2	3
3-iodo-2-propynyl-butyl-carbamate (IPBC)	carbamic acid, butyl-, 3-iodo-2-propynyl ester	55406-53-6	0.6	0.3	7
Propiconazol 3)	1H-1,2,4-triazole, 1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-	60207-90-1	1.6	0.9-10	7
Alfacypermethrin	cyclopropane carboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-,cyano (3-phenoxyphenyl)methyl ester [1.alpha.(s*), 3.alpha.]-(.+-.)-	67375-30-8	0.01	0.1	2
Tributyltinnaphthenate (TBTN) *	stannate, tributyl-, mono(naphthenoyloxy) derivs.	85409-17-2	4.4	1.8	4
Tebuconazol	1H-1,2,4-triazole-1-ethanol, .alpha.-[2-(4-chlorophenyl)ethyl]-.alpha.-(1,1-dimethylethyl)-, (+-	107534-96-3	0.6	0,37	1
Total			19.7		

* The active agent was not permitted, when this edition closed for contributions (October 2000).

1) Consumption according to the Danish Pesticide Statistics (Danish EPA. 1999 A).
For some of the preservatives, the distribution of the consumption between surface treatment and the industrial preservation methods is not clear, and a part of the volume included here may in fact be used for industrial preservation.

2) According to the Danish list of approved substances 1998 (Danish EPA. 1999 A). Includes only the number of products for this application.

3) Some products containing these agents are also approved for control of wood-destroying fungi on masonry.

Wood preservatives that contain propiconazol (CAS No 60207-90-1), boron acid (CAS No 10043-35-3) and disodium octaborate (CAS No 12008-41-2) are also approved for control of wood-destroying fungi in masonry, and a part of the consumption may in fact be used for masonry.

4.3.2.3 Consumption of biocides with finished products

The import/export of surface preservatives with wooden products is estimated to be quite small compared to the total consumption of preservatives for surface treatment in Denmark.

The relevant wooden products are not easily identified in the trade statistics, and due to the uncertainty the net import of surface-treated wood is estimated to range between 5,000 and 13,000 tonnes. See appendix 2 for the basis for the estimate. The biocides used for imported wood is roughly estimated under the assumption that the biocide content per tonne resembles the amount typically used for this application in Denmark.

The total consumption including import/export with wood products is shown in Table 4.20.

Table 4.20
Consumption of biocides for surface treatment of wood in Denmark 1998 including net import with surface treated wood

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Organotin compounds	4-5	Surface-treated wood	0.01	2
Dichlofluanid	0.003-0.004	Surface-treated wood	0.003-0.004	
Boron acide derivatives	10-13	Surface-treated wood	0.13-0.29	
Other organics	2.3-3	Surface-treated wood	0.005-0.05	3
Total	16-21			

1) Represents the average content of each biocide in the wood /Danish EPA 1999 B/. For surface treated wood the content will depend on the thickness of the wood, but it is assumed that the wood on average is treated with 7-10 litre preservative per tonne.
2) Includes bis(tributyltin)oxide and TBTN. The active agents were not permitted after October 2000.
3) Includes IPBC, propiconazol, alfacypermethrin and permethrin.

4.4 Product-type 9: Fibre, leather, rubber and polymerised materials preservatives

The group includes products used for the preservation of fibrous or polymerised materials, such as leather, rubber, paper and textiles by the control of microbiological deterioration of the material itself.

The product-type can be organised into the following sub-types:

- Preservatives for textiles
- Preservatives for leather
- Preservatives for rubber and other polymerised materials
- Preservatives for insulating materials of organic fibre
- Preservatives for paper (exclusive insulating materials) and other fibre materials

4.4.1 Preservatives for textiles

Biocides may be used for preservation of textiles during storage, transport and use of the textiles.

Liquids used during the production of the textiles (e.g. for sizing and finishing) and inks used for textile printing may also be preserved by biocides. The purpose of the use of these biocides is, however, to preserve the processing fluids or inks and not the finished textiles, and these agents are included in product-type 6: In-can preservatives.

The main application of preservatives for textiles is for preservation of textiles for outdoor applications. Preserved textiles are used for tents, tarpaulins, awnings, sunblinds, parasols, sails, waterproof clothing, etc. Virtually all textiles used for outdoor applications except clothing seem to be preserved by biocides. For in-door applications only shower curtains and in some instances mattress ticking are preserved.

Most of the textiles are made of synthetic materials like acrylic, polyester and PVC or is coated with PVC. The boundary between this sub-type and the sub-type 'Film preservatives for plastics' in section 4.2.2 is not clear-cut. For example bathroom curtains and tarpaulins are mainly made from reinforced soft PVC, whereas the function of the biocides is to prevent microbial growth on the surface. It has been chosen to include the PVC products in section 4.2.2 together with other uses of PVC and include the remaining textile products in this section, although the primary function of the biocides on synthetic textiles is also film preservative.

It is actually only for cotton textiles that the primary function of the preservatives is to preserve the fibres itself. Today cotton seems mostly (apart form clothing) to be used for garden furniture fabric, whereas it has been replaced by synthetic fibres for other applications. According to the producers of tents, awnings, etc. one of the reasons for this substitution is that the biocides on the market today do not provide the necessary protection of the cotton fabric. Cotton fabric was formerly preserved with pentachlorophenol (PCP), which is now prohibited in Denmark, but is still used for fabric in some other EU countries, especially the UK.

Biocides are not used for protection of textiles during storage and transport in Denmark, but textiles and clothing imported from sub-tropical and tropical areas, especially from Eastern Asia, may contain small amounts of biocides applied for preservation of the textiles during transport and storage in the humid and warm climate. The biocides are applied by spraying the biocides into the containers (Eksportrådet, 1996) and can be found in trace amount in textiles. Among the biocides, PCP seems still to be used to some extent in Asia for this purpose.

Clothing, especially for sport, may be preserved with biocides to prevent odour producing microbial growth on the sweat. One example is the use of tributyltin in some t-shirts. No examples have been found as regards the use of biocides for clothing for outdoor applications. It has within this project not been possible to assess these application areas further.

4.4.1.1 Actors on the market

The only identified Danish producer of preserved textiles is Grenaa Dampvæveri A/S. Main importers of fabric for production of tents are Isabella Jydsk Camping Industri A/S and Trio Sport International A/S.

Tents and other products of preserved fabric are imported by a wide range of importers.

4.4.1.2 Biocides used in Denmark for the application area

The identified biocides used in textile products produced in Denmark are shown in Table 4.21. The preserved textiles used for the products are predominantly produced in Denmark or other European countries.

Table 4.21
Biocides used for textile products produced in Denmark [1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
(1,1'-biphenyl)-2-ol-	o-phenylphenol	90-43-7	2
Carbamic acid, 1H-benzimidazol-2-yl, methyl ester	Carbendazim	10605-21-7	?
2(1H)-pyridinethione, 1-hydroxy-,zinc salt	Zinc pyrithion	13463-41-7	8-10
Ethyl Ziram		14324-55-1	10-25
thiocyanic acid, (2-benzothiazolylthio)methyl ester	TCMTB	21564-17-0	18

1) Most of the fabrics are produced abroad, but are used for production of tents and other products in Denmark

Imported tents, awnings, etc. are predominantly produced in Asia. It has been difficult to receive information on the biocides used for preservation of the fabric.

4.4.1.3 Consumption of biocides with finished products

The total consumption of biocides with textile products can only be estimated with very high uncertainty. The total consumption of cotton textiles for outdoor use has by 1983 been estimated at 500-600 tonnes, which were all preserved with pentachlorophenol (Tørslev, 1985). The total supply of tents, tarpaulins, awnings and sails in 1988 can based on the trade statistics be estimated at 5,000-7,000 tonnes (inclusive non-textile parts of the products). Only a part of this is the fabric and only a part of the fabric is preserved. The tarpaulins are virtually all produced of PVC and are included in section 4.2.2.

Based on the present information it is estimated that approximately 600-1,400 tonnes preserved textile is annually used in Denmark. Cotton seems only to be used for garden furniture, whereas the rest of the textiles are made of polyester, acrylic and other synthetic materials.

The estimated total consumption of biocides with textiles is shown in Table 4.22.

Table 4.22
Consumption of biocides with textile products in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in %	Note
Miscellaneous biocides	0.8-3.2	Tents, awnings, parasols, etc.	0.1-0.2	1

1) The total consumption of preserved textiles with tents, awnings, sails etc. is roughly estimated at 600-1,400 tonnes. The supply of tents and sails in 1998 was according to the trade statistics about 2,500 and 16 tonnes, respectively. A part of this are poles, etc. and some of the imported tents seem not to be preserved. In the trade statistics awnings are stated with tarpaulins, and the supply of awnings cannot be read from the statistics. The most common biocides in textiles used for production of tents and awnings in Denmark are applied in about 1.5 gramme per kg. Based on this it is estimated that the preserved textiles contain between 0.1 and 0.2% active agents. Within the limit of the project it has been nearly impossible to obtain specific information on biocides in imported tents, which are mostly produced in Asia. Some of the tents seems, however, not to be preserved.

4.4.2 Preservatives for leather

Biocides are applied to leather during the tanning process for life-time preservation of the leather.

4.4.2.1 Actors on the market

The only large Danish producer of leather is Swewi Svendborg A/S, but tanning also takes place in small scale at Mønsters Garveri. The biocides for tanning are directly imported by the users from suppliers abroad. Leather and leather products are imported by a large number of companies.

4.4.2.2 Biocides used in Denmark for the application area

Biocides used for tanning in Denmark are shown in Table 4.23. Some of the other chemicals used for tanning may also have a biocidal effect, although the primary function of the chemicals in the tanning process is another.

Table 4.23
Biocides used for tanning in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione	Dazomet	533-74-4	8%
Thiocyanic acid (2-benzothiazolylthio)methyl ester	TCMTB	21564-17-0	12%

Leather and leather products used in Denmark are, however, mainly imported, and the Danish production only accounts for a small percentage of the consumption with finished products. The main biocides that can be expected to be present in imported leather products are listed in Table 4.24 (Frendrup, 2000).

Table 4.24
Main biocides in imported leather and leather products [1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Most common:			
carbamodithioic acid, dimethyl-, potassium salt	Potassium dimethyldithiocarbamate	128-03-0	?
carbamodithioic acid, dimethyl-, sodium salt	Sodium dimethyldithiocarbamate	128-04-1	?
thiocyanic acid, methylene ester	Methylene bis(thiocyanate)	6317-18-6	?
thiocyanic acid, (2-benzothiazolylthio)methyl ester	TCMTB	21564-17-0	?
Less common:			
K-N-hydroxymethyl-N-methyldithiocarbonat			?
2(3H)-benzothiazolethione, sodium salt	Na-2-mercapto-benzothiazole	2492-26-4	?
carbamic acid, [1-(butylamino)carbnyl)-1H-benzimidiazol-2-yl]-, methyl este	Benomyl	17804-35-2	?
benzene, 1-[(diiodomethyl)sulfonyl]-4-methyl-		20018-09-1	?
3(2H)-isothiazolone, 2-octyl-	Octhilinone	26530-20-1	?

1) Import of products containing >5 ppm pentachlorphenol is prohibited. Surveys of pentachlorophenol in Germany, Switzerland and Austria (with similar regulation of PCP in finished

products as in Denmark) demonstrate that PCP can be found at levels above 5 ppm in a few percent of imported leather and leather products; mainly imported from Asia (UBA 1997; OFEFP 1998 among others). PCP cannot be considered one of the main preservatives in leather and is not mentioned by Frendrup 2000.

Chromium salts are widely used for tanning of leather. In 1998, about 80% of leather tanned worldwide was tanned with chromium salts (USGS, 1999). Chromium is not used any more for tanning in Denmark. The chromium salts may have a biocidal effect, but the main function of the chromium in the tanning process is not as a biocide, and chromium salts are consequently not included as biocide in this assessment. To give an impression of the magnitude of the chromium consumption with leather products, the consumption of chromium with leather products in Stockholm, Sweden, in 1995 has been estimated at about 6 tonnes (Lohm et al., 1997). Upscaled to the Danish population, it corresponds to some 20-30 tonnes chromium.

4.4.2.3 Consumption of biocides with finished products

The total consumption of biocides for tanning in Denmark is considered confidential.

No assessment of the content of biocides in imported leather products is available. The average concentration of the biocides in the leather is estimated to be 200-300 ppm (Frendrup, 2000), but will vary by agent. The expected most common biocides in imported leather are indicated in Table 4.24.

The main application areas for leather are furniture, clothing, bags, shoes and riding gear. The total consumption of leather products cannot be estimated exactly from the trade statistics; e.g. leather furniture is not registered under specific commodity numbers, and the production of leather products is not registered in terms of weight. The total consumption of leather products in Denmark in 1998 is roughly estimated at 3,000-8,000 tonnes.

Table 4.25
Consumption of biocides with leather in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
All agents	0.6-2.4	Preservatives in leather	0.02-0.03	2

1) Indicates the total biocide content of finished leather (Frendrup, 2000).
2) The distribution between the individual agents is not known. The total consumption of leather with finished products is roughly estimated to be 3,000-8,000 tonnes per year. According to the trade statistics, the supply of leather for production of leather products in Denmark is approximately 1,600 tonnes.

4.4.3 Preservatives for rubber and other polymerised materials

Preservatives may be used for rubber products for two reasons:

- Preservation of liquid latex raw materials
- Preservation of the finished rubber products

Liquid latex is preserved for control of microbial growth in the liquid before polymerisation of the latex. The preservatives used for this application may instead be considered 'In-can preservatives'.

Rubber products are in general not explicitly preserved against microbial degradation, but many of the chemicals used for manufacturing of rubber products may, however, have a biocidal effect as well. Product catalogues from leading suppliers of chemicals for the rubber industry includes in general no preservatives, but a few biocides are marketed for use in latex products (natural rubbers).

The only identified application where biocides are explicitly added to control microbial deterioration of the rubber is applications where the rubber is in permanent contact with soil, e.g. rubber in seal rings for tubes in soil. However, no specific information on the biocides in such products has been obtained.

Other polymerised materials include linoleum made from linseed oil. Linoleum has an inherent capability of preventing microbial degradation and growth at the surface due to some components of the linseed oil and is in general not added preservatives.

Polymerised materials like plastics, paints and fillers are added preservatives that are included in the product-types 'In-can preservatives' and 'Film preservatives'. It has not been possible to identify applications where the preservatives are added to protect the polymers itself.

4.4.3.1 Actors on the market

Enquiries to the main producers of rubber products in Denmark did not reveal any use of biocides for production of rubber products in Denmark.

4.4.3.2 Biocides used in Denmark for the application area

To stabilise *liquid latex* and prevent coagulation, ammonia (CAS no. 7664-41-7) is added to the latex at concentrations of about 0.2-0.6%. The ammonia may as well have a biocidal effect by increasing the pH and is included in the 'List of biocidal substances' of July 1999 from the European Chemical Bureau. It will, however, not be considered a biocide in this report. Liquid latex, e.g. used for rubber under sides of carpets, was formerly preserved with formaldehyde, but this is no longer used in Danish produced carpets. According to a leading Danish producer of carpets and a supplier of latex, the same is presumed to be true for most imported carpets. In cannot, however, be excluded that some imported carpets or other products made from liquid latex may contain preservatives in the rubber.

As mentioned above, many of the chemicals used for manufacturing of rubber products may as well have a biocidal effect. The following list includes chemicals placed on the global market by some of the leading suppliers of chemicals for the rubber industry (the list may not be complete). The listed chemicals are all included in the 'List of biocidal substances' of July 1999 from the European Chemical Bureau, but is used in the processing of rubber as accelerators, antioxidants, vulcanising agents etc.

Formaldehyde (CAS No. 50-00-0)
Thioperoxydicarbonic diamide (CAS No. 97-77-8)
Carbamodithioic acid, dimethyl-, sodium salt (CAS No. 128-04-1)
Tetramethyl thiuramidisulfide (CAS No. 137-26-8)
Thioperoxydicarbonic diamide ([(H2N)C(S)]2S2), tetramethyl- (CAS No. 137-26-8)
Zinc, bis(dimethylcarbamodithioato-S,S')- (T-4)- (CAS No. 137-30-4)

2-Mercaptobenzothiazole, zinc salt (CAS No.155-04-4)
2(3H)-benzothiazolethione (CAS No. 149-30-4)
Zinc oxide (CAS No. 1314-13-2)
2(3H)-benzothiazolethione, sodium salt (CAS No. 2492-26-4)

Most of these chemicals can be expected to be present in products produced in or imported to Denmark.

It has not been possible to identify any use of biocides for production of synthetic rubbers. Product catalogues from suppliers of chemicals for the rubber industry (globally) contain in some instances biocides for use for preservation of latex and natural rubber products. It has not been possible within the boundaries of this project to try obtaining specific information of biocides in imported rubber products and in this way confirm the presence of these chemicals in products marketed in Denmark. The list, which may not be comprehensive, is shown in Table 4.26.

Table 4.26
Biocides that may be present in imported latex products [1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Formaldehyde	Formalin	50-00-0	24,5-37
Thioperoxydicarbonic diamide	Disulfiram	97-77-8	?
Thioperoxydicarbonic diamide ([(H2N)C(S)]2S2), tetramethyl-	Thiram	137-26-8	?
Zinc oxide		1314-13-2	?
3(2H)-isothiazolone, 2-methyl-	MIT	2682-20-4	?
2(1H)-pyridinethione, 1-hydroxy-,zinc salt	Zinc pyrithione	13463-41-7	?
3(2H)-Isothiazolone, 5-chloro-2methyl-	CIT	26172-55-4	?

1) The list may not be comprehensive. The chemicals are in March 2000 marketed at the Internet as preservatives for latex.

4.4.3.3 Consumption of biocides with finished products
Due to lack of data it has not been possible to estimate the consumption of biocides with finished products of rubber and other polymeric materials.

4.4.4 Preservatives for insulating materials of organic fibres

Insulating materials of organic fibre materials like paper, cellulose, wool and flax (*Linum*) contain preservatives for control of microbial degradation of the fibres during use.

The preservatives are mixed up with the fibre materials before the insulation material is blown into the walls of the houses or placed above the ceiling. The used agents have both a biocidal effect and a flame retarding effect.

4.4.4.1 Actors on the market
Insulation materials of organic fibres are produced in Denmark by Isodan Danmark A/S and Miljøisolering Aps.

The main suppliers of insulation materials of organic fibres are Miljøisolering Aps, Isodan Danmark A/S, Borry Henriksen ApS and Holbæk Byggemateriale Compagni A/S.

4.4.4.2 Biocides used in Denmark for the application area

The main biocides used for this application area are boric acid and borax, which are used in insulation materials made of paper, cellulose fibres and wool. The boron compounds also have a flame retarding effect. Beside the boron compounds, the insulation materials may also contain aluminium hydroxide. The main function of the aluminium hydroxide is flame retardancy, but the compound may also have a biocidal effect by increasing the alkalinity of the material. Aluminium hydroxide will, however, not be considered a biocide in this context.

In flax, the main preservative seems to be ammonium sulphate, but ammonium phosphate may be used as well.

Table 4.27
Biocides used for preservation of insulation materials of organic fibres in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Borax decahydrate	Borax 1)	1303-96-4	2)
Sulfuric acid diammonium salt	Ammonium sulphate	7783-20-2	?
Boric acid		10043-35-3	2)
Ammonium phosphate		10124-31-9	6-10

1) In the list of biocidal substances from the EU, 'Borax' is used as chemical name for CAS no. 12267-73-1, tetraboron disodium heptaoxide, hydrate.

2) The totals of borax and boric acid vary from 5-25%.

4.4.4.3 Consumption of biocides with finished products

Insulating materials of paper account for the main part of the consumption of insulating materials of organic fibres (Table 4.28). The total content of boric acid and borax vary between 5% and 25% of the products dependent on whether the products are added other flame retardants (e.g. aluminium hydroxide). Based on information from suppliers, it is roughly estimated that the paper insulation on average contains 6-9% borax and boron acid with a 1:2 ratio between the two compounds. The consumption of insulation materials of wool is very close to 0 tonnes.

One of the main insulation materials of flax contains about 8% ammonium sulphate, and it is roughly estimated that the products on average contain 6-10% ammonium sulphate or ammonium phosphate.

Table 4.28
Consumption of preservatives for insulation materials of organic fibres in Denmark 1999

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Borax	16-45	Insulation materials of paper and cellulose	4-6	1
Boron acid	32-90	Insulation materials of paper and cellulose	2-3	1
Ammonium sulphate and phosphate	0.4-1.7	Insulation materials of flax	6-10	2
Total	48-137			

1) Based on information from suppliers it is estimated that the consumption of insulation materials of paper and cellulose fibre is 800-1500 tonnes/year. The insulation materials are estimated to contain on average 2-3% borax and 4-6% boron acid.
2) Based on information from suppliers it is estimated that the consumption of insulation materials of flax is 7-17 tonnes/year. The flax insulation materials are estimated to contain on average 6-10% ammonium sulphate or ammonium phosphate.

4.4.5 Preservatives for paper and other materials

'Paper and other materials' include:

- Paper and cardboard (other than insulating materials)
- Art and archaeological artefacts

Biocides used for prevention of slime formation during production of paper and cardboards are included in product-type 12: 'Slimicides'. Besides these preservatives may be used during the production process to control microbial growth in the wet paper, if it is stored before drying. According to the Danish paper factories, preservatives are not used for this purpose in Denmark.

Paper for applications where the paper can be exposed to moisture may be preserved. One example of use of preservatives for paper is preservation of library books that have been stored under moist conditions. No use of preservatives for this application in Denmark has been identified.

According to information from two museums in Denmark, biocides are not used for preservation of art, archaeological artefacts or other items in these two museums, but insecticides (included in section 5.5) are used for control of insects in the stores.

It has not been possible to identify any use of preservatives in Denmark for this application area.

4.5 Product-type 10: Masonry preservatives

Masonry preservatives are products used for preservation and remedial treatment of masonry or construction materials other than wood by the control of microbiological and algal attack.

The product-type does not include biocides for preservation of insulation materials, which are included in product-type 9.

Some of the wood preservatives are also approved for use on masonry. By attack of wood destroying fungi both wood and masonry may be preserved to

control the fungi. These preservatives are included in section 4.3: 'Wood preservatives'. Apart from this, the only masonry preservatives identified are agents for treatment of algal attack on masonry.

Mortar, which is moist when stored, is not added preservatives, as the high pH prevents microbial growth during storage.

4.5.1.1 Actors on the market

Producers and suppliers of products for cleaning of masonry are organised in the Danish Paintmakers Association (FDLF) and/or the trade organisation Soap, Perfume and Toiletware (SPT).

Suppliers of products containing masonry preservatives are S. Dyrup & Co. A/S, BN Skaderenovering I/S, Sadolin Farver A/S, Superfos A/S and Profa amba among others.

4.5.1.2 Biocides used in Denmark for the application area

Biocides for prevention of algal attack (algicides) are to be approved by the Danish EPA. According to the 'Survey of Approved Pesticides' no algicides were approved in 1998. In 1999, only one product containing quinoclamine in horticulture was approved for use.

For use as masonry preservatives, two products containing fatty acids (C8-C18, main fraction: decanoic acid) were according to the Danish EPA approved in 1998 and 1999, but the products are not included in the 'Survey of Approved Pesticides'.

A few years ago a number of products were approved for use as algicide (20 products in 1994). The most common active agents in the approved algicides were benzalkonium chloride and sodium hypochlorite. These agents are today not approved as algicides, but are allowed in cleaning materials. As a consequence, algae are today removed, and algal attack is prevented by use of 'masonry cleaners' instead of algicides.

Information on masonry cleaners from six of the main suppliers of formerly approved algicides has been obtained. The masonry cleaners from these all contain benzalkonium chloride or sodium hypochlorite, and the products in general have the same trade names as the formerly approved algicides.

Biocides used in products for cleaning of masonry is listed in Table 4.29.

Table 4.29
Biocides used for preservation and remedial treatment of masonry in Denmark 1998 [1)]

IUPAC name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Sodium hypochlorite		7681-52-9	5-15%
Quaternary ammonium compounds, benzyl-C8-C18-alkyldimethyl, chlorides	Benzalkonium chloride 2)	63393-96-4	1-10

1) Wood preservatives containing propiconazol (CAS No 12008-41-2), boron acid (CAS No 12008-41-2) and disodium octaborate (CAS No 60207-90-1) are also approved for control of wood-destroying fungi in masonry.

2) 'Benzalkonium chloride' is also used as trivial name for CAS no. 8001-54-5 and CAS no. 959-55-7.

4.5.1.3 Consumption of biocides with finished products

According to the Pesticide Statistics, the consumption of approved algicides in 1998 was 0 tonnes.

As mentioned above algicides are not used for prevention of algal attack on masonry anymore. As the same products are used today, the former use of algicides is assumed to give a good indication of the consumption of the active agents with 'masonry cleaners' today. The consumption trend from 1992 to 1996 is shown in Table 4.30.

Table 4.30
Consumption of active agents with algicides 1992-1996

	Consumption (tonnes active agent)				
	1992	1993	1994	1995	1996
Algicides	18.9	12.6	11.4	5.3	0
Sodium hypochlorite	1.9	1.7	1.8	1.5	0
Benzalkonium chloride 1)	22.1	14.3	10.3	3.8	0

1) Benzalkonium chloride was also active agent in some wood preservatives, which explains that the total consumption of the two agents is larger than the consumption of algicides.

Beside the consumption of sodium hypochlorite in approved algicides there has presumably in addition been some consumption of sodium hypochlorite in all-round cleaning materials applied for cleaning of masonry. Consequently the amount of sodium hypochlorite in approved products will somewhat underestimate the actual consumption.

The annual consumption will vary with higher consumption after mild winters. Based on information from suppliers the consumption has more likely increased than decreased since the mid-nineties.

Based on this information, the total consumption of biocides with 'masonry cleaners' in 1998 is estimated at 11-25 tonnes (Table 4.31). Some of the products may also be used as algicides indoors, but it is presumed to be a minor part of the total consumption.

Table 4.31
Consumption of biocides with products for preservation and remedial treatment of masonry in Denmark 1998 [1)]

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 2)	Note
Sodium hypochlorite	2-5	Cleaners for masonry, tiles etc.	5-10	4
Benzalkonium chloride	9-20	Cleaners for masonry, tiles etc.	3-4	3
Total	11-25			

1) The consumption of "wood preservatives" possibly applied on masonry is included in section 4.3.2.
2) Average concentration of approved algicides in the period 1991-1993. The concentration of the active agents in masonry cleaners from the main suppliers is the same today as in the formerly approved algicides.
3) The consumption of benzalkonium chloride with algicides during the period 1992-1994 ranged from 9 to 17 tonnes. It is estimated that the consumption of the agent with "masonry cleaners" in 1998 was of the same magnitude.
4) The consumption of sodium hypochlorite with approved algicides during the period 1992-1994 ranged from 1.7 to 1.9 tonnes. Beside this, sodium hypochlorite in all-round cleaning materials is expected also to be used for cleaning of masonry.

4.6 Product-type 11: Preservatives for liquid-cooling and processing systems

Products of this product-type are used for the preservation of water or other liquids used in cooling, heating or processing systems by the control of harmful organisms such as microbes, algae and mussels. District heating systems are neither liquid-cooling systems nor processing systems, but are included here, as they do not fit into any other product-type.

The product-type does not include slimicides (product-type 12) and products used for the disinfection of drinking water (product-type 5), drinking water drainwork (product-type 4), preservation of metalworking-fluids (product-type 13) and moisteners used in the printing process (product-type 6, section 4.1.4).

Biocides are applied to the systems either to preserve the liquids (control of microorganisms) or to disinfect the systems (kill the microorganisms) (Dokkum et al., 1998).

Biocides used for preservation of the liquid cooling system or air-conditioning systems are included here although the biocides in semi-open systems may serve as both preservatives and disinfectants. Microbial growth in the systems leads to biofilm mediated corrosion, and the formation of biofilms increases the heat exchange resistance of the systems.

The liquid systems can be organised into three types (Dokkum et al., 1998):

- Once-through cooling systems
- Open recirculation systems
- Closed recirculation systems

Once-through systems can be used when plenty of cheap cool water is available and adequate facilities for disposal of warm waterare available. Once-through cooling systems may be used for power plants and industrial installations. No use of biocides has specifically been identified for these systems, but biocides may be used in the systems.

Open recirculation systems are mainly used for cooling water in the food-processing and pharmaceutical industry and in large air-conditioning systems. The water in these systems is cooled down in open cooling towers. In these systems, the biocides are applied by shock dosage at a frequency of usually once or twice a week. To prevent development of resistant bacteria usually two biocides are used alternately. The water in the semi-open systems is changed continuously, and the average residence time of the water may be down to a few hours.

Closed systems include first of all district heating systems, but also liquid systems of air-conditioning systems. The biocides are added continuously. The control of microbial growth in district heating systems has thoroughly been described by Smidt et al. 1998.

Open processing systems are used for pressure founding and wash of semi-manufactures and tolls. Microbial growth may as well be a problem in these systems, but the use of biocides for control of the growth in these systems is not as widespread as in the food-processing and pharmaceutical industry.

In air-conditioning systems with open recirculating cooling water, the biocides may as well be applied for control of pathogenic bacteria; especially some species of *Legionella*. Some of the applied biocides are particularly efficient in the control of these organisms and are often used in air-conditioning systems of hospitals. The bacteria in the cooling water may be released with aerosols from the cooling towers and expose patients via e.g. windows. The content of *Legionella* in the cooling water is not a hospital specific phenomenon, but patients may be more liable to infection than the main population.

4.6.1.1 Actors on the market

Main suppliers of biocidal products for preservation of water used in cooling, heating or processing systems are Hydro-X A/S, Ashland Denmark A/S and Aqua-Sur A/S.

4.6.1.2 Biocides used in Denmark for the application area

Biocides used in Denmark for the application area are shown in Table 4.32.

The main biocides of choice for district heating system are quaternary ammonium compounds. According to a study on microbial corrosion in district heating systems, four groups of biocides are proposed by suppliers for use in district heating systems: Hydrogen peroxide, glutaraldehyde, quaternary ammonium compounds and isothiazolones, but only the use of quaternary ammonium compounds and isothiazolones is evident (Schmidt & Frølund, 1998). According to a survey from 1994, about 8% of the district heating stations used biocides.

For cooling water in air-conditioning systems and for the food processing and pharmaceutical industry, a number of biocides is used.

Table 4.32
Biocides used for preservation of water for cooling, heating and processing systems in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
2-bromo-2-nitro-1,3-propanediol	Bronopol	52-51-7	20
Pentanedial	Glutaraldehyde	111-30-8	15
Amines, N-tallow alkyltrimethylenedi-, acetates		263-188-5	30
2-methyl-3(2H)-isothiazolone	MIT	2682-20-4	0.5
1-decanaminium, N-decyl-N,N-dimethyl-, chloride	Didecyl dimethyl ammonium chloride	7173-51-5	15
Hypochlorous acid, sodium salt	Sodium hypochlorite 1)	7681-52-9	?
Magnesium chloride		7786-30-3	0.5-2
Quaternary ammonium compounds, alkylbenzyldimethyl, chlorides	Benzalkonium chloride; parasterol; rodalon etc.	8001-54-5	50
2,2-dibromo-2-cyano acetamide		10222-01-2	20
Magnesium (II) nitrate		10377-60-3	0.5-2
5-chloro-2methyl-3(2H)-isothiazolone	CIT	26172-55-4	1-2
3(2H)-isothiazolone, 2-octyl-	Octhilinone	26530-20-1	3
2-Propenal, polymer with formaldehyde		26781-23-7	40
Guanidine, N,N''-1,6 hexanediyl-bis-[N'-cyano-, polymer with 1,6-hexandiamine, hydrochloride		27083-27-8	20
Polymer with 1,1'-oxybis(chloroethane)1,2-ethanediamine, N,N,N'',N'-tetramethyl-,		31075-24-8	9-11
Bromochloro-5,5-dimethyl 2,4-Imidazolidinedione	Bromo chloro 5,5 dimethyl hydantoin	32718-18-6	92,5
Phosphonium tetrakis(hydroxymethyl)-, sulphate (2:1) salt	THPS 1)	55566-30-8	35
Quaternary ammonium compounds, benzyl-C12-C18 -alkyldimethyl, chlorides.	Benzalkonium chloride	68391-01-5	9-10

1) Particularly applied for control of pathogenic bacteria in air-conditioning systems.

4.6.1.3 Consumption of biocides with finished products

The total consumption of biocides for this application area is estimated on the basis of a questionnaire estimated to cover more than 80% of the market (see Table 4.33).

The market for biocides for cooling water and processing water is increasing, as it becomes more evident that corrosion and other operational problems of the systems are microbially mediated.

Table 4.33
Consumption of preservatives for cooling, heating and processing systems in Denmark 1999

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Quaternary ammonium compounds	0.3-0.6	Preservatives for district heating systems and cooling water	-	2
Isothiazolones	3.4-4.1	Preservatives for cooling water	-	2
Other	7.6-9.1	Preservatives for cooling water	-	2
Total	11-14			

1) The average concentration in the cooling water has not been determined.
2) Based on information from suppliers estimated to cover more than 80% of the market.

4.7 Product-type 12: Slimicides

Slimicides are used for the prevention or control of slime growth on materials, equipment and structures used in industrial processes.

The product-type can be organised into two sub-types:

- Slimicides for wood and paper pulp
- Slimicides used by oil extraction and fuel storage

4.7.1 Slimicides for wood and paper pulp

Slimicides are added to paper pulp to prevent the formation of slime during the pulping process by biocidal control of bacteria in the pulp. The slime formation may also be controlled by other agents as enzymes, and there seems to be a trend toward the use of these other agents.

4.7.1.1 Actors on the market
Suppliers of approved slimicides (1999) are Flemming Zwicky Aps., Chr. Krogh A/S and BetzDearborn AB (Sweden).

The main Danish producers of paper and paper products are Dalum Papir A/S, Skjern Papirfabrik A/S, Grenaa Papir A/S, Drewsen Silkeborg Papirfabrik A/S and Brødrene Hartmann A/S. Paper pulp is used in small scale by a few additional users.

4.7.1.2 Biocides used in Denmark for the application area
Biocides for control of slime in paper pulp have to be approved by the Danish EPA and aredescribed in the survey of approved pesticides (Danish EPA 1999 B).

The consumption of slimicides in Denmark in 1998 is listed in Table 4.34.

Table 4.34
Consumption of slimicides for pulp and paper in Denmark 1998 [1)]

Biocide (active agent)	CAS No	Consumption (tonnes active agents)	% active agent in biocidal products	Number of approved products 2)
2-bromo-2-nitropropan-1,3-diol	52-51-7	32.3	20; 95	2
2H-1,3,5-thiadiazine-2-thione, tetrahydro-3,5 dimethyl- Dazomet) 3)	533-74-4	0	86	1
Copper sulphate 4)	7758-98-7	ca. 0.2	-	-
2,2-dibromo-2-cyanoacetamid	10222-01-2	0.7	12	1
Total		33.2		4

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1998 (Danish EPA 1999 B). Includes only the number of products for this application.
3) Was not permitted after December 31, 1998.
4) Used for prevention of microbial growth in paper-pulp (not paper manufacturing). Not approved as slimicide.

4.7.1.3 Consumption of biocides with finished products

According to two paper producers, the content of the biocides in the finished paper is expected to be insignificant, but no analysis is available (Hoed, 2000; Tang, 2000). The biocides are water-soluble and are expected to follow the process water to the wastewater treatment system. The trace amounts following the fibre fraction are expected to be decomposed during the subsequent paper production processes.

A British report regarding pentachlorophenol (PCP) in paper and cardboard indicates that PCP may be present in paper and cardboard in trace amounts (MAFF, 1997). PCP has previously been widely used as slimicide in paper pulp and may still be in use in some countries out of Europe. In 36 out of 403 samples, PCP was found in concentrations above 0.008 ppm, with 0.7 ppm as the highest value. PCP is, however, a relatively stable compound.

On this basis, the content of biocides in the finished paper is assumed to be low, and no attempt has been done to estimate the content of biocides in the finished paper.

Paper pulp with copper sulphate is mixed with other raw materials and ends up in finished building materials.

4.7.2 Slimicides and other biocides used at oil extraction and fuel storage

Biocides are used at oil extraction for three purposes:

- Control of slime forming microorganisms in water-based drilling mud during storage (when necessary)
- Control of hydrogen sulphide formation by sulphate reducing bacteria by oil extraction
- Control of microbial growth and hydrogen sulphide formation in oil pipelines

Actually only biocides used for control of slime formation by preserving the drilling mud should be included in the product-type 'Slimicides', but for the sake of the clearness all biocides used by oil extraction and storage of oil are included here.

The biocides are added to flows pumped into the reservoir (drilling processes, injection and reinjection water) and to the transportation flow of produced oil and gas before transportation by either pipeline or tanker to shore.

The biocides are generally used in the offshore industry in very large quantities and are therefore supplied to the rig/platform in bulk containers. Chemicals from bulk containers are usually added to the drilling mud, the water injection or production flows through closed systems.

When the used drilling mud reappears at the surface, cuttings are separated from the mud in a shaker system, and the drilling mud is discharged to the sea.

Based on information from one Danish refinery, it is estimated that biocides are not added to the crude oil or oil products at the refineries. Microbial growth is prevented by avoidance of water in the tanks with crude oil and oil products.

During storage of fuels, especially diesel and fuel oil, slime formation by microorganisms may take place if water finds it ways into the tanks. The phenomenon is in Denmark known as 'diesel plaque' (in Danish: 'diesel pest'). The biocides are not preventively added to the fuel, but preventive addition of biocides is to some extent done by the owners of fuel tanks; for example on ferries. Biocides are most commonly only used when an infected tank is to be disinfected. Diesel plaque was formerly a more widespread phenomenon, but is today reduced by avoidance of water in the tanks.

Beside this, biocides may be used in antifouling paint for oilrigs, but according to the reports from the contractors to the Danish EPA, antifouling paints are not used for this purpose in the Danish oilfields.

4.7.2.1 Actors on the market

Suppliers of biocides for offshore activities have not been surveyed.

4.7.2.2 Biocides used in Denmark for the application area

All emissions from offshore activities in the Danish part of the North Sea are reported by the operators to the Danish EPA. For this assessment, the Danish EPA has asked for more specific information on the used biocides in 1998. The results are shown in Table 4.35 and Table 4.36.

Isothiazolones are used for disinfection and preventive control of microorganisms in fuel tanks. The compounds used, CIT an MIT, are also used as in-can preservatives for paint, fillers and other products.

Table 4.35
Biocides used for control of microbial growth by oil extraction and fuel storage in Denmark

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products
Pentanedial	Glutaraldehyde	111-30-8	12-49
1,2-benzisothiazol-3-(2H)-on	BIT	2634-33-5	9.5
3(2H)-isothiazolone, 2-methyl-	MIT	2682-20-4	0.3-0.4
Hypochlorous acid, sodium salt	Sodium hypochlorite	7681-52-9	7.5
3(2H)-Isothiazolone, 5-chloro-2methyl-	CIT	26172-55-4	1-1.3
Poly(iminocarbonimidoyliminocarbonimidoylimino-1,6-hexanediyl, hydrochloride)	PMBH	32289-58-0	20
Phosphonium tetrakis(hydroxymethyl)-, sulphate (2:1) salt	THPS	55566-30-8	49

4.7.2.3 Consumption of biocides with finished products

The consumption of biocides by oil extraction and fuel storage is shown in Table 4.36. Due to confidentiality, only the total consumption of slimicides in drilling mud and biocides for other offshore activities respectively, is given.

Table 4.36
Consumption of biocides for control of microbial growth by oil extraction and fuel storage in Denmark 1988

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Pentanedial, PMBH, BIT	3.3	Slimicides in drilling mud	?	2
Sodium hypochlorite, pentanedial, THPS,	85.1	Biocides for injection water and other off-shore purposes	?	2
Pentanedial	2.5	Preservation of crude oil in pipelines	?	2
CIT, MIT	0.005-0.034	Preservation and disinfection of fuel tanks	?	3
Total	91			

1) There is no information on the average content of the biocides in the drilling mud, oil or injection water.
2) Based on information submitted from the operators to the Danish EPA.
3) The biocidal products used contain 1-1.3% CIT and 0.3-0.4% MIT. The estimated total consumption is based on information from one main supplier.

4.8 Product-type 13: Metalworking-fluid preservatives

Metalworking-fluid preservatives are used for control of microbial deterioration of metalworking fluids.

Metalworking fluids are a very diverse group of products. An assessment of metalworking fluids marketed in Denmark 1987 includes more than 300 different products of which 133 products contain preservatives (Brandorf & Fries, 1987).

The main objectives of metalworking fluids are reduction of friction, removal of heat and flushing away chips. The fluids are nearly always used in closed or

semi-open systems where the fluids are recirculated and filtered to remove chips.

Biocides are added as preservatives to metalworking fluids based on emulsions, synthetic or semi-synthetic fluids and fluids based on pure vegetable oils. Metalworking fluids based on pure mineral oils and solvent-based liquids contain in general no biocides.

Besides the use as preservatives, biocides are also used for thorough disinfection of the systems by maintenance of the systems and changing of the fluids. The biocides are for this application strictly speaking not used as preservatives but as disinfectants, but will nevertheless be included here.

4.8.1.1 Actors on the market

The main Danish producer of metalworking-fluids is Castrol A/S. The main suppliers of metalworking-fluids are Castrol A/S, Fuchs & Sidal A/S, Rocol Scandinavia A/S, A/S Dansk Shell and Houghton Danmark A/S, but there is a large number of minor suppliers.

4.8.1.2 Biocides used in Denmark for the application area

Biocides identified as used for metalworking fluids in Denmark are listed in Table 4.37.

Table 4.37
Identified biocides used for metalworking-fluid in Denmark

IUPAC name (active agent)	Trivial name	CAS No	% active agent in metalworking fluid
1,2-benzisothiazol-3-(2H)-on	BIT	2634-33-5	<0.05
3(2H)-isothiazolone, 2-methyl-		2682-20-4	<1
methanol, [1,2-ethanediylbis(oxy)]bis-	Glyoxalmomno-Ethylenacetal	3586-55-8	<1
sodium-2-pyridinethiol-1-oxide	Sodium pyrithione	3811-73-2	<0.2
1,3,5-triazine-1,3,5(2H,4H,6H)-triethanol		4719-04-4	<1
morpholine, 4,4'-methylenebis-		5625-90-1	3
1H,3H,5H-oxazolo[3,4-c]oxazole, 7a-ethyldihydro-		7747-35-5	<0.5
carbamic acid, butyl-, 3-iodo-2-propynyl ester	IPBC	55406-53-6	<0.2

There are 30 biocides registered as preservatives in metalworking fluids in PROBAS. The list of preservatives is not shown due to confidentiality.

4.8.1.3 Consumption of biocides with finished products

The consumption of biocides with metalworking fluids in Denmark is estimated from information from suppliers covering approximately 70% of the market. The biocides have been organised into three groups: Quaternary ammonium compounds, isothiazolones and 'Other' (Table 4.38).

Table 4.38
Consumption of biocides for preservation of metalworking fluids in Denmark 1999

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Quaternary ammonium compounds	1.8-2.3	Preservatives in fluids	<1	2
Isothiazolones	1.5-2	Disinfectants/preservatives	<1	2
Other	6.8-9.1	Preservatives in fluids	1-3	2
Total	10-13			

1) Indicates the concentration in the metalworking fluid by usage.
2) Based on information from a questionnaire to suppliers estimated to cover about 60-80% of the Danish market.

5 Main group 3: Pest control

Products intended to protect plants or plant products against harmful organisms or prevent the action of such organisms, including repellents used to prevent roe-deer from eating shoots of fruit trees, are regulated by the Plant Protection Directive and not the Biocide Directive and are therefore not included in this report.

5.1 Product-type 14: Rodenticides

The product-type includes products used in the combat of mice, rats and other rodents. The product-type includes the active agent aluminium phosphide, which is used to control both water voles and moles. As moles are not rodents, aluminium phosphide is also included in product-type 23: 'Control of other vertebrates'.

The consumption of rodenticides is registered in the Danish Pesticide Statistics (Danish EPA, 1999 A).

All information on application and handling procedures are from the product labels supplied by the firms in connection with application for registration in Denmark to the Danish EPA.

Products used for the control of mice, rats, and other rodents are used either as an eating poison or as a gas. When used as an eating poison the biocides are applied to corn or placed in a block or distributed as powder in areas where the vermins move.

5.1.1.1 Actors on the market

Producers and dealers of rodenticides are not organised in any special trade organisation other than Dansk Planteværn.

Main producers of rodenticides in Denmark are A/S Mortalin, Kiltin and Tanaco Danmark A/S.

Main importers of rodenticides are Bell Laboratory Inc., Cyanamid Denmark, Inter-Trade A/S, Jydsk Rengøring, Kiltin, Kirk Chemicals, A/S Mortalin, Pharmacia og Upjohn Animal Health, A/S Rentokil, Tanaco Damark A/S, Trinol A/S, Zeneca Agro A/S, Arnold Zuschlag A/S.

5.1.1.2 Biocides used in Denmark for the application area

The consumption of active agents in biocides used for control of rodents is shown in Table 5.1. The figures are from the yearly Danish Pesticide Statistics (Danish EPA, 1999 A).

The demarcation between the Biocide Directive and the Plant Protection Directive is still not ultimately lined up. At present (October 2000), rodenticides used in the field, in the forest and in greenhouses are expected to be included under the Plant Protection Directive, whereas rodenticides for other applications will be under the Biocide Directive. Table 5.1 includes rodenticides for all applications.

Table 5.1
Consumption of approved biocides for rodenticides in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption of active agents (tonnes) 1)	% active agent in biocidal products	Number of approved products 2)
Chloralose	-	15879-93-3	0.137	4	4
Aluminium phosphide	Aluminium phosphide	20859-73-8	3.941 3)	56-57	7
Bromadiolon	2H-1-benzopyran-2-one, 3-(3-(4'-bromol,(1,1'-biphenyl)-4-yl)-3-hydroxy-1-phenylpropyl)-4-hydroxy	28772-56-7	0.036	0.005-0.25	32
Difenacoum	2H-1-benzopyran-2-one, 3-(3-[1,1'-.biphenyl]-4-yl-1, 2,3,4-tetrahydro-1-naphthalenyl)-4-hydroxy-	56073-07-5	0.002	0.005-0.0075	4
Brodifacoum	2H-1-benzopyran-2-one, 3-(3-(4'-bromo[1,1'-biphenyl]-4-yl)-1, 2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-	56073-10-0	0.00036 4)	0.005	2
Flocoumafen	-	90035-08-8	0	0.005	1
Difethialon	2H-1-benzo-thiopyran-2-one, 3-[3-(4'-brom-[1,1'-biphenyl]-4-yl)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-	104653-34-1	0.001	0.0025	4
Total			4.117		

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1999 (Danish EPA 1999 B). Includes only the number of products for this application.
3) Some of the aluminium is used for control of moles and also included in product-type 23.
4) To indicate usage consumption of active agent was calculated from usage of product and percentage of active agent herein.

5.2 Product-type 15: Avicides

The product-type includes products used for the control of birds in food storages, churches, bakeries etc., where they can be of nuisance or vectors of diseases.

Formerly alpha-chloralose was used in stupefying of birds, but usage is no longer permitted.

No use of avicides in Denmark has been identified.

5.3 Product-type 16: Molluscicides

The product-type includes products used for the control of molluscs, other than for plant protection purposes (agriculture, horticulture).

No molluscicides (active ingredient or product) were registered according to the Danish survey of approved pesticides 1999 (Danish EPA 1999 B).

Biocides used for liquid cooling and processing systems (Section 4.6) may also prevent molluscs in the systems. Agents for prevention of mollusc fouling on the surface of vessels and equipment for aquaculture are included in Section 6.2: 'Antifouling products'.

5.4 Product-type 17: Piscicides

Products used for the control of fish. The group does not include products for the treatment of fish diseases.

Until now, piscicides have not been covered by the Danish pesticide regulation, and the consumption is consequently not registered by the Danish EPA. It has not been possible to identify any use of piscicides in Denmark.

5.5 Product-type 18: Insecticides, acaricides and products to control other arthropods

Insecticides, acaricides and products to control other arthropods are used in the combating of arthropods (e.g. insects, arachnids and crustaceans). The product-type includes products used against vermin on cats and dogs.

The consumption of insecticides, acaricides and products to control other arthropods is registered in the Danish Pesticide Statistics (Danish EPA, 1999 A).

All information on application and handling procedures is from the product labels (Biocide office, Danish EPA).

Insecticides, acaricides and products to control other arthropods are used in the combating of arthropods at places where they are unwanted by humans, e.g. flies in stables, ants in houses and cockroaches in kitchens.

The product-type includes both products used to kill the target organism and products that in some way obstruct the normal development of the target organism. The product-type includes seven different application and usage methods:

- Sprays, aerosols and fogs
- Gasses
- Flypaper or flyplates
- Paints/smearing products
- Decoy boxes
- Powders
- Others

Most of the products are used by both professionals and non-professionals.

Products used for plant protection are not covered by the Biocide Directive (see further section 5.5.1.2).

5.5.1.1 Actors on the market

Producers and dealers of insecticides, acaricides and products to control other arthropods are not organised in any special trade organisation other than Dansk Planteværn.

Main Danish producers of insecticides, acaricides and products to control other arthropods are Bayer A/S, Kvik, Bifo-Pet, Superfoss kemi, Tanaco Danmark A/S and Borup Kemi A/S. Some of the company produce for others, which hold the registration of the final biocide products.

Main importers of insecticides, acaricides and products to control other arthropods are Aeropak A/S, Agrodan, AgrEvo, Allflex Danmark Aps, BASF A/S, Bayer A/S, Claren Kemi, Combiservice, Cyanamid Danmark, Dow Agro Science Danmark A/S, F.S. Import, Inter-trade A/S, IM-TEK, KemiAgro, KVK Agro A/S, LFS-kemi, Lopex, A/S Mortalin, NEDAB ApS, Novartis A/S, A/S Rentokil, Tanaco Danmark A/S, TCI, Trinol A/S,

5.5.1.2 Biocides used in Denmark for the application area

The 1998 consumption of active agents in biocides used to combat insects, acaricides and other arthropods is shown in Table 5.2. The figures are from the yearly Danish Pesticide Statistics (Danish EPA, 1999 A).

A number of active substances and/or specific products registered in Denmark under this product group appeasr not to be biocidal substances and/or products in the EU Directive sense of the term but rather plant protection products (treatment of plant products) or veterinary medicinal products (e.g. shampoos and flea collars for cats and dogs). The consumption of active substances in such products has been subtracted from the total consumption of the active substances in question (e.g. propoxur and rotenon).

A number of other substances and/or products is approved in Denmark for several uses, both as biocides, plant protection products and/or veterinary medicinal products. For still other products, the borderline of the application area between the Biocide Directive and other EU directives is currently under consideration. In these cases, the whole consumption of the involved active substances and/or products is still included in Table 5.2.

The different fields of application for approved biocides for the non-plant protection control of insecticides, acaricides and products to control other arthropods are listed in Table 5.3.

Table 5.2
Consumption of approved biocides for the non-plant protection control of insecticides, acaricides and products to control other arthropods in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption active agents (tonnes) 1)	% active agent in biocidal products (otherwise else is stated)	Number of approved products 2)
Citronella oil	-		0.026	No data	0
Cyromazin	-	?	0.691	2	2
Muscalure	-	?	0.002	0.0404	2
Piperonylbutoxyd (synergist)	1,3-benzodioxole, 5-[[2-(2-butoxyethoxy)ethoxy]methyl]-6-propyl ester, monochloride	51-03-6	3.987	0.4-15,1	41
Dimethoate	phosphorodithioc acid, 0,0-dimethyl S-(2-(methylamino)-2-oxoethyl)ester	60-51-5	0.098	20-40 (400 g/L)	5
Dichlorvos	phosphoric acid, 2,2-dichloroethenyl dimethyl ester	62-73-7	0.576	18.6	1
Pyrethrin I/pyrethrin II	-	121-21-1/ 21-29-9	0.571 4)	0.05-1.51	27
Malathion	butanedioic acid, [(dimethoxyphosphinothioyl)thio]-, diethyl ester	121-75-5	1.981	4	4
Diazinon	phosphorothioic acid, O,O-diethyl 0-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] ester	333-41-5	0.542	2	2
D-trans-allethrin	cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, 2-methyl-4-oxo-3-(2-propenyl)-2-cyclopenten-1-yl ester	584-79-2	0.439	0.5 g/L	3

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption active agents (tonnes) 1)	% active agent in biocidal products (otherwise else is stated)	Number of approved products 2)
Chlorpyrifos	phosphorothioic acid, o,o-diethyl o-(3,5,6-trichloro-2-pyridinyl) ester;	2921-88-2	1.000	0.8-2.5 2.5 g/box 0.625 g/piece 208 g/L	9
Phoxim	3,5-dioxa-6-aza-4-phosphaoct-6-ene-8-nitrile, 4-ethoxy-7-phenyl-, 4-sulfide	14816-18-3	0.910	0,08-3	6
Methomyl	Ethanimidothioic acid, N[[(methylamino)carbonyl]oxy]-methyl ester	16752-77-5	0.013	1.0683	2
Aluminium phoshide 3)	Aluminium phosphide	20859-73-8	1.136	56-57	4
Tetrachlorvinphos	phosphoric acid, 2-chloro-1-(2,4,5-trichlorophenyl)ethylenyl dimethyl ester,(Z)-	22248-79-9	0	50	1
Bioresmethrin	cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, (5-(phenylmethyl)-3-furanyl)methyl ester, (1R-trans)-	28434-01-7	0.136	0.08-0.2	12
Bioallethrin	cyclopropanecarboxylic acid, 2,2dimethyl-3-(2-methyl-1propenyl)-,2-methyl 4-oxo-3-(2propenyl)-2-cyclopenten-2-yl ester, [1R-[trans-1.alpha.(S*),3.beta.]]-	28434-00-6	0.001	0.3-0.5	4
Propetamphos	2-butenoic acid, 3-(((ethylamino)methoxyphosphinothioyl(oxy)-,1-methylethyl ester, (E)-	31218-83-4	0.009	1-2; 60 g/kg	4
Diflubenzuron	benzamide, N-(((4-chlorophenyl)amino)carbonyl)-2,6-difluoro-	35367-38-5	0.392	5-25	3
Azemethiphos	phophorothioic acid, S-((6-chloro-2-oxooxazolo)4,5-b(pyridin-3(2H)-yl)methyl), O,O-dimethyl ester	35575-96-3	0.404	1-10	14
Methopren	2,4-Dodecadienoic acid, 11-methoxy-3,7,11-trimethyl, 1-methylethyl ester, (E,E)-	40596-69-8	0.015	0.3-10	10
Permethrin	cyclopropanecarboxylic acid, 3-(2,2-dichlorovinyl)-2,2dimethyl-, (3-phenoxyphenyl) methyl ester	52645-53-1	1.316	0.5-25; 40 g/L	22
Deltamethrin	cyclopropanecarboxylic acid, 3-(2,2-dibromoethenyl)-2,2-dimethyl-, cyano(3-phenoxyphenyl) methyl ester, [1R-[1.alpha.(S*),3.alpha.]]-	52918-63-5	0.029	0.1-2.5	6
Cyfluthrin	cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(4-fluoro-3-phenoxy-phenyl)-methyl ester	68359-37-5	0.004	No data	0
Total			9.424		

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1999 (Danish EPA 1999 B). Includes only the number of products for this application.
3) Aluminium phosphide is regulated under the biocide directive when used in storing places before storing of e.g. grain, seeds and flour.
4) In the statistics referred to as only pyrethrin I.

Table 5.3
Field of application and product-type for approved biocides for the non-plant protection control of insecticides, acaricides and products to control other arthropods

Biocide (active agent) Declaration name	Control of flies and other insects in stables, cages ect.	Control of flies, ants ect. in and around private homes	Control of fleas in surrounding of domestic animals	Protection of wool and textiles	Control of insects in the food industry	Product-types 1)
D-trans-allethrin	X	X				Saf.
Aluminium phoshide	X					Gas
Azemethiphos	X	X				Db, ps, fp
Bioallethrin	X	X				Saf, ps
Bioresmethrin	X	x				Saf, ps
Chlorpyrifos	X	X		X		Saf, db, ps, oth
Citronella oil						No information available
Cyfluthrin						No information available
Cyromazin	X					Saf
Deltamethrin	X	X				Saf, pw
Diazinon			X			Saf
Dichlorvos	X					Fp
Diflubenzuron	X		X			Ps
Dimethoate	X					Ps
Malathion	X					Pw
Methomyl	X					Fp, ps,
Methopren	X	X	X			Saf
Muscalure	X					fp, ps
Permethrin	X	X		X		Saf, pw
Phoxim	X	X				pw, db
Piperonylbutoxyd (synergist)			X			saf
Propetamphos	X	X	X			pw, ps
Pyrethrin I/pyrethrin II	X	X			X	saf,ps
Tetrachlorvinphos			X			Saf

1) Ps: Paint/smearing product, db: Decoy boxes, fp: Flypaper, saf: Sprays aerosols and fogs, pw: powders, oth: other.

5.6 Product-type 19: Repellents and attractants

Repellents and attractants are products used to control harmful organisms (invertebrates such as fleas, vertebrates such as birds) by repelling or attracting, including those that are used for human or veterinary hygiene either directly or indirectly.

The product-type can be organised into two sub-types:

- Repellents for control of mosquitoes, fleas and other insects
- Repellents and attractants for control of game and birds

The consumption of repellents is registered in the Danish Pesticide Statistics, and repellants have to be approved by the Danish EPA (Danish EPA 1999 A). Attractants do not have to be approved, and the consumption is not registered.

All information on application and handling procedures are from the product labels (Biocide Office, Danish EPA).

5.6.1 Repellents and attractants for control of mosquitoes, fleas and other arthropods

Products in this group are biocidal products used to repel or attract mosquitoes, fleas and other arthropods. As examples of repellents for control of insects are products used in preventing mites from living in textiles.

Products used against mosquitoes, fleas and other insects are used either directly on humans or animals, as smoking products or in impregnated plates.

When used directly on humans or animals, the products are either sprayed or sponged to the skin.

5.6.1.1 Actors on the market

Producers and dealers of repellents and attractants are not organised in any special trade organisation other than Dansk Planteværn.

There are no Danish producers of repellents and attractants for control of mosquitoes, fleas and other insects.

Main importers of repellents for control of mosquitoes, fleas and other insects are: Agrolab A/S, Bayer A/S, Biona A/S, Fort Dodge Animal Health, Bjørn Hansen, Heiger and Co. A/S, Mallinkr., Medic Team Pps, Mycodan, Pharmacia og Upjohn Animal Health and Schering-Plough A/S.

5.6.1.2 Biocides used in Denmark for the application area

The 1998 consumption of active agents in biocides used to repel is shown in Table 5.4. The figures are from the yearly Danish Pesticide Statistics (Danish EPA, 1999 A). It has not been possible to identify any attractants with a biocidal effect.

Table 5.4
Consumption of approved repellants for control of mosquitoes, fleas and other insects in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption of active agents (tonnes) 1)	% active agent in biocidal products	Number of approved products 2)
Piperonyl butoxide (synergist)	1,3-benzodioxole, 5-[[2-(2-butoxyethoxy)ethoxy] methyl]-6-propyl ester, monochloride	51-03-6	0	28,3 mg/tablet	1
D-trans-allethrin s-d-trans-allethrin	cyclopropanecarboxylic acid, 2,2-dimethyl-3-(2-methyl-1-propenyl)-, 2-methyl-4-oxo-3-(2-propenyl)-2-cyclopenten-1-yl ester	584-79-2	0.001	6.5 mg/tablet 32.7 mg	1
1,2,-benzisothiazol-3(2H)-on	1,2-benzisothiazol-3-(2H)-on	2634-33-5	0.010	0.1-1	0
Citronella oil		8000-29-1	0.815	2; 100 g/L	6
Eucalyptus oil		8000-48-4	0.181	7.8-8.2	2
2-octyl-3-isothiazolon	3(2H)-isothiazolone, 2-octyl-	26530-20-1	0.029	1-2.9	0
Cypermethrin	cyclopropanecarboxylic acid, 3-(2,2-dichloro-ethenyl)-2,2-dimethyl- cyano (3-phenoxyphenyl) methyl ester	52315-07-8	0.003	1.02 g/sheet	1
Permethrin	cyclopropanecarboxylic acid, 3-(2,2-dichlorovinyl)-2,2dimethyl-, (3-phenoxyphenyl) methyl ester	52645-53-1	0.065	1-1.2 g/tag; 1.05-4	5
Alphacypermethrin	cyclopropane carboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-,cyano (3-phenoxyphenyl)methyl ester [1.alpha.(s*), 3.alpha.]-(.+-.)-	67375-30-8	0	15 g/L	1
Cyfluthrin	cyclopropanecarboxylic acid, 3-(2,2-dichloroethenyl)-2,2-dimethyl-, cyano(4-fluoro-3-phenoxy-phenyl)-methyl ester	68359-37-5	0	1-5	2
Total			1.104		

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1999 (Danish EPA 1999 B). Includes only the number of products for this application.

It should be noted that only one product is in the category 'other insects'. The product is used in preventing house dust mites from living in textiles and is, at present, the only product against mites in textiles sold on the Danish market. The product contains three substances (permethrin, 2-octyl-3-isothiazolon and 1,2-benzisothiazol-3(3H)-on) of which 2-octyl-3-isothiazolon is toxic and not registrered/approved for use in this product-type.

5.6.2 Repellents and attractants for control of game and birds

Repellents and attractant for control of game, especially roe-deer, are used in order to prevent them from eating new shoots on fruit trees, leaf-bearing trees and coniferous trees. The usage is included in this report as the products are used in the production of leaf-bearing and coniferous trees although use of repellents and attractants in fruit plantations is regulated according to the plant protection directive (91/414/EEC).

Biocides in repellents and attractants for control of birds are mainly used to prevent game and birds from staying at places were there are unwanted, e.g. pigeons at window sills.

5.6.2.1 Actors on the market

There are no Danish producers and no special trade organisation for the producers and dealers of repellents and attractants in Denmark.

Main importers of repellents for game and birds are Insekta, Trinol A/S, Tanaco Danmark A/S, A/S Rentokil and Åffa Produkter A/S.

5.6.2.2 Biocides used in Denmark for the application area

The consumption of approved repellents for control of game and birds in Denmark is presented in Table 5.5. The figures are derived from the Danish Pesticide Statistic 1998 from the Danish EPA.

Attractants do not have to be approved, and consequently the consumption of attractants does not appear from the statistics. It has not been possible to identify any use of attractants with a biocidal effect.

Table 5.5
Consumption of approved repellents for game and birds in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption of active agents (tonnes)	% active agent in biocidal products	Number of approved products 2)
Thiram	thioperoxydicarbonic diamide ([(H2N)C(S)]2S2), tetramethyl-	137-26-8	1.672	10	2
Polybutene	butene	9003-29-6	0.956	74.5-93	5
Polybutene (polyethylene vax)		9003-29-6	0.035	10	1
Total			2.663		

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1999 (Danish EPA 1999 B). Includes only the number of products for this application.

6 Main group 4: Other biocidal products

6.1 Product-type 20: Preservatives for food or feedstock

Preservatives for food or feedstock are used for the control of harmful organisms in food or feedstock. Preservatives for food and feedstock are in general covered by other regulation, but there are a few exemptions, for example preservatives in cheese rind.

Within this project there has not been made any attempt to assess the consumption of biocides for these exemptions.

6.2 Product-type 21: Antifouling products

Antifouling products are used to control the settlement and growth of fouling organisms (microbes and higher forms of plant or animal species) on vessels, aquaculture equipment or other structures used in water.

The product-type can be organised into three sub-types:

- Antifouling paints for vessels < 25 m
- Antifouling paints for vessels ≥ 25 m
- Antifouling products for other uses

The background for the organisation of the product-type into antifouling paints for vessels of < 25m and ≥ 25 m respectively is that the application of some of the agents in Denmark and many other countries are only permitted for vessels ≥ 25 m (Bek 1042; Bek. 761).

6.2.1 Antifouling paints for vessels < 25 m

Products in this group are biocidal products used to control the settlement and growth of fouling organisms (microbes and higher forms of plant or animal species) on vessels smaller than 25 m.

The antifouling paint is applied to the hull below the waterline, and the active agents are continuously released to the water.

6.2.1.1 Actors on the market

Producers and suppliers of antifouling paints are organised in the trade organisation 'The Danish Paintmakers Association' ('Foreningen for Danmarks Lak- og Farveindustri').

The only Danish producer of antifouling paints is J.C. Hempel's Skibsfarvefabrik A/S. The main importer of antifouling paints for small vessels is International Farvefabrik A/S.

6.2.1.2 Biocides used in Denmark for the application area

Biocides used for vessels <25 m in 1998 is shown in Table 6.1. The list is based on a gross list from PROBAS including all antifouling agents used in Denmark combined with information from (Madsen et al., 1998) and information from the Danish Paintmakers Association regarding which compounds are used for small vessels.

Diuron and Irgarol 1051 were previously used in combination with copper compounds. The use of Diuron and Irgarol has by January 1 2000 been prohibited for vessels smaller than 25 metres (Bek 1042 modified by Bek 297 of April 22, 2000; Bek 761).

The use of antifouling paint has by January 1 2000 been prohibited for all boats in freshwater, and for boats of less than 200 kg (with some exceptions, i.e. boats of wood in marine waters and boats in harbours classified as A and B) (Bek 761, 1999).

Table 6.1
Biocides used for antifouling paint for vessels < 25 m in Denmark [1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products (average) 3)
N'-(3,4-dichlorophenyl)-N,N-dimethyl-urea	Diuron 2)	330-54-1	4
Thiocyanic acid, copper(1+) salt	Copper thiocyanate	1111-67-7	20
Copper oxide	Cuprous oxide	1317-39-1	43
2(1H)-pyridinethione, 1-hydroxy-,zinc salt	Zinc pyrithione	13463-41-7	7 4)
1,3,5-triazine,2,4-diamine, N-cyclopropyl-N'-(1,1-dimethylethyl)-6-(methylthio)-	Irgarol 2)	28159-98-0	4

1) Two agents registered in PROBAS, which may be used for small vessels are not included due to confidentiality (all agents are shown in table 6.3 in confidential report).
2) The agents are not to be used after 1 January 2000 on vessels <25 m.
3) Average concentration (weight %) in the wet paints according to PROBAS.
4) The registered average concentration seems to be somewhat too high.

6.2.1.3 Consumption of biocides with finished products

The consumption of biocides (active agents) with antifouling paint for vessels <25 m in Denmark in 1996 has been estimated by Madsen et al. (1998). Based on information from the trade organisation, it is estimated that no significant changes have taken place between 1996 and 1998. The estimated consumption is shown in Table 6.2.

It is estimated that zinc pyrithione and copper to some extent have substituted for Diuron and Irgarol, which on January 1 2000 were prohibited for vessels smaller than 25 metres, but other agents considered confidential may be used as well.

Table 6.2
Consumption of biocides with antifouling paints for vessels <25 m in Denmark 1996 [1)]

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Diuron	2.6	Antifouling paint	4	2
Copper compounds (as Cu)	50	Antifouling paint	40	2
Zinc pyrithione	0.4	Antifouling paint	7	2
Irgarol	0.04	Antifouling paint	4	2
Other	0.1	Antifouling paint	?	2
Total	53			

1) Average concentration in the paint according to the Productregister. The registered average concentration seems to be somewhat too high.

2) Represents the consumption in 1996 (Madsen et al., 1998). The reference indicates the consumption as 'Import', but it is estimated that it actually represents the content of antifouling paints sold in Denmark. Based on information from a main supplier it is assumed that the consumption in 1998 is basically the same. The consumption pattern has changed by 1 January 2000, as Diuron and Irgarol is prohibited for most applications.

6.2.2 Antifouling paints for vessels ³ 25 m

Products in this group are biocidal paints used to control the settlement and growth of fouling organisms (microbes and higher forms of plant or animal species) on vessels of more than 25 m.

The paints are applied by professionals on the hull below the waterline when the vessels are in dry dock. The active agents are continuously released to the water during use.

6.2.2.1 Actors on the market
Producers and suppliers of antifouling paints are organised in the trade organisation 'The Danish Paintmakers Association' ('Foreningen for Danmarks Lak- og Farveindustri').

The only Danish producer of antifouling paint is J.C. Hempel's Skibsfarvefabrik A/S. Main importers of antifouling paints are Sigma Coatings A/S, Brifa Maling A/S, Jotun Danmark A/S and International Farvefabrik A/S.

6.2.2.2 Biocides used in Denmark for the application area
Tributyltin and copper compounds are the main biocides in antifouling paints for vessels ≥ 25 m.

The organotin compounds are either dispersed in the paint and released by diffusion (e.g. TBTO) or the organotin is incorporated in the polymer matrix; typically consisting of a tributyltinmethacrylat/methacrylat copolymer. The latter paint types are designated 'self-polishing paints' where the organotin compound is released in a controlled way to the seawater by a chemical reaction resulting in the formation of a water soluble reaction produc, which is polished away in time. Free association paints with organotins acting as a biocide are banned in the EC from September 1, 2000 (Directive 99/51/EEC implemented by (Bek 297)).

The Marine Environment Protection Committee (MEPC) of the International Maritime Organization under the UN works at present on developing a legal

instrument to regulate the use of shipboard anti-fouling systems. The IMO resolution A.895 (1999) states that a global instrument should ensure a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003. (IMO, 2000)

Table 6.3
Biocides used for antifouling paint for vessels ≥ 25 m in Denmark [1)]

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products (average) 2)
Hexabutyl distannoxane	TBTO	56-35-9	1 4)
N'-(3,4-dichlorophenyl)-N,N-dimethyl-urea	Diuron	330-54-1	5
Thiocyanic acid, copper(1+) salt	Copper thiocyanate	1111-67-7	21
Copper oxide	Cuprous oxide	1317-39-1	45
Copper oxide	Cupric oxide 3)	1317-38-0	0,4
Tributyl[(2-methyl-1-oxo-2-propenyl)oxy] stannate	TBT methylacrylate	2155-70-6	1
Copper sulphate	3)	7758-98-7	0.2
Zinc, [[2-[(dithiocar-boxy)amino]ethyl]carbamodithioato(2-)-.kappa.S,.kappa.S']-	Zineb	12122-67-7	10
2(1H)-pyridinethione, 1-hydroxy-,zinc salt	Zinc pyrithione	13463-41-7	7 5)
Methyl methacrylate-tributyltin meth-acrylate copolymer	TBT-methacrylate copolymer	26354-18-7	17
1,3,5-triazine,2,4-diamine, N-cyclopropyl-N'-(1,1-dimethylethyl)-6-(methylthio)-	Irgarol	28159-98-0	5

1) Four agents registered in PROBAS are not included in this report due to confidentiality. It is not clear whether all three compounds are used for large vessels. In addition zinc oxide are for a few products in PROBAS registered as antifouling agent, but for most products it is registered as a pigment, and zinc oxide will here be considered a pigment and not included in the assessment.
2) Average concentration in the paints according to PROBAS data.
3) The compounds are used in an insignificant amount. It is not evident whether the agent is used in vessels of less or more than 25 m.
4) TBTO is used as stabiliser in self-polishing paints.
5) The registered average concentration seems to be somewhat too high.

6.2.2.3 Consumption of biocides with finished products

An assessment of the consumption of antifouling paints for large vessels in Denmark has some inherent methodological problems. Due to the fact that paint sold in Denmark may be applied by a Swedish shipyard on a vessel from Singapore, maintaining a regular service between Tallinn and Helsinki, there is no connection between the amount of antifouling paint sold in Denmark and the release of the biocides from vessels to the Danish waters.

It is, however, presumed that the amount of antifouling paint sold in Denmark indicates the order of magnitude of the amount of antifouling paints used by Danish shipyards.

The total sale of biocides with antifouling paints for large vessels in Denmark 1999 is shown in Table 6.4. The total consumption is based on updated information from PROBAS combined with information from the Danish Paintmakers Association. Antifouling paint produced in Denmark and ex-

ported is not included, but some of the paint sold in Denmark may be shipped by the customer and applied abroad.

The total consumption of organotin compounds with antifouling paint in 1995 has been assessed by Lassen et al. (1997). The assessment was based on updated and quality assessed data from PROBAS. The substance flow analysis also included an assessment of the release of organotin compounds from shipyards and from ships in the Danish waters. The total release of organotin from ships to the inner Danish waters was in the analysis estimated at 0.7-5.2 tonne organotin per year.

Table 6.4
Consumption of biocides with antifouling paint for vessels ≥25 m in Denmark 1999

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
TBTO	2-3	Antifouling paint	1	
Diuron	1.2-2.2	Antifouling paint	5	
Copper (as Cu)	200-250	Antifouling paint	43	2
TBT methacrylate polymer	40-60	Antifouling paint	17	3
Zineb	5-10	Antifouling paint	10	
Zinc pyrithione	0.3-0.4	Antifouling paint	7	
Irgarol	1.2-2.2	Antifouling paint	5	
Confidential	3.5-7.5	Antifouling paint	-	4
Total (round)	250-340			

1) Indicates the average content of the agents in antifouling paint (both for small and large vessels) according to the registration in PROBAS.
2) Includes CAS No. 1111-67-7 and 1317-39-1. The consumption represents the total weight of the polymer.
3) Includes CAS No. 2155-70-6 and 26354-18-7. The figure represents the total weight of the TBT methacrylate polymers.
4) Includes confidential agents.

6.2.3 Antifouling products for other uses

Products in this group are biocidal products used to control the settlement and growth of fouling organisms (microbes and higher forms of plant or animal species) on nets and cages for marine aquaculture and other marine constructions than vessels.

As to the knowledge of the authors, the only application of antifouling paints in Denmark within this application area is the application for marine aquaculture. For aquaculture, the nets are every spring dipped in antifouling paint to prevent fouling.

Offshore oilrigs in the Danish part of the North Sea are - according to information from the operators to the Danish EPA - not painted with antifouling paint.

6.2.3.1 Actors on the market

Producers and suppliers are the same as for antifouling paints for vessels.

The users of the paints are organised in the trade organisation Danish Marine Aquaculture Association (Dansk Havbrugerforening).

6.2.3.2 Biocides used in Denmark for the application area

It has due to confidentiality not been possible to obtain information about the active agents used, but antifouling paint for aquaculture is mainly based on copper. It is, however, expected to be some of the same active agents as used for small vessels. Organotin compounds are not allowed for antifouling paints for aquaculture.

6.2.3.3 Consumption of biocides with finished products

The consumption of antifouling paint for this application is, based on information from the trade organisation 'Dansk Havbrugerforening', estimated at 5-10 tonnes per year. The estimated content of active agents is shown in Table 6.5.

Table 6.5
Consumption of biocides with antifouling paint for aquaculture in Denmark 1998

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in %	Note
Copper compounds (as Cu)	4.5-9	Antifouling paint for aquaculture	30-45	1
Other	<1	Antifouling paint for aquaculture	?	1
Total	5-10			

1) The total consumption of antifouling paints to marine aquaculture is based on information from the trade organisation Dansk Havbrugerforening estimated at 15-20 tonnes. The exact content of the paints is not known, but the main biocides are copper-based. The average Cu content of antifouling paints for pleasure boats are 39% (Madsen et al., 1998) and it is for the calculation here presumed that the average Cu content of antifouling paints for aquaculture will be within the range of 30-45%. The consumption of other biocides are based on the consumption pattern for antifouling paint for small vessels - supposed to be very small compared to the consumption of copper compounds. Antifouling paint is not used for offshore constructions in the Danish part of the North Sea.

6.3 Product-type 22: Embalming and taxidermist fluids

The product-type includes products used for the disinfection and preservation of human or animal corpses, or parts thereof. The product-type can be organised into two sub-types:

- Embalming fluids for humans
- Embalming and taxidermist fluids and chemicals for animals

6.3.1 Embalming fluids for humans

Deceased people are preserved for two main reasons:

- Education of medical students (P. Nielsen, 2000)
- Preservation of corpses for flight transport for funeral abroad.

For flight transport of corpses, it is required by the regulation that the corpses are preserved. Corpses for funeral in Turkey and Pakistan make up the main part of the transports out of Denmark. For transport to European countries, land transport by hearse is common, and the corpses are not preserved.

For delayed funeral in Denmark the corpse is usually not preserved, but stored cold.

6.3.1.1 Actors on the market

The chemicals for embalming are supplied by many companies.

The universities of Aarhus, Odense and Copenhagen preserve cadavers for education of medical students. Hospitals all over the country preserve corpses for funeral abroad.

6.3.1.2 Biocides used in Denmark for the application area

Biocides used for embalming of human corpses are shown in table Table 6.6.

Table 6.6
Biocides used for embalming of human corpses

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products [1)]
Formaldehyde	Formalin	50-00-0	25-37
Ethanol		64-17-5	96
Pentanedial	Glutaraldehyde	111-30-8	3-5

1) Concentration in the biocidal product from the producer.

6.3.1.3 Consumption of biocides with finished products

In total about 600-700 corpses are annually embalmed for education of medical students or funeral abroad. The estimated amount of embalming fluids is shown in Table 6.7.

More than half the corpses are transported out of the country for funeral, but at the same time preserved corpses of Danish people deceased abroad is transported into the country. The exact number has not been estimated. The total consumption of formaldehyde in the hospital sector in Denmark was in 1984 estimated at 20 tonnes (Axelsen, 1984). Compared to this the consumption for embalming is relatively small.

Table 6.7
Consumption of biocides with embalming fluids for human corpses [1)]

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Formaldehyde	0.8-1.2	Fluids for human corpses	15-20	2
Ethanol	8-11	Fluids for human corpses	40-50	2
Pentanedial	0.0015-0.018	Fluids for human corpses	0.05-0.27	3
Total	9-12			

1) Concentration in the fluid used for the preservation. For formaldehyde, the concentration represents the concentration used in corpses for transport.
2) It is estimated that about 300 cadavers are used for education of medical students and 300-400 corpses are embalmed for funeral abroad. The corpses for transport are preserved with approximately 4 litres 15-20% formaldehyde. The consumption of formaldehyde and ethanol for cadavers for education are based on information from the Universities.
3) Pentanedial is used in the preparations for cadavers for educational use as a part of the agent Lysoformin. The amount is roughly estimated based on information from one university.

6.3.2 Embalming and taxidermist fluids for animals

Animals are preserved both by 'dry ' preservation and by 'wet' preservation, submergence into preserving fluids.

Animal cadavers are preserved by 'wet preservation' for two main reasons:

- Taxonomical studies and monitoring programmes
- Education of veterinary students

The latter application in many ways resembles the preservation of human corpses for educational use mentioned in the previous section.

6.3.2.1 Actors on the market
There is a number of small suppliers of the chemicals.

There are about 15 establishments doing fulltime preservation (Reitz, 2000) and about 50 taxidermists. The research centres carry out 'wet' preservation for research and educational use.

6.3.2.2 Biocides used in Denmark for the application area
Biocides used for embalming and preservation of animals are shown in Table 6.8.

The following is as regards 'dry preservation' based on Reitz (2000), Danish zoological Taxidermists Association (Reitz, 2000) and The Royal Veterinary and Agricultural University as regards 'wet preservation'.

For wet preservation ethanol and to some extent ethanol mixed with formaldehyde are used.

Arsenic is the most used biocidal product for 'dry' preservation. Arsenic trioxide is mixed with soap flakes, calciumhydroxide, campher and water. This paste is painted with a brush to the inside of the skin.

For tanning of the hide of larger mammals tanning agents like alum (Aluminium potassium sulfate, dodecahydrate) and lutern are used. The agents may have some biocidal effect, but it is estimated that it is not the primary effect, and the agents are not included in the list of biocides. The tanning is often done by professional tanneries. Borax is sprinkled on the inside of the skin.

Formaldehyde and ethanol are used for 'dry' preservation as well as 'wet' preservation, but the amount used for 'dry' preservation is estimated to be insignificant compared to 'wet' preservation.

Table 6.8
Biocides used for embalming and preservation of animals

Chemical name (active agent)	Trivial name	CAS No	% active agent in biocidal products 1)
Formaldehyde	Formalin	50-00-0	24.5; 36
Ethanol	Ethanol	64-17-5	96
Benzoic acid, 4-hydroxy-, methyl ester	Methyl paraben	99-76-3	?
Pentanedial	Glutaraldehyde	111-30-8	25
2,2'-Oxybisethanol		111-46-6	17-22
bis(aceto-O)dioxouranium	Uranyl acetate	541-09-3	2
Dinatrium-tetraborat-decahydrate	Borax	1303-96-4	100
Arsenic trioxide	Arsenic	1327-53-3	100
Benzenesulfonic acid, 5-chloro-2-(4-chloro-2-((((3,4-dichloro-phenyl)amino)carbonyl)amino)phenoxy)-, monosodium salt		3567-25-7	1-10; 17-22
1H,3H,5H-oxazolo[3,4-c]oxazole, 7a-ethyldihydro-		7747-35-5	1-25
Osmic acid		20816-12-0	2
Paraformaldehyde		30525-89-4	1-8

1) The content in the product placed on the market.

6.3.2.3 Consumption of biocides with finished products

The estimated consumption of biocides for preservation of animals is shown in Table 6.9. The amount of fluids for taxonomically studies at the universities and preservation of animals for monitoring programmes has not been assessed in detail.

Table 6.9
Consumption of biocides for preservation of animal corpses [1)]

Biocides (active agents)	Consumption tonnes	Biocidal product or product group	Average content of agent in % 1)	Note
Arsenic trioxide	0.01-0.025	Taxidermy, paste for the inside of skin	15-16	2
Borax and other for taxidermi	<0.015	Taxidermy	-	2
Formaldehyde	0.3-1	Fluid for immersion of animals	4	3
Ethanol	2.5-5	Fluid for immersion of animals	25	3
Other	<0.02	Fixation of tissue	-	3
Total	3-6			

1) Concentration of the biocidal product used for embalming of an animal. Not indicated for groups of biocides.
2) Based on (Reitz, 2000).
3) Based on information from The Royal Veterinary and Agricultural University.

6.4 Product-type 23: Control of other vertebrates

Products of this group are used for the control vertebrates other than rodents (product-type 14), fish (product-type 17) and birds (product-type 15). Prod-

ucts that control the animals by an attractive or repellent action are included in product-type 19.

The only identified products for the control of other vertebrates are agents for the control of moles (*Talpa europaea*). The agents have to be approved by the Danish EPA and can only be used with permission.

In the Danish Pesticide statistics, the agents for control of moles are assessed together with rodenticides. The same agents may be used for control of rats and the water vole (*Arvicola amphibius*) and are consequently also included in product-type 14: Rodenticides.

As to the knowledge of the authors, biocides are not used for the control of other vertebrates like mink and marten. These predators are usually trapped or shot.

6.4.1.1 Actors on the market

Suppliers of approved agents for control of moles are Rentokil A/S, Mortalin A/S, Inter-Trade A/S, Tanaco Danmark A/S and Trinol A/S (Danish EPA 1999 B).

6.4.1.2 Biocides used in Denmark for the application area

The consumption of biocides used in Denmark for control of moles in 1998 is shown in Table 6.10.

Table 6.10
Consumption of biocides for control of other vertebrates in Denmark 1998 [1)]

Biocide (active agent) Declaration name	Chemical name	CAS No	Consumption (tonnes active agents)	% active agent in biocidal products	Number of approved products 2)
Aluminium phosphide	Aluminium phosphide	20859-73-8	3.9	56-57	7

1) Consumption according to the Danish Pesticide Statistics 1998 (Danish EPA 1999 A).
2) According to the Danish survey of approved pesticides 1998 (Danish EPA 1999 B). Includes only the number of products for this application.

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Appendix 1
Import, export and production of disinfectants in 1998

The following table is based on the commodity statistics from Statistics Denmark. Import and export data are derived from 'External Trade by Commodities and Countries' ('Udenrigshandelen'); Production data are derived from 'Manufacturers Sales of Commodities. Series A-D' ('Varestatistik for Industrien').

Supply = import + production - export.'

Commodity item	Commodity	Production	Import tonnes	Export tonnes	Supply tonnes
3808.40.10	Disinfectants, based on quaternary ammonium salts	11	66,8	138,3	-60,5
3808.40.20	Disinfectants, based on halogenated compounds	-	144,7	79,7	65
3808.40.90	Disinfectants, except disinfectants based on quaternary ammonium salts or halogenated compounds	6760	715,2	3548,1	3927,1

Appendix 2
Background information to product-type 8

The following appendix comprises background information regarding import/export of industrial preserved wood.

It is assumed that the preserved wood is found under the same commodity numbers as the numbers used by Hansen et al. 1997 and that only conifer wood is preserved.

The amount of chromium and creosote in preserved wood has been derived from a recent assessment by Hansen et al. (2000 a, b) and the following only comprise the background for the estimate of the consumption of the other biocides.

Registered import, export and production 1998 according to Statistics Denmark are shown in the following table.

Table A2.1
Registered import, export and production 1998 according to Statistics Denmark.

	Commodity number	All figures in tonnes				
		Import from S and N	Import from Fin	Import from rest	Export	Production [1)]
Poles	4403.10.10	110	0	0	0	119
Wood, painted, stained or treated with creosote or other kinds of biocides, except masts	4403.10.90	48,640	17,009	4,049	276	180
Items of conifer wood for hoops, posts, poles, sticks, etc.	4404.10.00	3,620	0	1,949	199	0
Railway sleepers	4406.90.00	101	0	49	0	0
Windows and glassdoors and frames of conifer wood	4418.10.50	99	0	996	40,035	96,270
Doors and frames and doorsteps	4418.20.50	3,521	0	1,537	3,874	25,789

1) The production is in the statistics 'Manufacturers Sales of Commodities' /Statistics Denmark 1999 B/ only represented in m^3 and value. Tonnes to value ratios for exported products is used to estimate the weight of the production

According to Hansen et al. (2000 b), only a minor part of the production and export of preserved wood is actually included in the trade statistics. The explanation may be that the pressure preservation is carried out for small companies below the lower limit of the Manufacturers Sales of Commodities. Based on the statistic of Danish Control of Preserved Wood and direct inquiries to actors on the market, the following figures on preserved wood have been estimated by Hansen et al. The figures include both pressure-preserved and surface preserved products, but exclude poles, railway sleepers and window and door frames i.e. they cover the commodity numbers 4403.10.90 and 4404.10.00. The figures in table A2.2 are used for the estimates instead of the data from Statistics Denmark regarding commodity numbers 4403.10.90 and 4404.10.00.

Table A2.2
Import, export and supply of preserved wood according to Hansen et al. (2000 b)

	Cr-containing wood	Cr-free wood	Total
Production	17,330	126,967	144,297
Import	28,041	24,125	52,166
Export	12,902	2,091	14,993
Supply	32,469	149,001	181,470
Supply/production	1.9	1.2	1.3

Three different estimation methods are used for vacuum, pressure and surface treatment, respectively.

It is roughly estimated that 0-20 of the preserved wood in table A2.2 is preserved with a surface treatment and the remaining 80-100% is pressure-preserved.

It is based on Table A2.2 assumed that the supply (net consumption) of the organic biocides with *pressure-preserved wood* is in the order of 1-1.4 times the consumption for production in Denmark, whereas for boron and copper compounds it is estimated at 1.2-1.5 times the consumption for production in Denmark (copper and boron follow chromium in the CCB preservatives). It is roughly estimated that the biocides contained in consumed wood are the same as in produced wood (except for creosote).

The net consumption of biocides with *vacuum-preserved wood* is estimated on the basis of the registered production, import and export of window and doorframes in Table A2.1 (4418.10.50 and 4418.20.50). The commodity numbers of the statistics also include non-preserved products, and a significant part of the products in 4418.10.50 is not wood. It is estimated that 90% of the wood in products produced in Denmark is preserved, and that vacuum and surface treatment each account for about half of this (Henriksen, 1999). It is assumed that the same applies to exported products, and products imported from the Nordic countries. It is assumed that 20-35% of commodity number 4418.10.50 is wood and that 35-55% of the wood is vacuum-preserved. Commodity number 4418.20.50 is assumed to be 100% wood. It is in addition assumed that there is an interdependency between production and export/import as regards the percentage of the wood vacuum-preserved. On this basis and the figures in Table A2.1, the net export is estimated to equal about 20% of the production. It is presumed that the biocides contained in consumed wood product is the same as used for production of vacuum-preserved wood in Denmark. This assumption is estimated to add an uncertainty to the total consumption of ± 20%.

Import and export of biocides with **surfac**e preserved wood are estimated by the assumption that the wood has been treated with 7 - 11 litres preservative per tonnes. This is based on the assumption that the preservatives cover 6-8 m^2 per litre (information from Danish producer) and that the wood-products have a thickness of 2-3 cm. It is roughly assumed that 35-55% of produced and exported products of commodity number 4418.10.50 and 4418.20.50 is surface preserved (of the first, wood only accounts for 20-35% of the weight). In addition, it is assumed that up to 10% of the import of 4403.10.90 is surface treated (Henriksen1999). As the data of table A2.2 replace 4403.10.90, it is assumed that 5-15% of the Cr-free wood is surface treated. It is in addition presumed that the biocides in imported/exported wood resemble the biocides

used for surface treatment in Denmark. The uncertainty on this assumption is estimated to add an uncertainty on net import of ± 20%.

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