



Draft Assessment Report (DAR)

- public version -

**Initial risk assessment provided by the rapporteur Member State
the Netherlands for the existing active substance**

SODIUM HYPOCHLORITE

**of the fourth stage of the review programme
referred to in Article 8(2) of Council Directive 91/414/EEC**

Volume 3, Annex B, part 4, B8

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B.8 Environmental Fate and Behaviour

B.8.1 Route and rate of degradation in soil (Annex IIA 7.1.1; Annex IIIA 9.1.1)

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no studies were carried out.

In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of soil organisms is not expected. Information on reaction products is not available.

B.8.2 Adsorption, desorption and mobility in soil (Annex IIA 7.1.2 and 7.1.3; Annex IIIA 9.1.2)

See B.8.1.

B.8.3 Predicted environmental concentrations in soil and groundwater (Annex IIIA 9.1.3, 9.2.1)

B.8.3.1 Predicted environmental concentrations in soil (PECs) (Annex IIIA 9.1.3)

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In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of soil organisms is not expected. Information on reaction products is not available.

B.8.3.2 Predicted concentrations in groundwater (Annex IIIA 9.2.1)

Based on the proposed use of the product and the way contaminated used soils are dealt with, the notifier expects that soil will not be exposed to sodium hypochlorite, and therefore no studies were carried out.

In the Netherlands however compost will be spread onto agricultural soil. The hypochlorites break down rapidly (DT50 few minutes) in compost and/or soil. Therefore exposure of groundwater is not expected. Information on reaction products is not available.

B.8.4 Fate and behaviour in water (Annex IIA 7.2.1; Annex IIIA 9.2.1, 9.2.3)

(from EPA red facts):

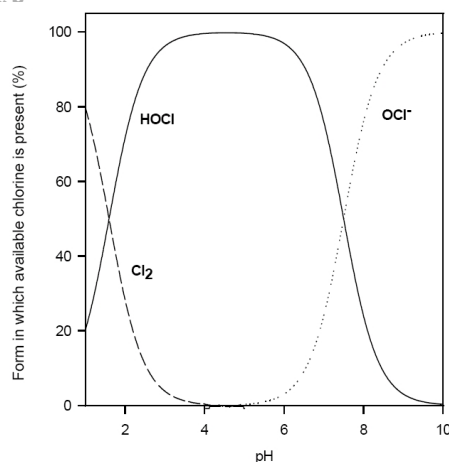
The environmental fate data requirements for the hypochlorite salts are primarily satisfied by the document, Ambient Water Quality Criteria for Chlorine, by J. Tobler, et. al., U.S. EPA, June 1981. In fresh water, the hypochlorites break down rapidly into non-toxic compounds when exposed to sunlight. In seawater, chlorine levels decline rapidly; however, hypobromite (which is acutely toxic to aquatic organisms) is formed. EPA believes that the risk of acute exposure to aquatic organisms is sufficiently mitigated by precautionary labeling and National Pollutant Discharge Elimination System (NPDES) permit requirements.

The pKa of hypochlorous acid is approximately 7.5 at 25°C (WHO, 2000).

In solution the sodium hypochlorite is in equilibrium with chlorine and hypochlorous acid. The equilibrium is temperature and pH dependant (RAR, 2007)

Species in aqueous solution as a function of pH

There are three species of chlorine in equilibrium in water: gaseous chlorine, HOCl (also a gas at room temperature and pressure), and ClO^- . An example of the distribution between them as a function of pH is shown in figure below (example for a 0.1 M Cl_2 solution). For example, at pH 7.5 half of the chlorine is active as HOCl and half is available as ClO^- . The pH of commercial solutions is above 11 and the only species effectively present is ClO^- . At pH12, the equilibrium OCl^-/HOCl is $10^{19.53}$ ($K_a=2.90 \cdot 10^{-8}$ at 25°C). The amount of hypochlorous acid decreases as pH and temperature increase. At pH 7.0 70% is HOCl whereas at pH 8.0 80% is ClO^- when the temperature is 25°C. Therefore in freshwater (characteristic pH range of 6.5-7.2) the dominant form is the more toxic HOCl while at estuarine pH's (7.5-8.2) the reverse is true. At pH values above 4.0, Cl_2 does not exist. Temperature also affects the equilibrium between hypochlorous acid and hypochlorite, but to a much lesser extent than pH, with the ionization content (pKa) for hypochlorous acid decreasing from 7.75 at 5°C to 7.63 at 15°C and 7.54 at 25°C (RAR, 2007).



Chemistry of hypochlorite in polluted water

Chlorine and all of its derived species are oxidative and very reactive compounds. Chlorine gas is a more efficient oxidiser than hypochlorous acid (HOCl), and hypochlorous acid is more efficient than the hypochlorite ion (ClO⁻). The balance between HOCl and ClO⁻ can be studied in polluted water with pH between 4 and 10.

In this case, the kinetic of the reactions and the final products obtained depend for a large extent on the percentage of each of the two species (HOCl, ClO⁻).

The main reaction routes can be described as follows:

- Chlorination with amines R-NH₂ or ammonium NH₄⁺ is very rapid and explains the very fast disappearance of available chlorine in waste water. The chlorine atom linked with a nitrogen atom is expressed as combined chlorine. $R-NH_2 + Cl_2 \rightarrow R-NHCl + H^+ + Cl^-$
If there is, at one point, a large excess of active chlorine over -NH₂, chloramines like R-NCl₂ and NCl₃ are formed. NCl₃ is a very volatile product: the concentration of NCl₃ in air and solution is similar.
- Oxidation reactions occur with many inorganic or organic compounds. Thus, for example, ferrous ion can be transformed into ferric ion, organic radicals can be transformed through hydrolysis, and C-C bonds can be broken. If there are no nitrogen compounds in the solution, this type of reaction is predominant.
- Chlorination of C atoms from organic molecules is easier for molecules with a shorter carbon skeleton. Three typical reactions are: **Reaction with phenol** giving monochlorophenols; **Reaction with molecules containing two carbon atoms**: acetaldehyde, acetonitrile, and acetic acid, which are chlorinated on the CH₃, and give chloroacetaldehydes, chloroacetonitriles and chloroacetic acids; **Reaction with final degradation of the carbon chain** giving THMs and especially CHCl₃ (chloroform).
- AOX is a measure of the number of C-Cl bonds formed in a reaction, expressed as Cl₂ consumed to form these bonds. Part of the AOX content is volatile; the main representative in this case is chloroform. It is very important to distinguish between the volatile and the non-volatile part in order to analyse the AOX. The non-volatile part is of high importance due to the potential stability of some of the components (mainly the chloroacetic and chloroaromatic compounds). Two different scenarios could be studied separately:

When chlorine is maintained constantly in excess, as in:

- swimming pools
- cooling systems
- drinking water

When chlorine is very rapidly and totally transformed into combined chlorine, as in:

- waste water treatment
- household use

- in contact with soil

B.8.4.1 Hydrolysis (Annex IIA 7.2.1.1)

Bleach decomposition is 2nd order with respect to NaOCl concentration. The second order rate law predicts that diluting the NaOCl by a factor of 2 should decrease the rate of NaOCl decomposition by a factor of 4. However, actual decomposition data for sodium hypochlorite solutions shows that a factor of 2 decrease in NaOCl concentration results in an approximate factor of 5 decrease in the rate of decomposition. This is because of the effect on the decomposition rate by the decrease in the total ionic concentration of the solution. Since the dilution of a bleach solution not only decreases the NaOCl concentration but also decreases the concentration of all the ions in the solution (chloride ions, the chlorate ions, hydroxide ions, etc.), the total ionic strength is also decreased and further reduces the decomposition rate (T.C.I., 2006, pamphlet 96).

B.8.4.2 Photolytic degradation (Annex IIA 7.2.1.2)

A sodium hypochlorite solution is very sensitive to light. Direct sunlight may cause rearrangement and decomposition resulting in the formation of chlorate and oxygen. The presence of isocyanuric acid in solution reduces this sensitivity to a great extent (RAR, 2007).

Half life of a 10 to 15% available chlorine solution will be reduced 3 to 4 times by sunlight. (IUCLID, 2000).

B.8.4.3 Biological degradation

B.8.4.3.1 Ready biodegradability (Annex IIA 7.2.1.3.1)

No studies are available. Not ready biodegradable.

(from AISE)

Hypochlorite in itself represents no BOD/COD load. In fact it reduces the COD by oxidising organic matter. The biodegradability of individual halogenated organic compounds depends mainly on:

- (1) their degree of halogenation (it decreases with increasing halogenation)
- (2) the positions of the halogen atoms and other substituents, as this is important for the degradation pathway
- (3) the molecular weight (Neilson et al, 1991).

Enzymatic (hydrolytic, oxidative and reductive) as well as non-biological (photolytic, radical) dehalogenation mechanisms have been described (eg Leisinger & Brunner, 1986; Stora Teknik, 1990, Janssen et al, 1991). As a rough guideline, aerobic biological metabolism can cope with 2-3 halogen

substituents, while reductive (anaerobic) dehalogenation may cope with higher substitutions (Gottschal & Gerritse, 1996).

However, an individual assessment of each compound based on the number and position of the substituents is needed to predict more exactly the biodegradation potential and route (Neilson et al, 1991).

B.8.4.3.2 Water-sediment studies (Annex IIA 7.2.1.3.2)

No studies are available. The hypochlorites break down rapidly. Therefore a DT50 in STP of 1 h is assumed.

B.8.5 Impact on water treatment procedures (Annex IIIA 9.2.2)

(from AISE)

Due to its use in irrigation water in mushroom crop, some residual hypochlorite may be present in the discharged waste water. In drains and sewers, residual hypochlorite will further react with inorganic and organic sewage components, which are in excess over hypochlorite. The hydraulic residence time in these systems is typically 1-24 hours.

The pH of well-buffered municipal sewage (7-8.5) is not affected by the discharge of hypochlorite at the above mentioned concentrations. A pH of 7.5 implies a 50:50 ratio of HOCl and OCl⁻, and the presence of the more reactive hypochlorous acid (HOCl) than in the toilet bowl, with its elevated pH conditions. A typical COD value of domestic waste water would be around 400 mg/l, versus 0.25-4 mg NaOCl/l. The average ratio of hypochlorite to other sewage constituents is therefore very low (<<1). During peak emissions only, it can reach up to 1:1 locally.

The following organic sewage constituents were found in mechanically treated sewage, in decreasing order of concentration (Painter, 1971):

- Fats and greases, free and esterified, saturated and unsaturated fatty acids (174 mg/l),
- Carbohydrates, ranging from simple sugars to complex polysaccharides, starch, etc. (104 mg/l),
- Proteins and their breakdown products like amino acids (60 mg/l), volatile acids (25 mg/l),
- Surfactants (23 mg/l),
- Soluble acids (12.5 mg/l),
- Urea and its breakdown products (2-16 mg/l),
- Creatine (6 mg/l),
- Phenols (0.2 mg/l),
- Aliphatic amine (0.1 mg/l).

Reduced inorganic constituents are present at a rather low concentration in municipal sewage (mostly <0.1 mg/l), except for ammonia (Painter, 1971). In municipal sewage up to 70 mg/l total-N can be recorded, mainly in the form of urea and proteins (Rueffer, 1964) which are degraded to ammonia. An analysis of sewage in the UK showed 46 mg/l $\text{NH}_3\text{-N}$ and 22 mg/l organic N (Painter, 1971). Hence, ammonia will on average be present at a 10-fold stoichiometric concentration versus hypochlorite, and N-chlorination will be a major process. Monochloramine will be the predominant species.

Formation of THMs and other volatile organohalogens, which require high concentrations of FAC and the completion of a long reaction sequence, is virtually impossible in sewers (Overleggroep Deskundigen Wasmiddelen-Milieu, 1989). At high NaOCl doses (> 10 mg/l) CHCl_3 represents 5-15% of the AOX (Raff et al, 1987). A chlorination study of primary and secondary sewage by Jolley (1975) showed that 99% of the added FAC is consumed in oxidation reactions and only <1% (on Cl weight basis) is incorporated into organic compounds (Jolley, 1975). Forty-six additional OBPs were identified after chlorination. It should be added that the studies were conducted in such a way that a residual FAC content of 2 mg/l was maintained with 60 minutes reaction time to simulate a worstcase situation. A figure around or below 1% AOX formation yield is also cited independently by Mills (1978) and Hull and Reckow (1993). Studies with secondary effluent, using a NaO^{36}Cl tracer, gave comparable results of <1% and 1.4% incorporation of the chlorine into organic sewage constituents (Faith et al, 1980; Koczwara et al, 1983). Mori et al (1978) found that 0.01% of the FAC applied to primary effluents ends up as volatile halogenated compounds.

Raff et al (1987) reported a 0.6% NaOCl-to-AOX conversion upon continuous dosage of 7-10 mg NaOCl/l in an activated sludge unit. The authors noted that the AOX formed was of a polar and macromolecular nature. Figure 4.4 shows another experiment on AOX formation in sewage (Schowanek et al, 1996). Under these experimental conditions there seems to be a threshold effect before chlorination starts. This can probably be attributed to a buffer effect from the presence of reduced compounds, which up to a certain dose are immediately oxidised by the hypochlorite added. The slope of the curve suggests a degree of NaOCl-to-AOX conversion of 0.75-2.25%, depending on the reaction conditions.

In summary, the degree of conversion of NaOCl (FAC) to AOX in sewage is around 1%. This is the same order of magnitude as in laundry wash water. Virtually all identified non-volatile chloroorganic compounds identified in sewage under realistic formation conditions were monochlorinated ones. 5-chlorouracil, 5-chlorouridine, 8-chlorocaffeine, 2-chlorophenol and 8-chloroxanthine were the five compounds present at the highest concentration in the Jolley study (Jolley, 1975). Peeters (1991) suggests that halogenated carboxylic acids, dichloroacetonitrile, chlorocyanide and chloropicrin can also be formed in sewage.

Based on background document edible mushrooms an emission of 0.09% of active substance was discharged to a WWTP (personal communication).

FIELD STUDY RESULTS - IN SITU MONITORING OF AOX FORMATION FROM HYPOCHLORITE

A field monitoring program was carried out on the sewage of five large apartment blocks in the city of Parma, Italy, to quantify in situ the organohalogen compounds emitted as a result of the domestic use of bleach containing sodium hypochlorite (Schowanek et al, 1996). The halogenated by-products present in the sewage were determined as AOX. The average AOX level was determined for three distinct experimental phases, each lasting 21 days: an "undisturbed period", a "no bleach period", and a "period with monitored bleach consumption". The study involved the participation of the site inhabitants in the second and the third phase. This design allowed in a highly realistic way to 1) compare a bleach-use situation with a no-bleach use situation, and 2) to quantify the fraction of NaOCl involved in halogenation reactions.

While all average AOX concentrations observed in this study fell within the typical range for domestic sewage across Europe (around ca. 50-250 µg AOX/l), an effect from the use of hypochlorite bleach on the AOX concentration in domestic sewage was detected. In absolute terms, the difference in average sewage concentration between a "no bleach" (106 µg AOX/l) and an "undisturbed" bleach use situation (143 µg AOX/l) was 37 µg AOX/l ($P < 0.05$). In relative terms, hypochlorite bleach contributed around 26% of the total AOX level in sewage at this particular site. Other sources of AOX in sewage were not quantified in this study. The POX fraction of the AOX was not measured separately.

The degree of NaOCl-to-AOX conversion was of the order of 1.5% (w/w). For perspective, this corresponds to a conversion of 0.075% (w/w) for bleach containing 5% NaOCl. These values are in good agreement with literature data. The average bleach-related AOX emission at the study site was around 7 mg per inhabitant per day. The EOX/AOX ratio, and the identity of the organohalogens was not further investigated in this study (EOX/AOX ratios have been published by Bakker et al, 1995).

B.8.6 Predicted environmental concentrations in surface water and sediment (PEC_{sw}, PEC_{sed}) (Annex IIIA 9.2.3)

B.8.6.1 Predicted concentrations in surface water (Annex IIIA 9.2.3)

The model for the sewage treatment plant as described in USES (1994) for pesticides in the paper industry is used. The dilution factor to surface water is 10. Sodium hypochlorite is not readily biodegradable.

Surface water (PEC_{sw})

Estimations are based on the following assumptions:

water solubility 10000 mg/L (i.e. not rate limiting);

octanol-water partition coefficient = -1;

Dose: 3.15 kg/ha

Number of applications: 40

Interval: 1 d

Kd estimated by model from octanol-water partition coefficient.

DT50 1 h

The removal rate in the WWTP is estimated by EUSES 2.0 based on the Kd value 85.1%.

An emission of 0.09% of active substance discharged to a WWTP.

When 40 times 0.09% * 3.15 kg/ha (0.002835 kg/ha) of sodium hypochlorite is discharged into to a WWTP, EUSES 2.0 estimates the concentration in the influent and effluent of the WWTP to be 3.3E-02 µg/L, and the concentration in surface water 3.3E-03 µg/L (during emission period) and 9.1E-03 µg/L (annual average concentration).

The corresponding available fraction expressed as chlorine (CL₂) estimated by EUSES 2.0 are for the concentration in the influent and effluent of the WWTP to be 3.1E-02 µg/L, and the concentration in surface water 3.1E-3 µg/L (during emission period) and 8.6E-03 µg/L (annual average concentration).

B.8.6.2 Predicted concentrations in sediment (Annex IIIA 9.2.3)

All ecotox data are expressed in mg/L. Therefore no PEC sed calculations are carried out.

B.8.7 Fate and behaviour in air (Annex IIA 7.2.2; Annex IIIA 9.3)

Because hypochlorite solutions are non volatile, no significant potential for dispersion in the air exists. However, hypochlorite may release chlorine when accidentally mixed with acids.

(from AISE)

REACTIONS IN THE ATMOSPHERE

Sodium hypochlorite has negligible volatility, whilst hypochlorous acid has a low volatility. The dimensionless Henry's coefficient for HOCl is estimated as 4.52×10^{-5} (Blatchley et al, 1992), and measured as 0.3 for NCl₃ at pH 7.5 and 20°C by Holzwarth et al (1984). The equilibrium concentration of hypochlorous acid vapour in the gaseous phase above a solution of 0.85g NaOCl/l depends upon the solution pH, as expected from the fact that hypochlorous acid is volatile but the hypochlorite anion is not. It increases from ~0.001 ppm when the solution pH is 11 (similar to usage pH), up to ~10 ppm when the solution pH falls to 7.5 (typical of after-use effluent) (P&G, 1992 - unpublished). The value of 10 ppm is equivalent to ~ 6 mg/m³ hypochlorous acid vapour in the gaseous phase immediately above a litre of a 0.85g NaOCl/l solution.

Any hypochlorous acid vapour reaching the troposphere is likely to undergo rapid photolysis, forming OH• and Cl• radicals (Graedel, 1980). Hydroxyl radicals are the initiators in the majority of atmospheric chemical processes in the troposphere. They can lead to the creation of ozone via reactions with organic

compounds (Atkinson, 1989), the production of nitric and sulfuric acids (contributors to acid rain) and the formation, from hydrocarbons, of aliphatic aldehydes (eye irritants present in smog).

However hydroxyl radicals present in urban atmospheres are primarily formed by Reaction 1 below (Graedel, 1980), and the contribution from the photolysis of bleach-derived hypochlorous acid can be shown to be negligible via a tropospheric budget of reactive chlorine (Graedel & Keene, 1995).

Key reaction



This budget indicates that the background level of about 1.5 ppb is made up from nine species, with one of these, inorganic chlorine (ie HOCl from all uses and/or Cl₂), representing just a few percent of that total. Data recorded above eastern North America gave a value for HOCl + Cl₂ of <26 ppt, and indicated that anthropogenic activities including water purification apparently do not directly emit significant amounts of HOCl to the troposphere (Maben et al, 1993).

Chlorinated species, predominantly hydrogen chloride, exist in the troposphere, mainly above the open oceans, and can upon reaction with OH• also produce chlorine radicals/atoms. The reactions of these radicals have been reviewed in some detail. Available data show that most chlorine atoms in the troposphere are likely to be consumed by organic compounds. This occurs via the abstraction of hydrogen to form hydrogen chloride, rather than by addition to the organic species (Graedel, 1980; Chlorine Institute Pamphlet, 1990; Keene, 1995). This indicates that the chlorination of organic compounds in the atmosphere is likely to be insignificant.

FATE OF HALOGENATED BY-PRODUCTS

ATMOSPHERIC REACTIONS OF THE VOLATILE HALOGENATED BY-PRODUCTS

In domestic use hypochlorite can react with many of the chemical species present in a soil, producing a variety of volatile halogenated compounds. Photolysis is a well-described and efficient degradation mechanism for many of these (Atkinson, 1989; Zetzsch & Becker, 1989).

Chloramines

Initial contact between a high concentration of hypochlorite and ammonium salts is likely to result in the short-term production, via monochloramine and dichloramine, of a small amount of trichloramine. Although this compound is rapidly hydrolysed to dichloramine (Heltz, 1980), a low level of trichloramine would be expected to reach the atmosphere due to its high volatility - it has a Henry's constant of 0.3 at 20°C (Holzwarth et al, 1984; this paper quotes Henry's constants in dimensionless units, but by comparison with the Blatchley et al, 1992, it is believed that they should be in atmospheres). In the atmosphere trichloramine is believed to undergo photolysis. The total maximum

discharge, through ventilation, of trichloramine from the use of chlorinated compounds in swimming pools in France, could be around 2.5 tonnes, and only about 0.2% of the total chlorine consumed

(Verhille, personal communication; Mannschott et al, 1995). Upon dilution of the hypochlorite and lowering of the pH, which occurs during use, only the less chlorinated chloramines are likely to continue to form, with monochloramine being substantially more abundant than dichloramine.

Monochloramine is volatile, with a Henry's constant of 0.45 atm at 20°C (Holzwarth et al, 1984, see above) and a dimensionless value of 3.4×10^{-4} .

However, monochloramine is unstable - at 0°C it will decompose to nitrogen, ammonium chloride and trichloramine (Mellor, 1931). In solution it will decompose by hydrolysis to ammonia and hypochlorous acid with a half-life of 10 hours (Margerum et al, 1978). Monochloramine can also break down in the presence of nitrogenous organics, such as proteins, via the transfer of chlorine to form organic chloramines (Yoon & Jensen, 1995). In view of the instability of monochloramine in solution, the levels in the gas phase above it are likely to be low.

Chloroform

The most abundant of the volatile AOXs formed in the household use of hypochlorite is chloroform, which has been predicted to be present at 15-75 µg/l in toilet cleaning waste water (Peeters, 1991) and measured at levels of 230-1000 µg/l in laundry bleach wash waste water; Smith, 1994; Colgate-Palmolive, 1991 unpublished).

Chloroform has a high vapour pressure of 160 mm Hg (0.21 atm.) at 20°C (Verschueren, 1983) and is thus likely to evaporate during use, in sewage treatment and from natural water. The half-life for the evaporation of chloroform from a 6.5 cm depth of a 1 mg/l solution is around 35 minutes at 1-2°C, and around 22 minutes at 25°C (Dilling, 1977). A half-life of 36 h has also been reported by Euro Chlor (1994). Almost complete volatilisation of chloroform can be expected.

From its vapour pressure and water solubility of ~8000 mg/l at 20°C (Verschueren, 1983) a dimensionless Henry's constant of 0.13 can be calculated.

Substantial further reductions in the chloroform concentration would be expected upon mixing within the atmosphere.

There are also many natural sources of chloroform, such as volcanoes, plants (barley, lemon, orange, cedar, moss) (Euro Chlor, 1994), seaweeds (Gribble, 1995) and algae (Siuda, 1979). However, the measured levels of chloroform in air vary from <0.015 to only 15 µg/m³, depending on locality. Far away from anthropogenic sources, chloroform levels range from <0.015-0.225 µg/m³ (van der Heijden et al, 1986), whilst those at urban sites in the US range from 0.3- ~10 µg/m³ (ATSDR, 1991/1993), and in Japanese and European cities from 1 to 15 µg/m³ (Su & Goldberg, 1976). For a total European consumption of commercial hypochlorite product of 1500 x 10E3 te per annum containing 5% NaOCl (Table 1.1), a conversion to AOX of 1.5% (Schowanek et al, 1996), and the assumption that around 30% of the AOX formed is volatile and could be chloroform, then the maximum emission of chloroform to the atmosphere is ~ 340 te. This quantity is insignificant when compared to either the yearly emission of VOCs from natural sources (around 2 million te) or the total yearly emission of VOCs (around 20 million te) in Europe in 1985 (Corinair, 1995).

Available data indicate that chloroform has a residence time in the atmosphere of several months, with calculated half-life of 100-180 days for its degradation. The probable underlying mechanisms are direct photolysis and reactions with strong oxidants such as singlet oxygen or hydroxyl radicals (van der Heijden et al, 1986, Euro Chlor 1994, Zetzsch & Becker, 1989).

Chloroform deposition half-life has been estimated to vary from more than 20 days to 900 years (IPCS EHC 163, 1994). During its presence in the atmosphere, chloroform is not expected to affect ozone levels significantly. It has a Photochemical Ozone Creation Potential (POCP) cited in the VOCs protocol of 0.7, which puts it in the lowest category for VOC controls and with materials whose reduction in emissions are not mandated under the protocol.

As chloroform has a life-time of at most around six months, little or none will reach the stratosphere. Hence if an Ozone Depletion Potential (ODP) were to be assigned to chloroform, under the UNEP Science Assessments for the Montreal Protocol, 1994, its ODP would be defined as zero.

In addition, chloroform has been assigned a low Global Warming Potential (GWP) of 25 for a 100 years time horizon, and qualitatively is shown to have a negative indirect contribution (Houghton et al, 1992).

B.8.8 Predicted environmental concentrations in air (PECA) (Annex IIIA 9.3)

Based on a vapour pressure of 1.74 – 2.0 kPa at 20°C, which is in fact the vapour pressure of water suggest that the concentrations of sodium hypochlorite in air are likely to be negligible and no PEC_{air} was calculated.

B.8.9 Definition of the residue (Annex IIA 7.3)

The major components of the environmental residue are as follows:

Soil

None

Water and sediment

Sodium hypochlorite/chlorine

Air

None

B.8.10 References relied on**References for the active substance**

Annex point / reference number	Author(s)	Year	Title Company Report No. Source (where different from company) GLP or GEP status Published or not	Data Protection Claimed Y/N	Owner
IIA 7	RAR (unknown)	2007	RISK ASSESSMENT REPORT FOR SODIUM HYPOCHLORITE, DRAFT November 2007 Italy non GLP Published (via ECB website)	N	ECB
IIA 7.2.1	T.C.I.	2006	Pamphlet 96, Sodium Hypochlorite Manual The Chlorine Institute inc. Edition 3, April 2006 Non GLP Published (http://www.chlorineinstitute.org/)	N	The Chlorine Institute
IIA 7.2.1	WHO	2000	Environmental Health Criteria 216, DISINFECTANTS AND DISINFECTANT BY-PRODUCTS Version November 30, 2000 Published non-GLP	N	WHO
IIA 7.2.1	EPA RED facts	1991	R.E.D. Facts Sodium and Calcium Hypochlorite Salts United States environmental Protection Agency, Pesticides And Toxic Substances (7508W), 738-F-91-108, September 1991.	N	EPA
IIA 7.2.1; 7.2.2	Association Internationale de la Savonnerie, de la Détergence et des Produits d'Entretien (AISE)	1997	Technical Task Force HYPOCHLORITE BENEFITS AND SAFETY ASPECTS OF HYPOCHLORITE FORMULATED IN DOMESTIC PRODUCTS SCIENTIFIC DOSSIER March 1997	N	AISE

References for the plant protection product

Annex point / reference number	Author(s)	Year	Title Company Report No. Source (where different from company) GLP or GEP status Published or not	Data Protection Claimed Y/N	Owner
IIIA 9.2.2; 9.3	Association Internationale de la Savonnerie, de la Détergence et des Produits d'Entretien (AISE)	1997	Technical Task Force HYPOCHLORITE BENEFITS AND SAFETY ASPECTS OF HYPOCHLORITE FORMULATED IN DOMESTIC PRODUCTS SCIENTIFIC DOSSIER March 1997	N	AISE