FOREWORD INTRODUCTION

SODIUM HYDROXIDE

CAS N°: 1310-73-2

SIDS Initial Assessment Report

For

SIAM 14

Paris, 26-28 March 2002

1. Chemical Name:	Sodium hydroxide
2. CAS Number:	1310-73-2
3. Sponsor Country:	Portugal
4. Shared Partnership with:	–
5. Roles/Responsibilities of the Partners:	–
• Name of industry sponsor /consortium	Solvay, Belgium
• Process used	–
6. Sponsorship History	The documents were prepared through the ICCA initiative (Solvay) and reviewed by the Portuguese authorities.
• How was the chemical or category brought into the OECD HPV Chemicals Programme?	–
7. Review Process Prior to the SIAM:	–
8. Quality check process:	–
9. Date of Submission:	–
10. Comments:	–

SIDS INITIAL ASSESSMENT PROFILE

CAS No.	1310-73-2
Chemical Name	Sodium hydroxide
Structural Formula	NaOH

RECOMMENDATIONS

The chemical is currently of low priority for further work.

SUMMARY CONCLUSIONS OF THE SIAR

Human Health

Solid NaOH is corrosive. Depending on the concentration, solutions of NaOH are non-irritating, irritating or corrosive and they cause direct local effects on the skin, eyes and gastrointestinal tracts. Based on human data concentrations of 0.5-4.0 % were irritating to the skin, while a concentration of 8.0 % was corrosive for the skin of animals. Eye irritation data are available for animals. The non-irritant level was 0.2-1.0 %, while the corrosive concentration was 1.2 % or higher. A study with human volunteers did not indicate a skin sensitisation potential of sodium hydroxide. This is supported by the extensive human experience.

The acute toxicity of sodium hydroxide depends on the physical form (solid or solution), the concentration and dose. Lethality has been reported for animals at oral doses of 240 and 400 mg/kg bw. Fatal ingestion and fatal dermal exposure has been reported for humans.

No valid animal data are available on repeated dose toxicity studies by oral, dermal, inhalation or by other routes for NaOH. However, under normal handling and use conditions (non-irritating) neither the concentration of sodium in the blood nor the pH of the blood will be increased and therefore NaOH is not expected to be systemically available in the body. It can be stated that the substance will neither reach the foetus nor reach male and female reproductive organs, which shows that there is no risk for developmental toxicity and no risk for toxicity to reproduction. Both *in vitro* and *in vivo* genetic toxicity tests indicated no evidence for a mutagenic activity.

Based on the available literature, there is a risk for accidental and intentional exposure to solid NaOH or to irritating or corrosive solutions of NaOH. Most of the ingestion accidents seem to be related with children and seem to occur at home. Accidental skin and eye exposure seem to be less frequently reported than ingestion in the medical literature. Dust formation is unlikely because of hygroscopic properties. Furthermore NaOH has a negligible vapour pressure and is rapidly neutralized in air by carbon dioxide and therefore dust and vapour exposure are not expected.

Environment

The hazard of NaOH for the environment is caused by the hydroxyl ion (pH effect). For this reason the effect of NaOH on the organisms depends on the buffer capacity of the aquatic or terrestrial ecosystem. Also the variation in acute toxicity for aquatic organisms can be explained for a significant extent by the variation in buffer capacity of the test medium. LC50 values of acute toxicity tests with aquatic organisms ranged between 33 and 189 mg/l.

Because the buffer capacity, the pH and the fluctuation of the pH are very specific for a certain ecosystem it was not considered useful to derive a PNEC or a $PNEC_{added}$. To assess the potential environmental effect of an NaOH discharge, the pH change of the receiving water should be calculated or measured. The change in pH should be compared with the natural variation in pH of the receiving water and based on this comparison t should be assessed

if the pH change is acceptable.

The use of NaOH could potentially result in an emission of NaOH and it could locally increase the pH in the aquatic environment. However, the pH of effluents is normally measured very frequently and can be adapted easily and therefore a significant increase of the pH of the receiving water is not expected. If emissions of waste water are controlled by appropriate pH limits and/or dilutions in relation to the natural pH and buffering capacity of the receiving water, adverse effects on the aquatic environment are not expected due to production or use of NaOH.

Aquatic sodium emissions originating from uses of NaOH are probably small compared to other sources. It is clear that an environmental hazard assessment of sodium should not only evaluate all natural and anthropogenic sources of sodium but should also evaluate all other ecotoxicity studies with sodium salts, which is beyond the scope of this report.

Exposure

Estimated worldwide demand of sodium hydroxide was 44 million tonnes expressed as NaOH 100% in 1999. The global demand is expected to grow with 3.1% per year.

NaOH is commercialised as a solid or as solutions with varying concentrations. NaOH solidifies at 20 °C if the concentration is higher than 52 % (by weight), which can be considered the maximum water solubility at 20 °C. NaOH has many industrial uses but it has also wide dispersive use. It is used for example for cleaning, disinfection, wood treatment and to make soap at home, but many other uses could exist.

NATURE OF FURTHER WORK RECOMMENDED

Environment and human health: no further work is recommended if sufficient control measures are in place to avoid significant human and environmental impact, including prevention of accidental exposure.

Due to the corrosivity of the substance, no further studies are required under the SIDS programme.

In the EU a risk assessment will be performed according to Council Regulation 793/93.

FULL SIDS SUMMARY

CAS N° 1310-73-2		SPECIES	PROTOCOL	RESULTS
PHYSICO-CHEMICAL				
2.1	Melting point		Data of Oxychem Caustic Soda Handbook	318 °C (solid, 100 %) 140 °C (solution of 80 %) 42 °C (solution of 60 %) 16 °C (solution of 40 %) -26 °C (solution of 20 %)
2.2	Boiling point		Data of Oxychem Caustic Soda Handbook	1388 °C at 1013 hPa (solid, 100 %) 216 °C at 1013 hPa (solution of 80 %) 160 °C at 1013 hPa (solution of 60 %) 128 °C at 1013 hPa (solution of 40 %) 118 °C at 1013 hPa (solution of 20 %)
2.3	Density		Data of Oxychem Caustic Soda Handbook	2.13 at 20 °C (solid, 100 %) 1.43 at 20 °C (solution of 40 %) 1.22 at 20 °C (solution of 20 %)
2.4	Vapour pressure		Data of Oxychem Caustic Soda Handbook	55 hPa at 1000 °C < 10-5 hPa at 25 °C (calculation)
2.5	Partition coefficient	Not relevant for ionisable compounds		
2.6	Water solubility	Miscible at all proportions.		
2.11	Oxidising properties	Not applicable		
2.12	Additional remarks	Vigorous exothermic reaction when sodium hydroxide is added to water.		
ENVIRONMENTAL FATE AND PATHWAY				
3.1.1	Photodegradation	Not applicable		
3.1.2	Stability in water	Strong alkaline substances that dissociates fully. The concentration of OH- (pH) is in general regulated by the equilibria between CO2, HCO3- and CO32-. In general the buffer capacity depends on the concentration of these substances.		
3.2	Monitoring data	The pH has been monitored very extensively in ecosystems. Significant differences in concentrations between ecosystems occur. The most important freshwater aquatic ecosystems of the world revealed average annual pH values between 6.5 and 8.3 (UNEP, 1995). Also sodium has been measured extensively in aquatic ecosystems. For example UNEP (1995) reported the concentration for a total number of 75 rivers in North-America, South-America, Asia, Africa, Europe and Oceania. The 10th–percentile, mean and 90th-percentile were 1.5, 28 and 68 mg/l, respectively.		
3.3	Transport and Distribution	Very mobile in soil and very soluble in water. No transport to air.		
3.5	Biodegradation	Not applicable		
ECOTOXICOLOGY				
4.1	Acute/prolonged toxicity to fish	Ceriodaphnia sp.: EC50 = 40 mg/l (Warne et al., 1999). No other valid studies available. The hazard of NaOH for the environment is caused by the hydroxyl ion (pH effect). For this reason the effect of NaOH on the organisms depends on the buffer capacity of the aquatic or terrestrial ecosystem (see also 3.1.2). Also the variation in acute toxicity for aquatic organisms can be explained for a significant extent by the variation in buffer capacity of the test medium. LC50 values ranged between 33 and 189 mg/l. Because the buffer capacity, pH and the fluctuation of the pH are very specific for a certain ecosystem it was not considered useful to derive a PNEC. For this reason there is no need for additional toxicity testing with NaOH.		
4.2	Acute toxicity to aquatic invertebrates			
4.3	Toxicity to aquatic plants e.g. algae			
4.4	Toxicity to micro-organisms e.g. bacteria			
4.5.1	Chronic toxicity to fish			
4.5.2	Chronic toxicity to aquatic invertebrates			

CAS N° 1310-73-2		SPECIES	PROTOCOL	RESULTS
TOXICOLOGY				
5.1.1 5.1.2 5.1.3	Acute Oral Acute Inhalation Acute Dermal	No valid studies available. Although valid studies with animals are not available, intentional and accidental ingestion of NaOH by humans has been reported frequently in the literature and for this reason there is no need for additional oral testing with animals. Furthermore gavage dosing of animals will not represent oral exposures in humans. The existing animal and human data on acute toxicity show that NaOH has a local effect and that systemic effects are not to be expected.		
5.2.1	Skin irritation/corrosion	Human	Patch Test, 0.2 ml	0.5 %: irritating for 55 % of volunteers
		Human	Patch test, 0.2 ml	0.5 %: irritating for 61 % of volunteers
		Human	Different protocols	1.0 %: irritating for about 50 % of volunteers
		Human	Filter paper discs	0.5 and 1.0 %: irritating
5.2.2	Eye irritation/Corrosion	Rabbit	Dose of 0.1 ml, EPA (1981) criteria for classification	0.004-0.2 %: non-irritant 0.4 %: mild 1.2 %: corrosive
		Rabbit	Modified Draize testing	0.1 and 0.3 %: no conjunctivitis nor iritis 1.0 and 3.0 %: conjunctivitis and iritis
		Rabbit	OECD Guideline 405	1 %: Not irritating 2 %: Irritating
5.4	Repeated dose	No valid studies available. However, under normal handling and use conditions (non-irritating) NaOH is not expected to be systemically available in the body. For this reason additional testing for repeated dose toxicity is considered unnecessary.		
5.5	Genetic Toxicity In vitro			
A.	Bacterial Test	S. typhimurium	Ames reversion test	- (without metabolic activation) - (with metabolic activation)
		E. coli	DNA repair test	- (without metabolic activation) - (with metabolic activation)
B.	Non-Bacterial In Vitro Test	Chinese hamster ovary (CHO) K1 cells	Chromosome aberration test	- (without metabolic activation) + (with metabolic activation), probably due to formation of clastogenic breakdown products of S9
5.6	Genetic Toxicity In vivo	Mouse bone-marrow cells	Micronucleus test	Negative
5.8	Reproduction Toxicity	No valid studies available. NaOH is not expected to be systemically available in the body under normal handling and use conditions (non-irritating) and for this reason it can be stated that the substance will not reach the foetus nor reach male and female reproductive organs. It can be concluded that a specific study to determine the developmental toxicity or the toxicity to reproduction is not necessary.		
5.9	Development / Teratogenicity			
5.11	Human experience	Many publications are included in the IUCLID dossier.		

SIDS Initial Assessment Report

1 IDENTITY

1.1 Identification of the Substance

CAS Number:	1310-73-2
IUPAC Name:	Sodium hydroxide
Molecular Formula:	NaOH
Structural Formula:	NaOH
Molecular Weight:	40
Synonyms:	Caustic soda
	Lye

1.2 Purity/Impurities/Additives

Sodium hydroxide is a white and deliquescent solid. Impurities are sodium chloride (≤ 2 %) and sodium carbonate (≤ 1.0 %), sulfate (≤ 0.2 %), while the concentration of other impurities is less than 0.1 %.

1.3 Physico-Chemical properties

It has a melting point and boiling point of 318 and 1388 °C, respectively. NaOH solidifies at 20 °C if the concentration is higher than 52 % (by weight), which can be considered the maximum water solubility at 20 °C. NaOH has a very low vapour pressure (< 10^{-5} hPa at 25 °C). The octanol water partition coefficient is not relevant for an inorganic substance such as NaOH.

NaOH is a strong alkaline substance that dissociates completely in water to sodium and hydroxyl ions. The dissolution/dissociation in water is strongly exothermic, so a vigorous reaction occurs when NaOH is added to water.

2 GENERAL INFORMATION ON EXPOSURE

2.1 Production Volumes and Use Pattern

Estimated world-wide demand of sodium hydroxide was 44 million tonnes expressed as NaOH 100% in 1999 (CMAI, 2000). The estimated production of NaOH in Western Europe was 9.3 million tonnes in 1998 (Euro Chlor, 1999). The global demand for NaOH is expected to grow with 3.1 % per year.

NaOH is produced via electrolysis of sodium chloride, which can be done via the mercury, membrane or diaphragm process. NaOH is commercialised as a solid (cast, flakes, pearls, compounders) or as solutions with varying concentrations. The most important industrial concentration is 50 %.

NaOH has mainly industrial uses. On a global level the main uses are (CMAI, 2000):
- Organic chemicals (18 %)
- Pulp and paper (18 %)
- Inorganic chemicals (15 %)
- Soaps, detergents and textile (12 %)
- Alumina (8 %)
- Water treatment (5 %)
- Others (25 %)

NaOH is also used by the drink and beer industry to clean non-disposable bottles. Although main quantities are used by the industry (large enterprises) it is also widely used by small and medium sized enterprises. It is used for example for disinfection and cleaning purposes.

NaOH (up to 100 %) is also used by consumers. It is used at home for drain and pipe cleaning, wood treatment and it also used to make soap at home (Keskin et al., 1991; Hansen et al., 1991; Kavin et al., 1996). NaOH is also used in batteries and in oven-cleaner pads (Vilogi et al, 1985).

The previously mentioned uses are only examples of uses but probably many other uses do occur because NaOH is widely available. However, significant differences in uses between countries can be expected.

2.2 Environmental Exposure and Fate

The high water solubility and low vapour pressure indicate that NaOH will be found predominantly in the aquatic environment. NaOH is present in the environment as sodium and hydroxyl ions, which implies that it will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. It is obvious that both sodium and hydroxyl ion have a wide natural occurrence (UNEP, 1995).

Atmospheric emissions of NaOH are rapidly neutralized by carbon dioxide or other acids and the salts (e.g. sodium carbonate) will be washed out by rain (Cooper et al., 1979). For this reason potential atmospheric emissions of NaOH are considered of no concern. Significant emissions to the terrestrial environment are not expected during normal handling and use of NaOH. Small terrestrial emissions will be neutralized by the buffer capacity of the soil. For this reason the environmental assessment can be limited to the aquatic compartment. Because NaOH does occur in the environment as Na^+ and OH^- a separate environmental assessment of both the sodium and the hydroxyl ion is needed.

Measured concentrations in aquatic ecosystems

The concentration of hydroxyl ions in the environment has been determined very extensively via pH measurements. The pH is a very important parameter of aquatic ecosystems and it is a standard parameter of water quality monitoring programmes. The most important freshwater aquatic ecosystems of the world revealed average annual pH values between 6.5 and 8.3 but lower and higher values have been measured in other aquatic ecosystems (UNEP, 1995). In aquatic ecosystems with dissolved organic acids a pH of less than 4.0 has been measured, while in waters with a high chlorophyll content the bicarbonate assimilation can result in pH values of higher than 9.0 at midday (UNEP, 1995). The pH of an aquatic ecosystem is mainly determined by geochemical, hydrological and/or biological processes.

Also sodium has been measured extensively in aquatic ecosystems. For example UNEP (1995) reported the concentration for a total number of 75 rivers in North-America, South-America, Asia, Africa, Europe and Oceania. The 10^{th} –percentile, mean and 90^{th}-percentile were 1.5, 28 and 68 mg/l, respectively.

NaOH addition and buffer capacity

An addition of NaOH to an aquatic ecosystem may increase the pH depending on the buffer capacity of the receiving water. In general the buffer capacity is regulated by the equilibria between CO_2, HCO_3^- and CO_3^{2-}:

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ (pKa1 = 6.35)

$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ (pKa2 = 10.33)

If the pH is between 7 and 9 then the bicarbonate ion is the most important species responsible for the buffer capacity of aquatic ecosystems. UNEP (1995) reported the bicarbonate concentration for a total number of 77 rivers in North-America, South-America, Asia, Africa, Europe and Oceania. The 10^{th} –percentile, mean and 90^{th}-percentile were 20, 106 and 195 mg/l, respectively. To underline the importance of the buffer capacity, a table is included with the concentration of NaOH needed to increase the pH to value of 9.0, 10.0, 11.0 and 12.0 at different bicarbonate concentrations (Table 1). The data of Table 1 were based on calculations but they were confirmed by experimental titrations (De Groot et al., 2002).

Use of NaOH and anthropogenic exposure

The use of NaOH could potentially result in an aquatic emission of NaOH and it could locally increase the sodium concentration and the pH in the aquatic environment.

The pH of effluents is normally measured very frequently, can be adapted (neutralized) easily and therefore a significant increase of the pH of the receiving water is not expected. However, in regions where the pH of effluents is not regulated, a NaOH discharge might cause a significant increase in the pH of the receiving water.

Table 1: Concentration of NaOH (mg/l) needed to increase the pH to values of 9.0, 10.0, 11.0 and 12.0 (De Groot et al., 2002).

Buffer capacity[A]	Final pH			
	9.0	10.0	11.0	12.0
0 mg/l HCO_3^- (distilled water)	0.4	4.0	40	400
20 mg/l HCO_3^- (10^{th} percentile of 77 rivers)	1.0	8.2	51	413
106 mg/l HCO_3^- (mean value of 77 rivers)	3.5	26	97	468
195 mg/l HCO_3^- (90^{th} percentile of 77 rivers)	6.1	45	145	525

[A] The initial pH of a bicarbonate solution with a concentration of 20-195 mg/l was 8.25-8.35.

Specific analytical data or other reliable data about the use of NaOH and the related emissions of sodium are not available. However, it should be realised that emissions originating from the use of NaOH are probably small compared to other anthropogenic sources of sodium e.g. mining and use of road salt. According to UNEP (1995) the sodium and chloride concentrations in water are tightly linked for the major rivers of the world. It is thus clear that an environmental hazard assessment of sodium should evaluate all the natural and anthropogenic sources.

2.3 Human Exposure

NaOH has many industrial and domestic uses and it is available to the general public. Furthermore the substance has been used already for a long time. For this reason accidental or intentional acute exposures (suicide) have been described extensively in the medical literature. Many medical case reports and reviews of medical treatment methods of NaOH burns are available.

Ingestion

According to Schober et al. (1989) between January 1976 and October 1988 a total number of 6 cases of ingestion of NaOH was reported by the Children Surgery Department (University of Graz, Austria). The University Hospital of Santiago de Compostela (Spain) reported about 67 cases of accidental ingestion of NaOH by children between 1981 and 1990 (Casasnovas et al., 1997). Most of the accidents occurred at home and the container was located within easy reach of the children. A nationwide survey of ingestion of corrosives has been performed for the period 1984-1988 in Denmark (Clausen et al., 1994). It revealed 57 admissions to hospital of children (0-14 years) due to NaOH ingestion. The authors were confident that all children with serious complications after ingestion of corrosives were included in the study.

At the Department of Paediatric Surgery (Adana, Turkey) 71 cases of NaOH ingestion by children were reported in a period of 12 years (Keskin et al., 1991). On the West Bank of Israel a total number of 29 children were admitted to hospital due to accidental NaOH ingestion between 1990 and 1997 (Yasser et al., 1998). Lye is used in this area for home made soap. At the Shands Hospital at the University of Florida 15 children were admitted between 1973 and 1984 which had ingested NaOH (Moazam et al., 1987).

All previously mentioned publications reported accidental ingestion of NaOH by children. Wijburg et al. (1985) reviewed the records of 170 patients admitted to the Department of Otolaryngology of the University Hospital of Amsterdam in the period January 1, 1971 to December 31, 1981 with suspected caustic ingestion. Of these 170 patients about 15 patients had ingested NaOH. Only in this case it was not clear if children were involved.

Humans can be exposed to sodium due to accidental or intentional ingestion of NaOH. However, humans are exposed daily to sodium via dietary uptake of sodium chloride. A normal uptake of sodium via food is 3.1-6.0 g per day according to Fodor et al. (1999).

Skin and eyes

A total of 23 burns of the eye due to NaOH or KOH were admitted to the eye clinic of the RWTH Aachen in Germany from 1985 to 1992 (Kuckelkorn et al., 1993). In 17 cases the accident happened during work, while 6 cases occurred at home using NaOH/KOH as drain cleaner. The alkali burns were of special interest because of the rapid and deep penetration of alkali into the ocular tissues.

From January 1984 to June 1991 a total number of 24 patients were treated for NaOH related eye injury in the Department of Ophthalmology, Postgraduate Institute of Medical Education and Research, Chandigarh, India (Saini et al., 1993). Over half of the patients which had ocular chemical burns were young people working in laboratories and factories.

Inhalation

For production and major uses of NaOH aerosols do normally not occur. However, for certain specific uses, e.g. cleaning ovens and disinfection of sheds, the formation of aerosols can not be excluded completely. For example the cleaning of ovens could result in an irritation of the throat due to the presence of NaOH in the air. However, it should be realised that aerosols of NaOH are not stable. They are rapidly transformed due to an uptake of carbon dioxide from the atmosphere resulting in the formation of sodium bicarbonate and sodium carbonate. The transformation of respirable NaOH aerosols into sodium carbonate aerosols can occur in seconds (Cooper et al., 1979). Analytical measurements, to determine the inhalation exposure of workers during production and use, seem to be unavailable.

3 HUMAN HEALTH HAZARDS

3.1 Effects on Human Health

NaOH has been used for a long time and has wide dispersive use and therefore there is information on human exposure and effects. For this reason the human health hazard assessment is not only based on animal toxicity data but also on human experience (including medical data). For this unique situation it was thought more appropriate to discuss the animal data and human data together for each SIDS element.

The major human health hazard (and the mode of action) of NaOH is local irritation and/or corrosion and therefore a separate section on skin and eye irritation/corrosion was included in the SIAR, although irritation/corrosion is not a SIDS element.

3.1.1 Toxicokinetics, Metabolism and Distribution

Sodium is a normal constituent of the blood and an excess is excreted in the urine. A significant amount of sodium is taken up via the food because the normal uptake of sodium via food is 3.1-6.0 g per day according to Fodor et al. (1999). Exposure to NaOH could potentially increase the pH of the blood. However, the pH of the blood is regulated between narrow ranges to maintain homeostasis. Via urinary excretion of bicarbonate and via exhalation of carbon dioxide the pH is maintained at the normal pH of 7.4-7.5.

When humans are dermally exposed to low (non-irritating) concentrations, the uptake of NaOH should be relatively low due to the low absorption of ions. For this reason the uptake of NaOH is expected to be limited under normal handling and use conditions. Under these conditions the uptake of OH^-, via exposure to NaOH, is not expected to change the pH in the blood. Furthermore the uptake of sodium, via exposure to NaOH, is much less than the uptake of sodium via food under these conditions. For this reason NaOH is not expected to be systemically available in the body under normal handling and use conditions.

An example will be given for an inhalation exposure scenario. Assume an exposure to an NaOH concentration of $2 mg/m^3$, which is the TLV in the USA, and a respiratory volume of 10 m^3 per day. In this case the daily exposure is 20 mg NaOH.

The amount of 20 mg NaOH is equivalent with 11.5 mg sodium which is a negligible amount compared to the daily dietary exposure of 3.1-6.0 g (Fodor et al., 1999). The amount of 20 mg NaOH is equivalent with 0.5 mmole and if this amount would be taken up in the blood stream it would result in a concentration of 0.1 mM OH^- (assuming 5 litre blood per human). This is a negligible amount when it is compared with the bicarbonate concentration of 24 mM of blood. This example confirms that NaOH is not expected to be systemically available in the body under normal handling and use conditions.

3.1.2 Acute Toxicity

Studies in Animals

Dermal

The hair of adult mice was clipped and a circular area 2 cm in diameter was painted by applicator with 50 % NaOH (Bromberg et al., 1965). Afterwards the area was irrigated with water at various intervals. The mortality of mice was 20, 40, 80 and 71 % when they were irrigated 30 minutes, 1 h, 2 h or not at all after the application. The animals were observed daily for up to 7 days after the

treatment. All animals developed rapidly progressive burns. No mortality or burns were observed when the mice were irrigated immediately after the application.

Oral

No acute oral toxicity study with animals has been carried out using (inter)national guidelines. An acute oral study with 1-10 % NaOH and rabbits revealed an LD50 of 325 mg/kg bw expressed as 100 % NaOH (Naunyn-Schiedeberg, 1937). Mortality was also observed when 1 % NaOH was dosed but in this case the applied volume was relatively high (24 ml per kg body weight). Another acute oral toxicity study has been reported in secondary literature but the original reference could not be found. This study indicated an LDL0 of 500 mg/kg bw in the rat. The gastric erosive activity of NaOH was studied with rats using a maximum erosion score of 100 (Van Kolfschoten et al., 1983). NaOH concentrations of 0.4; 0.5 and 0.62 % resulted in erosion scores of 10, 65 and 70 %, respectively.

Studies in Humans

Inhalation

No animal data are available on the acute inhalation toxicity. However, the inhalation of aerosols of 5 % NaOH by a 25-year-old women resulted in irreversible obstructive lung injury after working for one day in a poorly ventilated room (Hansen et al., 1991). Besides NaOH the product contained also smaller amounts of calcium carbonate, soft soap and protein.

Dermal

A fatal burn due to dermal NaOH exposure of a worker at an aluminum plant has been reported (Lee et al., 1995). He was found lying in a shallow pool of concentrated NaOH, which had been heated to ~95 °C.

Oral

The degree and type of injury after ingestion of NaOH depend on the physical form. Solid NaOH produces injury to the mouth and pharynx and is difficult to swallow. On the other hand liquid NaOH is easily swallowed, being tasteless and odorless, and is more likely to damage the esophagus and stomach (Gumaste et al., 1992).

Cello et al. (1980) described 9 cases of liquid NaOH ingestion, which resulted in esophageal and gastric injury. One person who ingested 10 g NaOH in water suffered transmural necrosis of the esophagus and stomach and died 3 days after admission to the hospital. A 42-year-old female swallowed approximately 30 ml of 16 % NaOH in a suicide attempt (Hugh et al., 1991). This resulted in a 9-cm stricture of the esophagus which was treated by gastric antral patch esophagoplasty.

Conclusion

NaOH is a corrosive substance and for this reason there is no need for further acute toxicity testing.

3.1.3 Irritation

Skin Irritation

Studies in Animals

An *in vivo* test was conducted with Yorkshire weanling pigs using applications of 2N (8 %), 4N (16 %) and 6N (24%) NaOH on the lower abdominal region (Srikrishna et al., 1991). Gross blisters developed within 15 minutes of application and 8 and 16 % NaOH produced severe necrosis in all

epidermal layers. A concentration of 24 % produced numerous and severe blisters with necrosis extending deeper into the subcutaneous tissue. Also an *in vitro* test was performed with isolated perfused skin flaps of Yorkshire weanling pigs using NaOH concentrations of 4N (16 %) and 6N (24%). At both concentrations NaOH showed severe necrosis of all epidermal cell layers and dermis. At times this lesion extended deep into the subcutaneous layers.

Studies in Humans

The valid *in vivo* skin irritation studies with solutions of NaOH are summarized in Table 2. Studies were valid if they were well documented and if they met generally accepted scientific principles.

A NaOH concentration of 0.5 % was tested within an interlaboratory evaluation of a human patch test for the identification of skin irritation hazard (Griffiths et al., 1997). A 25 mm Plain Hill Top Chamber containing a Webril pad was used and the treatment sites were assessed for irritation using a four-point scale at 24, 48 and 72 h after initiation of exposure. NaOH 0.5 % was irritating for 55 % of the volunteers.

A human skin irritation test with 0.5 % NaOH was performed using exposure periods of 15, 30 and 60 minutes (York et al., 1996). The treatment sites were assessed 24, 48 and 72 h after patch removal. The results showed that after a maximum exposure of 60 minutes, 61 % of the volunteers (20 of 33) showed a positive skin irritation reaction.

Four different patch systems, Finn chamber, Hill Top patch, Van der Bend chamber and Webril patch, were used to determine the skin irritation response of 1 % NaOH (York et al., 1995). Webril and Hill top patches generated the greatest levels of response. Eleven of 14 and 5 of 14 volunteers showed a positive skin reaction after 30 minutes for Webril and Hill top patches, respectively. With Finn and Van der Bend chambers 5 of 14 and 7 of 14 volunteers showed a positive reaction after 4 hours, respectively, which shows that the reactivity was reduced with these systems.

Table 2: Human in vivo skin irritation tests with NaOH

Species, Test Type	Protocol	Concentration	Result	Reference
Human, upper outer arm	0.2 ml applied to a Plain Hill Top Chamber with Webril pad, 1 h exposure	0.5 %	Irritating for 55 % of the volunteers	Griffiths et al. (1997)
Human, upper outer arm	Human patch testing with Hill Top Chambers, exposure between 15 and 60 min, 0.2 ml	0.5 %	Positive irritant for 61 % of volunteers	York et al. (1996)
Human, intact skin	Four different protocols, ≤ 4 hours	1.0 %	Positive irritant for about 50 % of volunteers	York et al. (1995)
Human, intact skin of back and forearm	Filter disc with 70 µl solution, 3, 15 and 60 min exposure	0.5 and 1 %	Irritating (mainly erythema).	Dykes et al. (1995)
Human, volar side of forearm	Filter disc with 40 µl solution, 24 h exposure	1, 2 and 4 %	Normal-reacting and hyper reactive subjects	Seidenari et al. (1995)

The cutaneous response to NaOH has been assessed in human volunteer subjects using both clinical scoring and two non-invasive instrumental methods; erythema measurement using an erythema meter and capillary blood flow using a laser Doppler device (Dykes et al., 1995). Solutions of 0.5 and 1 % NaOH were applied to back skin for 3, 15 and 60 min with assessments immediately after removal and at 1, 24 and 48 hours. Increased erythema was seen with increasing duration of exposure and an increase was also seen at 1h, 24h and 48h after removal of the patch. Comparison between back and forearm skin indicated a greater sensitivity to NaOH on the back.

Sodium hydroxide induced irritation was studied in 34 volunteers by means of 24-h patch testing at different concentrations and by a short-term test using an exposure duration of 10 minutes (Seidenari et al., 1995). The 24-h patch test with 4 % NaOH revealed a classification of subjects in 2 categories: subjects who reacted normally (25 of 34) and hyper-reactors (9 of 34). Hyper-reactors showed an enhanced inflammatory response, a decreased dermal reflectivity and an increase in transepidermal water loss.

Sodium hydroxide has been also been used extensively for *in vitro* skin irritation testing (see IUCLID).

Conclusion

Based on animal data it can be concluded that an NaOH solution of 8 % can be considered corrosive. Based on human data concentrations of 0.5–4 % were irritating. In 2 different studies a concentration of 0.5 % was irritating for only 55 and 61 % of the volunteers, respectively and therefore it is assumed that a concentration, which is slightly lower than 0.5 %, is the non-irritating concentration.

Eye Irritation

Studies in Animals

The valid eye irritation studies conducted with NaOH solutions are summarized in Table 3. Studies were valid if they were well documented and if they met generally accepted scientific principles.

Table 3: In vivo eye irritation tests with NaOH

Species	Protocol	Concentrations	Result	Reference
Rabbits	Dose of 0.1 ml in lower conjunctival sac of left eye	0.004; 0.04; 0.2; 0.4 and 1.2 %	0.004-0.2: non-irritant 0.4 %: mild irritation 1.2 % corrosive	Morgan et al. (1987)
Rabbits	Dose of 0.1 ml, washed (after 30 s) and unwashed eyes	0.1; 0.3; 1.0 and 3.0 %	0.1 and 0.3 %: no conjunctivitis nor iritis 1.0 and 3.0 %: conjunctivitis and iritis	Murphy et al. (1982)
Rabbits	OECD Guideline 405	1 and 2 %	1 %: Not irritating 2 %: Irritating	Jacobs (1992)

A volume of 0.1 ml NaOH was placed in the lower conjunctival sac of the left eye of Stauffland Albino rabbits (Morgan et al., 1987). Both the left and the right eye were evaluated for irritation and corneal thickness for up to 21 days using a slit-lamp biomicroscope with a pachymeter attachment. According to EPA criteria 0.001M (0.004%), 0.01M (0.04%) and 0.05M (0.2%) NaOH were considered non-irritant, while the irritation at 0.1M (0.4%) was mild and 0.3M (1.2%) was considered corrosive.

The severity of the effects are influenced by the exposure amount, concentration, duration and the treatment. Alkaline substances produce a liquefaction necrosis and therefore are able to penetrate the tissue (Murphy et al., 1982). When an amount of 100 µl was instilled into the eyes of rabbits concentrations of 1.0 and 3.0 % resulted in conjuctivitis which lasted through 7 days, while concentrations of 0.1 and 0.3 % did not.

Based on eye irritation tests with New Zealand White Albino rabbits, conducted according to OECD Guideline 405, a concentration of 1 % NaOH is not irritating to eyes while a concentration of 2 % was irritating to the eyes (Jacobs, 1992). A volume of 100 µl was instilled into the lower conjunctival sac and the classification was based on EC criteria. A concentration of 2 % was irritating due to the mean score for conjunctivitis and the mean score for corneal opacity.

Conclusion

The available animal data on eye irritation revealed small differences in eye irritation levels. The non-irritant level was 0.2-1.0 %, while the corrosive concentration was 1.2 % or higher than 2 %.

3.1.4 Sensitisation

Data on skin sensitisation were reported by Park et al. (1995). Male volunteers were exposed on the back to sodium hydroxide concentrations of 0.063 – 1.0 % (induction). After 7 days the volunteers were challenged to a concentration of 0.125 %. The irritant response correlated well with the concentration of NaOH, but an increased response was not observed when the previously patch tested sites were rechallenged. Based on this study sodium hydroxide has no skin sensitisation potential. Furthermore NaOH has been used widely and for a long time and no human cases of skin sensitisation have been reported and therefore NaOH is not considered to be a skin sensitizer.

3.1.5 Repeated Dose Toxicity

No animal data are available on repeated dose toxicity studies by oral, dermal, inhalation or by other routes for NaOH.

A 63 year old man was exposed daily for 20 years to mists of NaOH which was probably the cause for the obstructive airway disease which was observed (Rubin et al., 1992). The exposure was heavy but was not quantified and therefore the study has a limited value.

The hazard of repeated human exposure to sodium has been focused on the effects of sodium on the prevention and control of hypertension. Recommendations on dietary salt intake have been published by Fodor et al. (1999). A daily dietary intake of 2.0-3.0 g was reported to be a moderately restricted intake, 3.1-6.0 was reported as a normal intake, while a dietary intake of > 6 g sodium per day was considered an excessive intake.

It is not useful to do a repeated dose toxicity test with NaOH in rats because the long term hazard of sodium for humans has been characterized sufficiently. It is also not useful to study the repeated dose toxicity of hydroxide via an oral study because at high concentrations the substance is corrosive or irritating, while at low concentrations the hydroxide will be neutralized in the stomach by gastric juice, which has a very low pH. Furthermore it should be realised that oral exposure to NaOH is negligible under normal handling and use conditions and therefore an oral repeated dose study with rats is inappropriate. A further characterization of the potential inhalation exposure is needed to determine if a repeated dose study via inhalation is needed. Based on the previous discussion, additional testing for repeated dose toxicity is considered unnecessary for NaOH.

3.1.6 Mutagenicity

In vivo Studies

Valid in vivo genotoxicity studies are not available.

A mouse bone marrow micronucleus test using 15 mM NaOH at a dose of 10 mg/kg bw revealed no significant increase of nuclei (Aaron et al., 1989). The test compound was administered as a single i.p. dose to treatment groups (5 males and 5 females) at 30, 48 and 72h. Mouse oocytes of the Swiss strain were used to determine possible aneuploidy-inducing effects (Brook et al., 1985). Mice were injected intraperitoneally with 0.3-0.4 ml of 0.01 M NaOH and chromosome spreads were made 12 h after injection. NaOH was used as control substance. No evidence of non-disjunction was found in control groups up to the age of 40 weeks tested.

Both the *in vitro* and the *in vivo* genetic toxicity test indicated no evidence for a mutagenic activity. Furthermore NaOH is not expected to be systemically available in the body under normal handling and use conditions and for this reason additional testing is considered unnecessary (see section 3.1).

In vitro Studies

NaOH was assayed in the Ames reversion test with *S. typhimurium* strains TA1535, TA1537, TA1538, TA98, TA100 and in a DNA-repair test with *E. coli* strains WP2, WP67 and CM871 (De Flora et al., 1984). Based on the results of these tests NaOH was classified as non genotoxic.

The clastogenic activity of NaOH was studied in an in vitro chromosomal aberration test using Chinese hamster ovary (CHO) K1 cells (Morita et al., 1989). No clastogenic activity was found at NaOH concentrations of 0, 4, 8 and 16 mM NaOH, which corresponded with initial pH values of 7.4, 9.1, 9.7 and 10.6, respectively. Incubation of CHO-K1 cells with NaOH in the presence of rat liver S9 increased the clastogenic activity of S9, or induced new clastogens by breakdown of the S9. Therefore, testing at non-physiological pH might give false-positive responses, which means that the effect of sodium hydroxide is of a methodical kind and not valid to asses the genotoxicity under realistic conditions.

3.1.7 Toxicity for Reproduction

No valid studies were identified regarding developmental toxicity nor toxicity to reproduction in animals after oral, dermal or inhalation exposure to NaOH.

It is not useful to do a reproduction or developmental toxicity test with NaOH in rats because the hazard of sodium for humans has been characterized sufficiently (e.g. Fodor et al., 1999). It is also not useful to study the reproduction/developmental toxicity of hydroxide via an oral study because at high concentrations the substance is corrosive or irritating, while at low concentrations the hydroxide will be neutralized in the stomach by gastric juice, which has a very low pH. Furthermore it should be realised that oral exposure to NaOH is negligible under normal handling and use conditions and therefore an oral reproduction/developmental toxicity is inappropriate.

NaOH is not expected to be systemically available in the body under normal handling and use conditions and for this reason it can be stated that the substance will not reach the foetus nor reach male and female reproductive organs (see sections 3.1 and 3.6). It can be concluded that a specific study to determine the developmental toxicity or the toxicity to reproduction is not necessary.

3.2 Initial Assessment for Human Health

Solid NaOH is corrosive. Depending on the concentration, solutions of NaOH are non-irritating, irritating or corrosive and they cause direct local effects on the skin, eyes and gastrointestinal tracts. Based on human data concentrations of 0.5-4.0 % were irritating to the skin, while a concentration of 8.0 % was corrosive for the skin of animals. Eye irritation data are available for animals. The non-irritant level was 0.2-1.0 %, while the corrosive concentration was 1.2 % or higher. A study with human volunteers did not indicate a skin sensitisation potential of sodium hydroxide. This is supported by the extensive human experience.

The acute toxicity of sodium hydroxide depends on the physical form (solid or solution), the concentration and dose. Lethality has been reported for animals at oral doses of 240 and 400 mg/kg bw. Fatal ingestion and fatal dermal exposure has been reported for humans.

No valid animal data are available on repeated dose toxicity studies by oral, dermal, inhalation or by other routes for NaOH. However, under normal handling and use conditions (non-irritating) neither the concentration of sodium in the blood nor the pH of the blood will be increased and therefore NaOH is not expected to be systemically available in the body. It can be stated that the substance will neither reach the foetus nor reach male and female reproductive organs, which shows that there is no risk for developmental toxicity and no risk for toxicity to reproduction. Both *in vitro* and *in vivo* genetic toxicity tests indicated no evidence for a mutagenic activity.

Based on the available literature, there is a risk for accidental and intentional exposure to solid NaOH or to irritating or corrosive solutions of NaOH. Most of the ingestion accidents seem to be related with children and seem to occur at home. Accidental skin and eye exposure seem to be less frequently reported than ingestion in the medical literature. Dust formation is unlikely because of hygroscopic properties. Furthermore NaOH has a negligible vapour pressure and is rapidly neutralized in air by carbon dioxide and therefore dust and vapour exposure are not expected.

4 HAZARDS TO THE ENVIRONMENT

4.1 Aquatic Effects

At concentrations reported in publications and study reports, the toxicity has been assumed to be due to hydroxide only, because at these effect concentrations the concentration of sodium is too low to explain the effects. However, it should be realised that the results of toxicity tests with NaOH depend on the buffer capacity of the test medium. In a highly buffered test medium the hydroxyl ion will be neutralized and the observed toxicity will be low, while in a poorly buffered test medium the pH will increase rapidly and therefore the observed toxicity will be relatively high (see also section 2.1). Besides the direct effects (pH change) NaOH could also have indirect effects. The pH change could influence the speciation of other chemicals and therefore increase and/or decrease the toxicity e.g. NH_3 is more toxic than NH_4^+.

The available ecotoxicity tests with NaOH are presented in Table 4. In general the available toxicity studies with NaOH were not conducted according to current standard guidelines.

Table 4: Results of aquatic toxicity tests with sodium hydroxide

Species	Endpoint	Result (mg/l)	CoR[A]	Reference
Goldfish (*Carassius auratus*)	LC50 (24 H)	160	3	Jensen (1978)
Leucicus idus melanotus	LC50 (48h)	189	4	Juhnke et al. (1978)
Mosquitofish (*Gambusia affinis*)	LC50 (96 H)	125	3	Wallen (1957)
Guppy (*Poecilia reticulata*)	LC50 (24 H)	145	3	Yarzhombek et al. (1991)
Pike perch (*Lucioperca lucioperca L.*), fry	Toxic concentration	≥ 35	3	Stangenberg (1975)
Water flea (*Daphnia magna*)	Toxicity threshold	40 - 240	4	McKee et al. (1963)
Water flea (*Ceriodaphnia cf dubia*)	LC50 (48 H)	40	2	Warne et al. (1999)
Snail *Biomphalaria a. alexandrina*	Lethal concentration	450	3	Gohar et al. (1961)
Snail *Bulinus truncatus*	Lethal concentration	150	3	Gohar et al. (1961)
Snail *Lymnaea caillaudi*	Lethal concentration	150	3	Gohar et al. (1961)
Marine polychaete (*Ophryotrocha diadema*)	LC50 (48 h)	33-100	3	Parker (1984)

[A] Code of Reliability (CoR): 1 = valid without restrictions, 2 = valid with restrictions, 3 = invalid, 4 = not assignable.

Effects on fish

A 24-hour toxicity test with *Carassius auratus* (goldfish) revealed an LC50 of 160 mg/l (Jensen, 1978). At 100 mg/l, which was equivalent to a pH of 9.8, no mortality was observed. A toxicity test with a related species, *Leuciscus idus melanotus*, revealed an LC50 of 189 mg/l (Juhnke et al., 1978). A 96-hour test with *Gambusia affinis* (mosquitofish) revealed an LC50 of 125 mg/l (Wallen, 1957). At 84 mg/l no effects on the fish were observed. The pH was 9 at 100 mg/l. Solutions of NaOH in pond water started to be toxic to the fry of *Lucioperca lucioperca* L. (pike perch) at NaOH concentrations of 35 mg/l and higher (Stangenberg, 1975).

The chronic effect of NaOH on guppies (*Lebistes reticulatus*) has been tested at 25, 50, 75 and 100 mg/l (Rustamova, 1977; Code of Reliability = 3). An adverse effect on the survival rate, growth and

fecundity, as well as on the quality of the progeny was found. Upon prolonged exposure concentrations of 25-100 mg/l produced significant changes in the biology of the fish.

Effects on invertebrates

The LC50 after 48 hours of exposure was 40 mg/l for the freshwater cladoceran *Ceriodaphnia* cf. *dubia* (Warne et al., 1999). A short review of the toxicity of NaOH for invertebrates is given by McKee et al. (1963). The toxicity threshold concentration of NaOH for *Daphnia magna* was reported to range from 40 to 240 mg/l. Concentrations of 125 to 1000 mg/l were reported to be lethal to insect larvae.

The lethal concentration of NaOH to the vector snails *Biomphalaria a. alexandrina*, *Bulinus truncatus* and *Lymnaea caillaudi* was 450, 150 and 150 mg/l, respectively (Gohar et al., 1961). The LC50 after 48 hours of exposure was 33-100 mg/l for the marine polychaete *Ophryotrocha diadema* (Parker, 1984).

Effects on aquatic plants / algae

No data available.

Effects on micro-organisms

The inhibition of the bioluminescence of the bacterium *Photobacterium phosphoreum* by NaOH has been measured with the Microtox system (Bulich et al., 1990). The 15 minutes-EC50 was 22 mg/l. The test medium was 2 % NaCl which means that the medium was not buffered. The effect of NaOH on motility of the protozoan *Tetrahymena thermophila* was studied by microscope (Silverman et al., 1987). When 1% NaOH was diluted 62 times the motility was higher than 90 % of control cell motility (highest tolerated dose, HTD). This would be equal to a NaOH concentration of 161 mg/l. The studies with the bacterium *Photobacterium phosphoreum* and the protozoan *Tetrahymena thermophila* had a low reliability.

Conclusions

In many cases pH, buffer capacity and/or medium composition were not discussed in the publications, although this is essential information for toxicity tests with NaOH. This is the most important reason why most of the studies, mentioned in Table 4, were considered invalid. Although valid acute ecotoxicity tests and chronic ecotoxicity tests with NaOH are not available there is no need for additional testing with NaOH. A significant number of acute toxicity tests is available (see Table 4) and the results of the tests are more or less consistent. Altogether they give a sufficient indication about acute toxicity levels of sodium hydroxide.

Furthermore acute toxicity data cannot be used to derive a PNEC or a $PNEC_{added}$ for sodium hydroxide. Aquatic ecosystems are characterized by an alkalinity/pH and the organisms of the ecosystem are adapted to these specific natural conditions. Based on the natural alkalinity of waters, organisms will have different optimum pH conditions, ranging from poorly buffered waters with a pH of 6 or less to very hard waters with pH values up to 9. A lot of information is available about the relationship between pH and ecosystem structure and also natural variations in pH of aquatic ecosystems have been quantified and reported extensively in ecological publications and handbooks.

Normally a PNEC or a $PNEC_{added}$ has to be derived from the available ecotoxicity data. A $PNEC_{added}$ is a PNEC which is based on added concentrations of a chemical (added risk approach). Based on the available data it is not considered useful to derive a PNEC or a $PNEC_{added}$ for NaOH because:

- The natural pH of aquatic ecosystems can vary significantly between aquatic ecosystems,

- Also the sensitivity of the aquatic ecosystems to a change of the pH can vary significantly between aquatic ecosystems and
- The change in pH due to an anthropogenic NaOH addition is influenced significantly by the buffer capacity of the receiving water.

Although a PNEC or a $PNEC_{added}$ was not calculated for NaOH there is a need to assess the environmental effect of an NaOH (alkaline) discharge. Based on the pH and buffer capacity of effluent and receiving water and the dilution factor of the effluent, the pH of the receiving water after the discharge can be calculated. Of course the pH change can be measured also very easily via a laboratory experiment or by conducting field measurements. The change in pH should be compared with the natural variation in pH of the receiving water and based on this comparison it should be assessed if the pH change is acceptable.

To illustrate the procedure and to get an idea about the order of magnitude for maximum anthropogenic additions, the maximum NaOH addition will be calculated for 2 representative cases. According to Directive 78/659/EEC (CEE, 1978), the pH of surface water for the protection of fish should be between 6 and 9. In section 2.1 it has been mentioned that the 10^{th} percentile and the 90^{th} percentile of the bicarbonate concentrations of 77 rivers of the world were 20 and 195 mg/l, respectively. If it is assumed that only bicarbonate is responsible for the buffer capacity of the ecosystem and **f** it is assumed that an increase of the pH to a value of 9.0 would be the maximum accepted value then the maximum anthropogenic addition of sodium hydroxide would be 1.0 and 6.1 mg/l for bicarbonate concentrations of 20 and 195 mg/l, respectively. These examples give an indication of the maximum amount of NaOH which could be discharged to an aquatic ecosystem if there was an emission of a pure NaOH solution.

Sodium hydroxide concentrations of 1.0 and 6.1 are equivalent with sodium concentrations of 0.6 and 3.5 mg/l, respectively. These sodium concentrations are in general significantly lower than background concentrations of sodium in rivers of the world (see section 2.1). Concentrations of 0.6 and 3.5 mg/l of sodium are also significantly lower than concentrations present in reconstituted fresh water, which is used for toxicity testing. According to ASTM (1996) reconstituted very soft, soft, hard and very hard water, contains sodium concentrations of 3.3; 13; 53 and 105 mg/l, respectively. This confirms that the hazard of NaOH (not neutralized) is caused by the hydroxyl ion (pH effect).

4.2 Terrestrial Effects

Toxicity tests, which determined the effects of NaOH on terrestrial organisms, are not available. Significant exposure of the terrestrial environment is not expected and for this reason there is no need to perform toxicity test with terrestrial organisms. The results of terrestrial toxicity tests will depend strongly on the buffer capacity of the soil and can probably be predicted based on the buffer capacity of the soil.

4.3 Other Environmental Effects

No other environmental effects are expected.

4.4 Initial Assessment for the Environment

The hazard of NaOH for the environment is caused by the hydroxyl ion (pH effect). For this reason the effect of NaOH on the organisms depends on the buffer capacity of the aquatic or terrestrial ecosystem. Also the variation in acute toxicity for aquatic organisms can be explained for a

significant extent by the variation in buffer capacity of the test medium. LC50 values of acute toxicity test with aquatic organisms ranged between 33 and 189 mg/l.

Because the buffer capacity, pH and the fluctuation of the pH are very specific for a certain aquatic ecosystem it was not considered useful to derive a PNEC or a $PNEC_{added}$. To assess the potential environmental effect of an NaOH discharge, the pH change of the receiving water should be calculated or measured. The change in pH should be compared with the natural variation in pH of the receiving water and based on this comparison it should be assessed if the pH change is acceptable.

The use of NaOH could potentially result in an emission of NaOH and it could locally increase the pH in the aquatic environment. However, the pH of effluents is normally measured very frequently and can be adapted easily and therefore a significant increase of the pH of the receiving water is not expected. If emissions of waste water are controlled by appropriate pH limits and/or dilutions in relation to the natural pH and buffering capacity of the receiving water, adverse effects on the aquatic environment are not expected due to production or use of NaOH.

Aquatic sodium emissions originating from uses of NaOH are probably small compared to other sources. It is clear that an environmental hazard assessment of sodium should not only evaluate all natural and anthropogenic sources of sodium but should also evaluate all other ecotoxicity studies with sodium salts, which is beyond the scope of this report.

5 RECOMMENDATIONS

Environment and human health: no further work is recommended if sufficient control measures are in place to avoid significant human and environmental impact, including prevention of accidental exposure.

Due to the corrosivity of the substance, no further studies are required under the SIDS programme.

In the EU a risk assessment will be performed according to Council Regulation 793/93.

6 REFERENCES

Aaron et al. (1989). The Mouse Bone Marrow Micronucleus Test : Evaluation of 21 Drug Candidates, Mutation Research, 223, 129–140.

ASTM (1996). Annual Book of ASTM Standards – Volume 11.05. Standard E 729-88a : Standard Guide for Conducting Acute Toxicity Tests with Fishes, Macroinvertebrates, and Amphibians

Bromberg, BE et al (1965). Hydrotherapy of Chemical Burns. Plast Reconstr Surg, 35, 85–95.

Brook et al. (1985). Testing of 3 chemical compounds for aneuploidy induction in the female mouse, Mutation Research, 157, 215-220.

Bulich et al. (1990). The Luminescent Bacteria Toxicity Test: its Potential as an *in Vitro* Alternative. J Biol Chem, 5, 71-77.

Casasnovas et al. (1997). A retrospective analysis of ingestion of caustic substances by children. Ten-year statistics in Galicia. Eur J Pediatr, 156, 410-414.

CEE (1978). Directive du Conseil du 18 juillet 1978 concernant la qualite des eaux douces ayant besoin d'etre proteges ou ameliores pour etre aptes a la vie des poissons (78/659/CEE).

Cello et al. (1980). Liquid caustic ingestion – Spectrum of Injury. Arch Intern Med, 140, 501-504.

Clausen et al. (1994). Admission to Danish hospitals after suspected ingestion of corrosives. Danish Medical Bulletin, 41, 234-237.

CMAI (2000). Fifteenth Annual World Petrochemical Conference, March 29 & 30, 2000. Houston, Texas, USA.

Cooper et al. (1979). A critique of the U.S. standard for industrial exposure to sodium hydroxide aerosols, American Industrial Hygiene Association Journal, 40, 365-371.

De Flora et al. (1984). Genotoxicity activity and potency of 135 compounds in the Ames reversion test in a bacterial DNA-repair test. Mutation Research, 133, 161-198.

De Groot et al. (2002). Addition of sodium hydroxide to a solution with sodium bicarbonate to a fixed pH. Solvay Pharmaceuticals Int. Doc. No. 8320/47/01.

Dykes et al. (1995). A stepwise procedure for evaluating irritant materials in normal volunteer subjects. Human & Experimental Toxicology, 14, 204-211.

Euro Chlor (1999), Chlorine Industry Review, 1998-1999, Brochure of 16 pages.

Fodor et al. (1999). Recommendations on dietary salt. Canadian Medical Association Journal, 160, S29-S34.

Gohar HAF et al. (1961). Tolerance of Vector Snails of Bilharziasis and Fascioliasis to Some Chemicals. Proc Egypt Acad Sci, 16, 37–48.

Griffiths et al. (1997). Interlaboratory evaluation of a Human patch test for the identification of skin irritation Potential/Hazard. Food and Chemical Toxicology, 35, 255-260.

Gumaste VV et al. (1992). Ingestion of Corrosive Substances by Adults. Am J Gastroenterol, 87, 1–5.

Hansen et al. (1991). Obstructive Lung Injury after Treating Wood with Sodium Hydroxide. J Soc Occup Med, 41, 45-46.

Hugh TB et al. (1991). Gastric Antral Patch Esophagoplasty for Extensive Corrosive Stricture of the Esophagus. World J Surg, 15, 299–303

Jacobs GA (1992). OECD Eye Irritation Tests on Sodium hydroxide. J Amer Coll Toxicol, 11, 725.

Jensen RA (1978). A Simplified Bioassay Using Finfish for Estimating Potential Spill damage. Proc. control of hazardous material spills, Rockvill, MD, 104–108.

Juhnke I et al. (1978). Ergebnisse der Untersuchung von 200 Chemischen Verbindungen auf Akute Fischtoxizität mit dem Goldorfentest. Z Wasser Abwasser Forsch, 11, 161–164.

Kavin et al. (1996). Chronic esophagitis evolving to verrucous squamous cell carcinoma: Possible role of exogenous chemical carcinogens. Gastroenterology 110, 904-914.

Keskin E et al. (1991). The Effect of Steroid Treatment on Corrosive Oesophageal Burns in Children. Eur J Pediatr Surg, 1, 335–338.

Kuckelkorn et al. (1993). Retrospektive Betrachtung von schweren Alkaliverätzungen der Augen Klin Monatsbl Augenheilkd, 203, 397-402.

Lee et al. (1995). Fatal alkali burns. Forensic Science International, 72, 219-227.

McKee JE et al. (1963). Water Quality Criteria, 2nd edition, State Water Quality Control Board, Pasadena, CA.

Moazam F et al. (1987). South Med J, 80, 187–190.

Morgan et al. (1987). Prediction of Ocular Irritation by Corneal Pachymetry. Food Chem Toxicol, 25, 609-613.

Morita et al. (1989). Effects of pH in the in vitro chromosomal aberration test. Mutation Research, 225, 55-60.

Murphy et al. (1982). Ocular irritancy responses to various pHs of acids and bases with and without irrigation. Toxicology 23, 281-291.

Naunyn–Schmiedeberg's (1937). Archiv für experimentelle Pathologie und Pharmakologie (Berlin, Germany), 184, 587.

Parker, JG (1984). The Effects of Selected Chemicals and Water Quality on the Marine Polychaete. Wat Res, 18, 865–868.

Rubin AE et al. (1992). Obstructive Airway Disease Associated With Occupational Sodium Hydroxide Inhalation. British J Ind Med, 49, 213–214.

Rustamova SA (1977). Gidrobiol Zh, 13, 83-85.

Saini et al. (1993). Ocular chemical burns – clinical and demographic profile. Burns, 19, 67-69.

Schober PH et al. (1989). Ingestion von ätzenden Substanzen im Kindesalter. Wiener Klin Wschr, 101, 318–322.

Seidenari et al. (1995). Sodium Hydroxide-induced Irritant Dermatitis as Assessed by Computerized Elaboration of 20 Mhz B-scan images and by TEWL Measurement: A Method for Investigating Skin Barrier Function. Act Derm Venereol, 75, 97-101.

Silverman et al. (1987). Evaluation of *Tetrahymena thermophila* as an *in vitro* alternative to ocular irritation studies in rabbits. J Toxicol Cutan Ocul Toxicol, 6, 33-42.

Srikrishna V et al. (1991). The Effects of Sodium Hydroxide and Hydrochloric Acid on Isolated Perfused Skin. In Vitro Toxicology, 4, 207–215.

Stangenberg M (1975). The Influence od the Chemical Composition of Water on the Pike Perch Fry From the Lake Gopio. Limnologica, 9, 421–426.

UNEP (1995). Water quality of world river basins. UNEP Environment Library No. 14, Nairobi, Kenya.

Van Kolfschoten et al. (1983). Protection by Paracetamol against Various Gastric Irritants in the Rat. Toxicology and Applied Pharmacology, 69, 37-42.

Vilogi et al. (1985). Oven-cleaner Pads: New risk for corrosive injury. Am J Emerg Med, 3, 412-414.

Wallen, IE et al. (1957). Toxicity to *Gambusia affinis* of Certain Pure Chemicals in Turbid Waters. Sewage Ind Wastes, 29, 695–711.

Warne, MSJ et al. (1999). Toxicity of Laundry Detergent Components to a Freshwater Cladoceran and their Contribution to Detergent Toxicity. Ecotoxicology and Environmental Safety, 44, 196-206.

Wijburg FA et al. (1985). Nasogastric Intubation as Sole Treatment of Caustic Esophageal Lesions Ann Otol Rhinol Laryngol, 94, 337–341

Yarzhombek et al. (1991). Voprosy Ikhtiologii, 31, 496-502.

Yasser et al. (1998). Lye-induced esophagitis course and follow up of 29 patients. Gastroenterology, 114, A273.

York, M et al. (1995). Skin irritation testing in man for hazard assessment – evaluation of four patch systems. Human & Experimental Toxicology, 14, 729-734.

York, M et al. (1996). Evaluation of a human patch test for the identification and classification of skin irritation potential. Contact Dermatitis, 34, 204-212.

I U C L I D Data Set

Existing Chemical	:	ID: 1310-73-2
CAS No.	:	1310-73-2
EINECS Name	:	sodium hydroxide
EC No.	:	215-185-5
TSCA Name	:	Sodium hydroxide (Na(OH))
Molecular Formula	:	HNaO

Producer related part

Company	:	Solvay S.A.
Creation date	:	29.09.1994

Substance related part

Company	:	Solvay S.A.
Creation date	:	29.09.1994
Status	:	
Memo	:	JPE
Printing date	:	24.09.2002
Revision date	:	
Date of last update	:	24.09.2002
Number of pages	:	1
Chapter (profile)	:	
Reliability (profile)	:	
Flags (profile)	:	

1. General Information

Id 1310-73-2
Date 24.09.2002

1.0.1 APPLICANT AND COMPANY INFORMATION

Type	:	lead organisation
Name	:	Solvay S.A.
Contact person	:	A.G. Berends
Date	:	
Street	:	Rue de Ransbeek 310
Town	:	1120 Brussels
Country	:	Belgium
Phone	:	+ 32 2 264 3398
Telefax	:	+ 32 2 264 2990
Telex	:	
Cedex	:	
Email	:	albert.berends@solvay.com
Homepage	:	http:\\www.solvay.com
Remark	:	The IUCLID was prepared by Solvay on behalf of Euro Chlor, several members of the Japan Soda Industry Association and on behalf of a member of the Chlorine Chemistry Council. Euro Chlor managed the secretariat of the NaOH HPV Task Force.

05.12.2001

1.0.2 LOCATION OF PRODUCTION SITE, IMPORTER OR FORMULATOR

Remark	:	NaOH is produced in many different parts of the world. The number of production sites is more than 100.

29.05.2001

1.0.3 IDENTITY OF RECIPIENTS

1.0.4 DETAILS ON CATEGORY/TEMPLATE

1.1.0 SUBSTANCE IDENTIFICATION

IUPAC Name	:	sodium hydroxide
Smiles Code	:	
Molecular formula	:	NaOH
Molecular weight	:	40
Petrol class	:	other: not applicable

10.07.2002

1.1.1 GENERAL SUBSTANCE INFORMATION

Purity type	:	typical for marketed substance
Substance type	:	inorganic
Physical status	:	solid

1. General Information

Id 1310-73-2
Date 24.09.2002

Purity : > 96 % w/w
Colour : white
Odour : It has no specific odour.

04.12.2001

1.1.2 SPECTRA

1.2 SYNONYMS AND TRADENAMES

Caustic soda

07.05.2001

NaOH

10.07.2002

Soda lye

07.05.2001

Sodium hydrate

07.05.2001

1.3 IMPURITIES

Remark : Identity and percentage of impurities:

-CAS-No	EINECS-No	EINECS-Name	Contents
-7647-14-5	231-598-3	Sodium chloride	< 2%
497-19-8	207-838-8	Sodium carbonate	< 1%
-	-	Sulfate	< 0.2%
7775-09-9	231-887-4	Sodium chlorate	< 0.1%
-	-	Iron	< 100 mg/kg
-	-	Heavy metals	< 1 mg/kg
-	-	Nickel	< 15 mg/kg
-	-	Mercury	< 200µg/kg

-Under normal operating conditions the mercury content is 40
- 60 µg/kg. Mercury is only present if the mercury production method is used.

05.12.2001

1.4 ADDITIVES

Remark : Additives are not used
05.12.2001

1. General Information

Id 1310-73-2
Date 24.09.2002

1.5 TOTAL QUANTITY

Quantity : ca. 44000000 - tonnes produced in 1999

Remark : Estimated world-wide demand of sodium hydroxide was 44 million tonnes expressed as NaOH 100% in 1999 (CMAI, 2000).
The global demand for NaOH is expected to grow with 3.1 % per year.
23.09.2002 (25)

Quantity : = 9300000 - tonnes produced in 1998

Remark : The amount of 9.3 millions tonnes was produced in Western Europe.
23.09.2002 (34)

1.6.1 LABELLING

Labelling : as in Directive 67/548/EEC
Specific limits : No
Symbols : C, , ,
Nota : , ,
R-Phrases : (35) Causes severe burns
S-Phrases : (1/2) Keep locked up and out of reach of children
(26) In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
(37/39) Wear suitable gloves and eye/face protection
(45) In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)

Remark : S 1/2 : only for consumer products
23.09.2002 (35)

1.6.2 CLASSIFICATION

Classified : as in Directive 67/548/EEC
Class of danger : Corrosive
R-Phrases : (35) Causes severe burns
Specific limits : yes
1st Concentration : C >= 5 %
2nd Concentration : 2 % <= C < 5 %
3rd Concentration : 0.5 % <= C < 2 %
4th Concentration :
5th Concentration :
6th Concentration :
7th Concentration :
8th Concentration :
1st Classification : C; R 35
2nd Classification : C; R 34
3rd Classification : Xi; R 36/38
4th Classification :
5th Classification :
6th Classification :
7th Classification :
8th Classification :

1. General Information

Id 1310-73-2
Date 24.09.2002

05.12.2001

1.6.3 PACKAGING

1.7 USE PATTERN

Type of use : type
Category : Non dispersive use

05.12.2001

Type of use : type
Category : Use in closed system

05.12.2001

Type of use : type
Category : Wide dispersive use

05.12.2001

Type of use : industrial
Category : Basic industry: basic chemicals

05.12.2001

Type of use : industrial
Category : Chemical industry: used in synthesis

05.12.2001

Type of use : industrial
Category : Fuel industry

Remark : Petroleum reforming.
05.12.2001

Type of use : industrial
Category : Metal extraction, refining and processing of metals

Remark : Aluminum industry (8% of total use, CMAI 2000)
23.09.2002 (25)

Type of use : industrial
Category : Paper, pulp and board industry

Remark : 18% of total use (CMAI 2000)
23.09.2002 (25)

Type of use : industrial
Category : Personal and domestic use

05.12.2001

Type of use : industrial

1. General Information

Id 1310-73-2
Date 24.09.2002

Category : Public domain

Remark : Water treatment (5% of total use, CMAI 2000), fume treatment, epuration.
23.09.2002 (25)

Type of use : industrial
Category : Textile processing industry

05.12.2001

Type of use : industrial
Category : other: food industry, soap and detergents, rubber

05.12.2001

Type of use : use
Category : Absorbents and adsorbents

05.12.2001

Type of use : use
Category : Bleaching agents

05.12.2001

Type of use : use
Category : Cleaning/washing agents and disinfectants

Remark : 12% of total use (CMAI 2000)
23.09.2002 (25)

Type of use : use
Category : Food/foodstuff additives

05.12.2001

Type of use : use
Category : Intermediates

05.12.2001

Type of use : use
Category : Laboratory chemicals

05.12.2001

Type of use : use
Category : pH-regulating agents

05.12.2001

Type of use : use
Category : Pharmaceuticals

05.12.2001

Type of use : use
Category : Process regulators

1. General Information

Id 1310-73-2
Date 24.09.2002

05.12.2001

1.7.1 DETAILED USE PATTERN

1.7.2 METHODS OF MANUFACTURE

Origin of substance : Synthesis
Type : Production

Remark : The production of NaOH is based on the electrolysis of NaCl. Sodium hydroxide is produced in a fixed ratio of 1.128 tonnes (as 100 % NaOH) per tonne chlorine produced. Three different electrolysis processes exist: mercury, membrane and diaphragm.

Mercury process
In the mercury electrolyser, mercury flows concurrently with brine along the base of a cell. The mercury acts as the cathode and forms an amalgam with sodium. Chlorine is formed at the anodes, which are suspended in the brine. The amalgam flows to a reactor (denuder or decomposer) where the amalgam reacts with water in the presence of carbon (graphite) to form caustic soda and hydrogen. The free mercury is returned to the electrolytic cell. The resulting caustic soda solution is then stored in tanks at a 50% solution.

Diaphragm process
In the diaphragm electrolyser an asbestos diaphragm separates the anolyte and catholyte chambers. In some cases polymer modified asbestos is used as the diaphragm. Although asbestos is the most suitable material for diaphragms, new diaphragm materials are under development and are used in some facilities.

The anode is titanium with a suitable rare metal oxide coating and the cathode is steel or nickel coated steel. The anode and cathode have a fixed position in the cell. In general the distance between the anode and the cathode is arranged for optimum voltage.

Differential hydraulic pressure causes the anolyte to flow through the diaphragm from the anolyte compartment to the catholyte compartment. Chlorine is removed from the vapour space above the anolyte normally under suction. Diaphragm cell liquor containing 9-12% caustic soda and 15-17% sodium chloride overflows from the catholyte chamber to intermediate storage, although it can be used directly for other processes. An additional evaporation and a separation from the precipitated NaCl is required to reach the saleable concentration of 50% caustic soda.The sodium chloride concentration in 50% caustic soda liquor from this process is up to 1%.

Diaphragm cells can have a monopolar (cells in parallel) or bipolar (cells in series) configuration and there is a large variety of types which allows a wide range of current densities to be used. Consequently, a large number of cell designs are in operation.

Membrane process
Membrane electrolysers can also have a monopolar or bipolar configuration. In the membrane electrolysers the anolyte and catholyte chambers are separated by an ion selective membrane. In comparison with

1. General Information

Id 1310-73-2
Date 24.09.2002

the diaphragm electrolyser there is no physical flow from the anolyte to the catholyte chamber. Instead, sodium ions pass through the membrane and form caustic soda and hydrogen in the catholyte. Caustic soda and hydrogen are produced in the catholyte compartment by the addition of water.

The anodes are made from titanium with a suitable rare metal oxide coating. The cathodes are constructed in steel or nickel and may or may not have a coating. There is some variation in the material used to manufacture of the membrane, which acts as a cation exchange.

The strength of the caustic soda in the membrane process is up to 33 % (with a final NaCl concentration of less than 100 ppm in 50 % caustic solution). The solution is then sent to evaporators, which concentrate it to a strength of 50% by removing the water. The resulting caustic soda solution is inventoried in storage tanks prior to shipment.

Solidification
The anhydrous forms of caustic soda are obtained through further concentration of 50% caustic soda. Solid caustic soda results when molten caustic soda, from which all the water has been evaporated, is allowed to cool and solidify. Flake
caustic soda is made by passing molten caustic soda over cooled flaking rolls to form flakes of uniform thickness. The flakes can be milled and screened into several crystalline products with controlled particle size. The manufacture of
caustic soda beads involves feeding molten liquor into a prilling tower under carefully controlled operating conditions, producing a spherical bead.

04.12.2001

1.8 REGULATORY MEASURES

1.8.1 OCCUPATIONAL EXPOSURE LIMIT VALUES

Type of limit : TLV (US)
Limit value : 2 mg/m3

Remark : The transformation of respirable sodium hydroxide aerosols into sodium carbonate aerosols can occur in seconds, complicating the analysis of the dose-response experiments already performed and the application of the results of such experiments to industrial settings. Even without this complication, the work done in determining the response of humans to sodium hydroxide aerosols has been quite limited, providing a weak technical base for the current industrial hygiene standard in the United States, a ceiling value of 2 mg/m3 (Cooper et al., 1979).

23.09.2002 (3) (26) (77)

1.8.2 ACCEPTABLE RESIDUES LEVELS

1.8.3 WATER POLLUTION

1. General Information

Id 1310-73-2
Date 24.09.2002

1.8.4 MAJOR ACCIDENT HAZARDS

1.8.5 AIR POLLUTION

1.8.6 LISTINGS E.G. CHEMICAL INVENTORIES

1.9.1 DEGRADATION/TRANSFORMATION PRODUCTS

1.9.2 COMPONENTS

1.10 SOURCE OF EXPOSURE

1.11 ADDITIONAL REMARKS

1.12 LAST LITERATURE SEARCH

Type of search : Internal and External
Chapters covered : 3, 4, 5
Date of search : 22.11.2000

Remark : Interrogated databases (search from 1993 to 2000, after publication of HEDSET)

AQUIRE (TOXICITY TO FISH AND OTHER MARINE ORGANISMS)

BIODEG (BIODEGRADATION DATA)

BIOLOG (BIODEGRADATION BIBLIOGRAPHIC REFERENCES)

CCRIS (CHEMICAL CARCINOGENESIS RESEARCH INFORMATION SYSTEM)

CHRIS (HAZMAT DATA)

DART/ETIC (DEVELOPMENTAL AND REPRODUCTIVE TOXICOLOGY)

DATALOG (ENVIRONMENTAL FATE BIBLIOGRAPHIC REFERENCES)

EMIC (ENVIRONMENTAL MUTAGEN INFORMATION CENTER)

ENVIROFATE (ENVIRONMENTAL FATE DATA)

GENETOX (GENETIC TOXICOLOGY)

GIABS (INDEX TO GASTROINTESTINAL ABSORPTION STUDIES, 1957-1987)

1. General Information **Id** 1310-73-2
Date 24.09.2002

HSDB SUBSET (HAZARDOUS SUBSTANCES DATA BANK)

IRIS (INTEGRATED RISK INFORMATION SYSTEM)

MEDLINE (TOXICITY & CARCINOGENICITY BIBLIOGRAPHIC REFERENCES)

NIOSHTIC (HAZMAT BIBLIOGRAPHIC REFERENCES)

PHYTOTOX (TOXICITY TO PLANTS)

RTECS (TOXICITY, CARCINOGENICITY, TUMORIGENICITY, MUTAGENICITY, TERATOGENICITY)

TERRETOX (TOXICITY TO TERRESTRIAL ANIMALS)

TOXLINE (TOXICOLOGY LITERATURE ONLINE)

TSCATS (UNPUBLISHED HEALTH AND SAFETY STUDIES SUBMITTED TO EPA)

11.07.2002

1.13 REVIEWS

2. Physico-Chemical Data

Id 1310-73-2
Date 24.09.2002

2.1 MELTING POINT

Decomposition	:	no, at °C
Sublimation	:	No
Method	:	
Year	:	
GLP	:	no
Test substance	:	
Remark	:	Melting points: 318°C (solid, 100 %) 140°C (Solution of 80 %) 42°C (Solution of 60 %) 16°C (Solution of 40 %) -26°C (Solution of 20 %)
Reliability	:	(2) valid with restrictions Data from reliable handbook

05.12.2001 (84) (110)

2.2 BOILING POINT

Value	:	°C at 1013 hPa
Decomposition	:	no
Method	:	
Year	:	
GLP	:	no
Test substance	:	
Remark	:	Boiling points: 1388°C (solid, 100 %) 216°C (solution of 80 %) 160°C (solution of 60 %) 128°C (solution of 40 %) 118°C (solution of 20 %)
Reliability	:	(2) valid with restrictions Data from reliable handbook

05.12.2001 (84) (110)

2.3 DENSITY

Type	:	density
Value	:	at 20 °C
Method	:	
Year	:	
GLP	:	no
Test substance	:	
Remark	:	Densities: 2.13 g/cm3 (solid, 100 %) 1.43 g/cm3 (solution, 40 %) 1.22 g/cm3 (solution, 20 %)
Reliability	:	(2) valid with restrictions Data from reliable handbook

2. Physico-Chemical Data

Id 1310-73-2
Date 24.09.2002

05.12.2001 (84) (110)

2.3.1 GRANULOMETRY

Remark : Solid NaOH is available in different forms (e.g. pearls, flakes, cast). The flakes can be milled and screened into several crystalline products with controlled particle size.

29.05.2001

2.4 VAPOUR PRESSURE

Value : < .00001 hPa at 25 °C
Decomposition :
Method : other (calculated)
Year :
GLP : no
Test substance :

Method : The vapour pressure of NaOH at 25 °C can not be determined experimentally. Therefore the vapour pressure of NaOH at 25 °C was estimated by use of the modified Watson correlation. The vapour pressure of NaOH was derived from the boiling point.

06.12.2001 (28)

Value : = 55 hPa at 1000 °C
Decomposition :
Method :
Year :
GLP : no
Test substance :

Test substance : molten caustic soda
Reliability : (2) valid with restrictions
Data from reliable handbook

05.12.2001 (84)

2.5 PARTITION COEFFICIENT

Remark : Not relevant for ionisable compounds

07.05.2001

2.6.1 SOLUBILITY IN DIFFERENT MEDIA

Solubility in : Water
Value : = 520 g/l at 20 °C
pH value : >= 13
concentration : at °C
Temperature effects :
Examine different pol. :
pKa : at 25 °C

2. Physico-Chemical Data

Id 1310-73-2
Date 24.09.2002

Description	:	very soluble (> 10000 mg/L)
Stable	:	yes
Deg. product	:	
Method	:	
Year	:	
GLP	:	no
Test substance	:	
Remark	:	The most important industrial NaOH product is a 50 % solution in water and therefore it is evident that NaOH has a very high water solubility. OxyChem (2000) describes the solidification curve of NaOH. At 0 °C NaOH solidifies if the concentration is higher than 30 % (by weight). At 20 °C NaOH solidifies if the concentration is higher than 52 % (by weight). At 40 °C NaOH solidifies if the concentration is higher than 56 % (by weight).
Reliability	:	(2) valid with restrictions Data from reliable handbook

05.12.2001 (84)

2.6.2 SURFACE TENSION

2.7 FLASH POINT

Remark : not applicable
07.05.2001

2.8 AUTO FLAMMABILITY

Remark : not applicable
07.05.2001

2.9 FLAMMABILITY

Remark : not applicable
05.12.2001

2.10 EXPLOSIVE PROPERTIES

Remark : not applicable
07.05.2001

2.11 OXIDIZING PROPERTIES

Remark : not applicable

2. Physico-Chemical Data

Id 1310-73-2
Date 24.09.2002

07.05.2001

2.12 DISSOCIATION CONSTANT

2.13 VISCOSITY

2.14 ADDITIONAL REMARKS

Remark : Sodium hydoxide is soluble in aliphatic alcohols and glycerine. NaOH is a hygroscopical product and sensible to the air carbon dioxide.

29.05.2001 (24)

Remark : NaOH is highly soluble in water and dissociates to sodium and hydroxide ions, with the effect of increasing pH and alkalinity. In water the anhydrous form sinks (specific gravity of 2.13 at 20°C), dissolves, mixes with water and hydrates exothermically.

29.09.1994 (33)

Remark : The heat of solution of NaOH is high. The high heat of solution generates a large amount of heat which can cause local boiling or spurting when adding sodium hydroxide to water or any solution. When making solutions, always add the caustic soda to the water surface with constant stirring and never add water to caustic soda.

29.05.2001 (84)

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

3.1.1 PHOTODEGRADATION

Remark : Not applicable
05.12.2001

3.1.2 STABILITY IN WATER

Type : abiotic
t1/2 pH4 : at °C
t1/2 pH7 : at °C
t1/2 pH9 : at °C
Deg. product :
Method : other: Hydroxide dissolution reaction
Year :
GLP :
Test substance :

Remark : - The dissolution of alkali hydroxides in water is a strongly exothermic process; their solutons generate heat when diluted.
- Dilution of sodium hydroxide solutions of 40% or greater concentration can generate enough heat to raise the temperature above boiling point, causing dangerous eruptions of the solution.

Result : When hydroxides are dissolved in water, they dissociate to produce free hydroxide ions (thus raisiong the pH of the solution) and the counter metal cations:
NaOH <==> Na+ + OH-
The hydroxide ion may then react with free H+ or any acidic species that may be present, forming water:
OH- + H= <==> H2O, K = 10E14 (25°C)
Solubility of NaOH in solution is 109 g/100 g H2O; this solubility is affected by pH, temperature and the presence of other species in solution:
--> increased pH causes decreased solubility because a higher OH- concentration reduces the amount of solid hydroxide that can dissociate into free metal ions and OH- ions.
--> with increased temperature, the alkali metal hydroxide become more soluble.

Reliability : (4) not assignable
Original references not available

23.09.2002 (29) (58)

Type : abiotic
t1/2 pH4 : at °C
t1/2 pH7 : at °C
t1/2 pH9 : at °C
Deg. product :
Method : other: Hydroxide neutralization reaction
Year :
GLP :
Test substance :

Result : - Bases are characterized by their reaction with acids to form neutral salts.
- The alkali hydroxides can react both with strong acids such as HCl and H2SO4 and with gases that produce weak acids in solutions, such as hydrogen sulfide, sulfur dioxide and carbon dioxide:

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

NaOH + HCl --> NaCL + H2O
2 NaOH + H2S --> Na2S + 2 H2O (this reaction is commercially used for the extraction of H2S from natural gas)
- Hydroxides, both as solids and in aqueous solution, absorb CO2 readily from the air, reacting to form carbonates:
2 NaOH + CO2 --> Na2CO3 + H2O

Reliability : (4) not assignable
Original references not available

23.09.2002 (53) (58) (121)

Type : Abiotic
t1/2 pH4 : at °C
t1/2 pH7 : at °C
t1/2 pH9 : at °C
Deg. product :
Method : other: Hydroxide complexation and precipitation reactions
Year :
GLP :
Test substance :

Remark : - An important consequence of the addition of soluble hydroxides to natural waters is the formation of metal complexes and the precipitation of solid metal hydroxides and other species.
- Since most of the transition metals form sparingly soluble hydroxides, addition of a highly soluble hydroxide such as NaOH to water containing transition metal ions may result in the precipitation of metal hydroxides.
- This process can be used for metal removal in watewater treatment.

Result : - The metal ion concentration at which a solid hydroxide will precipitate is strongly dependent on the pH of the solution.
- The concentration of free metal ions in equilibrium with the solid hydroxide decreases with increasing pH. However, the actual solubility of the metal hydroxide may increase at high pH values, due to the formation of soluble hydroxo- complexes.
For example, iron(III) may form (Fe2(OH)2)4+, (FeOH)2+, (Fe(OH)2)+ and (Fe(OH)4)-; the relative abundance of these species in equilibrium with solid Fe(OH)3 is a function of total (Fe(III) concentration and pH (i.e. OH- concentration).

Reliability : (4) not assignable
Original references not available

23.09.2002 (102) (108)

Type : abiotic
t1/2 pH4 : at °C
t1/2 pH7 : at °C
t1/2 pH9 : at °C
Deg. product :
Method : other: Sodium precipitation process
Year :
GLP :
Test substance :

Remark : - Precipitation reactions do not generally remove significant amounts od sodium from solution under environmental conditions in non-arid regions.
- Almost all the salts of sodium are strong electrolytes and are highly dissociated in most natural waters.
- It is possible, however, for sodium and ligand concentrations to exceed the solubility products (in concentrated brine formed on evaporation and/or freezing) resulting in precipitate formation.

Reliability : (4) not assignable

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

Original reference is not available

23.09.2002 (43)

Deg. product :
Method : other: Sodium complexation process
Year :
GLP :
Test substance :

Result : Predominant sodium complexes in freshwater and seawater:

	Freshwater (+/- 10 mg/l Na)	Seawater (+/- 10750 mg/l Na)
Na+ (free ion)	100%	98-99%
NaHCO3	0.1%	<0.1%
NaCO3-	0.005%	<0.1%
NaSO4-	0.08%	1-2%

In freshwater systems, the sodium ion complexes are present at very low concentrations, compared with that of the uncomplexed aqueous ion.
In seawater, however, the concentration of sodium sulfate complex (NaSO4-) is significant, representing 1-2% of the sodium content; formation of NaSO4- has been shown to vary inverseley with both pressure and temperature.

Reliability : (4) not assignable
Original references not available

23.09.2002 (43) (52) (108)

3.1.3 STABILITY IN SOIL

Type : other
Radiolabel :
Concentration :
Soil temperature : °C
Soil humidity :
Soil classification :
Year :
Deg. product :
Method : other: Sodium complexation process
Year :
GLP : no
Test substance : no data

Remark : Activities of environmental sodium complexes (NaCl, NaCO3, NaHCO3, NaOH, NaSO4-) at equilibrium with representative soil pore water concentrations of the complexing ions have been examined as a funtion of pH;
Concentrations of free complexing ion are:

Na+	: 10E-3 M
CL-	: 10E-4 to 10E-2 M
SO2-	: 10E-4 to 10E-2 M
CO2 (g)	: 10E-3.5 to 10E-2.5 M

In well trained soils, uncomplexed sodium ion is the only important sodium

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

species up to pH 10, at which point sodium carbonate complexes may become important.
Competition for available ligands and significant formation of soodium complexes may occur when sodium concentrations are very high. However, to permit successful competition with the trace elements, the ratio of the molar concentration of sodium to the molar concentration of the other ions (major or trace elements) would have to be of the order of the inverse ratio of the stability constants for the complexes in question:

$$\frac{(Na+)}{(X+)} = \frac{K(X+Y)}{K(Na+Y-)}$$

X+ = Cation in competition with Na+ for complex formation
with ligand Y-
K = stability constant of complexes with Y-

example: complexes NaCO3- and CaCO3 with stability constants of 10E0.77 and 10E3.5, respectively. To have significant formation of NaCO3- complex, ion Na+ concentration has to be 240 times the ion Ca2+ concentration (10E3.15/10E0.77).

Reliability : (4) not assignable
Original references not available

23.09.2002 (61) (71)

3.2.1 MONITORING DATA

Remark : NaOH is present in the environment as sodium and hydroxyl ions. Both sodium and hydroxyl ions have a wide natural occurrence. In a global water monitoring program (UNEP, 1995) pH and sodium concentrations were two of parameters that were monitored in many lakes and rivers. The most important freshwater aquatic ecosystems of the world revealed average annual pH values between 6.5 and 8.3 but lower and higher values have been measured in other aquatic ecosystems. In aquatic ecosystems with dissolved organic acids a pH of less than 4.0 has been measured, while in waters with a high chlorophyll content the bicarbonate assimilation can result in pH values of higher than 9.0 at midday. The global mean pH value is 7.7. Within this range the bicarbonate ion is the most common carbonate species found in natural waters. In streams (< 100 km2) bicarbonate concentrations range from 0 to 350 mg/l, while in m ajor rivers (> 100,000 km2) the concentration ranges from 10 to 170 mg/l. Sodium concentrations in lakes and rivers display strong variability and orginate from natural weathering of rock, from atmosperic transport of oceanic inputs and from a wide variety of anthropogenic sources. Sodium concentrations in European rivers range between 1.2 and 574 mg/l.

05.12.2001 (111)

3.2.2 FIELD STUDIES

3.3.1 TRANSPORT BETWEEN ENVIRONMENTAL COMPARTMENTS

Type : Other
Media : water – soil
Air : % (Fugacity Model Level I)
Water : % (Fugacity Model Level I)

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

Soil	:	% (Fugacity Model Level I)
Biota	:	% (Fugacity Model Level II/III)
Soil	:	% (Fugacity Model Level II/III)
Method	:	other
Year	:	
Remark	:	The high water solubility and low vapour pressure indicate that NaOH will be found predominantly in water. In soil, mobility depends directly on the importance of the liquid phase of the soil and the possibility to form metal hydroxo-complexes with metal solid species. The 73% aqueous solution of NaOH at ambient temperatures is a highly viscous, gelatinous material and without additional dilution (precipitation), it is not expected to infiltrate soil to any significant extent. The 50% aqueous solution of NaOH us liquid and is expected to infiltrate soil to a measurable degree. As the dilution of NaOH increases, its speed of movement through soil increases. During movement through soil, some ion exchange will occur. Also, some of the hydroxide may remain in the aqueous phase and will move downward through soil in the direction of groundwater flow.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (33)

3.3.2 DISTRIBUTION

Media	:	air - biota - sediment(s) - soil - water
Method	:	
Year	:	
Remark	:	Considering its high w ater solubility, NaOH is not expected to bioconcentrate in organisms. High water solubility and low vapor pressure indicate that NaOH will be found predominately in the aquatic environment. The 73% aqueous solution of NaOH at ambient temperatures is a highly viscous, gelatinous material and without additional dilution (precipitation), it is not expected to infiltrate soil to any significant extent. The 50% aqueous solution of NaOH are liquid and are expected to infiltrate soil to a measurable degree. As the dilution of NaOH increases, its speed of movement through soil increases. During movement through soil, some ion exchange will occur. Also, some of the hydroxide may remain in the aqueous phase and will move downward through soil in the direction of groundwater flow.

23.09.2002 (33)

3.4 MODE OF DEGRADATION IN ACTUAL USE

Remark	:	Sodium persists indefinitely in the environment. The hydroxyl ion can be neutralized by acids, it can form complexes or it can be precipitated. The local fate of the hydroxyl ion depends on the OH- concentration, buffer capacity, pH, temperature and the concentration of trace elements (metals for example).

05.12.2001

3.5 BIODEGRADATION

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

Remark : Not applicable
05.12.2001

3.6 BOD5, COD OR BOD5/COD RATIO

Remark : Not applicable
05.12.2001

3.7 BIOACCUMULATION

Remark : Considering its high water solubility, NaOH is not expected to bioconcentrate in organisms. Log Pow is not applicable for an inorganic compound which dissociates.
05.12.2001

3.8 ADDITIONAL REMARKS

Memo : Stability in air:

Remark : The neutralization of a solution of NaOH in water which is exposed to the atmosphere takes place as a result of its reaction with carbon dioxide (CO2): NaOH + CO2 --> HCO3 + Na+
The overall atmospheric half-life of NaOH is governed by 3 independent processes and determined by the longest half-life of the rate limiting step.
The 3 independent processes of concern are modeled:
1) gas-phase transport of CO2 from the atmospheric bulk to the surface of the aerosol droplet.
2) liquid-phase transport of reactants through the aerosol droplet to the reaction zone.
3) reaction between dissolved CO2 and NaOH.

Result : Half-lives of individual processes

-1) Diffusion of CO2 from bulk to aerosol surface:
Instantaneous reaction; therefore, concentration of CO2 in gas phase just above gas-liquid interface is zero.
t1/2 = 0.35 sec and rate constant k1 = 1.98/sec

-2) Diffusion of reactants within droplet to reaction zone:
Instantaneous reaction; the droplet surface is in equilibrium with the surrounding air; thus, the concentration of dissolved CO2 just inside the surface of the droplet is the saturation concentration under the prevailing atmospheric conditions; using the Henry's constant for CO2 in water, this concentration is calculated to be 4.8 E-7 g/cm3.
t1/2 = 0.011 sec and rate constant k1 = 63/sec

-3) Intrinsic reaction of neutralization process:
t1/2 = 13 sec and rate constant k1 = 0.055/sec

-
The half-lives for the individual processes indicate that the intrinsic reaction rate between CO2 and NaOH is the slowest and therefore rate-limiting

3. Environmental Fate and Pathways

Id 1310-73-2
Date 24.09.2002

step; the rate constant for this step is therefore chosen as the overall rate constant for the overall neutralization process.
Approx. half-life of aerosol NaOH in the atmosphere:
T1/2 = 13 sec

Test condition : - aerosol size : 0.3 to 10 µm of diameter
- density of the aerosol droplet : 1.5217
- atmosperic CO2 concentration : 340 ppm or 6.12 E -7 g/cm3
- atmospheric temperature : 286° Kelvin
- wind speed : negligible
- NaOH conc. (liquid phase) : 50 % by wt corresponding to a concentration of NaOH in droplet of 0.76 g/cm3

23.09.2002 (40)

Remark : The USEPA has concluded that "NaOH is not persistent in the environment" (USEPA, 1988). The immediate effect in water is to raise the pH, and it may precipitate many cations in the water. Heat is generated from dissolution of solid or solutions. Alkalinity may be neutralized by acidic materials in the environment, mostly by CO2 absorbed into water from the atmosphere. In air, anhydrous NaOH is highly deliquescent and will absorb moisture and carbon dioxide from the air, resulting in the formation of sodium carbonate. The reactions of NaOH are those expected of a strong base. The sodium ion will become part of the very large pool of sodium naturally occurring in the environment (EnviroTIPS, 1984)

10.05.2001 (33) (113)

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

4.1 ACUTE/PROLONGED TOXICITY TO FISH

Type	:	static
Species	:	Carassius auratus (Fish, fresh water)
Exposure period	:	24 hour(s)
Unit	:	mg/l
Limit test	:	
Analytical monitoring	:	no
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	no data

Method :
METHOD FOLLOWED
- static 24 h test
STATISTICAL METHODS
- no described

Result :
RESULTS: EXPOSED

500 ppm	Both fish expired in 10 minutes
160 ppm	Median tolerance limit (TLm) 24 hrs.
100 ppm	Both fish survived 24 hours
50 ppm	Both fish survived 24 hours
25 ppm	Both fish survived 24 hours

RESULTS: CONTROL
no data

Test condition :
TEST ORGANISMS
- Strain: not described
- Age/size/weight: not described
- Feeding: not described
- Pretreatment: not described
DILUTION WATER
- Source: Louisville city water
- Hardness: not described
TEST SYSTEM
- Concentrations: 25; 50; 100; 160 and 500 mg/l
- Exposure vessel type/test volume: 16 liters
- Number of replicates/fish per replicate: 1/2
- pH: 9.8 (100 mg/l solution)
- Testtemperature: not described
- Oxygen content: not described
- Photoperiod: not described
TEST PARAMETER
- mortality

Reliability :
(3) invalid
Documentation insufficient for assessment, several test conditions not described

23.09.2002 (47)

Type	:	static
Species	:	Gambusia affinis (Fish, fresh water)
Exposure period	:	
Unit	:	
Limit test	:	
Analytical monitoring	:	no

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Method : other
Year :
GLP : no
Test substance : no data

Method : METHOD FOLLOWED
- static 96 h test with checks made after 24, 48, 72 and 96 hours
STATISTICAL METHODS
- no data

Result : RESULTS: EXPOSED
- All fish were normal at 84 mg/l and lower. At 100 mg/l one fish died in 24 hours and another died in 48 hours. At 180 mg/l and higher all fish died. The median tolerance limit (TLm) after 24, 48 and 96 hours was 125 mg/l.
RESULTS: CONTROL
- not described

Test condition : TEST ORGANISMS
- Wild caught: Stillwater Creek in Payne County, Okla.
- Age/sex/weight: adult females
- Feeding: locally collected detritus and plankton, during the test the fish were not fed
- Pretreatment: 2-3 weeks acclimatization in laboratory
DILUTION WATER
- Source: two local farm ponds with turbid water
- pH: between 7.8 and 8.3
- Alkalinity: < 100 mg/l
TEST SYSTEM
- Test conc. : 10; 18; 32; 56; 100; 180; 320; 560; 1000 mg/l
- Exposure vessel type: cylindric pyrex jars 12 in. high and 12 in. in diameter containing 15 liters
- Number of replicates/fish per replicate: 1/10
- Aeration: yes
- pH: 8.3-9.0 (100 mg/l)
- Test temperature: 22-24°C
- Oxygen content: not described
- Turbidity: 1000 mg/l (init.), 550 mg/l (final)
- Photoperiod: not described
TEST PARAMETER
- mortality

Reliability : (3) invalid
The dilution water was turbid, which could influence the buffer (neutralization) capacity of the water. This is a significant methodological deficiency. The pH was not measured at all concentrations which means that the documentation was insufficient for assessment.

23.09.2002 (117)

Type : static
Species : Poecilia reticulata (Fish, fresh water)
Exposure period : 24 hour(s)
Unit : mg/l
LC50 : = 145

Method : METHOD
Approximate values of LC0 (24h) and LC100 (24h) were determined using one individual per glass beaker. For estimation the LC50 (24h) the interval between LC0 and LC100 was investigated in detail using 5 fish per concentration.

Test condition : TEST ORGANISMS
- Source: a warm-water reservoir near Moscow
- Age/size/weight: nonpedigreed adults

4. Ecotoxicity **Id** 1310-73-2
Date 24.09.2002

- Feeding: not described
- Pretreatment: not described
DILUTION WATER
- Source: not described
- total hardness: not described
TEST SYSTEM
- Concentrations: not described
- Exposure vessel type: glass beakers
- pH: not described
- Test temperature: not described
TEST PARAMETER
- mortality

Reliability : (3) invalid
Documentation insufficient for assessment, several test conditions not described

23.09.2002 (126)

Type : static
Species : other: Lucioperca Lucioperca L. (pike perch)
Exposure period : 24 hour(s)
Unit : mg/l
Method : other: not described
Year :
GLP : no
Test substance : no data

Result : RESULTS: EXPOSED
- Solutions of NaOH in pond water started to be toxic to the fry of Lucioperca lucioperca L. (pike perch) at NaOH concentrations of 35 mg/l (pH 8.2) and higher. At a concentration of 52 mg/l, 40 % of the total fry died within 24 hours. Thus a pH over 8.2 appeared to be dangerous to the pike perch fry.
RESULTS: CONTROL
- not described

Test condition : TEST ORGANISMS
- Wild caught: lake Goplo
- Age/size/weight: fry, 11.5-16 mm
- Feeding: not described
- Pretreatment: not described
DILUTION WATER
- Source: pond water
- total hardness: 130 mg/l CaCO3
TEST SYSTEM
- Concentrations: not described
- Exposure vessel type: glass aquariums
- pH: not described
- Test temperature: not described
TEST PARAMETER
- mortality

Reliability : (3) invalid
Documentation insufficient for assessment. A pH of 8.2 is a very normal pH for aquatic ecosystems and for this reason it is doubtful if a pH of 8.2 is really toxic for fry of pike perch.

23.09.2002 (104)

Type : static
Species : other: Notropis sp.
Exposure period : 120 hour(s)
Unit : mg/l

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Minimal Lethal Concentration	:	= 100
Limit test	:	no
Analytical monitoring	:	no
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data

Method : METHOD
Checks were made on dissolved-oxygen content, pH and alkalinity to make sure that the conditions were within limits favorable to fish. If these conditions fell outside the limits, the results were discarded.
STATISTICAL METHOD
The minimum lethal concentration was defined as the lowest concentration of a toxic material which would kill any of the test animals within a period of 120 hours. 100 % survival of controls was required.

Test condition : TEST ORGANISMS
- Source: Wild caught in the vicinity of Appleton, Wisconsin
- Age/size/weight: not described
- Feeding: not described
- Pretreatment: not described

DILUTION WATER
- Source: stabilized Fox River water
- pH: 7.6-7.8
- total alkalinity: 140-160 ppm

TEST SYSTEM
- Concentrations:
- Exposure vessel type: two-liter open battery jars
- Fish per replicate: one to five fish, depending on the oxygen resources of the test solution
- pH: not described
- Oxygen content: > 4 mg/l
- Test temperature: 18°C

TEST PARAMETER
- mortality, observations were made hourly up to five days

Reliability : (3) invalid
Documentation insufficient for assessment, several test conditions not described

23.09.2002 (114)

Type	:	other
Species	:	Cyprinus carpio (Fish, fresh water)
Exposure period	:	
Unit	:	
Limit test	:	no
Analytical monitoring	:	no
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data

Method : METHOD
The toxicity of NaOH was determined using oral administration and intraperitoneal injection. Intraperitoneal injection of NaOH wa made in aqueous solution.

Result : RESULTS
The results obtained in the form of half-lethal doses (LD50) by injective and oral administration were 150 mg/kg and 1100 mg/kg respectively.

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Test condition	:	TEST ORGANISMS - Source: not described - Age/size/weight: 20-40 g - Feeding: not described - Pretreatment: not described TEST PARAMETER - mortality
Reliability	:	(3) invalid Documentation insufficient for assessment, test procedure is not a standard method

24.09.2002 (126)

Type	:	other
Species	:	Cyprinus carpio (Fish, fresh water)
Exposure period	:	24 hour(s)
Unit	:	mg/l
LC100	:	= 180
Limit test	:	
Analytical monitoring	:	no data
Method	:	other: Fish toxicity test
Year	:	
GLP	:	no
Test substance	:	no data

Test condition	:	Water temperature was 25°C
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (78)

Type	:	other
Species	:	Leuciscus idus melanotus (Fish, fresh water)
Exposure period	:	48 hour(s)
Unit	:	mg/l
LC0	:	= 157
LC50	:	= 189
LC100	:	= 213
Limit test	:	
Analytical monitoring	:	no data
Method	:	other: Mann H (1975) Vom Wasser, 44, 1-13
Year	:	1975
GLP	:	no
Test substance	:	no data

Reliability	:	(4) not assignable Documentation insufficient for assessment, several test conditions not described

23.09.2002 (48)

Type	:	other
Species	:	Oncorhynchus kisutch (Fish, fresh water, marine)
Exposure period	:	5 day(s)
Unit	:	mg/l
Min. lethal concentration	:	= 20
Limit test	:	
Analytical monitoring	:	no data
Method	:	other: Acute fish toxicity test
Year	:	
GLP	:	no

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Test substance : no data

Test condition : Kraft mill waste effluent was used.
Reliability : (4) not assignable
Original reference not available

23.09.2002 (33)

Type : other
Species : other: Freshwater fish
Exposure period :
Unit :
Limit test :
Analytical monitoring : no data
Method : other: Fish toxicity test
Year :
GLP : no
Test substance : no data

Remark :

Species	Exposure time (h)	Safe dose	Lethal dose (mg/l)
Bluegill sunfish (Lepomis macrochirus)	48	-	99 (TLm)*
Brook trout (Salvelinus fontinalis)	24	-	25
Cutthroat trout (Salmo clarki)	24	10	35 (5 days)
Creek chub (Semolitus atromaculatus)	24	20	40
King salmon	-	27	48
Shiners (Cymatogaster aggregata)	120	-	100
Goldfish, bass	3-20	-	100
	7 days	50	-
Silver salmon	-	-	20
Some fish	5	200	-

* TLm = median lethal toxicity

The pH acceptable for most of freshwater adult fish is generally > 9.
Harmful effects are burns on external skin of gills and abundant formation of mucus. Fish die by duffocation because of the slow destruction of their respiratory organs.
Lethal pH threshold is:
Bluegill sunfish = 10.5
Carp = 10.8

Reliability : (4) not assignable
Only secondary literature

23.09.2002 (69)

4.2 ACUTE TOXICITY TO AQUATIC INVERTEBRATES

Type :
Species : Ceriodaphnia sp. (Crustacea)
Exposure period : 48 hour(s)

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Unit	:	mg/l
EC50	:	= 40.4
Analytical monitoring	:	no
Method	:	other: see freetext
Year	:	1999
GLP	:	no
Test substance	:	no data
Method	:	METHOD FOLLOWED - acute 48-h immobilization test according to the NSW Environment Procection Authority STATISTICAL METHODS - Trimmed Spearman-Karber
Test condition	:	TEST ORGANISMS - Source/supplier: not desribed - Feeding: S. capricornutum and Ankistrodesmus sp., no feeding during the test STOCK AND TEST SOLUTION - Vehicle, solvent: no solvent used DILUTION WATER - Source: dechlorinated and filtered Sydney mains water, aged 1 month and adjusted to 500 µS/cm with seawater - Hardness: not described TEST SYSTEM - Test concentrations: five concentrations in a geometric series, plus a control - Exposure vessel type: 200 ml test solution in a 250 ml glass beaker - Number of replicates/individuals per replicate: 3/5 - Test temperature: 23 +/- 1°C - Dissolved oxygen: measured, but not described - pH: measured, but not described - Intensity of radiation: < 1000 lx - Photoperiod: 16h:8h light-dark cycle TEST PARAMETER - Immobility
Reliability	:	(2) valid with restrictions Test procedure in accordance with national standard methods with acceptable restrictions Test procedure in accordance with national standard methods with acceptable restrictions

23.09.2002 (118)

Type	:	
Species	:	Daphnia magna (Crustacea)
Exposure period	:	
Unit	:	mg/l
Lethal	:	= 156
Analytical monitoring	:	no data
Method	:	other: Invertebrate toxicity test
Year	:	
GLP	:	No
Test substance	:	no data
Test condition	:	NaOH (156 mg/l) was diluted in Erie Lake water (pH 9.1 to 9.5).
Reliability	:	(4) not assignable Original reference not available Original reference not available

23.09.2002 (33)

Type	:	
Species	:	Daphnia magna (Crustacea)

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Exposure period	:	
Unit	:	mg/l
Toxicity threshold concentration	:	= 40 - 240
Analytical monitoring	:	no data
Method	:	other: invertebrate toxicity test
Year	:	
GLP	:	no
Test substance	:	no data
Reliability	:	(4) not assignable Only secondary literature Only secondary literature

23.09.2002 (69)

Type	:	static
Species	:	Daphnia sp. (Crustacea)
Exposure period	:	48 hour(s)
Unit	:	mg/l
minimum lethal concentration	:	= 100
Analytical monitoring	:	no
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD Checks on dissolved oxygen, pH and alkalinity were made before and after the test. STATISTICAL METHOD The minimum lethal concentration was defined as the lowest concentration of a toxic material which would kill any of the test animals within a period of 48 hours.
Test condition	:	TEST ORGANISMS - Source/supplier: not described - Feeding: not described DILUTION WATER - Source: stabilized Fox River water - pH: 7.6-7.8 - Alkalinity: 140-160 ppm TEST SYSTEM - Test concentrations: not described - Exposure vessel type: vial containing 25 ml of testsolution - Individuals per replicate: 2 animals - Test temperature: not described - Dissolved oxygen: not described - pH: not described TEST PARAMETER - Immobilization
Reliability	:	(3) invalid Documentation insufficient for assessment, several test conditions not described Documentation insufficient for assessment, several test conditions not described

23.09.2002 (114)

Type	:	
Species	:	other aquatic arthropod: freshwater insect larvae
Exposure period	:	
Unit	:	mg/l

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Lethal : = 125 - 1000
Analytical monitoring : no data
Method : other: Invertebrate toxicity test
Year :
GLP : no
Test substance : no data

Reliability : (4) not assignable Only secondary literature
Only secondary literature
23.09.2002 (69)

Type :
Species : other aquatic mollusc: Cockle
Exposure period : 48 hour(s)
Unit : mg/l
LC50 : = 330 - 1000
Analytical monitoring : no data
Method : other: Invertebrate toxicity test
Year :
GLP : no
Test substance : no data

Test condition : Water was aerated.
Reliability : (4) not assignable Original reference not available
Original reference not available
23.09.2002 (89)

Type :
Species : other aquatic mollusc: Oysters
Exposure period :
Unit :
Analytical monitoring : no
Method : other: Invertebrate toxicity test
Year : 1963
GLP : no
Test substance : no data

Result : Lethal concentration: 4.5 hours, 90 mg NaOH/l
Lethal concentration: 23 hours, 180 mg NaOH/l (pH 12)
Reliability : (4) not assignable Only secondary literature
Only secondary literature
24.09.2002 (69)

Type :
Species : other aquatic mollusc: Vectro snail
Exposure period :
Unit :
Analytical monitoring : no
Method : other:invertebrate toxicity test
Year : 1961
GLP : no
Test substance : no data

Method : METHOD FOLLOWED
- 96 h test
STATISTICAL METHOD
- not described
Result : RESULTS: EXPOSED
- The results showed that Biomphalaria a. alexandrina tolerated a

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

concentration of 400 mg/l NaOH. Bulinus truncatus and Lymnaea caillaudi tolerated a 100 mg/l NaOH solution. The lethal concentration of NaOH to Biomphalaria a. alexandrina, Bulinus truncatus and Lymnaea caillaudi was 450, 150 and 150 mg/l respectively.
RESULTS: CONTROLS
- not described

Test condition : TEST ORGANISMS
- Wild caught: river Nile
- Age/size/weight: full grown snails
- Feeding: not described
- Pretreatment: 3 days acclimatization in laboratory
DILUTION WATER
- Source: cleared Nile water
- Alkalinity: not described
TEST SYSTEM
- Test conc.: series of concentrations varying 50 mg/l
- Exposure vessel type: 200 ml test solution in a 250 ml jar
- Number of replicates, snails per replicate: 1/20
- pH: not described
- Test temperature: 27°C
- Oxygen content: not described
TEST PARAMETER
- Mortality

Reliability : (3) invalid Documentation insufficient for assessment, test procedure is not a standard method
Documentation insufficient for assessment, test procedure is not a standard method

23.09.2002 (37)

Type :
Species : other aquatic worm: Planarian worm
Exposure period : 48 hour(s)
Unit : µmol/l
Lethal concentration : = 4
Analytical monitoring : no data
Method : other: Invertebrate toxicity test
Year :
GLP : no
Test substance : no data

Test condition : Distilled water at a pH of 7.8 was used.
Reliability : (4) not assignable Original reference not available
Original reference not available

23.09.2002 (33)

Type :
Species : other aquatic crustacea: Saltwater shrimp
Exposure period : 48 hour(s)
Unit : mg/l
LC50 : = 30 - 100
Analytical monitoring : no data
Method : other: Invertebrate toxicity test
Year :
GLP : no
Test substance : no data

Test condition : Water was aerated.
Reliability : (4) not assignable Original reference not available
Original reference not available

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

24.09.2002 (89)

Type	:	static
Species	:	other: Mayfly larvae and Chironomus larvae
Exposure period	:	48 hour(s)
Unit	:	mg/l
Analytical monitoring	:	no
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	STATISTICAL METHOD The minimum lethal concentration was defined as the lowest concentration of a toxic material which would kill any of the test animals within a period of 48 hours.
Result	:	RESULTS The minimum lethal concentration of the Mayfly larvae exposed to NaOH was 100 mg/l. The minimum lethal concentration of the Chironomus larvae was 700 mg/l.
Test condition	:	TEST ORGANISMS - Source: wild caught, Lake Winnebago and adjacent waters DILUTION WATER - Source: Stabilized Fox River water - pH: 7.6-7.8 - Alkalinity: 140-160 ppm TEST SYSTEM - Test concentrations: not described - Exposure vessel type: glass vessels - Individuals per replicate: not described - Test temperature: not described - pH: not described TEST PARAMETER - Mortality
Reliability	:	(3) invalid Documentation insufficient for assessment, several test conditions not described. Documentation insufficient for assessment, several test conditions not described.

23.09.2002 (114)

Type	:	
Species	:	other: Ophryotrocha Diadema
Exposure period	:	48 hour(s)
Unit	:	mg/l
LC50	:	= 33 - 100
Analytical monitoring	:	no
Method	:	other: see freetext
Year	:	1983
GLP	:	no
Test substance	:	no data
Method	:	METHOD FOLLOWED - Acute 48-h toxicity test STATISTICAL METHODS - Not described
Test condition	:	TEST ORGANISMS - Source/supplier: University of Gothenburg, Sweden - Feeding: fragmented spinach, no feeding during the test STOCK AND TEST SOLUTION

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

- Vehicle, solvent: no solvent used
DILUTION WATER
- Source: filtered sea water
- Hardness: not described
TEST SYSTEM
- Test concentrations: a half-logarithmic series of concentrations and one control
- Exposure vessel type: 50 ml test solution
- Number of replicates/individuals per replicate: 2/10
- Test temperature: not described
- Dissolved oxygen: not described
- pH: not described
TEST PARAMETER
- Mortality

Reliability : (3) invalid Documentation insufficient for assessment, several test conditions not described
Documentation insufficient for assessment, several test conditions not described

23.09.2002 (86)

4.3 TOXICITY TO AQUATIC PLANTS E.G. ALGAE

Remark : No data available
05.12.2001

4.4 TOXICITY TO MICROORGANISMS E.G. BACTERIA

Type : aquatic
Species : other protozoa: Tetrahymena thermophila
Exposure period : 2 minute(s)
Unit :
Analytical monitoring : no
Method : other: see freetext
Year : 1987
GLP : no
Test substance : no data

Method : METHOD
Test in which the motility pattern of Tetrahymena was observed, evaluated and quantified. The positive control in this test was 1.0 % sodium hydroxide.

Result : RESULTS
When 1 % NaOH was diluted 62 times the motility was higher than 90 % of control cell motility (highest tolerated dose, HTD). This would be equal to a NaOH concentration of 161 mg/l.

Test condition : TEST ORGANISMS
- Strain: T. thermophila (30377)
- Source/supplier: ATCC, Rockville, MD
- Feeding: liver powder, 0.1%; S. cervisiae, 0.1%; soy lecithin 0.001%
DILUTION WATER
- Source: filtered MM2 medium
TEST SYSTEM
- Test concentrations: not described
- Exposure vessel type: 50 µl diluted chemical and 50 µl T. thermophila suspension is placed on a microscope coverglass

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

- Test temperature: 30°C
TEST PARAMETER
- Motility pattern

Reliability : (3) invalid
Documentation insufficient for assessment, several test conditions not described

24.09.2002 (100)

Type : other
Species : Photobacterium phosphoreum (Bacteria)
Exposure period : 15 minute(s)
Unit : mg/l
EC50 : = 22
Analytical monitoring : no
Method : other: see freetext
Year : 1990
GLP : no
Test substance : no data

Method : METHOD FOLLOWED
- Microtox Toxicity Test (commercially available) in which light readings are performed before and 15 minutes after sample addition.
STATISTICAL METHODS
- not described

Test condition : TEST ORGANISMS
- Strain: freeze-dried Photobacterium phosphoreum B-NRRL11177
- Supplier: Mirobics Corporation (Carlsbad, CA)
DILUTION WATER
- water containing 2% NaCl
TEST SYSTEM
- Test temperature: 15°C
TEST PARAMETER
- Amount of light loss

Reliability : (3) invalid
Unsuitable test system

24.09.2002 (17)

4.5.1 CHRONIC TOXICITY TO FISH

Species : Lebistes reticulatus (Fish, fresh water)
Endpoint : other: see freetext
Exposure period :
Unit : mg/l
Analytical monitoring : no
Method : other: see freetext
Year : 1977
GLP : no
Test substance : no data

Method : METHOD FOLLOWED
- Two tests were run. In the first, fry of 1 to 2 days old were tested, In the second, sexually mature females were exposed together with males to solutions with NaOH.
STATISTICAL METHODS
- not described

Result : RESULTS

4. Ecotoxicity **Id** 1310-73-2
Date 24.09.2002

The presence of NaOH had an adverse effect on the survival rate, growth and fecundity, as well as the quality of the progeny of the guppy. Upon prolonged exposure concentrations of 25 to 100 mg/l produced significant changes in the biology of the fish.

Test condition : TEST ORGANISMS
- Strain: Lebistes retivulatus (guppy)
- Pretreatment: not described
DILUTION WATER
- not described
TEST SYSTEM
- Concentrations: 25, 50, 75 and 100 mg/l and one control
- Exposure vessel type/test volume: glass aquaria with 3 ind/liter
- renewal of test solutions: daily
- Test temperature: 20-25°C
- Oxygen content: not described
TEST PARAMETER
- Survival rate, growth, maturation time, fecundity

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (94)

4.5.2 CHRONIC TOXICITY TO AQUATIC INVERTEBRATES

Remark : no data available
05.12.2001

4.6.1 TOXICITY TO SEDIMENT DWELLING ORGANISMS

4.6.2 TOXICITY TO TERRESTRIAL PLANTS

Remark : no data available
05.12.2001

4.6.3 TOXICITY TO SOIL DWELLING ORGANISMS

Remark : no data available
05.12.2001

4.6.4 TOX. TO OTHER NON MAMM. TERR. SPECIES

Remark : no data available
05.12.2001

4.7 BIOLOGICAL EFFECTS MONITORING

4. Ecotoxicity

Id 1310-73-2
Date 24.09.2002

Remark : no data available
05.12.2001

4.8 BIOTRANSFORMATION AND KINETICS

Remark : no data available
05.12.2001

4.9 ADDITIONAL REMARKS

Remark : Outside of the recommended range of pH 6.5 to 9.0, freshwater fish suffer adverse physiological effects increasing in severity until lethal levels are reached. The recommended pH range for marine life is cited as 6.5 to 8.5.Because salt water has a large buffering capacity, pH is more stable than in freshwater and marine species are less tolerant of changes in pH than freshwater fish.

23.09.2002 (112)

5. Toxicity

Id 1310-73-2
Date 24.09.2002

5.0 TOXICOKINETICS, METABOLISM AND DISTRIBUTION

5.1.1 ACUTE ORAL TOXICITY

Type	:	other
Value	:	=
Species	:	rat
Strain	:	
Sex	:	
Number of animals	:	
Vehicle	:	
Doses	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Remark	:	Orally applied 0.2N NaOH caused extensive damage to gastric mucosa of rats; histology: necrosis usually extending down through about two-thirds of the mucosa.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (91)

Type	:	other
Value	:	
Species	:	rat
Strain	:	
Sex	:	male
Number of animals	:	
Vehicle	:	water
Doses	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD The gastric erosive activity of NaOH was studied with rats u sing a maximum erosion score of 100.
Result	:	RESULTS - Increasing concentrations caused increasing gastric injury. NaOH concentrations of 0.4, 0.5 and 0.62 % resulted in erosion scores of 10, 65 and 70 % respectively.
Test condition	:	TEST ORGANISMS - Source: Centraal Proefdierbedrijf, TNO, Zeist, The Netherlands - Age: not described - Weight at study initiation: 190-220 g ADMINISTRATION - Concentrations: 0.4, 0.5 and 0.62 % - Dose: 0.5 ml/100 g body weight (equivalent with 20, 25 and 31 mg NaOH (100%) / kg bw)
Reliability	:	(4) not assignable Documentation insufficient for assessment

5. Toxicity

Id 1310-73-2
Date 24.09.2002

11.12.2001 (115)

Type	:	LD50
Value	:	= 325 mg/kg bw
Species	:	rabbit
Strain	:	
Sex	:	no data
Number of animals	:	46
Vehicle	:	water
Doses	:	
Method	:	other
Year	:	1937
GLP	:	no
Test substance	:	no data
Method	:	STATISTICAL METHODS - not described
Test condition	:	TEST ORGANISMS - Source: not described - Age: not described - Weight at study initiation: 2500-3500 g ADMINISTRATION - Dose: 160 - 940 mg/kg bw - Volume: 4.9 - 31 ml/kg body weight
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (75)

Type	:	
Value	:	= 500 mg/kg bw
Species	:	rabbit
Strain	:	
Sex	:	
Number of animals	:	
Vehicle	:	
Doses	:	
Method	:	other: Acute oral toxicity test
Year	:	
GLP	:	no
Test substance	:	no data
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (33)

Type	:	other
Value	:	
Species	:	cat
Strain	:	
Sex	:	
Number of animals	:	
Vehicle	:	
Doses	:	
Method	:	other: not specified
Year	:	
GLP	:	no
Test substance	:	no data

Result : Application of 8.3% NaOH to the esophagus; NaOH destroyed the superficial layer of the squamous mucosa and caused submucosal and transmural thrombosis in the blood vessels.
Reliability : (4) not assignable
Original reference not available

23.09.2002 (5)

5.1.2 ACUTE INHALATION TOXICITY

Type : other
Value :
Species : rat
Strain : Wistar
Sex : male
Number of animals : 24
Vehicle : no data
Doses :
Exposure time : 2 hour(s)
Method : other
Year :
GLP : no
Test substance : no data

Method : METHOD
The incidence of acute laryngitis was determined. This lesion was graded for each animal as either 0 (normal tissue), 0.5 (trace), 1 (very slight), 2 (slight), 3 (moderate) or 4 (severe).
12 animals were killed within 1 hour of removal from the exposure chamber. The other 12 animals were killed 1 day post-exposure.
Result : RESULTS
At a NaOH aerosol concentration of 750 µg/l, 11 animals showed acute laryngitis after 1 hours and after 1 day post-exposure. The average severity of the lesions was 1.58 (1 hour post-exposure) and 1.25 (post-exposure).
No rats died during the test.
Test substance : TEST ORGANISMS
- Source: Hilltop Lab. Animals, Inc., Scottdale, PA
- Age: juvenile rats
- Weight at study initiation: 130 ± 29 g
- Controls: not described
ADMINISTRATION
- Type of exposure: whole body
- Concentrations: 750 µg/l
- Particle size: 0.8 µm
- Preparation of particles: Sodium aerosol was generated by sweeping argon heated to approximately 600°C across a molten sodium surface. The sodium quickly reacted with oxygen in the dilution air to from sodium oxides. The sodium aerosol reacted rapidly with H2) and CO2 to form NaOH and Na2CO3. The aerosol was usually Na2CO3 unless the composition of the dilution air was modified to maintain a higher percentage of NaOH.
EXAMINATIONS
- Microscopic examinations of cross sections of nose, larynx, trachea with esophagus and lungs. Other tissues examined for some animals included stomach and eyes.
Reliability : (3) invalid
Test conditions described in sufficient details but no standard method used. Difficult to determine the exact exposure to NaOH as it reacts rapidly with

CO2 in ambient air to form Na2CO3.

23.09.2002 (131)

5.1.3 ACUTE DERMAL TOXICITY

Type	:	other: see freetext
Value	:	
Species	:	mouse
Strain	:	
Sex	:	no data
Number of animals	:	27
Vehicle	:	water
Doses	:	
Method	:	other: see freetext
Year	:	1965
GLP	:	no
Test substance	:	no data
Method	:	METHOD FOLLOWED - Sodium hydroxide was applied to the back of 27 mice. Afterwards the area was irrigated for 1 hour with water at various time intervals
Result	:	RESULTS The mortality of the mice was 0; 20; 40; 80 and 71 % when they were irrigated immediately, 30 minutes, 1 hour, 2 hours or not at all after the application.
Test condition	:	TEST ORGANISMS - Source: not described - Age/strain: 54 A/He and C57 black adult mice - Weight at study initiation: 25-35 g ADMINISTRATION - Area covered: circular 2 cm - Concentration: 50 % NaOH - Total volume applied: not described
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (15)

5.1.4 ACUTE TOXICITY, OTHER ROUTES

Type	:	LD50
Value	:	= 40 mg/kg bw
Species	:	mouse
Strain	:	
Sex	:	
Number of animals	:	
Vehicle	:	
Doses	:	
Route of admin.	:	i.p.
Exposure time	:	
Method	:	other: not specified
Year	:	
GLP	:	no data
Test substance	:	no data
Reliability	:	(4) not assignable

Original reference not available

23.09.2002 (96)

5.2.1 SKIN IRRITATION

Species	:	human
Concentration	:	
Exposure	:	
Exposure time	:	48 hour(s)
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Result	:	RESULTS The suggested optimum concentration, producing mild to moderate reactions in as close to 75 % of the individuals tested, was 2 % under the conditions the test was performed.
Test condition	:	HUMAN VOLUNTEERS - Sex: male - Number of volunteers: 42 AMINISTRATION/EXPOSURE - Area of exposure: intact skin of the forearm - Concentration: 1, 2 and 4% - Total volume applied: 15 µl - Method of administration: closed patch
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (123)

Species	:	human
Concentration	:	
Exposure	:	
Exposure time	:	
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD Irritant dermatitis after application of NaOH was studied by means of visually scoring, contact thermography (Agner and Serup, 1988) and by using imprints of a polysulfide rubber base (Agner and Serup, 1987).
Result	:	RESULTS Application of 2 % NaOH in some cases did not produce any inflammation at all, while in others it caused sever crusting. Based on the imprints no skin damage was found in most cases, but in 31 % of the imprints a

characteristic pattern of very few, very deep impressions on otherwise normal skin appeared. These alterations remained unchanged for 96 hours.

Test condition : HUMAN VOLUNTEERS
- Sex: 10 female, 6 male
- Age: median age, 29.5 years (range 22-39)
- Number of volunteers: 16 healthy Caucasian volunteers

AMINISTRATION/EXPOSURE
- Area of exposure: the anteriolateral surface of both upper arms
- Concentration: 2%, pH 13.7
- Vehicle: destilled water
- Method of administration: closed patch using Finn chambers (diameter 12 mm)
- Duration of exposure: < 1 hour

EXAMINATIONS
- Scoring system: 0 (no reaction)-3 (strong posive reaction)
- Examination time points: 24, 48 and 96 hours

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (1)

Species : human
Concentration :
Exposure :
Exposure time :
Number of animals :
Vehicle :
PDII :
Result :
Classification :
Method : other: see freetext
Year :
GLP : no
Test substance : other TS: see freetext

Method : METHOD
The response to sodium hydroxide has been assessed on the back of human volunteer subjects using both clinical scoring and two instrumental methods; erythema measurements using an erythema meter and capillary blood flow using a laser Doppler device.

Remark : Another study was performed in which the irritating effect of sodium hydroxide on the back and forearm skin were compared. For this study a total of 15 subjects (13 female, 2 male), mean age 31.4 years, range 19-45 years were recruited. A 1% sodium hydroxide solution was applied to back and forearm skin. Assessments were made at 1, 24, 48 and 72 h. Comparison between back and forearm skin indicated a greater sensitivity to sodium hydroxide on the back.

Result : RESULTS
Increased erythema was seen with increasing duration of exposure and an increase was also seen at 1, 24 and 48 hours after removal of the patch. The results obtained with the erythema meter and blood flow meter paralleled the clinical erythema scores.

Test condition : HUMAN VOLUNTEERS
- Sex: 20 female, 10 male
- Age: mean age, 27.5 years (range 18-40)
- Number of volunteers: 30

AMINISTRATION/EXPOSURE
- Area of exposure: lower back, above the waist and below the mid-point of

the neck to waist area. Flexor aspect of the forearm
- Concentration: 0.5 and 1% aqueous solution
- Method of administration: closed patch using Finn chambers (diameter 12 mm)
- Duration of exposure: 3, 15 and 60 minutes
EXAMINATIONS
- Scoring system: 0 (no reaction)-3 (severe reaction)
- Examination time points: 1, 24 and 48 h.

Test substance : TEST SUBSTANCE
- Sodium hydroxide ('Analar', BHD ltd, Poole)

Reliability : (2) valid with restrictions
Study well documented, meets generally accepted scientific principles, acceptable for assessment

11.12.2001 (32)

Species : human
Concentration : .5 %
Exposure :
Exposure time : 1 hour(s)
Number of animals :
Vehicle :
PDII :
Result :
Classification :
Method : other: see freetext
Year :
GLP : no
Test substance : other TS: see freetext

Method : METHOD FOLLOWED
- Sodium hydroxide was used in an interlaboratory test to validate an alternative (in vivo) method to the Draize skin irritation test involving use of human volunteers to identify skin irritation hazard. The study was performed in three different test facilities.

Result : RESULTS
-In each test facility, sodium hydroxide appeared to be a very clear irritant with about half the volunteers reacting after 1 hour of treatment. The response was so vigorous that exposure for a greater duration was not undertaken at any site.

Test condition : HUMAN VOLUNTEERS
- Sex: not described
- Age: not described
- Number of volunteers: approximately 30
AMINISTRATION/EXPOSURE
- Area of exposure: upper outer arm
- Total volume applied: 0.2 ml
- Method of administration: 25 mm Plain Hill Top Chamber
EXAMINATIONS
- Scoring system: 0 (no reaction) - +++ (severe reaction)
- Examination time points: 24, 48 and 72 hr after initiation of exposure

Test substance : TEST SUBSTANCE
- Sodium hydroxide, 98% (Sherman Chemicals)

Reliability : (2) valid with restrictions
11.12.2001 (39)

Species : human
Concentration : 4.9 %
Exposure :

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Exposure time	:	
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	In-vitro test
Year	:	
GLP	:	no data
Test substance	:	no data
Result	:	RESULTS The results showed that 4.88 % NaOH could be classified as corrosive.
Test condition	:	TEST SYSTEM (IN -VITRO) - Cell type: Skin cutaneous model ZK 1350 - Supplier: Advanced Tissue Sciences, La Jolla, CA AMINISTRATION/EXPOSURE - Area of exposure: 9 mm² - Vehicle: water - Total volume applied: 15 µl - Duration of exposure: 10 seconds EXAMINATIONS - Scoring system: corrosive: < 80 % viability or non-corrosive (> 80 %). The viability of the treated skin cultures was calculated as percentage of the control values.
Reliability	:	(3) invalid Unsuitable test system

23.09.2002 (60)

Species	:	human
Concentration	:	
Exposure	:	
Exposure time	:	24 hour(s)
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no data
Test substance	:	other TS
Method	:	METHOD Clinical and instrumental (transepidermal water loss and sonography) were carried out after exposure to sodium hydroxide.
Remark	:	Another study was performed in which the short-term effect of sodium hydroxide was examined. In 30 subjects a patch test with 40 µl of 0.1 mol/l (0.4%) NaOH was placed on the right forearm for 10 minutes. Instrumental evalutations were carried out immediately after drying. No visible signs of inflammation were observed at 10 minutes on the test areas.
Result	:	RESULTS The intensity of skin responses at 24 h increased according to NaOH concentration, varying from apparently dry skin associated faint or patchy erythema to erythema and oedema with severe erosions and crusting. Skin reactions tot the 1 % concentration were quite uniform in all subjects. The test with 4 % NaOH allowed a classification of subjects in two categories: subjects who reacted normally (25 persons) and hyper-reactors

(9 persons). Hyper-reactors showed an enhanced inflammatory response.

Test condition : HUMAN VOLUNTEERS
- Sex: 33 female, 1 male
- Age: 18 to 45 years
- Number of volunteers: 34

AMINISTRATION/EXPOSURE
- Area of exposure: right forearm (1 and 2%), left forearm (4%)
- Concentration: 1, 2 and 4 % aqueous solution
- Total volume applied: 40 µl
- Method of administration: closed patch using Finn chambers

EXAMINATIONS
- Scoring system: 0 (no reaction) - 5 (erythema, oedema and more extensive erosions or crusting)
- Examination time points: 0.5, 48 and 72 hours

Reliability : (2) valid with restrictions
Study well documented, meets generally accepted scientific principles, acceptable for assessment

23.09.2002 (98)

Species : human
Concentration : .8 %
Exposure :
Exposure time : 5 minute(s)
Number of animals :
Vehicle :
PDII :
Result :
Classification :
Method : other: see freetext
Year :
GLP : no
Test substance : no data

Method : METHOD
Metalworker trainees underwent skin examination for skin atopy, including standardized questionnaire, clinical skin examination and a series of skin irritability tests. The tests included measurements of transepidermal water loss (TEWL) before and after irritation with sodium hydroxide.

Result : RESULTS
The mean TEWL before was 9.8, the mean TEWL after was 19.9.
Linear regression was performed evaluating the relationship between atopy score and irritability and demonstrated that skin atopy is not associated with increased skin irritability.

Test condition : HUMAN VOLUNTEERS
- Sex: male
- Age: 15 to 20 years
- Number of volunteers: 205 persons from 19 different companies in eastern Switzerland

AMINISTRATION/EXPOSURE
- Area of exposure: medial 1/3 of the flexor side of the forearm
- Total volume applied: 0.1 ml
- Method of administration: plastic blocks (21 to 32 mm)

EXAMINATIONS
- Scoring system: not described
- Examination time points: 5 to 10 minutes after the irritants had carefully been wiped off.

Reliability : (3) invalid
Unsuitable test system

23.09.2002 (107)

Species	:	human
Concentration	:	1 %
Exposure	:	
Exposure time	:	
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	other TS: see freetext
Result	:	RESULTS Webril and Hill top patches generated the greatest levels of response (11/14 and 5/14 after 30 minutes). With the Finn and Van der Bend chambers reactivity was reduced (5/14 and 7/14 after 4 hours).
Test condition	:	HUMAN VOLUNTEERS - Sex: male and female - Age: 18 to 65 years - Number of volunteers: 14 AMINISTRATION/EXPOSURE - Area of exposure: not described - Method of administration: Finn chamber (0.04 ml), Hill Top patch (0.2 ml), Van der Bend chamber (0.03 ml) and Webril patch (0.2 ml) - Duration of exposure: 4 hours or until one third of the panel demonstrated 'positive' reactions EXAMINATIONS - Scoring system: erythema 0 (no erythema)- 4 (severe erythema); Oedema 0 (no oedema) - 4 (severe oedema); Exudation/surface encrustation 0 (no effects)- 2 (more than half of the area affected) - Examination time points: immediately, 1, 24, 48 and 72 h. after removal
Test substance	:	TEST SUBSTANCE NaOH (Analar Grade; BDH Ltd, Poole, Dorset)
Reliability	:	(2) valid with restrictions Study well documented, meets generally accepted scientific principles, acceptable for assessment

23.09.2002 (128)

Species	:	human
Concentration	:	.5 %
Exposure	:	
Exposure time	:	
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	yes
Test substance	:	other TS: see freetext
Method	:	METHOD Treatment sites were assessed for the presence of irritation using a 4 point

scale at 24, 48 and 72 hours after patch removal. Sodium dodecyl sulfate (20 %) was used as a positive control and is the minimum concentration classified as "irritating to skin" (R38) under EU regulations.

Result : RESULTS
The total number of "positive" reactions was 20 of the 33 subjects which is higher than SDS (20 %).

Test condition : HUMAN VOLUNTEERS
- Sex: not described
- Age: 18 to 65 years
- Number of volunteers: approximately 30
AMINISTRATION/EXPOSURE
- Area of exposure: upper outer arm
- Total volume applied: 0.2 ml
- Method of administration: 25 mm Hill Top chamber
- Duration of exposure: from 15 and 30 minutes through 1, 2, 3 and 4 h
EXAMINATIONS
- Scoring system: 0 (no reaction) - +++ (strongly positive reaction
- Examination time points: 24, 48 and 72 hours after patch removal

Test substance : NaOH (Sherman, 98%)

Reliability : (1) valid without restriction
Test procedure in accordance with generally accepted scientific standards and described in sufficient detail

23.09.2002 (129)

Species : mouse
Concentration :
Exposure :
Exposure time : 24 hour(s)
Number of animals :
Vehicle :
PDII :
Result :
Classification :
Method : In-vitro test
Year :
GLP : no
Test substance : other TS: see freetext

Method : METHOD USED:
-The dermal side of the skin explants was in contact with the medium whereas the substance was applied to the epidermal side of the skin explants. As parameters for the membrane-damaging effect the enzymes lactate dehydrogenase and glutamic-oxalacetate tranaminase were measured and glucose utilization was also determined during the incubation period.

Result : RESULTS
The effects of NaOH were underestimated when only the results of enzyme release and glucose utilization were assessed, it is supposed that NaOH caused its destructive effects only by its high pH-value and was partly neutralized by the incubation medium.

Test condition : TEST SYSTEM (IN -VITRO)
- Cell type: Skin explants of female hairless mice (age 60-80 days of age)
AMINISTRATION/EXPOSURE
- Area of exposure: 50 mm^2
- Concentration: 500, 1000, 2500 and 5000 µg/cm^2 skin
- Vehicle: not described
- Total volume applied: 5 µl
- Number of replicates: 5 skin explants per concentration

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Test substance	:	TEST SUBSTANCE - NaOH (Henkel KGaA, Düsseldorf)
Reliability	:	(3) invalid Unsuitable test system

23.09.2002 (6)

Species	:	other
Concentration	:	10 %
Exposure	:	
Exposure time	:	5 minute(s)
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	In-vitro test
Year	:	
GLP	:	no
Test substance	:	no data
Result	:	RESULTS The t50 of 10 % sodium hydroxide was 2.4 minutes and can therefore be classified as corrosive.
Test condition	:	TEST SYSTEM (IN -VITRO) - Cell type: Skin model ZS 1300 - Supplier: Advanced Tissue Sciences, La Jolla, CA AMINISTRATION/EXPOSURE - Area of exposure: 11 mm² - Vehicle: water - Total volume applied: 25 µl EXAMINATIONS - Skin culture damage was based on the observation that a 50% reduction in cell viability at a test material exposure time of < 3 minutes classifies the test material as corrosive.
Reliability	:	(3) invalid Unsuitable test system

23.09.2002 (87)

Species	:	other: rat, mouse, guinea pig
Concentration	:	
Exposure	:	
Exposure time	:	
Number of animals	:	
Vehicle	:	
PDII	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	other TS: see freetext
Method	:	A stepwise screening test is presented for skin and eye irritations, suitable for industrial chemicals wich are not applied to human skin or eyes intentionally. Sodium hydroxide was used as one of the test chemicals. The method consisted of physicochemical tests and animal tests using rats, mice or guinea pig, namely, a skin irritation test, an intradermal reaction test and an eye irritation test in a sequential manner. In the following table

the miminum concentrations/ amounts at wich NaOH showed positive effects are given:

-Animal	Test	Concentration	Amount
-rat	skin irritation	5%	50 mg/kg
mouse	skin irritation	5%	50 mg/kg
guinea pig	skin irritation	5%	1.25 mg/kg
rat	intradermal test	0.25-0.3%	125-150 µg/kg
mouse	intradermal test	0.25-0.3%	1.25-1.5 mg/kg
guinea pig	intradermal test	0.075-0.1%	18.8-25 µg/kg
rat	eye irritation	1.25%	625 µg/kg

-ns

Test substance : TEST SUBSTANCE
NaOH (reagent grade from Wako Pure Chemical Industries)

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (99)

Species : pig
Concentration :
Exposure :
Exposure time :
Number of animals :
Vehicle :
PDII :
Result :
Classification :
Method : other: In-vivo and in-vitro test
Year : 1991
GLP : no
Test substance : other TS: see freetext

Method : METHOD USED (IN VIVO):
- NaOH was applied to the skin of a pig. Macroscopic oservations were recorded for 30 minutes.
METHOD USED (IN VITRO):
- 4N or 6N NaOH in water was uniformly distributed. After 8 hr of steady perfusion samples were taken for light microscopy and transmission electron microscopy.

Result : RESULTS: IN-VIVO
Gross blisters developed within 15 min. of application. NaOH at 8% and 16% produced severe necrosis in all epidermal layers. 24% NaOH produced numerous and severe blisters with necrosis extending deeper into the subcutaneous tissue.
---> highly irritating (8%, 16%) to corrosive effects (24%)
RESULTS: IN-VITRO
NaOH at 16% and 24% showed severe necrosis of all epidermal cell layers

and dermis. At times these lesions extended deep into the subcutaneous layers. A decrease in glucose utilization and changes in vascular resistence were described.
---> corrosive effects

Test condition : IN VIVO: TEST ANIMALS
- Strain: Yorkshire weanling pigs
- Sex: not described
- Source: not described
- Weight at study initiation: approximately 20 kg
- Number of animals: 4

IN VIVO: ADMINISTRATION/EXPOSURE
- Area of exposure: 5 cm2 area on the lower abdominal region
- Concentration: 2N (8%), 4N (16%) and 6N (24%)
- Total volume applied: 200 µl
- Duration of exposure: 30 minutes

IN VITRO: TEST SYSTEM
- Cell type: isolated perfused skin flaps of a Yorkshire weanling pig (20 kg)

IN VITRO: ADMINISTRATION/EXPOSURE
- Area of exposure: 5 cm2 area on the lower abdominal region
- Concentration: 4N (16%) and 6N (24%)
- Total volume applied: 200 µl
- Duration of exposure: 8 hours

Test substance : TEST SUBSTANCE
- NaOH (Fisher Scientific)

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (103)

Species : pig
Concentration :
Exposure :
Exposure time :
Number of animals : 2
Vehicle :
PDII :
Result :
Classification :
Method : other: see freetext
Year : 1987
GLP : no
Test substance : no data

Method : METHOD USED
- the skin of anaesthetized pigs was exposed to NaOH, then biopsies were obtained immediately after and up to 7 days after injury. The biopsies were evaluated using a light microscope.

Result : RESULTS
Immediately after application of NaOH dispersed collagen fibres showed increased eosinophilia and a fine densely spaced cross-striation in polarized light and vesicular nuclei were present within dermal cells; during the following days a narrow demarcation zone of neutrophilic granulocytes separated the zone containing abnormal collagen fibres from normal tissue.

Test condition : TEST ANIMALS
- Strain: Danish Landrace pigs
- Sex: not described
- Source: not described
- Weight at study initiation: 19-29 kg

AMINISTRATION/EXPOSURE

- Area of exposure: not described
- Concentration: 0.3N (1.2%), 0.5N (2%) and 1N (4%) NaOH
- Vehicle: not described
- Total volume applied: not described
- Duration of exposure: 60 - 90 seconds

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (49)

Species : Rat
Concentration : 8 %
Exposure :
Exposure time : 1 minute(s)
Number of animals : 20
Vehicle :
PDII :
Result :
Classification :
Method : other: see freetext
Year : 1993
GLP : No
Test substance : no data

Method : METHOD FOLLOWED
- Sodium hydroxide was applied to the abdomens of 20 rats.
Afterwards the area was washed with 500 ml distilled waterstarting 1, 10 and 30 minutes postinjury.

Result : RESULTS
After injury with NaOH the subcutaneous tissue pH had not recovered to the pre-experimental level by the 90th minute.
When washing started within 1 minute of injury the tissue pH value did not exceed 8.00. Washing had no effect when the delay between injury and the start of washing was 10 and 30 minutes.

Test condition : TEST ANIMALS
- Strain: SD rats
- Sex: not described
- Source: not described
- Weight at study initiation: approximately 300 g

AMINISTRATION/EXPOSURE
- Area of exposure: abdominal skin
- Vehicle: not described
- Total volume applied: not described
- Method of administration: 2N NaOH on a filter paper with a diameter of 2 cm

EXAMINATIONS
- Scoring system: subcutaneous tissue pH was recorded
- Examination points: at 1-minute intervals, up to 90 minutes after injury

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (125)

5.2.2 EYE IRRITATION

Species : rabbit
Concentration :
Dose :
Exposure time :

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	corrosive
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Remark	:	(Highly) irritating effects: 0.2% (3 min.): moderately severe burns 0.25% (30 sec. or less): mild burn Corrosive effects: 0.2% (>3 min.): devasting lesions: necrosis of the conjunctiva, ishemic necrosis of the limbal blood vessels, opacification of the cornea, extreme congestion and thickening of the iris; severity of irritation is depending on the concentration of NaOH and the duration of contact.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (44)

Species	:	Rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	Corrosive
Classification	:	
Method	:	other
Year	:	
GLP	:	No
Test substance	:	no data
Remark	:	Study of the biochemical and histological effects of 0.01N (0.04%), 0.05N (0.2%), 0.1N (0.4%), 0.25N (1%), 0.5N (2%) NaOH; 0.25, 0.5N NaOH: decrease in alkaline and acid phosphatase activity, cornea became grey-white and edematous; histologic and metabolic patterns, as well as re-epithelization of the experimentally burned cornea were a function of NaOH concentration and the duration of contact.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (13)

Species	:	rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	corrosive
Classification	:	
Method	:	Draize Test
Year	:	
GLP	:	no

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Test substance	:	no data
Remark	:	NaOH was placed directly in the cornea and the eyes were later examined and scored; 0.5%: slight irritation, 10%: severe irritation and corrosion.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (38)

Species	:	rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	Draize Test
Year	:	1944
GLP	:	no
Test substance	:	other TS: see freetext
Method	:	METHOD Two groups of 6 rabbits each were used. The eyes of the first group were gently washed for 2 min with 300 ml of tap water 30 s after exposure to NaOH; the test eyes of the second group were not washed after exposure.
Result	:	RESULTS Concentrations of 1.0 % and 3.0 % resulted in conjuctivitis which lasted through 7 days, while concentrations of 0.1 and 0.3 % did not. The duration of the corneal opacities produced by 1.0 % NaOH were reduced as a result of washing the test eyes 30 s after instillation.
Test condition	:	TEST ANIMALS - Strain: New Zealand albino rabbits - Sex: unselected - Source: Zartman Farms, PA. - Age: not described - Weight at study initiation: 2.0-2.5 kg - Number of animals: two groups of 6 rabbits ADMINISTRATION/EXPOSURE - Concentration and pH value: 3.0% (13.5), 1.0% (13.1), 0.3% (12.8) and 0.1% (12.3) - Amount of substance instilled: 0.1 ml - Vehicle: water - Exposure period: washed (after 30 s) and unwashed eyes EXAMINATIONS: - Scoring system: fluorescein, 1 (severe) - 4 (non-irritant) - Observation period: prior to instillation and 1 h, 1, 2, 3 and 7 days after instillation
Test substance	:	TEST SUBSTANCE NaOH, Fisher Scientific Company, Fair Lawn NJ.
Reliability	:	(2) valid with restrictions Comparable to guideline study with acceptable restrictions

11.12.2001 (74)

Species	:	rabbit
Concentration	:	
Dose	:	
Exposure time	:	

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no data
Test substance	:	no data

Method : METHOD FOLLOWED
Rabbit eyes were exposed to concentrations of 1N (4%) or 4N (16%) for 30 seconds or 3 minutes.

Result : RESULTS
Severity and prognosis of alkali burns vary greatly depending on the three analyzed factors: the extent of injury, the duration of contact and the pH value of the solution; the extent of the injury seems to be the most decisive factor influencing the course of the burn.

Reliability : (4) not assignable
Abstract

23.09.2002 (9)

Species	:	Rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	No
Test substance	:	no data

Method : METHOD
Rabbit eyes were exposed to a concentration of 1 % NaOH for eighteen to 24 hours. A grading system from 1 to 10 is used for rating the damage produced by the chemical in the eye.

Result : RESULTS
An injury grade of 10 out of 10 is found for a 1% NaOH solution.

Reliability : (4) not assignable
Documentation insufficient for assessment

23.09.2002 (18)

Species	:	Rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	6
Vehicle	:	
Result	:	
Classification	:	
Method	:	OECD Guide-line 405 "Acute Eye Irritation/Corrosion"
Year	:	1981
GLP	:	Yes

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Test substance : other TS

Result : RESULTS
A 2% NaOH solution caused moderate corneal injury (mean 2.0 for a maximum score of 4) which covered approx. half of the cornea. By 96 hours, the corneal injury had not changed substantially but the area of the eye covered had been drastically reduced. Severe conjunctival irritation was also observed between 4 and 96 hours at this concentration. The effects observed with a 1% solution were less than that observed with the 2% solution.

Test condition : TEST ANIMALS
- Strain: New Zealand albino rabbits
ADMINISTRATION/EXPOSURE
- Concentration test substance: 2.0 % and 1.0 %
- Amount of substance instilled: 0.1 ml into the lower conjunctival sac
- Vehicle: water
EXAMINATIONS
- Scoring system and observations: Draize scoring criteria, according to OECD 405

Reliability : (1) valid without restriction
GLP guideline study

23.09.2002 (45)

Species : Rabbit
Concentration : .8 %
Dose :
Exposure time :
Comment :
Number of animals :
Vehicle :
Result :
Classification :
Method : other
Year :
GLP : No
Test substance : no data

Method : METHOD
The healing course of 6 rabbit cornea was monitored using a micropolarographic system. This system was used to quantify the differences of oxygen uptake before and after test solution exposure.

Result : RESULTS
The healing course following the exposure consisted of two well defined phases: an initial period of hypoflux lasting some 48 hours before rising back up to the pre-lesion baseline, followed by a period of hyperflux lasting about 7 days before decreasing to the pre-lesion baseline.

Test condition : TEST ANIMALS
- not described
ADMINISTRATION/EXPOSURE
- Amount of substance instilled: not described
- Exposure time: 10 seconds
EXAMINATIONS
- Scoring system and observations: every 24 hours over a period of 10 days

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (66)

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Species	:	rabbit
Concentration	:	4 %
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	6
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD The eyes were examined 3 times a week with special attention paid on conjunctival injection or necrosis, corneal ulceration and neovascularization.
Result	:	RESUITS One animal died on day 5 and was excluded from the experiment. After 33 days, 70 % of the cornea ulcerated or perforated.
Test condition	:	TEST ANIMALS - Strain: New Zealand albino rabbits - Sex: both sexes - Source: not described - Age: not described - Weight at study initiation: 2.0-3.0 kg ADMINISTRATION/EXPOSURE - Amount of substance instilled: 0.4 ml - Vehicle: water - Exposure period: 20 s, flushed for 15 s EXAMINATIONS - Scoring system: 4 grades, no ulcers - descemetocele - Observation period: 3 times a week, total duration 33 days
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (88)

Species	:	rabbit
Concentration	:	8 %
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	30
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD After application of NaOH the cornea were evaluated daily using a portable slit-lamp. Cornea were examined for the presence of defects, ulcers, perforation and infection.
Result	:	RESULTS The incidence of perforation at 3 weeks was 20 %. By 5 days after alkali

injury 36 % of the cornea were ulcerating. Most cornea did no begin to ulcerate until day 10.

Test condition : TEST ANIMALS
- Strain: New Zealand albino rabbits
- Sex: both sexes
- Source: not described
- Age: not described
- Weight at study initiation: 2.0-2.5 kg

ADMINISTRATION/EXPOSURE
- Amount of substance instilled: 0.5 ml into a circular plastic well held firmly against the cornea
- Vehicle: water
- Exposure period: 60 s, hereafter the NaOH solution was aspirated

EXAMINATIONS
- Scoring system: 0 (no ulceration) - 4 (perforation)
- Observation period: daily for 21 days

Reliability : (2) valid with restrictions
Study well documentated, meets generally accepted scientific principles, acceptable for assessment

11.12.2001 (120)

Species : Rabbit
Concentration :
Dose :
Exposure time :
Comment :
Number of animals : 7
Vehicle :
Result :
Classification :
Method : other: see freetext
Year :
GLP : No
Test substance : other TS: see freetext

Method : METHOD
After instillation of NaOH in the left eye, both eyes were evaluated for irritation and corneal thickness for up to 21 days using a slit-lamp biomicroscope with pachymeter attachment.

Result : RESULTS
Concentrations of 0.001M (0.004%), 0.01M (0.04%) and 0.05M (0.2%) NaOH were considered non-irritant, while the irritation at 0.1M (0.4%) was mild and 0.3M (1.2%) was considered corrosive.

Test condition : TEST ANIMALS
- Strain: Stauffland Albino rabbits (New Zealand and Florida White cross)
- Sex: male and/or female
- Source: Phillips Rabbitry, Soquel, CA
- Age: not described
- Weight at study initiation: 2.0-3.0 kg

ADMINISTRATION/EXPOSURE
- Concentration of test substance: 0.001, 0.01, 0.05, 0.1 and 0.3 M prepared by serial dilution of a 0.3 M-stock solution
- Amount of substance instilled: 0.1 ml into the lower conjunctival sac
- Vehicle: distilled water
- Exposure period: 21 days

EXAMINATIONS
- Scoring system: Draize scoring system
- Observation period: prior to treatment and 1,2,3,4,7 and then every 3-4

days up to 21 days after application of the test substance

Test substance : TEST SUBSTANCE
NaOH, reagent grade, J.T. Baker Chemicals (Phillipsburg, NJ)

Reliability : (2) valid with restrictions
Study well documentated, meets generally accepted scientific principles, acceptable for assessment

23.09.2002 (72)

Species : rabbit
Concentration :
Dose :
Exposure time :
Comment :
Number of animals : 7
Vehicle :
Result :
Classification :
Method : other: see freetext
Year :
GLP : no
Test substance : no data

Method : METHOD
After exposure to NaOH the rabbits were killed and the cornea were removed and studied with light microscopy and scanning electron microscopy.

Result : RESULTS
If the cornea were exposed to 0.4 % NaOH for 10 seconds, the epithelium appeared to be normal after 48 hours. After contact with 4 % NaOH for 10, 20 and 60 seconds, stromal edema and the extent of the damaged area of the endothelium increased in proportion to length of exposure.

Test condition : TEST ANIMALS
- Strain: New Zealand white rabbits
- Sex: both sexes
- Source: not described
- Age: not described
- Weight at study initiation: 2-3 kg

ADMINISTRATION/EXPOSURE
- Concentration of test substance: cornea were injured with 6-mm diameter filter paper soaked in 0.1N (0.4%) or 1N (4%) NaOH applied to the center surface of the right cornea
- Exposure period: 5, 10, 20 or 60 seconds

EXAMINATIONS
- Scoring system: not applicable
- Observation period: different time intervals

Reliability : (3) invalid
Unsuitable test system

23.09.2002 (8)

Species : rabbit
Concentration :
Dose :
Exposure time :
Comment :
Number of animals :
Vehicle :
Result :
Classification :

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD Fluorescein stain was used to aid in determing the extent of corneal damage.
Result	:	RESULTS Results per concentration are not presented. Based on extrapolation a concentration of 3 % NaOH would result in a Draize score of 20 units from a possible total of 110 units.
Test condition	:	TEST ANIMALS - Strain: Japanese white rabbits - Sex: both sexes - Source: not described - Weight at study initiation: not described - Number of animals: 3-6 ADMINISTRATION/EXPOSURE - Concentration of test substance: 4 different concentrations - Exposure period: 5, 10, 20 or 60 seconds EXAMINATIONS - Scoring system: Draize score - Observation period: 1,3,6,24,96 and 169 hr following application
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (119)

Species	:	rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD The intraocular pressure (IOP) responses following sodium hydroxide burn were continuously monitored up to three hours after application.
Result	:	RESULTS The ocular hypertensive response to NaOH consisted of a rapid initial rise followed by a gradual second rise.
Test condition	:	TEST ANIMALS - Strain: Albino rabbits - Sex: not described - Source: not described - Weight at study initiation: 1.8 to 2.8 kg - Number of animals: not described ADMINISTRATION/EXPOSURE - Concentration of test substance: 0.125N (0.5%), 0.5N (2%) and 2.0N (8%) - Amount of substance: 0.05 ml

- Exposure period: three hours without washing after application
EXAMINATIONS
- Scoring system: not described
- Observation period: three hours

Reliability : (3) invalid
Documentation insufficient for assessment

11.12.2001 (22)

Species	:	Rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data

Method : METHOD
Tear samples were collected from the eyes for two weeks after the burn. The samples were assayed for plasminogen activator (PA) activity. Assays for total protein and protein profiles were also done.

Result : RESULTS
The protein concentration of the tears dropped 40 % from the normal level at 2 days post injury and regained the normal concentration after 7 days. Ulceration of the cornea began to manifest 14 days after application.

Test condition : TEST ANIMALS
- Strain: rabbits
- Sex: not described
- Source: not described
- Weight at study initiation: not described
- Number of animals: not described
ADMINISTRATION/EXPOSURE
- Concentration of test substance: 1N (4 %) on soaked filter paper disks (6 mm)
- Exposure period: 35 s
EXAMINATIONS
- Scoring system: not described
- Observation period: for two weeks after the burn

Reliability : (4) not assignable
Abstract

11.12.2001 (36)

Species	:	rabbit
Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	1988

5. Toxicity

Id 1310-73-2
Date 24.09.2002

GLP	:	no
Test substance	:	other TS: see freetext
Method	:	METHOD The effects of NaOH application were assessed several times over a period of 5 hours by slit-lamp and pachometer examination for corneal change/damage and corneal thickness (swelling).
Result	:	RESULTS The mean score for epithelial damage was 3.0 and the mean score for opacity was 2.5.
Test condition	:	TEST ANIMALS - Strain: New Zealand White Albino - Sex: male and female - Source: not described - Weight at study initiation: 2-2.5 kg - Number of animals: not described ADMINISTRATION/EXPOSURE - Concentration of test substance: 1N (4 %) - Amount of test substance: 0.1 ml - Exposure period: 10 seconds followed by rinse EXAMINATIONS - Scoring system: corneal opacity, 0 (no ulceration or opacity) - 4 (complete corneal opacity, iris not discernible) epithelial damage, 0 (no ulceration) - 4 (complete intense corneal colouring) - Observation period: 5, 30, 60, 120, 180 and 240 minutes after treatment
Test substance	:	TEST SUBSTANCE 1 N-NaOH (4 %), E. Merck, Darmstadt, FRG
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (46)

Species	:	rabbit
Concentration	:	
Dose	:	
Exposure time	:	1 minute(s)
Comment	:	rinsed after (see exposure time)
Number of animals	:	58
Vehicle	:	
Result	:	
Classification	:	
Method	:	other: not described
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD Central corneal alkali burns were induced in rabbits by applying 5 NaOH concentrations on uniformly soaked 7 mm filter paper discs. Clinical parameters were evaluated daily by microscopic examination and photography, and corneal myeloperoxidase levels were measured periodically.
Result	:	RESULTS All 0.2N and 0.5N NaOH injuries were covered by intact epithelium at day 14, but the incidence of chronic epithelial defects was high with 1N and 2N NaOH alkali injuries (85 and 83 % respectively) and occurred in 100 % of the animals following 4N NaOH burns.
Test condition	:	TEST ANIMALS - Strain: New Zealand White Albino

- Sex: male
- Source: single animal breeder
- Weight at study initiation: 2.5-3.5 kg
ADMINISTRATION/EXPOSURE
- Concentration of test substance: 0.2N (0.8 %), 0.5N (2 %), 1N (4 %), 2N (8 %) and 4N (16 %)
- Amount of test substance: Seven mm filter paper discs were soaked for 10-20 sec in the NaOH solutions
EXAMINATIONS
- Scoring system: not described
- Observation period: daily up to 14 days after exposure

Reliability : (2) valid with restrictions
Study well docmented, meets generally accepted scientific principles, acceptable for assessment

23.09.2002 (81)

Species : mouse
Concentration :
Dose :
Exposure time :
Comment :
Number of animals :
Vehicle :
Result :
Classification :
Method : other: see freetext
Year :
GLP : no
Test substance : other TS: see freetext

Method : METHOD
In this study the acute toxicity to the eye is assessed by measuring the permeability of the corneal epithelium of freshly killed mice to the fluorophore, sulforhodamine B. After removal of the test substances a drop of the dye solution was applied for one minute. Herafter the total fluorescence of the cornea was determined.

Result : RESULTS
A dose-response curve was generated for NaOH. A sharp rise in toxcity score above pH 11 was observed.

Test condition : TEST ANIMALS
- Strain: mice DBA/2
- Source: Department of Laboratory Animal Medicine, Stanford University Medical Center
- Number of animals: not described
ADMINISTRATION/EXPOSURE
- Concentration test substance: 10-6 N - 1 N
- Amount of substance instilled: a drop
- Vehicle: water
- Exposure time: 1 minute, at the end of the period the eye is flushed
EXAMINATIONS
- Scoring system and observations: not described

Test substance : TEST SUBSTANCE
10 N NaOH solution by VWR Scientific

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (67)

Species : other

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Concentration	:	
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	irritating
Classification	:	
Method	:	other: In-vitro and in-vivo tests
Year	:	
GLP	:	no data
Test substance	:	no data
Remark	:	NaOH was used as a model substance to correlate and validate alternative (in vivo and in vitro) methods to the Draize eye irritation test. The test systems evaluated were: - Griffith's low volume eye irritation test - Hen's egg chorioallantoic membrane assay - Cornea epithelial wound closure in culture - Differential release of plasminogen-activator in cornea epithelial cells - Permeability test for acute corneal toxicity - Cytotoxicity test in three established cell-lines and one primary cell culture
Reliability	:	(3) invalid Unsuitable test system

23.09.2002 (11)

Species	:	other: human and rabbit isolated eyes
Concentration	:	4 %
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD At the end of the experiment the corneal morphology was assessed by microscope. The number of layers in the epithelium, its continuity and the state of the cells were noted.
Result	:	RESULTS NaOH produced a localized large increase in corneal thickness. Clear wound margins and opacity were observed within seconds of treatment.
Test condition	:	IN-VITRO TEST SYSTEM - Cell type: Isolated human and rabbit eyes - Source: not described ADMINISTRATION/EXPOSURE - Amount of substance and exposure period: 20 µl for 10 seconds and 100 µl for 1 minute (20 µl aliquots at 10 s intervals) followed by an exhaustive rinsing EXAMINATIONS - Scoring system: not described
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (10)

Species	:	other: human cell culture
Concentration	:	10 %
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD NaOH was applied to the test system and cytotoxicity was measured as decreased vital dye metabolism.
Result	:	RESULTS The time (in minutes) of exposure to sodium hydroxide that reduced cell viability by 50% (t50 value) was determined and appeared to be 0.03 min.
Test condition	:	IN-VITRO TEST SYSTEM - Cell type: Skin model ZK1200 - Source: Advanced Tissue Sciences, La Jolla, CA ADMINISTRATION/EXPOSURE - Amount of substance: 0.03 ml - Vehicle: water - Exposure period: 30 minutes, rinsed after
Reliability	:	(3) invalid Documentation insufficient for assessment

11.12.2001 (82)

Species	:	other: human cell line
Concentration	:	1 %
Dose	:	
Exposure time	:	
Comment	:	
Number of animals	:	
Vehicle	:	
Result	:	
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD Cellular alterations in the cells were measured after exposure to NaOH using transepithelial electrical resistance (TER) and transepithelial permeability to sodium fluorescein (TEP).
Result	:	RESULTS A percentage of 0.12 % NaOH caused the fluorescein retention to decrease to 85 % relative to the negative control. A percentage of 0.19 % NaOH caused the electrical resistance to decrease to 50 % relative to the negative control.
Test condition	:	IN-VITRO TEST SYSTEM - Cell type: human corneal epithelial cell line (10.014 pRSV-T)

- Source: human donor cornea, Maryland Eye Bank
ADMINISTRATION/EXPOSURE
- Amount of substance: 0.1 ml
- Vehicle: water
- Exposure period: 5 minutes at 37°C followed by three rinses

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (55)

5.3 SENSITIZATION

Type	:	no data
Species	:	human
Number of animals	:	
Vehicle	:	
Result	:	not sensitizing
Classification	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	other TS: see freetext
Method	:	METHOD Visual scoring was recorded by the subjective evalutation method and by the transepidermal water loss method. After the seventh day reading sodium hydroxide (0.125%) was re-applied to all pretested sites and reading was performed on the next day.
Result	:	RESULTS The irritant response was well correlated to the concentration of the irritant. However, increased response was not observed when subclinical doses were rechallenged on the previously patch tested sites.
Test condition	:	HUMAN VOLUNTEERS - Sex: male - Age: between 20 and 25 - Number of volunteers: 15 without any previous history of atopy - Controls: yes, distilled water and empty chambers AMINISTRATION/EXPOSURE - Area of exposure: back - Preparation of test substance: 1.0 % NaOH was serially diluted as a half to obtain 5 different solutions - Concentrations used for induction: 50 µl, 1.0, 0.5, 0.25, 0.125 and 0.063 % - Duration of exposure: 24 hours (induction and challenge) - Examination time points: 0.5, 24, 48, 96 h and seventh day after patch removal - Challenge schedule: on day 7, NaOH was reapplied - Challenge concentration: 0.125% EXAMINATIONS - Grading system: not described
Test substance	:	TEST SUBSTANCE NaOH, Hayashi Pure Chemical Ins., Osaka, Japan
Reliability	:	(2) valid with restrictions Study well documented, meets generally accepted scientific principles, acceptable for assessment

23.09.2002 (85)

5. Toxicity

Id 1310-73-2
Date 24.09.2002

5.4 REPEATED DOSE TOXICITY

Type	:	
Species	:	rat
Sex	:	no data
Strain	:	no data
Route of admin.	:	inhalation
Exposure period	:	10 weeks
Frequency of treatm.	:	20 min., twice weekly
Post exposure period	:	not specified
Doses	:	40% (dispersed aerosol)
Control group	:	no data specified
Method	:	other: not specified
Year	:	
GLP	:	no
Test substance	:	no data
Result	:	Bronchial epithelium was sometimes wrinkeled, sometimes flattened and in places ulcerated and necrotic; the peribronchial lymphadenoid tissue was hypertrophic and extruded cushion-like into the bronchial lumen, causing slit-like deformities.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (30)

Type	:	
Species	:	rat
Sex	:	no data
Strain	:	no data
Route of admin.	:	inhalation
Exposure period	:	not specified
Frequency of treatm.	:	30 min., twice weekly
Post exposure period	:	not specified
Doses	:	unknown concentration in air; derived from 5%, 10%, 20%, 40% NaOH solutions
Control group	:	no data specified
Method	:	other: not specified
Year	:	
GLP	:	no
Test substance	:	no data
Result	:	40%: all exposed rats died mostly from bronchopneumonia 20%: the septa were dilated and cracked, the bronchi were dilated and their epithelial cover was thin and frequently desquamated; light round-cell infiltration of the submucuous membrane tissue of the trachea.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (116)

Type	:	
Species	:	rat
Sex	:	no data
Strain	:	Wistar
Route of admin.	:	gavage
Exposure period	:	1 day - 10 months
Frequency of treatm.	:	once daily
Post exposure period	:	not specified

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Doses	:	7 ml of 0.5N NaOH (assuming a body weight of 375 g, the dose is equivalent with 373 mg/kg bw)
Control group	:	no data specified
Method	:	other: not specified
Year	:	
GLP	:	no
Test substance	:	no data
Remark	:	At intervals of 1 day to 10 months stomachs were examined histologically.
Result	:	Falling-off of the entire gastric mucosa. Intestinal metaplasia in 18/26 rats examined. As intestinal metaplasia can be induced by a benign process of regeneration, it is not directly related with carcinogenesis.
Reliability	:	(4) not assignable Original reference not available

23.09.2002 (80)

Type	:	
Species	:	cattle
Sex	:	male
Strain	:	other
Route of admin.	:	oral feed
Exposure period	:	29-408 days
Frequency of treatm.	:	continuously in diet (barley)
Post exposure period	:	not specified
Doses	:	diet contained 87.5% NaOH-treated barley (see method)
Control group	:	yes, concurrent vehicle
Method	:	other: see freetext
Year	:	1987
GLP	:	no
Test substance	:	no data
Method	:	METHOD FOLLOWED Eighteen, 14-week-old male, Friesian calves were treated. Application of NaOH was done by spraying with a 30% solution at a rate of 35 kg NaOH/kg barley. Diet contained 87.5% NaOH-treated barley, 10% extracted soyabean meal, and 2.5% of a vitamin/mineral supplement.
Result	:	RESULTS Treated calves became polyuric with urine-pH ranging from 9.0-9,5; significantly raised plasma creatinine levels on day 29; at necropsy bilateral renal lesions were observed ofwhite cortical foci, medullary stippling, and the presence of uroliths in the renal papillae and calyces; histology: tubular dilatation, atrophy, necrosis, and mineralization, interstitial fibrosis with mononuclear cell invasion and consequent glomerular changes; the authors stated, that feeding of NaOH-treated barley can result in nephrotoxicosisin cattle.
Reliability	:	(3) invalid Unsuitable test system

23.09.2002 (50)

5.5 GENETIC TOXICITY 'IN VITRO'

Type	:	Ames test
System of testing	:	Salmonella typhimurium TA 1535, TA 1537, TA 1538, TA 98, TA 100
Test concentration	:	
Cycotoxic concentr.	:	
Metabolic activation	:	no data
Result	:	negative

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Reliability	:	(3) invalid Documentation insufficient for assessment
05.12.2001		(27)
Type	:	DNA damage and repair assay
System of testing	:	Escherichia coli WP2, WP67, CM871
Test concentration	:	
Cycotoxic concentr.	:	
Metabolic activation	:	no data
Result	:	negative
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Reliability	:	(3) invalid Documentation insufficient for assessment
05.12.2001		(27)
Type	:	DNA damage and repair assay
System of testing	:	E. coli WP2, WP2uvrA, WP67, CM611, WP100, W3110polA+, p3478pola-
Test concentration	:	
Cycotoxic concentr.	:	
Metabolic activation	:	with and without
Result	:	negative
Method	:	other
Year	:	
GLP	:	no
Test substance	:	other TS: see freetext
Test substance	:	highest technical grade available
Reliability	:	(3) invalid Documentation insufficient for assessment
23.09.2002		(68)
Type	:	Mammalian cell gene mutation assay
System of testing	:	Chinese hamster ovary cells (CHO-K1 cells)
Test concentration	:	4-16 mM
Cycotoxic concentr.	:	
Metabolic activation	:	with and without
Result	:	positive
Method	:	other: see reference
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD FOLLOWED The clastogenic activity of NaOH was studied in an in vitro chromosomal aberration test using Chinese hamster ovary (CHO) K1 cells.
Result	:	RESULTS No clastogenic activity was found at NaOH concentrations of 0, 4, 8 and 16 mM NaOH, which corresponded with initial pH values of 7.4, 9.1, 9.7 and 10.6 respectively. Incubation of CHO-K1 cells with NaOH in the presence

of rat liver S9 increased the clastogenic activity of S9, or induced new clastogens by breakdown of the S9. Therefore, testing at non-physiological pH might give false-positive responses, which means that the effect of sodium hydroxide is of a methodical kind and not valid to asses the genotoxicity under realistic conditions.

Reliability : (2) valid with restrictions
Comparable to guideline study with acceptable restrictions

23.09.2002 (73)

Type : other
System of testing : DNA polymerase from avian myeloblastosis virus
Test concentration : 10 mM
Cycotoxic concentr. :
Metabolic activation : no data
Result : negative
Method : other: see freetext
Year :
GLP : no
Test substance : no data

Method : METHOD
Sodium hydroxide has been tested for its ability to affect the accuracy of DNA synthesis in vitro.

Result : RESULTS
Sodium hydroxide did not affect synthesis (negative).

Reliability : (3) invalid
Documentation insufficient for assessment

23.09.2002 (101)

5.6 GENETIC TOXICITY 'IN VIVO'

Type : Cytogenetic assay
Species : other
Sex : no data
Strain : other
Route of admin. : i.p.
Exposure period :
Doses :
Result :
Method : other: see freetext
Year :
GLP : no
Test substance : no data

Method : METHOD FOLLOWED
Species: grasshopper (Spathosternum prasiniferum) the grasshoppers were injected abdominally with 0.02 ml of a pH 9 NaOH solution and the testes were fixed after intervalls of 4, 18, and 24 h; no validated test

Result : RESULTS
Marked changes were observed in the spermatocyte chromosomes of the 24-h specimens; the frequency of chromatid and chromosome type breaks was 3.2% (18/564 cells examined); other abnormalities included multipolar spindels, asynchronous separation of chromosomes, distribution of chromosomes in small groups, extreme stickiness and clumping of chromosomes, and sticky bridges.

Reliability : (3) invalid
Unsuitable test system

11.12.2001 (64)

Type	:	Micronucleus assay
Species	:	mouse
Sex	:	male/female
Strain	:	CD-1
Route of admin.	:	i.p.
Exposure period	:	
Doses	:	10 m g/kg of 15 mM NaOH
Result	:	
Method	:	other: see freetext
Year	:	
GLP	:	no
Test substance	:	other TS: reagent grade
Method	:	METHOD The test compound was administered as a single i.p. dose to treatment groups (5 males and 5 females) for sacrifice at 30, 48 and 72 hours. NaOH was used as control substance.
Result	:	RESULTS No significant increase of nuclei was observed.
Reliability	:	(3) invalid Documentation insufficient for assessment

23.09.2002 (2)

Type	:	other: aneuploidy induction
Species	:	mouse
Sex	:	female
Strain	:	Swiss
Route of admin.	:	i.p.
Exposure period	:	12 hours
Doses	:	
Result	:	negative
Method	:	other
Year	:	
GLP	:	no
Test substance	:	no data
Method	:	METHOD Mouse oocytes were used to determine possible aneuploidy-inducing effects. Mice were injected intraperitoneally with 0.3-0.4 ml of 0.01 M NaOH and chromosome spreads were made 12 hours after injection. NaOH was used as control substance.
Result	:	RESULTS No evidence of non-disjunction was found in the control groups up to the age of 40 weeks tested.
Reliability	:	(3) invalid Unsuitable test system

11.12.2001 (16)

5.7 CARCINOGENICITY

Remark	:	no data available

05.12.2001

5. Toxicity

Id 1310-73-2
Date 24.09.2002

5.8.1 TOXICITY TO FERTILITY

Remark : no data available
05.12.2001

5.8.2 DEVELOPMENTAL TOXICITY/TERATOGENICITY

Species	:	mouse
Sex	:	female
Strain	:	other: random -bred H-Velaz
Route of admin.	:	other: intraamniotically
Exposure period	:	
Frequency of treatm.	:	once
Duration of test	:	
Doses	:	2 µl of 0.001M NaOH
Control group	:	yes
Method	:	other: see freetext
Year	:	1972
GLP	:	no
Test substance	:	no data

Method : METHOD FOLLOWED
On the 13th day of gestation, 2 µl 0.001 M NaOH solution was injected intraamniotically to groups of foetuses from 7 females. The results were read on the 16th day of gestation. Foetal mortality and the incidence of cleft palate in surviving embryos were studied.

Result : RESULTS
The mortality of foetuses was 46 % but no mortality was found in the surviving foetuses. No cleft palates were observed.

Reliability : (3) invalid
Unsuitable test system

23.09.2002 (31)

5.8.3 TOXICITY TO REPRODUCTION, OTHER STUDIES

5.9 SPECIFIC INVESTIGATIONS

5.10 EXPOSURE EXPERIENCE

Remark : Toxicokinetics:
NaOH is fully ionized and therefore no data on the metabolism of NaOH itself exists; radiosodium appeared in the circulation of man 3 min. after ingestion; it also appeared promptly in the blood stream after application to intact skin, the vagina, and after s.c., i.m., and intrasynovial injection; the main excretion route is via urine, small amounts were found in the faeces, sweat, tears, nasal mucous, saliva, and vaginal and urethral discharges.

23.09.2002 (65)

5. Toxicity

Id 1310-73-2
Date 24.09.2002

Remark : Ref. 1)
A mortality study of a limited population chronically exposed to caustic dust did not find any relationship between duration or intensity of exposure and mortality. The overall number of observed deaths due to malignant neoplasms were less than expected. However, there were 7 deaths due to cancer of the digestive tract and peritoneuum when 4.3 were expected.
Ref. 2)
In a renal cancer mortality study, elevated odds ratios were identified for employment in the cell maintenance area of chlorine production and with those presumptive exposures considered to occur in this job, namely caustic, and kidney cancer. Due to the small sample size and inconsistency, it is impossible to state whether this small increase is due to NaOH or chance.

23.09.2002 (14) (83)

Remark : After accidential local or oral exposure to NaOH between 1989 - 1993 seven cases with skin and eye irritation, indisposition and headache were committed to a clinic for additional treatments.

29.09.1994 (7)

Remark : A case was reported in which a 19-year-old man ingested eight capsules filled with 100 % NaOH. Within 1/2 hour after ingestion he developed hematemesis and abdominal pain, without dysphagia. Endoscopy revealed a black eschar over the antrum of the stomach with sparing of the esophagus and duodenum. An endoscopy after 4 days revealed healing gastric ulcers. The patient cured with supportive care.

23.09.2002 (19)

Remark : The University Hospital of Santiago de Compostela (Spain) reported about 67 cases of accidental ingestion of NaOH by children between 1981 and 1990. Most of the accidents occured at home and the container was located within easy reach of the children.

23.09.2002 (20)

Remark : Nine cases of liquid NaOH ingestion, which resulted in esophageal and gastric injury are described. One person who ingested 10 g NaOH in water suffered transmural necrosis of the esophagus and stomach and died 3 days after admission to the hospital.

23.09.2002 (21)

Remark : A nationwide survey of ingestion of corrosives has been performed for the period 1984-1988 in Danmark. It revealed 57 admissions to hospital of children (0-14 years) due to NaOH ingestion. The authors were confident that all children with serious complications after ingestion of corrosives were included in the study.

23.09.2002 (23)

Remark : A total of 23 burns of the eye due to NaOH or KOH were admitted to the eye clinic of the RWTH Aachen in Germany from 1985-1992. In 17 cases the accident happened during work, while 6 cases occurred at home using NaOH/KOH as drain cleaner. The alkali burns were of special interest because of the rapid and deep penetration of alkali into the ocular tissue.

5. Toxicity **Id** 1310-73-2
Date 24.09.2002

23.09.2002 (56)

Remark : A fatal case is reported of a worker in an aluminum plant who was found lying in a shallow pool of concentrated caustic solution, which had been heated to approximately 95°C.

30.05.2001 (59)

Remark : A case of an 18-year-old man is described who ingested concentrated caustic soda in a suicide attempt. On arrival the patient was found to be in a satisfactory condition. After 24 hours he had signs of peritonitis and paralytic ileus and emergency laparotomy was undertaken. He was found at laparotomy to have transmural necrosis of the stomach, duodenum, gallbladder, jejunum, and colon in addition to extensive pancreatic and omental injury. The patient died of multiorgan failure.

23.09.2002 (63)

Remark : Three unusual cases of caustic soda burn in adults are described. A 40-year-old male is described with burnings on the dorsum of his left hand with caustic soda in an industrial accident. Patchy areas of skin necrosis were noted over the back of the hand distal to the wrist. A 35-year-old female is described who was involved in a domestic accident in which the dorsum of both hands, right upper arm, chin and nasal tip sustained splashed of caustic soda. The last case is a 30-year-old female who burned the dorsum of her right foot with caustic soda in an industrial accident.

23.09.2002 (79)

Remark : Corrosive alkalis are used in the soft drink and beer industries for the cleaning of non-disposable glass containers. A case of acute poisoning due to caustic alkalis concerns a 28-y-old woman who consumed carbonated lemonade from a non-disposable glass container. The patient was transferred to the hospital where oedema of the lips and white mucosal burns of the buccal cavity were seen. An esophagoscopy revealed the presence of limited depth and extension burns in the mucous membrane of the esophagus.

01.05.2001 (105)

Remark : Twelve children over a 6-year period underwent aerdigestive tract endoscopy after ingestion of lye-containing cosmetic products. The ages of these children ranged from two to 25 months. The children had swollen lips, facial erythema, and occasionally facial burns. Endoscopy revealed pharyngeal burns in five patients but no laryngeal or esophageal burns in any patient.

23.09.2002 (106)

Remark : Measurements of pure alkali concentrations in the working area air of an alkali plant in the Dalian Chem. Industrial Corporation and examination of 258 workers showed that irritating symptoms in the upper respiratory tract and in mucosa and skin may appear when the pure alkali concentration in the working area is between 8.7 mg/m3 and 37.15 mg/m3.

23.09.2002 (124)

5. Toxicity **Id** 1310-73-2
Date 24.09.2002

Remark : Twenty nine patients were diagnosed between 1990-1997 for accidental ingestion of lye during childhood. Lye is used in this area for home made soap. The majority presented to a pediatrician immediately after ingestion. All patients have had gastroscopy, and Ba-swallow to estimate the size of the stricture. All strictures were in the middle and distal esophagus, average length 1-6 cm. It could be concluded that childhood strictures have a better success rate of dilation.
23.09.2002 (127)

Remark : The inhalation of aerosols of 5 % NaOH by a 25-year-old woman resulted in irreversible obstructive lung injury after working for one day in a poorly ventilated room. Besides NaOH the product contained also smaller amounts of calcium carbonate, soft soap and protein.
23.09.2002 (42)

Remark : Between January 1976 and October 1988 a total number of 6 cases of NaOH was reported by the Children Surgery Department (University of Graz, Austria).
23.09.2002 (97)

Remark : At the Shands Hospital at the University of Florida 15 children were admitted between 1973 and 1984 which had ingested NaOH.
23.09.2002 (70)

Remark : At the Department of Paediatric Surgery (Adana, Turkey) 71 cases of NaOH ingestion by children were reported in a period of 12 years.
23.09.2002 (51)

Remark : The records of 170 patients admitted to the Department of Otolaryngology of the University Hospital of Amsterdam in the period January 1, 1971 to December 31, 1981 with suspected caustic ingestion were reviewed. Of these 170 patients about 15 patients had ingested NaOH. In this case it was not clear whether children were involved.
23.09.2002 (122)

Remark : The degree and type of injury after ingestion of NaOH depend on the physical form. Solid NaOH produces injury to mouth and pharynx and is difficult to swallow. On the other hand liquid NaOH is easily swallowed, being tasteless and odorless, and is more likely to damage the esophagus and stomach. The severity of the effects depend on the quantity ingested, the concentration, the duration of the exposure and other factors.
16.05.2001 (41)

Remark : The initial symptom of exposure of the eye to NaOH is intense pain and a decrease of the visual acuity due to damage to the corneal epithelium and corneal edema. Due to a shortening of the collagen fibers of the cornea and sclera the intraocular pressure increases. In mild cases, the corneal and conjuctival epithelium will slough, causing defects that can be seen on fluorescein staining. In more severe cases, conjuctival swelling and necrosis occur, with corneal haze or even frank opacity due to damaged collagen fibers. The hallmark of severe burns is ischemic necrosis. In

general, prognosis is related to the degree of avascular necrosis of the conjuctiva and sclera, especially at the limbus. If vacularity is lost to more than one half of the corneal limbus, the chance of retaining the eye is poor.

16.05.2001 (76)

Remark : A 63-year-old man worked daily for 20 years cleaning large industrial jam containers by boiling lye (NaOH) solution without using respiratory protective equipment. Physical examination, chest x ray film, pulmonary function tests, and arterial blood gases were all compatible with severe obstructive airway disease with significant air trapping. It is probable that this massive and prolonged occupational exposure to the corrosive effect of NaOH mists induced irritation and burns to the respiratory system, eventually leading to severe obstructive airway disease.

This study shows that a massive exposure to NaOH mists can eventually result in severe effects on the respiratory system. The study would have been more useful (valid) if the exposure would have been quantified.

11.07.2002 (93)

Remark : In 1999 three fatal exposures to sodium hydroxide were reported. Persons in the age of 61, 43 and 54 years were involved. In all cases the exposure route was via ingestion.

11.12.2001 (62)

Remark : A number of 28 patients who had ingested sodium hydroxide were prospectively studied. The exact volume and concentration were difficult to ascertain in each case, but approximately 50-200 ml of 25-37 % solution was ingested. The injury to the upper gastrointestinal tract was assessed within 36 hours after alkali intake. The esophagus was injured in all patients, the stomach in 93.5 % and the duodenum in 32.3 % of the patients.

11.12.2001 (130)

Remark : A voluntary intoxication by injection in the left basilic vein of 10 ml of concentrated caustic soda is reported. The main effects were, besides local necrosis, haemolysis, acute renal failure with initial anuresis, intravascular coagulation and cyanosis. This was confirmed by using the usual spectrophotometric methods as well as electrophoretic methods.

11.12.2001 (12)

Remark : The risk of serious esphageal injury after granular sodium hydroxide ingestion is about 25 %. About 5 % of the patients develop strictures. When liquid sodium hydroxide was ingested the chance of esophageal injury was virtually 100 %. Strictures develop in almost all of these patients.

11.12.2001 (57)

Remark : A three year survey of accidents and dangerous occurrences in the UK chemical industry is described. In the period 1983-1985, 32 incidents involving caustic soda were reported.
No further details about the incidents are given.

11.12.2001 (92)

Remark : A number of 63 patients suffering from esophageal lye corrosion before the appearance of esophageal carcinoma is described. The mean age of patients at lye ingestion was 6.2 6.2 years; the mean latent time between lye corrosion and esophageal carcinoma was 41 years. The later the lye was ingested the earlier carcinoma of the esophagus appeared. 84 % of carcinomas were found to be in the bronchial bifurcation area of the esophagus.

23.09.2002 (4)

5.11 ADDITIONAL REMARKS

Type : other

Remark : Effects on the cardiovascular system:
0.5% NaOH was applied to the gastrointestinal serosa of rats; a fall in blood pressure and inhibited respiration were observed in both hypertensive and normotensive rats; in 8% of the treated animals a fall in heart rate was described.

01.05.2001 (90)

Type : other

Remark : Induction of intestinal metaplasia:
oral application of 0.5 ml 0.1N NaOH once weekly for 12 weeks does not enhance the frequency of intestinal metaplasia in rats in comparison to untreated controls (sequential weekly killing until week 69).

01.05.2001 (54)

Type : other

Remark : Induction of metaplasia:
truncal vagotomy resulted in a significant increase in the incidence and numbers of intestinal metaplasia and atypical glandular hyperplasia after 52 weeks; additional intragastral application of 3.0 ml 5% NaOH solution enhanced this effect significantly; NaOH and sham operation also induced a significant increase in the incidence of intestinal metaplasia compared to the animals treated with vagotomy only.

29.09.1994 (109)

Type : other: Connective Tissue Necrosis

Remark : An intradermal injection of 0.2 ml of 0.1 N sodium hydroxide was given to young wistar rats on either side of the midline of the dorsal skin. The necrosis of connective tissue was evident immediately after the intradermal injection. Tissue sections were studied by histological and histochemical methods and biochemical estimations were done.

23.09.2002 (95)

6. Analyt. Meth. for Detection and Identification

Id 1310-73-2
Date 24.09.2002

6.1 ANALYTICAL METHODS

6.2 DETECTION AND IDENTIFICATION

7. Eff. Against Target Org. and Intended Uses

Id 1310-73-2
Date 24.09.2002

7.1 FUNCTION

7.2 EFFECTS ON ORGANISMS TO BE CONTROLLED

7.3 ORGANISMS TO BE PROTECTED

7.4 USER

7.5 RESISTANCE

8. Meas. Nec. to Prot. Man, Animals, Environment

Id 1310-73-2
Date 24.09.2002

8.1 METHODS HANDLING AND STORING

8.2 FIRE GUIDANCE

8.3 EMERGENCY MEASURES

8.4 POSSIB. OF RENDERING SUBST. HARMLESS

8.5 WASTE MANAGEMENT

8.6 SIDE-EFFECTS DETECTION

8.7 SUBSTANCE REGISTERED AS DANGEROUS FOR GROUND WATER

8.8 REACTIVITY TOWARDS CONTAINER MATERIAL

9. References

Id 1310-73-2
Date 24.09.2002

(1) - Agner et al. (1988), Acta Derm Venerol 68, 192-195 - Agner et al. (1987), Contact Dermatitis 11, 205-211

(2) Aaron et al. (1989), Mutation Research, 223, 129-140

(3) ACGIH (2001), TLVs and BEIs, Threshold Limit Values for Chemical Substances and Physical Agents, ACGIH, Cincinatti, Ohio, USA

(4) Appelqvist P et al. (1980), Cancer, 45, 2655-2658

(5) Ashcraft et al. (1974), cited in: Martin F.M., Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(6) Bartnik FG (1990), Toxicol In Vitro, 4, 293-301

(7) BASF AG (1993), Werksaerztlicher Dienst, unpublished data of BASF AG

(8) Bazan et al. (1991), Exp Eye Res, 52, 481-491

(9) Bechara et al. (1989), Invest Ophthalmol Visual Sci, 30, 38

(10) Berry et al. (1993), Toxic In Vitro, 7, 461-464

(11) Blein et al. (1991), Toxicol In Vitro, 5, 555-557
Lawrence et al. (1986), Food Chem Toxicol, 24, 497-502
Jumblatt et al. (1987), Altern Meth Toxicol, 5, 139-145
Chan KY (1986), Curr Eye Res, 5, 357-362
Maurice D et al. (1986), Toxicol Lett, 31, 125-130
Sasaki et al. (1991), Toxicol In Vitro, 5, 403-406

(12) Blin et al. (1983), Ann Fr Anesth Réanim, 2, 97-99

(13) Bolkova et al. (1984), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(14) Bond et al. (1985), Amer J Ind Med, 7, 123-139 (Ref. 2)

(15) Bromberg et al. (1965), Plast Reconstr Surg, 35, 85-95

(16) Brook et al. (1985), Mutation Research, 157, 215-220

(17) Bulich et al. (1990), J Biol Chem, 5, 71-77

(18) Carpenter CP et al. (1946), Amer J Ophtalmol, 29, 1363-1372

(19) Carroll et al. (1994), Vet Human Toxicology, 36, 373

(20) Casasnovas et al. (1997), Eur J Pediatr, 156, 410-414

(21) Cello, JP et al. (1980), Arch Intern Med, 140, 501-504

(22) Chiang et al. (1971), Invest Opthamol, 10, 270-273

(23) Clausen JO et al. (1994), Danish Medicinal Bulletin 41, 234-237

(24) Clayton et al. (1982), Patty's Industrial Hygiene and Toxicology, 3rd ed., Vol. 2B, page 3061-3062, John Wiley and Sons, New York

9. References

Id 1310-73-2
Date 24.09.2002

(25) CMAI (2000), Fifteenth Annual World Petrochemical Conference, March 29 & 30, 2000, Houston, Texas, USA

(26) Cooper et al. (1979), American Industrial Hygiene Association Journal, 40, 365-371

(27) De Flora et al. (1984), Mutation Research, 133, 161-198

(28) De Groot (2001), Estimation of vapour pressure of NaOH at 25 °C, Internal Memorandum of Solvay Pharmaceuticals, Weesp, The Netherlands

(29) Dean JA (ed.) (1979), Lange's Handbook of Chemistry, 12th edition, McGraw-Hill Book Co., New York

(30) Dluhos et al. (1969), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(31) Dostal M (1973), Folia Morphol, 21, 97-101

(32) Dykes et al. (1995), Human & Experimental Toxicology 14, 204-211

(33) Environment Canada (1984), EnviroTIPS, Sodium Hydroxide, Environmental Protection Services, Ottawa, Ontario

(34) Euro Chlor (1999), Chlorine Industry Review, 1998-1999, Brochure of 16 pages

(35) European Commission (1993), Annex I of Directive 67/548/EEC (19th ATP : Directive 93/72/EEC), Reference No 011-002-00-6

(36) Freedman et al. (1989), Invest Ophthalmol Visual Sci, 30, 40

(37) Gohar et al. (1961), Proc Egypt Acad Sci, 16, 37-48

(38) Griffith et al. (1980), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(39) Griffiths et al. (1997), Food and Chemical Toxicology 35, 255-260

(40) Guinnup et al. (1988), Estimation of the half-life of sodium hydroxide aerosol in the atmsophere, Office of airquality planning and standards, USEPA, Research Trinagle Park, North Carolina

(41) Gumaste VV et al. (1992), Am J Gastroenterol, 87, 1-5

(42) Hansen KS et al. (1991), J Soc Occup Med, 41, 45-46

(43) Horne RA (1969), Marine Chemistry, John Wiley and Sons, New York

(44) Hughes (1946), cited in: Martin FM, Report EPA/600/8-88/081, Order-Nr. PB88-231949, 1988

(45) Jacobs GA (1992), J Amer Coll Toxicol, 11, 725

(46) Jacobs GA et al. (1988), Toxicol In Vitro, 2, 253-256

(47) Jensen RA (1978), Simplified bioassay using finfish for estimating potential spill damage, Proc. control of hazardous material spills, page 104-108, Rockvill, MD

(48) Juhnke et al. (1978), Z Wasser Abwasser Forsch, 11, 161-164

9. References

Id 1310-73-2
Date 24.09.2002

(49) Karlsmark et al. (1988), Forensic Sci Int, 39, 227-233

(50) Kennedy S et al. (1987), Vet Pathol, 24, 265-271

(51) Keskin E et al. (1991), Eur J Pediatr Surg, 1, 335-338

(52) Kester DR et al. (1970), Effects of temperature and pressure on sulfate-ion association in seawater, Geiochim. Cosmochim. Acta, 34: 1039-51

(53) Kirk-Othmer Encyclopedia of Chemical Technology (1982), 3rd edition, John Wiley and Sons, New York

(54) Kojima N et al. (1987), Jap J Canc Res, 78, 126-133

(55) Kruszewski et al. (1997), Fundamental and Applied Toxicology, 36, 130-140

(56) Kuckelkorn et al. (1993), Klin Monatsbl Augenheilkd, 203, 397-402

(57) Leape, LL (1986), In: Pediatric Esophageal Surgery, Ashcraft KW et al., page 73-88

(58) Leddy et al. (1982), Alkali and chlorine products, in: Kirk-Othmer Encyclopedia of Chemical Technology, 3rd edition, John Wiley and Sons, New York

(59) Lee et al. (1995), Forensic Science International 72, 219-227

(60) Liebsch et al. (1995), Toxic In Vitro 9, 557-562

(61) Lindsay WL (1979), Chemical Equilibria in Soils, John Wiley and Sons, New York

(62) Litovitz et al. (2000), American Journal of Emergency Medicine, 18, 517-566

(63) Losanoff et al. (1996), Surgery, 119, 720

(64) Manna et al. (1966), Nucleus, 9, 119-131

(65) Martin FM (1988), Report EPA/600/8-88/081, Order-No. PB88-231949

(66) Mauger et al. (1985), Acta Ophthalmologica, 63, 264-267

(67) Maurice DM et al. (1995), In Vitro Toxicology, 8, 113-120

(68) McCarroll NE et al. (1981), Environ Mutagen, 3, 429-444

(69) McKee JE et al. (1963), Water Quality Criteria, 2nd edition, State Water Quality Control Board, Pasadena, CA

(70) Moazam F et al. (1987), South Med J, 80, 187-190

(71) Morel FMM (1983), Principles of Aquatic Chemistry, John Wiley and Sons, New York

(72) Morgan et al. (1987), Food Chem Toxicol, 25, 609-613

(73) Morita et al. (1989), Mutat Res, 225, 55-60

(74) Murphy et al. (1982), Toxicology, 23, 281-291

9. References

Id 1310-73-2
Date 24.09.2002

(75) Naunyn-Schmiedeberg's (1937), Archiv für experimentielle Pathologie und Pharmakologie (Berlin, Germany), 184, 587-604

(76) Nelson JD et al. (1987), Postgrad Med J, 81, 62-75

(77) NIOSH/OSHA (1981), Occupational Health Guidelines for Chemical Hazards- Volume 3, Editors Mackison et al.

(78) Nishiuchi Y (1975), Suisan Zoshoku, 23, 132

(79) O'Donoghue et al. (1996), Br J Clin Pract, 50, 108-110

(80) Oohara et al. (1982), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(81) Ormerod et al. (1989), Investigative Ophthalmology & Visual Science, 30, 2148-2153

(82) Osborne et al. (1995), Fundamental and Applied Toxicology, 28, 139-153

(83) Ott et al. (1977), J Occup Med, 19, 813-816 (Ref. 1)

(84) OxyChem (2000), Caustic Soda Handbook

(85) Park et al. (1995), Journal of Dermatological Science, 10, 159-165

(86) Parker JG (1984), Wat Res, 18, 865-868

(87) Perkins et al. (1996), Fundamental and Applied Toxicology 31, 9-18

(88) Petroutsos et al. (1984), Opthalmic Res, 16, 185-189

(89) Portman JE (1970), The toxicity of 120 substances to marine organisms, Shellfish Information Leaflet, Fisheries Experimental Station, Conway, N. Wales, Ministry of Agriculture, Fisheries and Food

(90) Radhakrishnan et al. (1985), cited in Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949 (1988)

(91) Robert et al. (1988), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(92) Robinson BJ (1987), Proceedings of the World Conference Chemical Accidents, July 1987, CEP, 33-36

(93) Rubin AE et al. (1992), Britisch J Ind Med, 49, 213-214

(94) Rustamova SA (1977), Gidrobiol Zh, 13, 83-85.

(95) Sanyal et al. (1993), Indian J Med Res, 63, 1609-1619

(96) Sax (1984), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(97) Schober PH et al. (1989), Wiener Klin Wschr, 101, 318-322

(98) Seidenari et al. (1995), Act Derm Venereol 75, 97-101

(99) Sekizawa et al. (1994), The Journal of Toxicological Science 19, 25-35

9. References

Id 1310-73-2
Date 24.09.2002

(100) Silverman et al. (1987), J Toxicol Cutan Ocul Toxicol, 6, 33-42

(101) Sirover et al. (1976), Science, 194, 1434-1436

(102) Snoeyink et al. (1980), Water Chemistry, John Wiley and Sons, New York

(103) Srikrishna et al. (1991), In Vitro Toxicology 4, 207-215

(104) Stangenberg M (1975), Limnologica, 9, 421-426

(105) Stefanidou et al. (1993), Veterinary and Human Toxicology 39, 308-310

(106) Stenson et al. (1993), Otolaryngology, 109, 821-825

(107) Stolz et al. (1997), Contact Dermatitis 36, 281-284

(108) Stumm et al. (1981), Aquatic Chemistry, 2nd edition, Wiley-Interscience, New York

(109) Tatsuta M et al. (1988), Arch Geschwulstforsch, 58, 305-311

(110) The Merck Index (1989), Budavari et al. (eds), Merck & Co., Rahway, USA

(111) United Nations Environment Programme (1995), UNEP Environment library No 14, Nairobi, Kenya

(112) USEPA (1986), Quality Criteria for Water, pH, EPA-440/9-76-023

(113) USEPA (1988), Federal Register, 53, 49688-90

(114) Van Horn et al. (1949), Effects of Kraft Mill Wastes, American Fisheries Society

(115) Van Kolfschoten et al. (1983), Toxicology and Applied Pharmacology 69, 37-42

(116) Vyscosil et al. (1966), cited in: Martin FM, Report EPA/600/8-88/081, Order-No. PB88-231949, 1988

(117) Wallen et al. (1957), Waters Sewage Ind Wastes, 29, 695-711

(118) Warne MSJ (1999), Ecotoxicology and Environmental Safety, 44, 196-206

(119) Watanabe et al. (1989), Toxicol In Vitro, 3, 329-334

(120) Wentworth et al. (1993), Arch Opthalmol, 111, 389-392

(121) Whaley TP (1973), Sodium, potassium rubidium, cesium and francium, in: Trotman-Dickenson AF (ed.), Comprehensive inorganic chemistry, Pergamon Press, Oxford, England

(122) Wijburg FA et al. (1985), Ann Otol Rhinol Laryngol, 94, 337-341

(123) Willis et al. (1988), Contact Dermatitis, 18, 20-24

(124) Xiahong M et al. (1994), Weisheng Yanjiu, 23, 71-73

(125) Yano et al. (1993), Burns, 19, 320-323

(126) Yarzhombek et al. (1991), Voprosy Ikhtiologii, 31, 496-502

9. References

Id 1310-73-2
Date 24.09.2002

(127) Yasser et al. (1998), Gastroenterology, 114, A273

(128) York et al. (1995), Human & Experimental Toxicology, 14, 729-734

(129) York et al. (1996), Contact Dermatitis, 34, 204-212

(130) Zargar et al. (1992), The American Journal of Gastroenterology, 87, 337-341

(131) Zwicker et al. (1979), Journal of Environmental Pathology and Toxicology, 2, 1139-1150

10. Summary and Evaluation

Id 1310-73-2
Date 24.09.2002

10.1 END POINT SUMMARY

10.2 HAZARD SUMMARY

10.3 RISK ASSESSMENT

28.05.2001