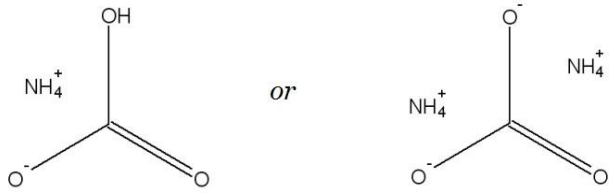
SIDS INITIAL ASSESSMENT PROFILE

CAS No.	10361-29-2
Chemical Name	Ammonium carbonate
Structural Formula	

SUMMARY CONCLUSIONS OF THE SIAR

Ammonium carbonate, as described by CAS No. 10361-29-2, is an inorganic substance that consists of ammonium bicarbonate (CAS No. 1066-33-7) and diammonium carbonate (CAS No. 506-87-6), and their relative quantities are depending on the ratio of carbonic acid and ammonium salt. Ammonium carbonate may also exist as a mixture of ammonium bicarbonate and ammonium carbamate. Ammonium bicarbonate (NH_4HCO_3; CAS No. 1066-33-7) was assessed previously in the programme (SIAM 22, sponsor France/ICCA). This assessment covers the ammonium carbonate mixture, as described by CAS No. 10361-29-2, and uses test data for the following substances as indicated in the text.

- *Ammonium carbonate*: Carbonic acid, monoammonium salt, mixture with carbamic acid, monoammonium salt or mixture of Ammonium bicarbonate and ammonium carbamate
- *Ammonium carbonate (1:1)*: Carbonic acid, ammonium salt (1:1) or Ammonium bicarbonate, previously assessed in the programme
- *Ammonium carbonate (1:2)*: Carbonic acid, ammonium salt (1:2) or Diammonium carbonate

Physical and Chemical Properties

Ammonium carbonate is colourless, translucent or white, in the form of either crystals or powder. The substance has a strong odour of ammonia and sharp taste. Ammonium carbonate volatilizes at about 60 °C and decomposes before boiling and in hot water. The water solubility of ammonium carbonate is 320,000 mg/L at 20 °C. The dissociation constant is not applicable to an inorganic salt such as ammonium carbonate. *Ammonium carbonate (1:1):* The melting point is 107 °C and the density is 1.583 g/cm^3. It has water solubility of 174,000 mg/L at 20°C and measured vapour pressure of 7.85 kPa (dry ammonium carbonate) at 25.4 ^oC. The empirical value may represent decomposition of the substance into ammonia and carbon dioxide. This might explain the difference between measured and estimated values. The estimated log P_{ow} value for ammonium carbonate (1:1) is -3.08.

Ammonium carbonate (1:2): The melting point is 58 °C and water solubility is 100,000 mg/L at 15 °C. The estimated vapour pressure is 8.04×10^{-8} Pa at 25 ^oC. The estimated log P_{ow} value for ammonium carbonate (1:2) is -1.49.

Human Health

Toxicokinetics

No specific studies are available on the absorption, distribution, metabolism, or excretion of ammonium carbonate. Ammonia and ammonium ions are integral components of normal metabolic processes and play an essential role in the physiology of human and other species. The toxicological profile of the test substance is assumed to be due to the free ammonia rather than to the ionized form. Ammonia or ammonium ion can be absorbed by the inhalation and oral routes of exposure, but there is a less certainty regarding absorption through the skin. Most of the inhaled ammonia is retained in the upper respiratory tract and is subsequently eliminated in expired air. Ingested ammonium compounds are absorbed in the intestinal tract. Ammonia or ammonium ion is widely distributed to all body compartments although substantial first-pass metabolism occurs in the liver where it is transformed into urea and glutamine. Ammonia or ammonium ion absorbed into the tissues is taken up by glutamic acid, which participates in transamination and other reactions. Most of ammonia or ammonium ion is excreted in the urine as urea and minimal amounts are excreted in the faeces and in expired air.

Bicarbonate ions are integral components of normal metabolic processes and play an essential role in the physiology of

human and other species. Bicarbonate ion can be formed from CO_2 and H_2O and this equilibrium reaction acts as the major extracellular buffer system in blood and interstitial fluids of vertebrates. CO_2 from the tissues diffuses rapidly into red blood cells, where it is hydrated with water to form carbonic acid. This reaction is accelerated by carbonic anhydrase, an enzyme present in high concentrations in red blood cells. The carbonic acid formed dissociates into bicarbonate and hydrogen ions. Most of the bicarbonate ions diffuse into the plasma.

Acute Oral Toxicity

Ammonium carbonate was administered by oral gavage at 2,000 mg/kg bw to 3 rats in the first step and at 300 mg/kg bw to 3 rats in each of the second and third steps. All animals died at 2,000 mg/kg bw. At necropsy, small intestine was filled with red viscous fluid. The lung, trachea and bronchus filled with red foamy fluid and dark red spots were observed. Clinical signs included prone position, lying on side, convulsion, piloerection, salivation, staining around mouth, nasal discharge and dirty nose. No mortality or clinical signs were observed in rats treated with 300 mg/kg. LD_{50} cut-off value in female rats for ammonium carbonate was 500 mg/kg bw [OECD TG 423].

Ammonium carbonate (1:1) was administered by oral gavage at 215, 681, 1,470 and 2,150 mg/kg bw to 5 rats/sex. All animals died at 2,150 mg/kg bw and 3 of 5 female rats died at 1,470 mg/kg bw. Clinical signs included poor general state, apathy, abnormal position, dyspnea, staggering, tonic convulsions, exophthalmos and salivation Gross pathology revealed general congestion, glandular stomach and slightly reddened mucosa. The acute oral LD_{50} values of ammonium carbonate (1:1) for male and female rats were 1,470-2,150 mg/kg bw and ca. 1,470 mg/kg bw, respectively [OECD TG 401].

In another study, the acute oral LD_{50} values for male and female rats were ca. 2,000 mg/kg bw and <2,000 mg/kg bw, respectively [OECD TG 401]. All female rats and 2 of 5 male rats died at 2,000 mg/kg. Clinical signs included poor general state, dyspnoea, apathy, abdominal position, lateral position, atonia, tonic convulsions and exophthalmos. Also, gross pathology revealed general congestion, diffusely reddened glandular stomach, and liquid and slight bloody contents in small intestines.

Ammonium carbonate (1:2) was administered by oral gavage at 215, 681, 1,470 and 2,150 mg/kg bw to 5 male and 5 female rats in each dose. Mortalities were observed at 2,150 mg/kg bw in both male and female rats, and general congestion of stomach and small intestine was observed in dead animals. The acute oral LD_{50} values of ammonium carbonate (1:2) for male and female rats were 2,150 mg/kg bw and 1,800 mg/kg bw, respectively [OECD TG 401].

Acute Inhalation Toxicity

Acute inhalation toxicity tests are not available for ammonium bicarbonate. As an indication of the possible inhalation toxicity, data for ammonia is given (ammonia is the thermal decomposition products of ammomium bicarbonate).

In an acute inhalation study, twelve mice per dose were exposed to 0, 3,440, 4,220 and 4,860 ppm (equivalent to 0, 2.41, 2.95 or 3.40 mg NH_3/L air) of ammonia by whole-body exposure for one hour. 10 of 12 mice died at 4,860 ppm and 5 of 12 mice died at 4,220 ppm. Liver weight was significantly elevated in survivors at 4,220 and 4,860 ppm. Clinical signs included tremors, ataxia, convulsions, seizure, dyspnea and coma. Also, gross pathology revealed diffuse hemorrhage in lungs, and histology showed diffuse intra-alveolar hemorrhage and acute vascular congestion in lungs. In livers, acute congestion of hepatic sinusoids and blood vessels was observed. The calculated acute inhalation LC_{50} value of ammonium carbonate (1:1) for mice was ≥13.8 mg NH_4HCO_3/L air (equivalent to 2.96 mg NH_3/L air).

Acute Dermal Toxicity

The acute dermal LD_{50} value of ammonium carbonate was greater than 2,000 mg/kg bw for male and female rats [OECD TG 402, EU Method B.3 and EPA OPPTS 870.1200]. Ammonium carbonate was directly applied to the skin under an occlusive wrap of rats (5 males and 5 females) at the concentration of 2,000 mg/kg bw. The duration of exposure was 24 hours and the animals were observed for 14 days following a single treatment. No mortality and gross pathology findings were noted in animals during the study.

Skin Irritation

A study was performed following *In Vitro* Skin Irritation: Reconstructed Human Epidermis Test [OECD TG 439] to assess ammonium carbonate by a single application of 50 µL volume. For each treated tissue, optical density was calculated and the tissue viability was expressed as a % relative to negative control. Following exposure with ammonium carbonate, the mean treated skin value was 115%. Based on the result, ammonium carbonate was not skin irritating.

A study was performed under *In Vitro* Skin Corrosion: Human Skin Model Test [OECD TG 431] to assess ammonium carbonate (1:1) by a single topical application of 25 µL volume. In the corrosion test, the mean viability of the treated EpiDerm™ tissues was 105% after 3 minutes exposure and 36% after 1 hour exposure. In the irritation test, the mean viability of the treated EpiDerm™ tissues was 71% after 1 hour exposure with about 42 hours post-incubation. Based on the results, ammonium carbonate (1:1) was not skin irritating.

Eye Irritation

The acute eye irritation test was performed according to [OECD TG 405, EU Method B.5, EPA OPPTS 870.2400 and MAFF TG 12 Nousan No.8147]. Slight cornea opacity (score of 0.2), moderate conjunctival redness (score of 2) and slight

chemosis (score of 0.8) were observed at the 24- and 72-hours examinations. Based on these results, ammonium carbonate was not eye irritating to rabbits under the test conditions.

Skin sensitization

No data on skin sensitization is available.

Repeated Oral Toxicity

In a repeated dose oral toxicity study in rats [OECD TG 407], ammonium carbonate was administered via gavage to 5 animals/sex/dose at 0, 31.25, 125 and 500 mg/kg bw/day for 28 days. At the end of dosing, there were no statistically significant changes noted on haematology, clinical chemistry and organ weight. Mortality, general conditions and gross evidences of clinical signs and symptoms were examined in all animals throughout the study. Individual body weight of both sexes was measured once a week during the dosing period. Food consumption was recorded. Sensory activity, grip strength and motor activity, urinalysis, haematology, clinical chemistry, organ weights and histopathology were examined. Histopathology was evaluated only in the control, high dose groups, and the low dose group whose macroscopic lesions were observed. No death was observed in either sex. No treatment-related effects were observed in clinical signs, body weight, ophthalmological examination and urinalysis. The effects on haematology (increased eosinophils [44.4%] and neutrophils [37.3%] and decreased lymphocytes [8.8%]) and clinical chemistry (increased Cl and decreased K) were not considered to be treatment-related because the changes were within normal physiological range for rats of the strain and age used. The effects on organ weight (increased ovaries [22,6%] and pituitary gland [28,6%] weight, and decreased lung [8.7%] weight) were not supported by the pathological findings; these effects were considered to be an adaptive change. Therefore, the NOAEL for repeated dose oral toxicity was considered to be 500 mg/kg bw/day (highest dose tested).

Genotoxicity

In an Ames test [OECD TG 471] with multiple strains of *Salmonella typhimurium* TA1535, TA1537, TA98, TA100, and *Escherichia coli* WP2*uvr*A, ammonium carbonate did not induce gene mutation in bacteria *in vitro* both with and without metabolic activation. In an *in vitro* chromosomal aberration test using Chinese hamster ovary K1 cells, ammonium carbonate induced chromosomal aberrations at 2.5 mg/mL (49% of cell growth rate) with metabolic activation and did not induce chromosomal aberrations without metabolic activation. An *in vivo* micronucleus assay using mouse bone marrow cells [OECD TG 474] showed negative results up to 1,000 mg/kg bw. Based on these results, ammonium carbonate was not considered to be genotoxic.

No reliable data are available for the carcinogenicity of ammonium carbonate.

Reproduction and Developmental Toxicity

Ammonium carbonate has been investigated in a reproduction and developmental toxicity screening test in rats [OECD TG 421]. Ammonium carbonate was administered by oral gavage to 12 animals/sex at 0, 250, 500 or 1,000 mg/kg bw/day. Male rats were administered for 2 weeks prior to mating, during mating period and 2 weeks post mating period (at least 28 or more days), and female rats were administered from 2 weeks prior to mating to day 3 of lactation including the mating and gestation period. During the observation period, there were no dose-related effects on clinical signs, body weight, food consumption, mating, gestation, delivery, organ weights, necropsy and histopathology in parents. No dose-related changes in clinical signs, body weight, viability index, external malformations and sex ratios were noted in pups. This study found no indication of any reproduction toxicity in parent animals or developmental toxicity in pups at the highest dose of 1,000 mg/kg bw/day. Therefore, the NOAEL for reproduction and developmental toxicity was 1,000 mg/kg bw/day.

Ammonium carbonate does not present a hazard to human health due to its low hazard profile. Adequate screening-level data are available to characterize the human health hazard for the purposes of the OECD the Cooperative chemical assessment Programme.

Environment

Photodegradation is not applicable to inorganic substances such as ammonium carbonate. However, ammonium carbonate decomposes when exposed to air with loss of ammonia (NH_3) and carbon dioxide (CO_2) and is converted into ammonium bicarbonate. In the aquatic environment, ammonium carbonate dissociates into and releases NH_3/NH_4^+ and HCO_3^-/CO_3^{2-} depending on pH and temperature. The dissociated NH_4^+ is easily mineralized to nitrite ion (NO_2^-) by *Nitrosomonas*, and nitrite ion is oxidized to nitrate ion (NO_3^-) by *Nitrobactor*. Environmental fate analysis is based on log K_{ow} and log K_{oc}, and typical fugacity modelling is not applicable to ammonium carbonate as it is an inorganic compound. Ammonium carbonate is not expected to bioaccumulate in soil or aquatic organisms due to its high solubility in water. However, bioaccumulation of some ammonium compounds is closely related to nitrogen cycles in air, soil and water.

Ammonia aquatic toxicity depends on temperature, pH and ionic strength in the test water. A key factor is the speciation of ammonia: uninonzied ammonia (NH_3) and ammonium ion (NH_4^+). The speciation changed markedly with temperature and pH, and also with the test water ionic strength. The concentration of un-ionized ammonia increases with higher pH and temperature, and the un-ionized ammonia appeared to be much more toxic than ammonium ion. Because un-ionized ammonia is a neutral molecule and un-ionized ammonia is able to diffuse across the epithelial membranes of aquatic organisms much more readily than the charged ammonium ion.

The following acute toxicity test results have been determined for aquatic species. The values based on the ammonia concentration are also given on the table:

Species	Test guideline	Endpoints	Temperature (°C)	pH	Test substance
Fish [*Oryzias latipes*]	OECD TG 203	96 h, LC_{50} > 100 mg/L (nominal; semi-static) > 0.48-2.58 mg NH_3/L (estimated)	22.3-23.6	7.52-8.21	Ammonium carbonate
Fish [*Oncorhynchus mykiss*]	No data	96h, LC_{50} = 102.2 mg/L (measured; flow-through) = 18.1 mg/L (measured, total ammonia nitrogen)	13.9	8.10	Ammonium carbonate (1:1)
Fish [*Oncorhynchus mykiss*]	No data	96h, LC_{50} = 97.7 mg/L (measured; flow-through) = 17.3 mg/L (measured, total ammonia nitrogen)	13.6	8.12	Ammonium carbonate (1:1)
Invertebrate [*Daphnia magna*]	OECD TG 202	48h, EC_{50} > 100 mg/L (nominal; static) > 0.85-3.43 mg NH_3/L (estimated)	20.3-20.9	7.81-8.4	Ammonium carbonate
Algae [*Pseudokirchneriella subcapitata*]	OECD TG 201	72h, E_rC_{50} / E_yC_{50} > 100 mg/L (nominal; static) > 0.06-0.82 mg NH_3/L (estimated)	22.8	7.3-8.4	Ammonium carbonate
Algae [*Pseudokirchneriella subcapitata*]	OECD TG 201 EU C.3 EPA OPPTS 850.5400	72h, E_rC_{50} = 252.92 mg/L (growth rate; nominal; static)72h, E_yC_{50} = 122.46 mg/L (yield; nominal; static) 72h, E_bC_{50} = 141.44 mg/L (biomass; nominal; static) (un-ionized ammonia (NH_3) =4.8% of total ammonia at pH 8.01; 47.1% of total ammonia at pH 9.26)	23	8.01-9.26	Ammonium carbonate

The following chronic toxicity test results have been determined:

Atlantic Salmon 53d, NOEC < 168 mg/L (measured, ammonium carbonate (1:2), <0.07 mg NH_3/L, pH 6.74, 13°C)

In the aquatic environment, ammonium carbonate dissociates into and releases ammonium ion (NH_4^+) and bicarbonate ion (HCO_3^-). The dissociated NH_4^+ cation has a significant eutrophication potential due to nitrogen in form of ammonium ion. When ammonium ion increases in water, plant growth is enhanced, and dissolved oxygen is reduced when dead plant material decomposes, which eventually can cause organisms in water to die.

Ammonium carbonate has a low hazard profile for the environment. Adequate screening-level data are available to characterize the environmental hazard for the purposes of the OECD Cooperative Chemicals Assessment Programme. The pH and temperature of water bodies can affect the concentration of un-charged ammonia derived from the assessed substance; ammonia is the toxicologically relevant form for aquatic toxicity. Ammonia also has indirect and long-term effects on ecosystems, e.g. eutrophication, groundwater pollution and soil acidification due to the nitrification of ammonia.

Exposure

Production

In the Republic Korea (sponsor country), the production, use and import volumes of ammonium carbonate were 60,448, 60,635 and 720 tonnes in 2010, respectively. For the volumes of ammonium carbonate, the production, use and import volume of ammonium carbonate (1:1) and ammonium carbonate (1:2) were 2,084, 1,479, 702 and 58,364, 59,154, 18 tonnes in 2010, respectively.

In the sponsor country, ammonium carbonate (1:1) is produced as a by-product in the process of manufacturing basic organic compounds. The production process is as follows: chemical reaction occurs among raw materials such as alkylbenzene, phthalic anhydride, urea, copper(I) chloride and ammonium molybdate, producing ammonia gas as a by-product, . Adding CO_2 to the ammonia gas, produces ammonium carbonate (1:1)

Reaction formula:

1. Initial reaction: $C_8H_4O_3 + CH_4N_2O \rightarrow C_9H_8N_2O_4 \rightarrow C_8H_5NO_2 + CO_2 + NH_3$
2. Decomposition: $NH_2 \cdot CONHCO \cdot NH_2 \rightarrow CO_2 + NH_3 + NH_2CN$
3. Ammonium carbonate solution (1:1): $CO_2 + NH_3 + H_2O \rightarrow NH_4HCO_3$

Use Pattern

In general, ammonium carbonate is used for baking powders, washing and defatting woollens, tanning, dyeing, manufacture of rubber articles, casein glues, casein colours, fire extinguishers and pharmaceutical aid. Ammonium carbonate (1:1) is used for fire extinguishers, manufacture of porous plastic and ceramics, dyes, pigments, fertilizers and defatting textile.

In the sponsor country, ammonium carbonate is mainly used for nitrogen oxide removal of cement, manufacture of hydroxylamine sulphate, and as food additives for chocolate and cocoa, intermediates, process regulators and reducing agents. Ammonium carbonate (1:1) is mainly used as process regulators, an ingredient of cosmetics, pH regulating agents and electroplating agents. Ammonium carbonate (1:2) is mainly used for electroplating, semiconductor and adhesive.

Occupational Exposure

In production facilities of the sponsor country, ammonium carbonate (1:1) is produced as a by-product of basic organic compounds in closed systems. Workplaces are controlled according to in-house operation safety regulation. Waste gases generated in workplaces are controlled by Regenerative Thermal Oxidizer (R.O.T), and waste water is treated through treatment facilities and contract agencies. In workplaces, workers are equipped with personal protective equipment such as dust masks, gloves, clothes and boots. According to monitoring data, ammonium gases were estimated to be below detection limit in workplaces, and ammonium carbonate (1:1) generated was stored in tanks. Therefore, occupational exposure is considered to be negligible in the sponsor country.

In use facilities of the sponsor country, ammonium carbonate (1:2) is handled in closed systems. Workplaces are under control in accordance with the material safety data sheet. Occupational external exposure is managed by dust collector. To ensure workers safety during tank maintenance, workers are equipped with personal protective equipment such as safety helmet, rubber gloves, masks and goggles. Therefore, occupational exposure is considered to be negligible in the sponsor country.

Exposure of the general population

Ammonium carbonate is mainly used as a food additive in the sponsor country. According to Korean Food Additives Codex, it is used as alkali agents for chocolate, dry cocoa-sugar mixture, cocoa powders, nib, dust, mass and press cake. Also, it is used as raising agents for grain products for infants, fish sticks and fillets and as neutralizing agents for dietary casein products. Ammonium carbonate is an approved food additive.