



Ammonia

Updated: April 2016

.....

Anhydrous ammonia (Ammonia, Liquid Ammonia, NH_3 , CAS no 7664-41-7) is a colorless gas with a penetrating pungent odor. Ammonia exists in nature and is also man-made.

Ammonia hydroxide (Ammonia solution, Ammonia water, Ammonia, NH_4OH , CAS no 1336-21-6) is a colorless aqueous solution of ammonia in water. It is sometimes mistakenly referred to as "liquid ammonia" (such as on the MedlinePlus website), but the term. "liquid ammonia" actually refers to the liquid obtained by compressing anhydrous gaseous ammonia [MedlinePlus, MW].

Liquid ammonia is transported in bulk as a pressurized gas. Ammonia solutions have different properties depending upon the ammonia concentration in the water. For example, In Europe three types of ammonia hydroxide are designated as goods that are dangerous to transport and are classified according to their respective ammonia concentrations:

% of Ammonia	Class	Classification
10% - 35%	8	Corrosive Substances
35%-50%	2.2	Non-flammable non toxic gasses
More than 50%	2.3 + 8	Toxic Gasses, Corrosive Substances

Ammonia is released into the atmosphere by natural processes such as the decay of organic matter, plant materials, dead animals, animal excreta, and volcanic activity. It is also released by anthropogenic activities such as use of fertilizers; spillage or leakage from storage or production facilities; or loss from waste water effluents [ATSDR].

Atmospheric ammonia has a half – life of several days. Ammonia volatilizes into the atmosphere from water or soil. It is then reabsorbed and fixed through microbial processes and transformed into nitrate or nitrite anions. These anions are then adsorbed into sediment and suspended organic material or taken up by plants.

Usage and exposure

Commercially produced ammonia is used primarily as fertilizer or in the manufacture of plastics, synthetic fibers and resins, explosives, and household cleaners [ATSDR].

Anhydrous ammonia is widely used as a refrigerant in meat, poultry, and fish processing facilities, dairy and ice cream plants, wineries, breweries, and other food processing facilities; and petrochemical facilities [OSHA]. Anhydrous ammonia is also a key ingredient in the illegal production of methamphetamines (meth) [MDA].

The most common manner in which the general public is exposed to elevated levels of ammonia is through use of household cleaners containing ammonia or ammonium salts. People who live near farms or who visit farms during the application of fertilizer, or who live near cattle feedlots, poultry confinement buildings, or other areas where livestock is raised are also exposed to ammonia.

Exposure to ammonia also occurs through ingestion of water or food [ATSDR].

Exposure to significant amounts of ammonia in occupational settings occurs during production, preparing or using ammonia formulations such as fertilizers or cleaners, or during manufacturing or maintenance of refrigerators or other equipment containing ammonia. Firefighters may also be exposed to ammonia.

Routes of Exposure: inhalation, skin and eye contact, ingestion.

The most common route of exposure to ammonia is inhalation [PHE]. There are many reports in literature of human deaths resulting from inhalation of ammonia [ATSDR].

Skin or eye contact may accidentally occur while handling products containing ammonia without using protective measures.

Ingestion can occur accidentally or through substance abuse.

Target Organs

Respiratory tract, skin, eyes, upper gastrointestinal tract.

Metabolism

Ammonia is produced and used endogenously in all mammalian species. It is an essential mammalian metabolite for DNA, RNA, and protein synthesis and is essential for maintaining acid-base balance. Humans produce up to 17 grams of ammonia daily. Approximately 4 grams are produced in the gut by intestinal bacteria. It then enters the portal circulation and is metabolized rapidly in the liver to form urea. The ammonia is excreted through the kidneys as urea and urinary ammonium compounds. Levels of ammonia in the blood of healthy humans range from 0.7 to 2 mg/L [ATSDR].

Health Hazards

Acute Effects

The most significant effects of exposure to excessive amounts of ammonia are due to its irritative and corrosive properties. Exposure to ammonia gas causes chemical (alkali) burns of the respiratory tract, skin, and eyes. Ammonia dissolves in the moisture on the surface of the skin, mucous membranes, and eyes. It then becomes ammonium hydroxide, which is a highly ionized weak base that causes necrosis of the tissues. Specifically, ammonium hydroxide causes saponification of cell membrane lipids resulting in cell disruption and death. It also extracts water from the cells, and initiates an inflammatory response that further damages the surrounding tissues.

Infection, scarring, and other complications may develop days or weeks following inhalation or ingestion.

Hepatic and renal effects have also been reported in animals and humans; however, ammonia does not appear to be a primary liver or kidney toxicant [ATSDR].

Respiratory Effects: Ammonia is an upper respiratory irritant in humans. Accidental exposures to concentrated aerosols of ammonium salts or high concentrations of ammonia gas have resulted in nasopharyngeal and tracheal burns, airway obstruction and respiratory distress, and bronchiolar and alveolar edema.

Dermal Effects: The skin is extremely sensitive to airborne ammonia or ammonia dissolved in water. Dermal exposures to liquid ammonia or concentrated solutions and/or ammonia gas are frequently occupationally related and produce cutaneous burns, blisters, and lesions of varying degrees of severity. Unlike acid burns that cause a coagulation necrosis, ammonia causes alkali burns, resulting in liquefaction of the tissue and deeper penetration.

Ocular Effects: Ammonia is slightly irritating to the eyes following even brief exposure at concentrations of 100 ppm, and causes immediate irritation at more than 500 ppm. Higher concentrations of ammonia and ammonium hydroxide are corrosive and rapidly penetrate the eyes, causing permanent injury. Emergency measures should therefore be taken if ammonia is splashed into the eyes. [ATSDR, PHE].

Most people can bear exposure to an air concentration of 250 ppm for 30– 60 minutes.

Ingestion causes immediate burning of the mouth and throat, drooling, difficulty swallowing, abdominal pain, vomiting and haematemesis. Hemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases [PHE].

Neurological Effects. Neurological effects in humans following inhalation or dermal exposure to ammonia are usually limited to blurred vision due to direct contact. Severe exposures result in significant elevation of blood ammonia levels (hyperammonemia) that can lead to diffuse nonspecific encephalopathy, muscle weakness, decreased deep tendon reflexes, and loss of consciousness [ATSDR].

Chronic effects

Chronic occupational exposure to low levels of airborne ammonia (<25 ppm) were found to have little effect on pulmonary function or odor sensitivity among factory workers [ATSDR].

Ammonia has no structural alerts for DNA reactivity, and is not mutagenic [PHE].

Carcinogenicity

Ammonia has not been classified as a human carcinogen and is not considered to be an animal carcinogen. Ingestion of ammonium hydroxide by rats over a period of 2 years did not result in an increase in cancers [PHE].

References:

- ATSDR. U.S. Department of Health and Human Services. Public Health Service Agency for Toxic Substances and Disease Registry. Draft Toxicological Profile for Ammonia. September 2014.
- ADR. Economic Commission for Europe Committee on Inland Transport. European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR). Volume 1. United Nations. New York and Geneva 2014. ECE/Trans/242 (Vol.1).
- MDA. Minnesota Department of Agriculture. Anhydrous Ammonia Theft. <<http://www.mda.state.mn.us/chemicals/spills/ammoniaspills/theft.aspx>>. Accessed 27/04/2016.
- MW. Merriam Webster Dictionary. Definition of liquid ammonia. <<http://www.merriam-webster.com/dictionary/liquid%20ammonia>>. Accessed 27/04/2016.
- OSHA. U.S. Department of Labor. Occupational Safety & Health Administration. Safety and Health Topics. Ammonia Refrigeration. <<https://www.osha.gov/SLTC/ammoniarefrigeration/recognition.html>>. Accessed 27/04/2016.
- PHE. Public Health England. Guidance. Ammonia: health effects, incident management and toxicology.

<<https://www.gov.uk/government/publications/ammonia-properties-incident-management-and-toxicology>>. Accessed 27/04/2016.