AMMONIA

Chemical Symbol:	NH_3
Synonyms:	Anhydrous Ammonia
DOT Proper Shipping Name:	Ammonia, Anhydrous
DOT Classification:	2.2 (Non-flammable gas)
DOT Label:	NON-FLAMMABLE GAS
TC Shipping Name:	Ammonia, anhydrous, liquefied
TC Label:	CORROSIVE GAS
UN Number:	UN 1005

DESCRIPTION

Ammonia is the compound formed by the chemical combination of the gaseous elements nitrogen and hydrogen. In the molar proportion of 1 part nitrogen and 3 parts hydrogen. This relationship is shown in the chemical symbol for ammonia, NH_3. On a weight basis, the ratio is 14 parts nitrogen and 3 parts hydrogen or approximately 82% nitrogen and 18% hydrogen. The term ammonia as used throughout this monograph is the name of the chemical compound, NH_3, which is commonly called anhydrous ammonia, Anhydrous means "without water" and when used with ammonia indicates that the water content is less than 0.2%. This differentiates it from the various widely used aqueous solutions of ammonia, At room temperature and atmospheric pressure, ammonia is a pungent, colourless gas. It may be compressed and cooled to a colourless liquid. Between the melting and critical points, liquid ammonia exerts a vapour pressure that increases with rising temperature. When anhydrous ammonia in a closed container is in equilibrium to anhydrous ammonia vapour, the pressure within the container bears a definite relationship to the temperature.

Liquid ammonia is lighter than water, having a density of 42.57 lb/ft^3 (681.9 kg/m3) at -28oF (-33.3^{o}C); as a gas, ammonia is lighter than air, its relative density Is 0.597 compared to air at a pressure of 1 atm and a temperature at 32^{o}F (0.0^{o}C). Ammonia gas burns at atmospheric pressure, but only within limited range of 16% 10 (to) 25% by volume of ammonia air. Ammonia is a highly reactive chemical, forming ammonium salts in reactions with inorganic and organic acids.

USES

About 80% of all ammonia produced in the United States is used in agriculture as a source of nitrogen, which is essential for plant growth. Nitrogen makes up 16% of the plant protein. When a fruit, vegetable, or grain crop is grown and harvested, nitrogen is removed from the soil. If the fertility of the land is to be maintained, nitrogen and other elements essential to plant growth such as potassium and phosphorus must be restored to the soil by the fertilisation. Depending upon the particular crop, up to 200 lb (90 7 ka) of nitrogen may be economically applied per acre.

It can be injected at a depth of several inches below the surface of the soil by specially designed equipment, or it can be dissolved in irrigation water, Ammonia is used extensively in the fertiliser industry to produce solid material such as ammonium salts, nitrate salts, and urea. Ammonium sulphate, ammonium nitrate, and ammonium phosphate are made directly by neutralising the corresponding acids- sulphuric acid, nitric acid, and phosphorus acid- with ammonia. Ammonium sulphate, ammonium nitrate, ammonium phosphate, and urea are used for direct application to the soil In dry form and in combination with other phosphate and potassium salts.

Ammonia is also used in the production of nitrogen fertiliser solutions that consist of ammonia, ammonium nitrate, urea, and water in various combinations. In addition to their use as fertilisers, ammonia and urea are used as a source of protein in ruminant livestock feeds. Urea is used in mixed feed supplements to supply the nitrogen needed for the biosynthesis of proteins by the microorganism in ruminating animals such as cattle, sheep, and goats.

Ammonia is oxidised in the production of nitric acid, the principal ammonia derivative used in making explosives. Both industrial and military explosives are divided into two main types: high explosive such as dynamite, nitroglycerine, and TNT, which detonate rapidly to give a shattering blast for demolition purposes. Dynamite, a general term for high explosives used in mining and construction, contains nitroglycerine or other organic nitrogen compounds absorbed in a combustible material.

Ammonia is required for the synthesis of ammonium salts and certain alkalies, dyes, pharmaceuticals, synthetic textile fibres, and plastics.

Used in both absorption- and compression- type systems, ammonia is the oldest, most efficient and economical mechanical refrigerant known.

Ammonia is used in extracting certain metals such as copper, nickel, and molybdenum from their ores.

Ammonia vapour is utilised as the developing agent for diazonium salts (white printing) and is also employed in the production of diazotype microfilm duplicates.

Ammonia is used in scrubbers to neutralise sulphur oxides in their removal from stack gases in electric power generation and other furnace operations such as smelting.

Ammonia is highly soluble in water, forming aqueous ammonia (ammonium hydroxide or aqua ammonia), which has many applications. In a very dilute solution (2% to 5% ammonia) it is available as "household ammonia."

PHYSIOLOGICAL EFFECTS

Persons having chronic respiratory disease or persons who have shown evidence of undue sensitivity to ammonia should not be employed where they will be exposed to ammonia. Ammonia and the ambient atmosphere has an intense irritating effect on the mucous membranes of the eyes, nose, throat, and lungs. High level ammonia can produce corrosive effect on tissues and can cause laryngeal and bronchial spasm and oedema so as to obstruct breathing. The pungent odour of ammonia affords a protective warning, and as long as people are conscious they can avoid breathing significant contaminated air.

MATERIALS OF CONSTRUCTION

When combined with water vapour, ammonia will attack copper, zinc, or alloys containing copper as a major alloying element. Therefore, these materials should not be used in contact with ammonia. Copper, brass, or galvanised fittings and pipe should not be used. Unions, valve, gauges, pressure regulators, and relief valves or other fittings having copper, brass, or bronze parts are not suitable for ammonia service.

All ammonia piping should be extra heavy (Schedule 80) steel when threaded joints are used. Standard weight (Schedule 40) steel may be used when joints are either welded or joined by welding-type flanges.

All fittings must be at least extra heavy. Non-malleable metals such as cast iron must not be used. Forged or cast steel valves and fittings should be in any service subject to significant strain or vibration.

Hose should be manufactured specifically for ammonia service and should have a minimum burst pressure not less than 1750 psig.

SAFE STORAGE, HANDLING AND USE

Personnel working with anhydrous ammonia should be thoroughly familiar with safety precautions for handling a gas corrosive to human tissue, as well as measure for handling emergencies.

Determining When Cylinders Are Empty

The best way to determine if an ammonia cylinder is empty is to weigh it without cap and compare the weight with the tare weight stamped on the cylinder. A pressure gauge should be Installed in a system using vapour supplied from cylinders, A gauge pressure reading of less than 25 psig (172 kPa) without frost formation on the cylinder walls indicates that the cylinder is essentially empty. The ammonia vapour content of a 150-lb (68-kg) cylinder at 25 psig (172kPa) is approximately 0.54 lb (0.24 kg).

DISPOSAL

Ammonia may be disposed of by discharge into water of sufficient volume to absorb it. A ratio of 10 parts water to 1 part ammonia may be considered sufficiently.

HANDLING LEAKS AND EMERGENCIES

A leak in an ammonia system can be detected by odour. The location of the leak may be determined with moist wet litmus paper, moist filter paper Impregnates with phenolphthalein, or by detection instruction. Only personnel trained for or designated to handle emergencies should attempt to stop a leak, Respiratory equipment of a type suitable for ammonia must be worn. All persons not so equipped must leave the affected area until the leak has been stopped,

If ammonia vapour is released, the irritating effect of the vapour typically will force personnel to leave the area before the have been exposed to the dangerous concentration. If, despite all precautions, a person should become trapped In an ammonia atmosphere, he or she should breathe as little as possible and open his or her eyes only when necessary, Depending upon the concentration of ammonia, partial protection may be gained by holding a wet cloth over the mouth and nose. Since ammonia vapour In air will rise, a trapped person should stay close to the floor to take advantage of the lower vapour concentrations at that level. With good ventilation or rapidly moving air currents, ammonia vapour, being lighter than air, can be expected to dissipate readily to the upper atmosphere without further action being necessary.

LEAKS

A cylinder that continues to leak should be removed from the building to a safe area and the supplier notified, For further information see the North America Emergency Response Guidebook, published by DOT [8]. When ammonia is discharged into the environment, accidentally or intentionally, in an amount equal to or exceeding its reportable quality of 100 lb (45.4 kg) during a 24-hour period, this discharge must be reported.

FIRE

Exposure An ammonia container exposed to a fire should be removed if it can be done safely. If for any reason the container cannot be removed, it should be kept cool with water spray from a safe distance until well after the fire is out. Fire fighting personnel should be equipped with protective clothing and respiratory equipment. Information on such safety equipment, and on general procedures for securing the area, Is given CGA G-2 [7].

FIRST AID

Inhalation - Any conscious person that has inhaled ammonia causing irritation should be assisted in an uncontaminated area to inhale fresh air. A person overcome by ammonia should immediately be carried to an uncontaminated area. If breathing has ceased, artificial respiratory must be started immediately, preferably by trained personnel, if breathing is weak or has been restored by artificial respiration, oxygen may be administered.

Skin Contact - The area affected should be immediately flooded with water. If no safety shower is available, immerse in any available water of acceptable temperature. Water will have the effect of thawing out clothing, which may be frozen to the skin. Such clothing should be removed and flooded with water continued for at least 15 minutes. Do not apply salves or ointments or cover burns with dressing; however, protect the injured area with clean cloth prior to medical care. Do not attempt to neutralise the ammonia. If ammonia has entered to nose or throat and the patient can swallow, have the patient drink large quantities of water. Never give anything by mouth to an unconscious person.

Eye Contact - The eyes must be flooded immediately with copious quantities of clean water. Speed is essential. Eye fountains should be used, but if they are not available, water may be poured over the eyes. In any case the eyelids must be kept open and irrigation must continue for at least 30 minutes. The patient must receive prompt attention from a physician,

preferably an ophthalmologist. Persons subject to ammonia exposure should not wear contact lenses.

CONTAINERS

Under the appropriate regulations; anhydrous ammonia is transported as a liquefied compressed gas in cylinders, insulated and uninsulated tank cars (and multi-unit tank car tanks), barges, and tankers. It is stored in bulk in large capacity containers installed above or below ground. Very large above ground containers are often low pressure, refrigerated, and consequently insulated tanks.

CYLINDERS

Cylinders meeting the requirements of the following DOT/TC specifications are authorises for ammonia service: 3A480, 3A480X, 3AA480, 3AL480, 3E1800, 4, 4A480, and 4AA480 [9.11], Ammonia cylinders are available in seamless (one-piece) or welded (two-piece) construction and in a number of convenient sizes, the two most highly used capacity of 15 lb (45.4 kg and 68,0 kg) of ammonia.

The valve of each ammonia cylinder having a capacity of 15 lb (6.8 kg) or more usually has an internal dip tube connected to it. This makes it possible to withdraw either liquid or vapour by positioning the cylinder so the end of the dip tube is in the desires phase.

REQUALIFICATION

In addition to hydrostatic testing of cylinders at the time of manufacture, DOT requires the owner or his authorised agent to fulfil periodic requalification requirements for his cylinders. Hydrostatic retest or visual inspection under certain conditions is the accepted methods for prequalifying cylinders. Prequalifying periods and test pressures for cylinders in ammonia service are shown in table 6.

Cylinders exposed to fire must be property heat treated and tested before being returned to the service.

STATIONARY CONTAINERS

Ammonia storage containers must be designed for at least 250 psig (1720 kPa), constructed in accordance with the ASME Boiler and Pressure Vessel Code, Section VII, and should be stressed relived after fabrication.

METHODS OF MANUFACTURE

The first commercial successful synthetic ammonia plant in the United States was put into operation in 1921. It utilised the Haber-Bosch process, in which a preheated mixture of nitrogen and hydrogen was subjected to pressure in the presence of a catalyst. Most ammonia produced commercially today is manufactured by processes that are modifications of the Haber-Bosch process. Several sources of hydrogen have been used, including natural gas, refinery gas, or coke oven gas. Nitrogen may be supplied be introducing compressed air into the process stream or by introducing nitrogen from an air separation unit.