

## Using Agricultural Anhydrous Ammonia Safely<sup>1</sup>

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Anhydrous ammonia is one of the most efficient and widely used sources of nitrogen for plant growth. The advantages of ammonia's relatively easy application and ready availability have led to its increased use as a fertilizer on Missouri farms.

Anhydrous ammonia also has disadvantages, especially in its handling. It must be stored and handled under high pressure, which requires specially designed and well-maintained equipment. Workers also must be trained to handle this product and to follow strict work procedures to ensure operator safety.

What is anhydrous ammonia (NH<sub>3</sub>), and why is it so risky to handle? It is a chemical made up of one part nitrogen (N) and three parts hydrogen (H<sub>3</sub>). The physical properties of this fertilizer make it one of the most potentially dangerous chemicals on the farm.

Anhydrous means without water. Consequently, when anhydrous ammonia and moisture come into contact, they rapidly combine. When it is injected into the soil, the liquid ammonia expands into a gas and is readily absorbed in the soil moisture. Similarly, the liquid or gas that contacts body tissue - especially the eyes, skin and respiratory tract - will cause dehydration, cell destruction and severe chemical burns. Victims exposed to even small amounts of ammonia require immediate treatment to avoid permanent injury.

Anhydrous ammonia has a built-in safety factor - you can't stand to breathe it. No one can voluntarily remain in a concentration of anhydrous ammonia gas strong enough to damage the nose, throat, lungs, eyes or

skin. When people receive burns or eye damage from the product, it is because of a sudden release of it where the victim is unprotected and cannot escape. Table 1 gives examples of the effects of various concentrations of anhydrous ammonia vapor on the human body.

Under atmospheric temperature and pressure, anhydrous ammonia is a colorless gas with a sharp, penetrating odor. For use as an agricultural fertilizer, it is compressed into a liquid resembling water. In the liquid state, under pressure, it is stored in specially made tanks strong enough to withstand internal pressures of a minimum of 250 pounds per square inch (psi). As the outside temperatures increase, the temperature of the anhydrous ammonia increases, causing the vapor pressure in the tank to increase. For example, at 60° F, the pressure is 93 psi and at 100° F, the pressure is nearly 200 psi.

Ammonia is corrosive to certain metals and their alloys, such as copper and zinc. Galvanized pipe and brass fittings must not be used with equipment used for storing or applying ammonia. Containers should be made of high-strength steel or other suitable material and fittings should be made of black iron.

### ACCIDENTS WITH ANHYDROUS AMMONIA

Due to its properties and the manner in which it is stored, anhydrous ammonia can create a dangerous situation when it is accidentally released. The following are some examples of misusing anhydrous ammonia and its equipment that can result in accidents:

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**Table 1.** Concentration of anhydrous ammonia vapor.

| PPM(parts per million) | Percent by volume | Effects on the human body  |
|------------------------|-------------------|--|
| 5                      | 0.005             | Detectable by almost all persons. Some people complain of nose irritation after 5 minutes    |
| 134                    | 0.0134            | Most people experience dryness and irritation of nose, throat and eyes.                      |
| 700                    | 0.07              | Coughing. Severe eye irritation, if not treated, may lead to partial or total loss of sight. |
| 1700                   | 0.17              | Serious lung damage, death unless treated.   |
| 2000                   | 0.2               | Burns and blisters skin after a few seconds of exposure.                                     |
| 5000                   | 0.5               | Death by suffocation within minutes.   |

- Filling tanks beyond recommended capacity.
- Knocking open the hose-end valve accidentally.
- Moving the applicator tank before filling hoses have been disconnected from nurse tank.
- Venting pressure release valve while a person is in line of discharge.
- Breaking of transfer hose, especially an old or misused one.
- Failing to bleed hose coupling before disconnecting.
- Rupturing of low pressure hose due to pressure buildup when knives plug.
- Releasing ammonia when knives are unplugged.
- Overturning an applicator or nurse tank while in transit or in the field.

All of the above accident situations can result in injury, extensive property damage or both.

To minimize the chance of an accident, take steps to ensure all equipment is in top operating condition. Be sure all agricultural workers handling or applying ammonia have been specially trained in equipment maintenance and operation, proper personal protective equipment and emergency first aid.

## OPERATOR PROTECTION

Even with the best precautions, you may be involved with the accidental release of ammonia. Simple protection can prevent serious consequences if used consistently.

A face shield or goggles, rubber gloves and a heavy-duty long-sleeved shirt are recommended as minimum protection for operators routinely handling ammonia.

Wear gloves and eye protection whenever you are working on or operating anhydrous equipment or handling hoses.

It is important to wear properly fitting goggles or a face shield when working with ammonia. A face shield will help prevent you from breathing a direct blast of ammonia and also will reduce possible eye exposure. Regular glasses do not provide adequate protection. Never wear contact lenses when working with ammonia. Ammonia might get under the lenses and cause permanent eye damage before you can remove the lenses and flush your eyes with water.

Loose-fitting rubber gloves with an extended cuff are recommended for handling anhydrous ammonia. Turn the extended cuff down so ammonia does not run down your sleeve when you raise your arms. You can remove gloves that fit loosely in case of an emergency.

You can further protect your arms from splashes by wearing heavy-duty clothing such as coveralls or work shirts that cover your arms. Thin dress shirts or short sleeves don't provide satisfactory protection.

If you store bulk quantities of anhydrous ammonia on your farm, you will need additional protective equipment. Keep two rainsuits or slickers and gas masks with an ammonia canister filter available for emergency work. The protection from a canister filter is limited and you should only use it in low concentrations of ammonia. When a serious leak occurs, call your local fire department for assistance. Firefighters have the proper training and equipment - including a self-contained breathing apparatus and protective suit to deal with major ammonia leaks where high concentrations of ammonia are probably present.

The operator's manual for anhydrous ammonia equipment should include instructions on proper procedures and protective equipment to use when handling ammonia. Review this information before operating the equipment.

## FIRST AID = WATER + WATER + WATER

Every second is critical when someone is sprayed with liquid ammonia or engulfed in concentrated vapors. Exposure to anhydrous ammonia can be harmful if it contacts the skin and eyes or if it is inhaled or swallowed. When ammonia contacts the skin or eyes, tissue damage occurs rapidly. Immediately flushing the exposed body area(s) with water is crucial.

Regulations require that all farm vehicles used for anhydrous ammonia carry a container filled with at least 5 gallons of water. This water must be readily available for flushing the eyes and skin in case of exposure. You should change the water daily to ensure you have a clean supply.

Safety specialists recommend you keep a second 5-gallon container of water on the tractor. This provides another source of water for first aid in case the tractor operator is unable to reach the water container on the nurse or applicator tank. You should also carry a 6- to 8-ounce, water-filled plastic eye wash bottle in your shirt pocket. It provides an immediate supply of water if an accident does occur. The objective of the eye wash bottle is to get the excess ammonia out of the eyes in the first few seconds until you or the victim can get to the larger water supply to continue flushing.

When a victim has been exposed to anhydrous ammonia, move him or her to a safe place and flush the exposed area immediately with water for a minimum of 15 minutes. Remove contaminated clothing as soon as you have thawed them out. (Remember, the sub-zero temperature of anhydrous ammonia can freeze exposed clothing to skin below it. If you remove clothing before you thaw it with rinse water, extensive skin damage can result.)

Do not apply salves, creams or ointments. They won't stop the damaging action to skin. Contact a doctor immediately after emergency first aid treatment.

Even if small amounts of ammonia enter the eyes, irrigate them immediately with water for 15 minutes or more. Hold the eyelids open during irrigation to ensure water contacts all parts of the eye. Immediate first aid is important to avoid partial or total loss of vision. Again, consult a doctor after giving emergency first aid.

Ammonia vapors are easily detected because of their pungent odor, even in low concentrations. Inhaling ammonia can irritate the respiratory tract and lungs. At high concentrations, ammonia combined with the moisture in the lungs may damage the lung lining and reduce the lungs' ability to transfer oxygen to the bloodstream.

When a person has inhaled ammonia, move them to a safe area. Exposures to low concentrations of ammonia for a short period of time may not require treatment. Exposure to higher concentrations may cause convulsive coughing and respiratory spasms. Provide

cardiopulmonary resuscitation if the victim is not breathing. Obtain medical help as soon as possible.

In case ammonia has been swallowed, contact a doctor immediately. Have the victim, if conscious and able, drink large amounts of water to dilute the chemical. Do not induce vomiting if the victim is in shock or unconscious. If vomiting occurs, keep the head lower than the hips to prevent vomitus from entering the lungs.

## CONTAINER AND SYSTEM REQUIREMENTS

The specially fabricated and designed pressurized equipment should meet the guidelines provided by the American National Standards Institute in publication K61.1-1981, Safety requirements for storage and handling of anhydrous ammonia. All parts and contact surfaces must withstand a minimum working pressure of 250 psi. This includes pressure welds, safety valves, gauges, fittings, hoses and metering devices.

All containers used for storing ammonia must be painted white or silver. Light colors reflect heat and this helps keep the temperature and pressure down inside the tank during warm weather.

## MAINTAIN ANHYDROUS AMMONIA EQUIPMENT

Keep anhydrous ammonia equipment in good condition. Be on the lookout for defects in nurse tanks, regardless of whether you own them or lease them. Make periodic inspections and repair or replace equipment. Accident victims are just as injured regardless of who owns the tank. The following procedures for maintenance are taken from guidelines recommended by the Fertilizer Institute. For a complete copy of the detailed guidelines, write to: The Fertilizer Institute, 1015 18th St. NW, Washington, D.C. 20036.

**Daily inspection.** Each day give the tank and hoses a brief inspection. Look for problems with:

- Hoses - Check for cuts, soft spots, bulges, kinking, flattening or slipping at the coupler.
- Tires - Inspect for proper inflation, cuts, weathering, wear and tightness of lug bolts on wheels.

Each time you fill the nurse tank, check the liquid level gauge and pressure gauge. The gauges should be working properly and be consistent in their readings. Don't use nurse tanks with faulty gauges. To repair or replace faulty gauges, the tank must be emptied and the

tank pressure dropped to zero before faulty parts can be removed.

**Immediate repair.** Several situations are cause for immediate repair or replacement. Any leak in a liquid or vapor shut-off valve calls for repair or replacement of the valve. If an accident causes a dent, gouge, crack or other damage to the tank that might result in failure, inspect the tank, and if necessary, repair it before placing it back into service. A certified welder must make any welding repairs on the tank and the welds must be hydrostatically tested to ASME standards. An overturned tank or collision between the tank and other farm machinery are examples of causes for inspection.

**Annual inspection.** At least once a year, inspect these items carefully and repair or replace as needed:

**Hoses.** Lay hose out straight and examine carefully for:

- cuts exposing reinforcement fabric
- soft spots or bulges
- blistering or loose outer cover
- unusual abuse, such as kinking or flattening by a vehicle
- slippage of hose at any coupling
- brass or copper fittings or waterhose-type clamps
- hoses over 1/2 inch O.D. not marked with the following information:
  - "Anhydrous Ammonia"
  - xxx psig (maximum working pressure)
  - Manufacturer's name or trademark
  - Year of Manufacture

Immediately replace hoses that show these defects. Hoses exposed to anhydrous ammonia lose strength. You should replace them according to the following schedule regardless of visible damage:

**Table 2.**

| Braid material  | From date of installation |
|-----------------|---------------------------|
| Rayon           | 2 years                   |
| Nylon/Kevlar    | 4 years                   |
| Stainless steel | 6 years                   |

## AMMONIA TRANSFER

Most ammonia accidents involve improper handling procedures. Read your owner's manual and follow instructions. Do not leave during the transfer procedure. Check with your dealer if you are unsure about the correct procedure. Ask for instructions when renting or

borrowing equipment. Review the procedures with farm workers before allowing them to handle equipment to ensure their safety.

When filling a nurse or applicator tank, be thoroughly familiar with the equipment and procedures prior to any transfer. Because most accidents occur when transferring ammonia, it is very important to wear a protective face shield or goggles and rubber gloves when you are involved in this procedure.

Be sure the 5-gallon container is full of clean water.

Park the nurse tank on level ground, downwind from the filling operation. Place it close to the operation to eliminate any stress on the hose. Avoid working near any obstacles that would make evacuation difficult, such as fences, buildings or ditches. Block the wheels to prevent the nurse tank from moving. A serious situation could develop if the tank moved and a hose tore loose during the filling operation.

Before connecting the hose, make sure the coupling and connections are free of dirt and other foreign material. Visually check to see that the threads are not damaged. This will reduce the chance of an ammonia leak when pressure is applied.

Workers should carry the filler hose by the valve body or coupling, not by the valve wheel. This reduces the chance of the valve wheel opening and spraying ammonia. Remember the valve wheel and fitting are designed to be closed by hand pressure only. Don't use a wrench - it can damage the fitting.

If you are using a compressor to transfer ammonia, follow recommended instructions in your operator's manual. Maintain a vapor pressure 5 to 10 pounds lower in the tank being filled to keep a forward flow.

Do not overfill the nurse or applicator tank. Keep check on the liquid level by opening the 85 percent fill bleeder valve. A white fog will appear when it reaches this level. As a part of the normal loading procedure, check the liquid level float gauge accuracy by comparing it with the fixed liquid level gauge. It is important to fill only to 85 percent or less of the total liquid capacity of the tank. As the outside temperature increases, the temperature of the liquid increases and the liquid expands, causing the vapor pressure in the tank to increase. If the tank is overfilled and no vapor space is available, the safety relief valve might fail, causing the tank to rupture or explode.

After the filling operation is complete, secure the hose in the storage position for transit. Take a final walk around the nurse or applicator tank to confirm that all steps have been taken.

### **Prevention and precautions**

**Work upwind!** Work upwind of machinery, the hose-end valve, bleeder valve, coupler or plugged applicator tubes. This gives an advantage of getting away quickly if anhydrous ammonia is suddenly released. Plan an escape route. Know which way to run.

**Handle valves with care!** Grasp valves by the valve body or the coupling, not by the valve handle. The valve handle might accidentally turn and open. If you throw a hose with an end valve over the tank, it might open when it hits the tank and spin open the rest of the way. All tanks are fitted with excess flow valves that operate automatically when a hose ruptures. A carelessly handled valve that is partially opened may not provide adequate flow to activate the excess flow valve and the entire tank of ammonia could escape. Attach the end coupling to the dummy fitting provided when transporting or not using the hose.

**Respect pressure!** You must release pressure from the coupler using a bleeder valve before disconnecting the coupler. Bleed the pressure off slowly and then disconnect the coupler immediately. On a warm day, leaving a coupler connected for five to 10 minutes after bleeding allows ammonia in the hose to rebuild pressure. On cold days, rubber seals are stiff and may not seal completely. The resulting leak might spray anhydrous ammonia vapors as the tank valve is opened. It also may create a cloud of vapor, limiting access to the equipment for reclosing the valve.

**Check your safety water tank!** Check this water supply (at least 5 gallons) daily. It may freeze in cold weather or become too hot to safely flush eyes on warm sunny days.

**Change the water weekly.** It might absorb ammonia from the air and become contaminated. Carrying a water supply on both tank and tractor gives extra protection.

**Check applicator tubes!** When removing dirt from a plugged applicator tube, treat it as if it contains pressurized anhydrous ammonia. They often do. This could be of particular concern when you work among the knives of an anhydrous ammonia applicator. You might not be able to move fast enough to escape the pungent fumes without injury.

**Leave a message!** Co-workers should know each other's activity schedule when applying anhydrous ammonia. An overdue operator may have had an accident. An accident causing eye damage leaves the operator helpless and stranded. Check if you see operators stopped in the field for an unusual period of time when conditions are normal and equipment should be moving.

### **ROAD SAFETY**

Towing a nurse tank presents problems because anhydrous ammonia is a hazardous material. An accident with a nurse tank on the highway could result in serious injury, costly repairs and liabilities.

Nurse tanks of 3,000 gallons or less mounted for transport are considered "implements of husbandry" when they are used exclusively for agricultural purposes. Nurse tanks must have the words "anhydrous ammonia" in large green lettering and a non-flammable gas placard with the words "non-flammable" or "1005" on both sides and on each end of the tank. Applicator tanks must contain the same identification on at least the rear of the container. Motorists on the highway can easily identify an ammonia tank by these markings.

All nurse tank wagons must be securely attached to the vehicle pulling them. Use a drawbar, hitch pin, safety clip and a safety chain. Before each highway trip, check the hitch pin, safety clip and safety chain to see that they are secure.

Nurse tank wagons are designed to follow smoothly in the path of the towing vehicle. Nurse tanks can overturn or collide with another vehicle if the tank wagon swerves from side to side. Make sure your tank wagon is hooked up properly. Also make sure the wheel lug nuts are tight and the tires are in good shape and properly inflated.

When hauling a loaded nurse tank, drive at speeds of 30 mph or less. The potential for a serious accident is increased at higher speeds, because you might lack sufficient braking capacity to safely control the wagon. Hauling more than one loaded nurse tank is a violation of Missouri law.

Because farm implement tires are designed for travel at low speeds, allow sufficient time to reach your destination. When towing at 25 mph or less, display a slow-moving-vehicle sign on the wagon.

State law has additional requirements for towing a nurse tank or applicator tank at night. You must display two red reflectors, visible to the rear, at the extreme right and left projections of the trailing unit. If the brake and turn lights on the towing vehicle are obscured, you must put brake and turn lights on the nurse or applicator tank.

National Safety Council, Safe Handling of Anhydrous Ammonia, Accident Prevention Bulletin 699.41-11.

## **OTHER USES FOR ANHYDROUS AMMONIA**

In addition to its use as a nitrogen fertilizer, anhydrous ammonia has other purposes on the farm. It has been used with high-moisture grains to control mold growth. When using it with grain, use the same precautions that you use when applying it as fertilizer. The same hazards exist whenever you handle ammonia under pressure.

Anhydrous ammonia also is used to add non-protein nitrogen to corn silage. The ammonia is under pressure up to the cooling reactor in this application. Wear a face shield or goggles and rubber gloves along with heavy-duty clothing, including long-sleeved shirts, when connecting and disconnecting the ammonia hose and fitting.

## **SUMMARY**

Anhydrous ammonia is perhaps the most dangerous chemical on the farm. It can be handled safely when you follow proper procedures. Make sure you wear personal protective equipment and provide plenty of clean water for first aid. Keep the equipment in good condition and observe proper procedures when transferring ammonia. When transporting ammonia on the highway, travel at a safe speed and use a safety chain and a safety clip on the hitch pin. By following recommended procedures, you can reduce the chance of an accident.

## **REFERENCES**

The Fertilizer Institute, External Visual Inspection Guidelines for Anhydrous Ammonia Nurse Tanks and Applicator Tanks, 1982.

American National Standards Institute, Inc., Safety Requirements for the Storage and Handling of Anhydrous Ammonia, Publication K61.1-1981.

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