



# Direct Seeding

## Anhydrous Ammonia Use at Seeding

Many farmers are interested in adding an anhydrous ammonia application system to their one-pass direct seeding planter systems. This is a practical option if a suitable ground opener can be found that ensures separation of the anhydrous ammonia ( $\text{NH}_3$ ) from the seed row and also seals the soil surface to prevent escape of  $\text{NH}_3$ . However,  $\text{NH}_3$  requires careful handling to ensure personal safety.

### Why Anhydrous Ammonia?

Several characteristics make  $\text{NH}_3$  a practical choice for many direct seeding farmers:

- **Effectiveness as nitrogen fertilizer source:** Most research shows that nitrogen supplied as  $\text{NH}_3$  is used by crops as effectively as nitrogen from any other source.
- **Cost:** At some locations and in some years,  $\text{NH}_3$  may offer a price advantage over other forms of nitrogen. The cost of handling and trucking  $\text{NH}_3$  is included in the price per tonne.
- **Field capacity:** The field capacity (acres per hour) of a direct planting system depends on how often the planter must stop to refill with seed and fertilizer. The combination of an air seeder, for seed and granular fertilizer other than nitrogen, and an  $\text{NH}_3$  tank, for nitrogen, allows the greatest number of acres between fills.  $\text{NH}_3$  is 82 per cent nitrogen, and this high concentration (expressed as 82-0-0) allows 1.78 times more acres to be planted per tonne of fertilizer as compared to urea which is only 46 per cent nitrogen (46-0-0). A sample calculation is shown below.

- **Storage and trucking:**  $\text{NH}_3$  is delivered to the field by the fertilizer dealer, saving both storage and trucking for the farmer.

#### Sample calculation of field capacity comparison of nitrogen in dry granular form versus $\text{NH}_3$

A dual-tank air cart with a 90-bushel tank applying seed and a 140-bushel tank applying 34-17-0 fertilizer at 60 pounds/acre of nitrogen is limited to 40 acres between fills. The 90-bushel tank of barley seeding at 85 pounds/acre would cover 53 acres. However, by adding a 1750-gallon  $\text{NH}_3$  tank, the nitrogen source covers 120 acres between fills, and the field capacity limit is now the barley seed from the 140-bushel tank covering 100 acres. (Phosphate fertilizer ( $\text{P}_2\text{O}_5$ ) is being applied through the 90-bushel tank, but is not the limiting factor.)

### How Does $\text{NH}_3$ Work?

At normal temperatures and pressures,  $\text{NH}_3$  is a gas. For agricultural use,  $\text{NH}_3$  is stored in its liquid form in a pressure tank at about 100 pounds per square inch gauge pressure (psig) at 20°C. As the temperature rises, the pressure needed to keep it liquid also rises. When it is not under pressure, the boiling point of  $\text{NH}_3$  is -34°C, very similar to that of propane. At or below -34°C,  $\text{NH}_3$  is a liquid even without pressure.

The pressure in the tank causes the liquid  $\text{NH}_3$  to flow through the open valve to the metering system. It goes through the meter and distribution system to the outlet in the ground opener and into the soil.



As the  $\text{NH}_3$  is released from the tank into the distribution system, the sudden drop in pressure from about 100 psig to about 0 psig causes rapid boiling of the  $\text{NH}_3$  (that is, changing from a liquid to a vapour) because its temperature is much higher than  $-34^\circ\text{C}$ . The rapid boiling converts the  $\text{NH}_3$  into a mixture of gas bubbles and liquid drops flowing rapidly through the system.

Vaporization of  $\text{NH}_3$  requires energy. Therefore vaporizing  $\text{NH}_3$  takes heat from the surrounding air, the equipment handling the liquid or the liquid  $\text{NH}_3$  itself. The cold lines and valves become covered with frost from water vapour in the air. The rapid absorption of heat can be a safety problem (see “ $\text{NH}_3$  Safety Issues” on page 4).

$\text{NH}_3$  vapour is lighter than air so it rises. The vapour is colourless. The white “puffing” which results when  $\text{NH}_3$  escapes is water vapour condensed from the air by the cooling effect of the liquid  $\text{NH}_3$  as it boils.

In some systems,  $\text{NH}_3$  goes through a cold flow converter between the meter and the distribution system. In the cold flow converter, there is a swirling mass of vaporizing  $\text{NH}_3$ . The vaporizing  $\text{NH}_3$  draws heat from the surrounding liquid  $\text{NH}_3$ . By the time about 15 per cent of the  $\text{NH}_3$  vaporizes, the rest of the  $\text{NH}_3$  is cooled to its liquid temperature ( $-34^\circ\text{C}$ ) at 0 psig. After the liquid  $\text{NH}_3$  has been injected into the soil, it gradually vaporizes.

Once in the soil, the  $\text{NH}_3$  finds another hydrogen ion ( $\text{H}^+$ ) on a water molecule or in the soil organic matter and becomes  $\text{NH}_4$  (ammonium). The crop can take up  $\text{NH}_4$  directly through its roots. Some  $\text{NH}_4$  is consumed by micro-organisms and released as  $\text{NO}_3$  (nitrate), which is also used directly by the crop.

## **$\text{NH}_3$ System and Planter Combination**

A direct seeder with  $\text{NH}_3$  is simply a combination of two machines on one chassis. An air seeder



**Anhydrous ammonia application in a one-pass seeding system**

handles the seed and certain fertilizer types, and the added  $\text{NH}_3$  system handles that. However, some extra parts or features should be added or considered when an  $\text{NH}_3$  system is added to a planter.

### **Safety couplers**

If the  $\text{NH}_3$  tank is pulled behind the air tank of an air seeder, the main delivery hose must have safety break-away couplers at both the rear of the air tank and the rear of the seed drill. Safety chains must also be in place to prevent the loss of control in the event of hitch pin loss.

### **$\text{NH}_3$ application rate controllers**

Because of the danger of seed damage by  $\text{NH}_3$ , it is advisable to use an  $\text{NH}_3$  rate controller rather than a fixed orifice meter. A controller is better able to ensure that the correct rate of  $\text{NH}_3$  is being applied. Without a controller, there is a danger of overapplication of  $\text{NH}_3$ , particularly if the meter is not adjusted to compensate as the day warms up. Overapplication is especially dangerous when the seed bed is dry and when  $\text{NH}_3$  is applied through a double shoot opener.

Several models of  $\text{NH}_3$  controllers are available: Dickey John, Raven, Micro-Trak, Field Electronics. The Dickey John, Raven and two models of Micro-Trak have been evaluated and the results are reported in *Testing of  $\text{NH}_3$*



*Controllers* (Alberta Farm Machinery Research Centre/Prairie Agricultural Machinery Institute Evaluation Report 723).

To accurately measure the flow of  $\text{NH}_3$ , most controllers use a heat exchanger to cool the  $\text{NH}_3$  below  $-34^\circ\text{C}$  so that it remains as a liquid. Similar to a cold flow converter, there is not much pressure left after the heat exchanger, flow meter and control valve. Therefore, the distribution lines to the shank must be arranged to ensure uniform flow under gravity. There should be no sags in the lines, particularly after the final distributor. If there are low points in a line, the cold liquid accumulates there until the line fills, and then the pressure builds enough to force the full line to empty. This results in overapplication for some distance along the seed row, causing poor or no crop emergence for several feet of that row.

Controllers need to be calibrated for ground speed and for flow through the meter. All monitors come with instructions for calibration and for setting up the control unit for the desired application. Properly calibrated controllers keep the application rate within 2 to 3 kg/acre (5 pounds/acre) for application rates of 20 to 75 kg/acre (40 to 160 pounds/acre). Controllers account for changes in daily temperature and changes in travel speed.

Application rate controllers can change the application rate on the go if the need for more or less nitrogen in certain areas of the field is known. Recent controller designs have a computer communication port so that a computer, with the necessary program information and real-time global positioning, can set the  $\text{NH}_3$  meter to a preplanned nitrogen rate for each area of the field.

### **Additional hardware**

The addition of  $\text{NH}_3$  to a direct planter results in many more hoses, fittings, manifolds and so on. These have to be carefully arranged, so the wings of the planter lift without causing kinking or pinching of the lines.

Cooling by  $\text{NH}_3$  causes frost to form on the lines. The frost collects dirt that falls from the lines as mud. The mud usually falls on the operator who is performing other maintenance. Therefore, items such as pressure gauges and rate controllers should be positioned to allow easy access for maintenance and adjustment.

### **Ground openers**

The ground opener is the part of the planter most affected by the use of  $\text{NH}_3$ . Two concerns must be addressed: soil freezing on the openers and  $\text{NH}_3$  escaping from the band.

**Soil freezing on the opener:** The cooling effect of  $\text{NH}_3$  can cause moist soil to freeze on the opener. The accumulation of soil causes a wider furrow and reduces the flow of soil back over the seed row. This problem is aggravated by cold soil, high  $\text{NH}_3$  application rates and wet soil.

Some possible solutions to this problem are as follows:

- Modify the opener to isolate the  $\text{NH}_3$  line from the metal parts of the opener.
- Do not use metal tubing for the  $\text{NH}_3$ . Use the same plastic as that used for the distribution lines.
- Ensure the outlet point of the  $\text{NH}_3$  tube is below the metal parts of the ground opener.
- Try 1/4-inch diameter  $\text{NH}_3$  lines (rather than 3/8-inch lines) to reduce the cooling effect of the  $\text{NH}_3$ .

**$\text{NH}_3$  escaping from the band:** If  $\text{NH}_3$  escapes from the band, it could damage the germinating seed or be lost to the atmosphere. The seed row and the  $\text{NH}_3$  zone should be at least 25 mm (1 inch) apart. Use an  $\text{NH}_3$  detection kit to check the performance of the ground opener.

Several factors can result in  $\text{NH}_3$  escaping from the band. The soil may be lumpy, leaving open spaces between the  $\text{NH}_3$  band and the seed row or the soil surface. Not enough soil may be flowing back over the  $\text{NH}_3$  band because the soil is too wet, the equipment is moving too fast, the



soil is freezing on the opener, or distribution problems are causing temporarily higher rates of  $\text{NH}_3$ .

Some possible solutions to this problem are as follows:

- Try the solutions given above for soil freezing on the opener if soil freezing appears to be causing the problem.
- Use seed-row-covering harrows or packer wheels behind the opener to ensure soil is replaced on the seed row.
- Try increasing the packing pressure.
- Try changing the travel speed (try going slower, in most cases), changing the opener depth or modifying the opener to increase the flow of soil back over the band.
- Check for  $\text{NH}_3$  distribution problems such as sags in the lines in cold flow systems. Cold liquid accumulates in the sags until it is forced out suddenly at a high rate.
- Find a drier field to plant if this one is too wet and nothing else works.

### Soil compaction in wheel tracks

$\text{NH}_3$  supply wagons are generally pulled behind the planter, so the wagon tires run on the soil above the planted seed. If the pressure on the ground is too great, the soil will be too dense for the seedling to push through. Crop emergence damage will be most noticeable in wet soils and clayey soils.

The first solution to this problem is to reduce the tire air pressure to the minimum required to carry the fully loaded wagon. In most cases, this level is considerably below the pressure recommended on the sidewall of the tire. See *Solving the Wheel Track Dilemma in Direct Seeding* (Agdex 519-12) for more information. Some attempts have been made to change the wheel tread width, so the wagon tires do not run in the same line as the tractor or air seeder tank.

### Other application issues

- Check that seeds are staying in the seed band, and not falling into the fertilizer band.

- Maintain and adjust  $\text{NH}_3$  equipment properly. Poor equipment or improper adjustment may reduce the effectiveness of applications.
- $\text{NH}_3$  may be corrosive to metallic parts containing copper, zinc or silver (anything described as brass or bronze).
- A cellular telephone is very useful for coordinating  $\text{NH}_3$  refill schedules. Delays in delivery of  $\text{NH}_3$  could prove costly to the planting operation.

## $\text{NH}_3$ Safety Issues

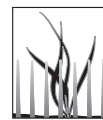
$\text{NH}_3$  is a hazardous substance. Personal contact with  $\text{NH}_3$  is dangerous at any concentration.

### Safety protection and first aid

- **ALWAYS wear safety apparel including eye protection when working on or around  $\text{NH}_3$  equipment.** The eyes are the part of the body most sensitive to  $\text{NH}_3$  damage. Eyes have few blood vessels for cooling and very little water, and they do not grow new tissue readily.
- You can smell  $\text{NH}_3$  at a concentration of 50 parts per million (ppm). It has sharp, pungent odour. It is safe up to 100 ppm for several hours. At 400 ppm, the eyes are irritated and exposure should be avoided.
- Contact with liquid  $\text{NH}_3$  is the most common accident. The liquid causes a caustic burn from its chemical makeup and a freeze burn as it absorbs water from the skin (the word “anhydrous” means it seeks water).
- Flooding the exposed parts with water is the most immediate need and, in fact, the only first aid needed until full medical attention is received.
- If liquid is spilled, do not remove clothing until flooded with water. The frozen cloth may tear away the flesh.

### Safe operation of $\text{NH}_3$ systems

- Ensure the  $\text{NH}_3$  system is correctly designed, assembled and **regularly maintained**.
- Always use a pressure tank tested to 250 psig to hold  $\text{NH}_3$ , not an LPG tank!



- Turn the equipment and stay upwind if a leak occurs.
- Any coupling between air drills, air tanks and the nurse tank needs to be protected by safety chains, locking draw pins and safety break-away fittings.
- Do not bend hoses, tighten fittings or separate connectors when under pressure.
- Drain all hoses and lines, including the line at the ground opener, before working on any part of the NH<sub>3</sub> system. Make sure they are **empty**. If a plugged NH<sub>3</sub> line is removed from the opener, it can spit out liquid NH<sub>3</sub>.
- Know the correct sequence to open and close valves to purge the system of NH<sub>3</sub>. Rate controllers have special purge controls.
- Remember that NH<sub>3</sub> vapour is combustible if it is 16 to 25 per cent by volume in air and has an ignition source.
- Take a course — and include your helpers — on safe handling of NH<sub>3</sub>.

*Prepared by Murray Green, Alberta Agriculture, Food and Rural Development*

*Factsheets in the Direct Seeding Series are also available through Alberta Agriculture's Internet site at <http://www.agric.gov.ab.ca/agdex/500/index.html>.*