Agricultural Marketing Policy Center

B R I E F I N G

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The Production of Ammonium Nitrate and Nitrogen Solutions (UAN)

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Objective Analysis For Informed Decision Making

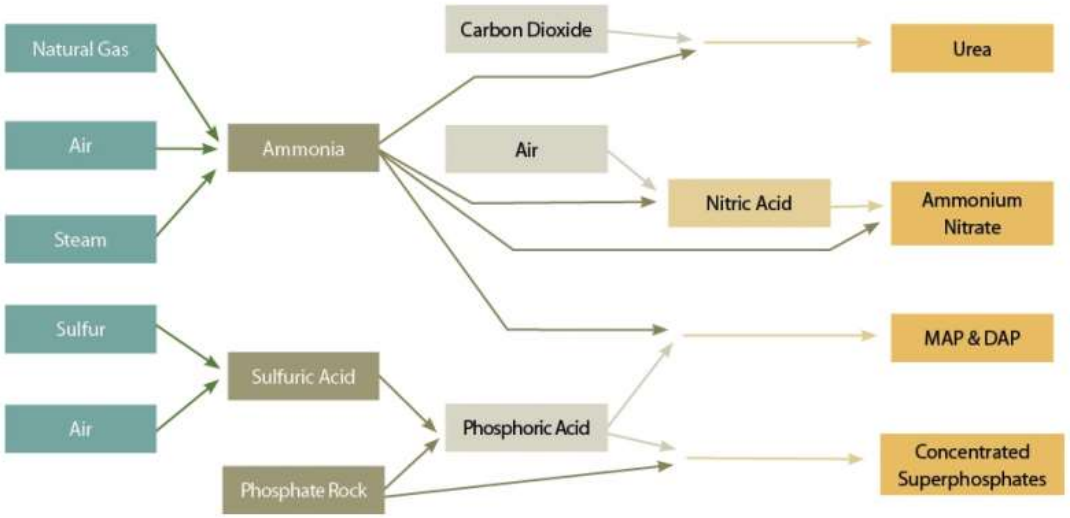
Introduction

Most agricultural fertilizers contain three basic plant nutrients — nitrogen, phosphorus, and potassium — as well as small amounts of certain "micronutrients," such as zinc, sulfur and other metals necessary for plant growth. Nitrogen is necessary for the formation of plant proteins and is the most widely used of the three nutrients. Although nitrogen is present in soil and air, it is generally unavailable to plants in its raw form. Thus, manufacturers convert atmospheric nitrogen into usable forms to enhance crop production. The commercial conversion process involves ammonia production (Briefing Paper 108). This briefing paper describes the processes used to produce ammonium nitrate and nitrogen solutions (also known as UAN), which is the most commonly used fertilizer end product in the United States (11,399,279 material tons in 2011).

Ammonium Nitrate Production

For economic efficiency reasons, ammonium nitrate and nitrogen solutions are manufactured in an integrated production process in which numerous fertilizer outputs are produced from ammonia. Figure 1 shows the numerous fertilizer end products derived from combinations of ammonia and phosphate, including ammonium nitrate and nitrogen solutions.

Figure 1: Process Flow Diagram for Fertilizer Production



Source: Fertilizer 101

Ammonium nitrate is manufactured in a three step process: the production of nitric acid, reacting nitric acid and ammonia to produce liquid ammonium nitrate, and storing products for further processing or direct use.

Step 1: Nitric acid production

Ammonia oxidation is the process by which ammonia is mixed with air in a reacting tank that contains a catalyst to encourage the conversion of ammonia into nitric oxide. Nitric oxide is then combined with water and steam at elevated temperatures and pressure to produce nitric acid. The oxidation and conversion can occur using a single pressure vessel technology or using dual pressure vessels, which require two different reactor tanks operating at different pressures.

Step 2: Liquid ammonium nitrate production

Nitric acid and liquid ammonia are then mixed in a tank that promotes water evaporation. This process causes a neutralized reaction between the two components and produces a liquid form of ammonium nitrate. An estimated 65 percent of global nitric acid production is used to make ammonium nitrate, and much of the remainder is used in the production of phosphorous-based fertilizers.

Step 3: Storage for further processing or use

Liquid ammonium nitrate can be stored until it is sold, blended to make other products, or further processed into a solid granulated or prilled form.

Ammonium Nitrate in the Marketplace

Ammonium Nitrate in the Marketplace

Ammonium nitrate is typically processed into granular or prill forms (Figure 2) or blended to make nitrogen solutions. While the general granulation and prilling process is similar to that of urea productions (described in detail in Briefing Paper 112), there are several key additional aspects. Liquid ammonium nitrate solutions are partially hardened to form a melt and, during this process, additives are mixed into the melt to stabilize prills or granules against temperature fluctuations. Additional identifying additives are incorporated into the melt for regulatory reasons in response to the 1995 Oklahoma City Bombings (see Briefing Paper 107).

Figure 2: Picture of Ammonium Nitrate Granules

Liquid Nitrogen Solutions (UAN) Production

Nitrogen solutions (UAN) are produced by blending ammonium nitrate, liquid urea, and water. Some facilities use pre-processed solid forms of urea and ammonium nitrate and combine them in a blending container with water to form nitrogen solutions. Other plants use recycled and stripped liquid ammonia, nitric acid, and carbon dioxide, which are all by-products of other production processes. This recycling method is more common, however, because fertilizer plants can capitalize on cost savings that result from integrating UAN production into the overall fertilizer manufacturing process.

When UAN is produced in an integrated, multiproduct plant, recycled and stripped carbon dioxide, ammonia, and nitric acid by-products are linked within the UAN manufacturing process to obtain ammonium and urea solutions. These solutions are then mixed in a synthesizer to form liquid UAN, which can be combined with other products such as herbicides. The liquid mixture is then stored in tanks, which is less costly than storing solid urea or solid ammonium nitrate.

UAN Products

UAN solutions usually contain either 28 or 32 percent nitrogen and typically consist of 45 percent ammonium nitrate, 35 percent urea, and 20 percent water. The end product is a clear liquid fertilizer that is often injected into drip or spray irrigation systems in a process known as fertigation. UAN is most often applied during seeding.

UAN has some important chemical and application cost advantages over other forms of nitrogen fertilizer. First, UAN "salts out" (i.e., decomposes in such a way that important proteins are lost) at lower temperatures than urea and ammonia nitrate solutions (both of which will decompose when the ambient temperature falls below freezing). Second, high air temperatures can also reduce the quality of fertilizers and UAN is able to withstand higher air temperatures. Third, the combined solubility of ammonium nitrate and urea are similar to the nitrogen content of ammonium nitrate (which was widely used prior to the mid-1990s), which had a 33.5 percent nitrogen content. Given the increased safety concerns and mandated security regulations surrounding ammonium nitrate, many suppliers have exited the ammonium nitrate market (see Briefing Paper 107). UAN provides farmers with a safe and viable alternative without sacrificing agronomic properties, making the product more attractive than urea in areas with short growing seasons.

Summary

Ammonium nitrate is produced in a three step process that combines nitric acid with liquid ammonia. Nitrogen solution products (UAN) are typically produced using recycled by-products from ammonia production including liquid ammonia, nitric acid, and carbon dioxide. These compounds are then further processed to create ammonium nitrate and urea, which are combined to produce UAN. Most often, the production processes for ammonium nitrate and nitrogen solutions are integrated in a production plant where the primary component being produced is ammonia. These processes convert nitrogen into forms that can effectively deliver required nutrients to crops.

Reference:

The Fertilizer Institute. "Fertilizer 101". Washington D.C. 2004