Specific Gravity and pH Variability Affect UAN Blending

Prudence needed to produce viable end product.

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Summary: *In the past, UAN composition was fairly uniform and unanticipated blending issues were relatively infrequent. That has changed however. Variations from load to load and supplier to supplier are more common. Variations in pH and specific gravity (density) can wreak havoc on your UAN blending processes. There are different reasons for the variations in UAN composition, so it is prudent to be aware of what you are dealing with if your goal is a viable end product.*

Most nitrogen (N) fertilizer production begins with the reformation of natural gas to produce hydrogen, which is then used for ammonia production. As a result, natural gas constitutes about 70 percent of the cost of ammonia production. Ammonia is then used to produce various N-containing fertilizer products and intermediates such as:

- Urea
- Ammonium nitrate
- Ammonium sulfate
- Ammonium phosphate
- Urea-ammonium nitrate solution.

This makes natural gas one of the raw, precursor molecules for all N materials, including both liquid and dry N fertilizers.

This discussion will address the liquid urea-ammonium nitrate (UAN) combinations that have seen substantial increases in demand.

Since 1980s

What has occurred since the 1980s is that UAN has continued to increase in total U.S. market share (Figure 1) while domestic natural gas prices have increased in cyclical swings, which at times significantly increased the cost of all N-related materials, including UAN (Figure 2). These cyclical increases in price volatility were further compounded by extremely low-cost natural gas in many other parts of the global economy. As a result, over the past 30 years many of the major N producers acquired smaller companies and, owing to higher natural gas costs, then closed or moth-balled the smaller, less efficient production facilities. This significantly decreased North American N production. Because of this, imported N materials have continued to increase and today are well over 50 percent of U.S. N consumption. With major natural gas reserves being identified across the northern U.S. in recent years, natural gas prices have fallen low enough to start discussions on the building of new N facilities in North America.

Ratio variations

With the loss of production and production personnel due to retirement and an increased volume of solutions being imported from the international market, we are seeing observable variations in the ratios of urea to ammonium nitrate. It is fairly common for imported UAN to be of higher analysis than 32 percent and sometimes lower. It is sometimes being cut with water, but this may not always be a refined process and, as a result, there are often observable variations in pH and specific gravity by the time the product reaches the dealer. In some cases, the addition of anhydrous ammonia is used to meet grade or possibly as a corrosion inhibitor. The problem that is created by the addition of free ammonia to meet total N grade or for corrosion inhibition is that there are observable broad ranges of UAN pH in the market. These variations in free ammonia and pH can significantly affect UAN compatibility with common-mix partners.

Blending

One major fluid fertilizer product mixed with UAN is ammonium polyphosphate (APP) as either 10-34-0 or 11-37-0. The blending of these two components tends to be done in the early to mid-part of the growing season. It has been observed over the last decade that there are sometimes causes of precipitate formation when these two materials are co-mingled in several typical fertilizer blends. In many cases where the individual components of UAN and APP could be individually tested, it has been found that the pH of UAN is higher than typical MSDS data sheets indicate. During this time, the UAN that has been tested has been found to have a pH in the 6.8 to 9.2 range. Figure 3 presents the relationship of the free ammonia content to the pH of UAN products.

In addition, there is a relatively broad range of specific urea to ammonium nitrate formulations that can be used in making UAN solution--and variations do occur, depending upon the specific producer and the time of year. While the production of a specific analysis of UAN may include a range of specific urea:ammonium nitrate ratios (Figure 4), the products that UAN may be blended with often do not allow for such significant ranges in the proportion of urea to ammonium nitrate or pH. This is not only true of mixing with ammonium polyphosphates but with other secondary and micronutrients as well.

Two tests

It is recommended that when receiving UAN, two tests should be used to determine potential formulation issues with UAN,

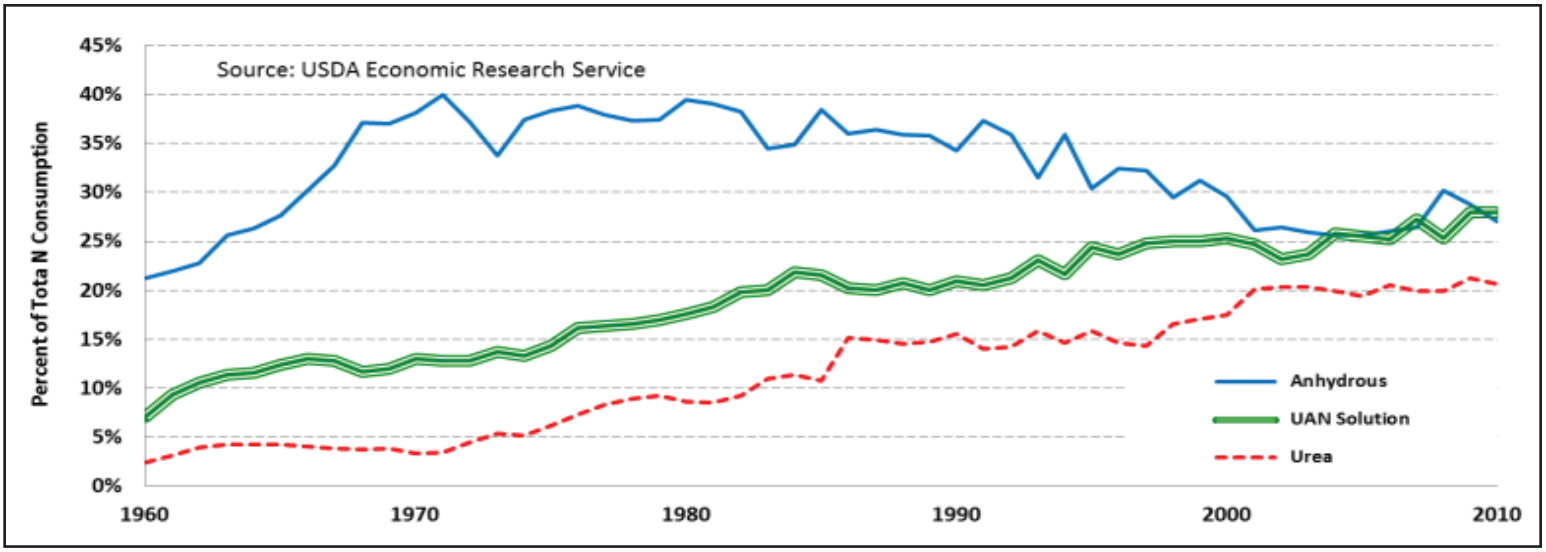

Figure 1. *U.S. Nitrogen Product Market Share, 1960-2010.*

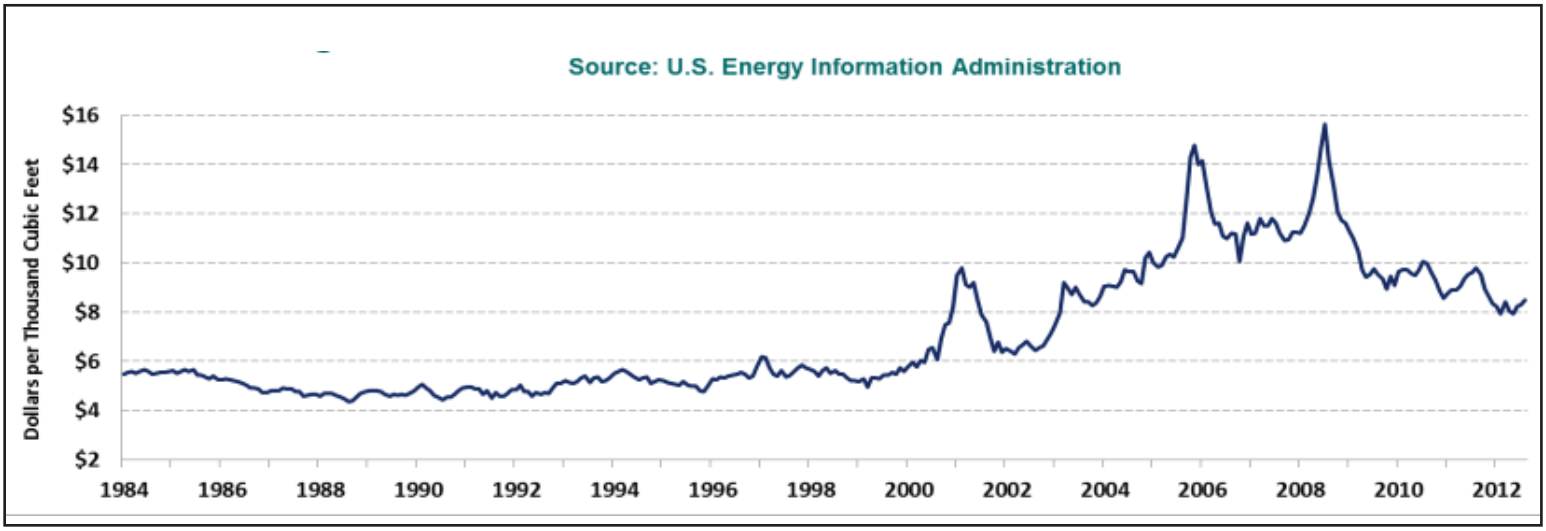

Figure 2. *U.S. Price of Natural Gas Sold to Commercial Consumers.*

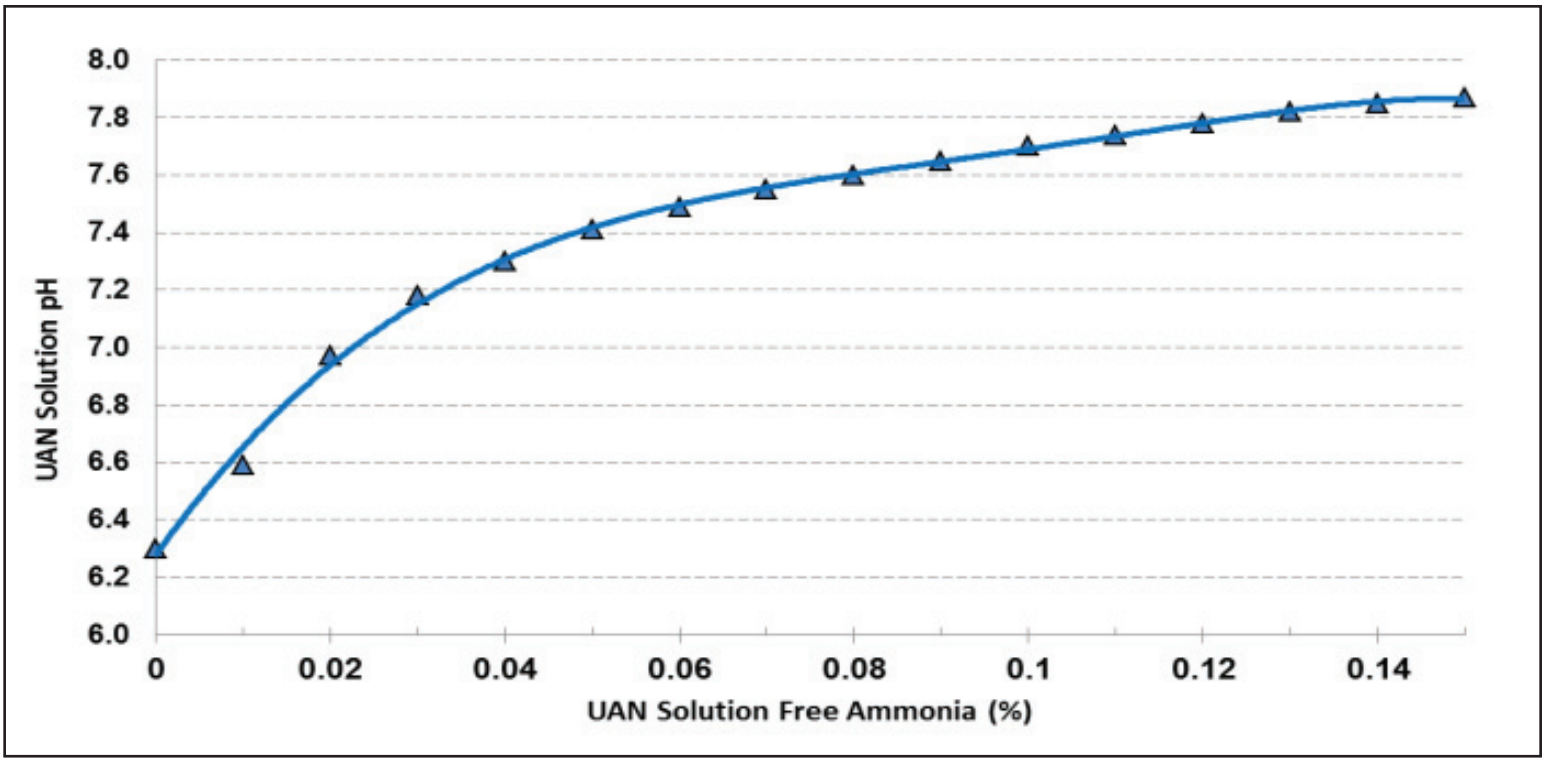

Figure 3. *Free Ammonia Effect On UAN Solution pH.*

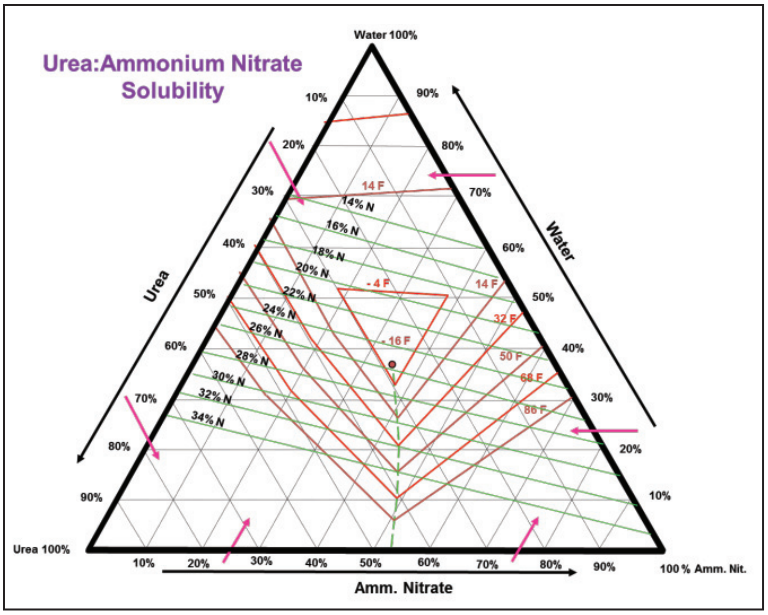

Figure 4. *Urea:Ammonium Nitrate Solubility.*

Figure 5. *UAN (32-0-0) & APP Compatibility Issue, spring 2012.*

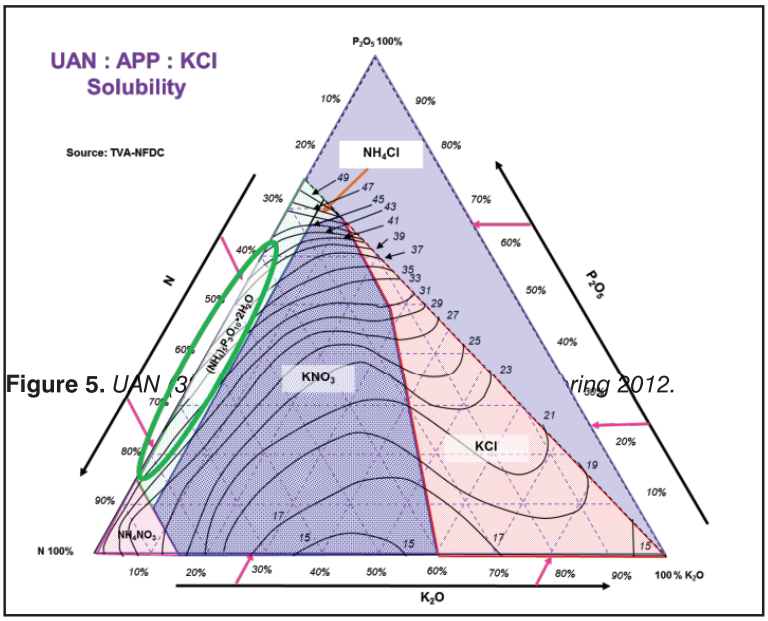

Figure 6. *UAN : APP : KCL Solubility Diagram.*

especially in late-winter to early-spring when product temperatures may be very cold:

- The first is the use of a hydrometer to check specific gravity (estimates N content)
- The second is testing the pH with a properly calibrated pH meter.

This important information allows the user to be aware of composition variations in advance so that adjustment can be made when co-mingling with other products.

Clogging

Figure 5 presents a picture of a tank manway from the spring of 2012 that was opened within a few hours of blending UAN and ammonium polyphosphate. As is seen in the picture, these two products solidified quickly and the resulting precipitates were not flowable enough to be pumped out of the tank. This situation tends to happen most often at the first to mid-part of the planting season when dealers are receiving loads of cold product that are not being mixed with warmer product in storage before being blended for field application. One recommendation is to have enough individual product volumes to be laid into storage prior to the early part of the season to dampen slight pH and specific gravity variations.

Familiarize yourself

While some variability in the specific formulation of UAN has been around since the initial development of the UAN industry, the increased reliance on imported product has exacerbated this variability and subsequent compatibility issues. It seems to occur more often with unseasoned personnel or when not enough volume is in the storage tanks to minimize ratio variations and/or free ammonia and product are shipped out immediately. In the past, some manufacturers of UAN have, in fact, had UAN summer blends and UAN winter blends, seasonally altering the ratios of urea to ammonium nitrate. When one thinks about that, the product is relative to the location of the facility involved, whether it is located in a northern climate or a southern one. Take time to familiarize yourself with the product you are receiving.

Solubility

Another factor affecting UAN-APP compatibility is simply the overall solubility when UAN and APP are directly blended together (no additional water), especially during times of the year when product and air temperatures are cold. While UAN and APP are generally thought of as completely compatible, the solubility of the UAN-APP system is drastically affected by the ratio of UAN to APP in the blend. Figure 6 presents the UAN-APP-KCl solubility diagram developed by the National Fertilizer Development Center (NFDC-TVA) during the early years of the fluid industry. The portion of the graph circled in green (left side of triangular diagram) illustrates that total nutrient solubility (N + P_2O_5 + K_2O) decreases drastically as the proportion of UAN increases in UAN-APP mixes while the potential for precipitation formation increases (forming less soluble ammonium tri-polyphosphates). This problem rarely occurs when 28 percent UAN is used for these mixes rather than 32 percent UAN and occurs more frequently for 11-37-0 APP than for 10-34-0 APP. Previously discussed variations in UAN product analysis, pH and urea:ammonium nitrate ratio makeup further increase the potential for unanticipated compatibility issues.

Finally...

The information provided herein is not to assign blame or liability. It is simply educational in order that dealers and wholesales better understand the problematic issues that can occur with even the simplest blending of UAN and ammonium polyphosphates.

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