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Storage and Handling Characteristics Of Ammonium Polyphosphate Solution

Ammonium polyphosphate solution (APP, 10-34-0, 11-37-0) is the most common liquid P fertilizer material in the U.S. today. While 10-34-0 is the most common grade of APP solution, 11-37-0 is also found in some markets. While the following comments reference 10-34-0, most comments are applicable to 11-37-0 as well. The only real differences will be density, salt-out temperature and water content. While APP solution can commonly be found throughout the fertilizer industry, proper storage and handling techniques are not always followed at the retail level. As a result, it is far too common to hear of storage problems associated with APP solution. Grayish-brown and white precipitates at the bottom of the tank, cottage cheese-like particles floating in the product and slimy, stringy masses throughout the product are all evidence of storage problems associated with APP solution and/or other grades made with APP solution.

Most of the APP solution produced today is made by the pipe reactor process. In this process, wet-process superphosphoric acid and anhydrous ammonia are reacted in a "pipe" to produce a melt that has a temperature of 600° F to 700° F and a polyphosphate content of 70% to 75%. After the initial reaction in the pipe, the melt must be rapidly cooled, diluted with water, and further neutralized with ammonia to maintain the high polyphosphate content and resultant high quality. At the time of manufacturing, the APP solution should have the following properties (approximate, may vary):

	Characteristic	10-34-0	11-37-0
1.	pH (depending on acid source)	5.8-6.2	5.8-6.2
2.	Density	11.65 lb/gal	11.9 lb/gal
3.	% N by weight	10.0%	11%
4.	% P_2O_5 by weight	34.0%	37%
5.	N: P_2O_5 ratio	.294	.297
6.	Polyphosphate content	65%-75%	65%-75%
7.	Salt-out, F°	0°	32°

Since APP solution is made from wet-process phosphoric acid, it contains varying amounts of impurities such as iron, magnesium, calcium, aluminum, fluorine, carbon, etc. The amounts of specific impurities and the ratio of one impurity to another can impart different characteristics on the final APP solution products. For example, impurities such as carbon and certain metals affect the color and/or clarity of the final product. But, the clarity or color of the product has no bearing on the quality of the APP solution.

Other impurities, magnesium for example, in time will result in precipitate formation that can cause problems. Polyphosphates are an important property of APP solution since they not only increase the solubility of the ammonium phosphate salts, but also sequester (dissolve) metallic impurities in the product and lengthen the shelf life of the APP solution. Once polyphosphates are "built" in the pipe reactor process, they begin to hydrolyze (break down) when the product is stored. At some point, there will not be enough polyphosphate present to sequester all the impurities present in the product.

There are several factors which influence the effectiveness of the polyphosphate in reducing precipitate formation:

1. The amount of polyphosphate initially present.
2. The amount of impurities present in the acid.
3. Storage temperature of the product.
4. Storage pH of the product.
5. Length of time product is stored.
6. Other "impurities" added to product (sludge, zinc, etc.)

The product pH, polyphosphate content, and impurities present in the acid have a major bearing on the overall quality of the product and are only controllable by the producer of the product. However, there are several factors that should be managed by the users of the product that affect the quality of APP solution in storage. Over time, polyphosphates hydrolyze (split apart) and the ability of the product to sequester impurities decreased. As a very crude guideline, the polyphosphate level of on-grade APP solution will decrease about 1% per month at product temperatures of less than 90°. At temperatures above 90°, the rate of polyphosphate breakdown rapidly increases. These factors point out the importance of not storing APP solution any longer than necessary, especially at warm temperatures.

The amount of impurities in the APP solution is influenced by the amounts in the acid it is produced from, but can be increased at the storage site. Even under normal conditions and good initial product quality, precipitates form in APP solution during extended storage resulting in varying amounts of sludge formation at the bottom of the tank. If this sludge is not removed prior to refilling the tank, the impurity level of the new product is increased- and can have adverse effects on the storage properties of otherwise good quality product. Adding micronutrients to APP solution, such as zinc, may also decrease the shelf life of the product since zinc is really nothing more than an "impurity" once it is in the product.

A final point is that there are other unpredictable factors which can cause problems with storage of APP solution (and products made from APP). Interactions between the types and amounts of impurities, the specific polyphosphate fractions (pyro-, tripoly-, etc.) in the product, and other properties make it difficult to pinpoint all the potential problems or the actual shelf life of a particular product. The best that can be done is to minimize potential problems by taking care of the controllable factors. A few suggestions:

1. Don't store APP solution (or products made from APP solution) longer than necessary. It is best if the tanks are as close to empty as possible after a season.
2. Avoid storage over the summer months. Since heat speeds up the hydrolysis of polyphosphate, it is best to not store product when the temperature is high unless the product is to be used that summer.
3. Completely empty and clean the accumulated sludge from storage tanks every 2 years. Every year is better.
4. Pull a representative sample from each tank that is not empty prior to adding new product. By knowing the product pH, density, polyphosphate content, % N, % P_sO_5, % K_2O, and visually inspecting the product, potential problems can be minimized.
5. Make sure that the APP solution is not contaminated with products that may affect the physical or chemical properties of the product.