UNDERSTANDING FLUID FERTILIZERS AND THEIR POTENTIAL FIT IN AUSTRALIAN AGRICULTURE

Dr.Larry Murphy
President, Murphy Agro
Former President, Fluid Fertilizer Foundation
Manhattan, Kansas USA

Background

The use of fluid sources of nutrients in Australia dates back to the 1960s when aqua ammonia was used in sugar cane production in Queensland. In recent years, an upsurge of interest in fluid nutrient sources has expanded research and usage to include a wider range of materials, a better understanding of how they perform under Australian conditions and options for their application and use. Recognition of the characteristics and capabilities of fluid nutrient sources can aid growers in evaluating how these materials may fit in to their cropping systems, how fluid nutrients may affect nutrient use efficiency and most importantly how fluid nutrient sources may potentially affect profitably in Australian crop production systems.

Fluids in North America, primarily Canada and the USA, represent about 25 to 30 percent of the total fertilizer market, more if anhydrous ammonia is lumped into that category. That market has grown from modest beginnings in the 1950s to become a major portion of the fertilizer used in both the USA and Canada. The percentage of the market varies with world prices of fertilizers, however, and has experienced some significant variations with the recent high world prices of fertilizer. Interest in and use of fluid nutrient sources is growing in Mexico particularly in high value crops where precision application is essential. Fluids have also been available in Europe since the 1950s, their use having developed essentially in parallel with North America, Fluid nutrient sources are important in South Africa and Argentina but represent much lower percentages of the total fertilizer market.

Fluid fertilizers include liquid fertilizers and suspensions. Liquid fertilizers are homogenous solutions of dissolved fertilizers, while suspensions are mixtures of fertilizer and water, comprising some of the fertilizer in suspension.

There are good reasons for the use of large tonnages of fluid products, and those reasons, (advantages of fluids) have also caused interest in fluid products to develop in Australia.

Fluid Fertilizers in Australia

In recent years, the use of fluid fertilizers has increased in Western Australia (WA) and South Australia according to industry reports (CSBP). Researchers have reported more efficient uptake of phosphorus (P) and improved wheat yields when fluid P fertilizer was applied on calcareous soils in South Australia compared to solid P fertilizers, but similar benefits have not been as dramatic on acidic soils in WA. Consistent responses to applied liquid P and Zn have been obtained on soils of the Eyre Peninsula which contain large amounts of free calcium carbonate but differences on acidic soils in WA have not been as great..

CSIRO and University of Adelaide researchers have reported significantly different soil P reaction products between fluid and solid P sources. Further, SARDI researchers have demonstrated that more continuous distribution of fluid P and micronutrients in the seed row for cereals is an advantage which carries through to grain harvest even when the chemical source of the P or micronutrients is identical. The use of fluid fertilizers has continued to grow particularly in WA because the cost of fluid nitrogen (N) fertilizers has been only marginally higher there than solid urea. That has frequently not been the case in other states where the cost of fluid N has been higher than urea. Driving factors in adoption of fluid N fertilizers in grower operations have been attributed to convenience and flexibility of application methods and placement. However, convenience may not always translate into direct economic benefits.

Farmers have continued to increase their use of fluid fertilizers in Australia. Based on data of the Fertilizer Industry Federation of Australia, fluid fertilizers represent about 5 % of total fertilizer use, but this proportion was substantially higher in WA. The main interest in WA has been in the application of liquid N. In South Australia, the adoption of liquid fertilizers has been in response to research that has demonstrated more efficient uptake of P and improved yields of wheat from fluid P on calcareous soils.

Fluid Fertilizer Advantages

Interest in fluid fertilizers is based on a number of factors including ease of handling, adaptability to various methods of application, precision placement, uniformity of application, compatibility with agricultural chemicals and agronomic performance. Fluid fertilizer advantages can be summed up in one word - FLEXIBILITY. Certainly there are disadvantages compared to conventional dry fertilizer programs and they also must be recognized, including: product costs; availability in the market place; storage; and transport.

Adaptability of fluid fertilizers to various methods of application has been and continues to be an important factor in their adoption in both North America and Australia. Methods of fluid fertilizer application include:

- Precision placement near the seed;
- Adaptability to variable rate applications;
- Boom spray applications;
- Weed and feed applications (combinations with herbicides);
- Side dressing (for row crops);
- Fertigation (application in irrigation water);

- Foliar fertilization.

The ability to apply fluid fertilizers with precision placement at seeding is a major factor in the growth of fluids over the past few years in the Canadian Prairies and northern states in the US Great Plains.. The similarity of small grain production systems utilized by Canadian, northern US and Australian crop producers has been an important consideration in the transfer of technology and interest in the use of fluids in Australia.

Fluid Products: Nitrogen

Nitrogen solutions have been the first area of emphasis in Australia. Like the North American market, urea-ammonium nitrate (UAN) solutions containing 28-32% (weight percentage) N have provided a safe, high analysis material with wide flexibility. This combination of N sources enhances the solubility of each material and allows much higher N concentrations than either component alone. Urea solutions also have specific fits in some crop production systems requiring special considerations in application.

Phosphorus

Fluid phosphorus (P) sources in North America have evolved primarily into ammonium polyphosphate (APP) solutions over the past 40 years. These high analysis materials are predicated on the production of superphosphoric acid (nominally $H_4P_20_7$) and have certain characteristics which benefit the quality of the solutions produced with them. Common analyses of these products are 10-15-0 (elemental P, weight percentage) and 11-16-0. They mix readily with UAN and other fluid materials and can carry higher concentrations of micronutrients such as zinc (Zn) than P-containing fluids produced from orthophosphoric acid. Superphosphoric acid is a condensation product of orthophosphoric acid (H_3P0_4) commonly utilized in the production of solid P fertilizers such as monoammonium phosphate (MAP), diammonium phosphate (DAP) and triple superphosphate.

Research in South Australia (South Australian Research and Development Institute (SARDI)) and CSIRO (Land & Water) and Victoria (Victorian Department of Primary Industries (DPI)) over the past several years has indicated that fluid P sources (fluidized MAP, MAP suspensions, orthophosphoric acid and APP) have performed well on a number of soils, frequently outstripping the performance of conventional solid forms of the same compound (MAP) at the same rate of application. Interestingly, data developed by CSIRO scientists regarding the understanding of the soil chemistry and availability of fluid P sources (polyphosphates), probably the best current research on the topic world-wide, show substantial differences in soil reaction products and plant availability.

However, the only APP currently available in Australia is imported and has a substantially higher cost. Orthophosphate solutions and suspensions are currently being examined as possible fluid P sources for the Australian market. Just where developments will lead is unclear.

Potassium

Fluid sources of potassium (K) are fairly limited in both North America and Australia. Fluid sources of K include potassium chloride, potassium nitrate, potassium thiosulfate (KTS), potassium carbonate and potassium phosphates. Potassium chloride and potassium nitrate solutions are relatively low analysis and combinations with N and P fluids create analyses with low K levels. Potassium thiosulfate (KTS), potassium carbonate and potassium phosphates such as monopotassium phosphate (MKP) contain higher K concentrations but are somewhat more expensive.

Sulfur

Fluid sources of sulfur (S) are limited mainly to ammonium sulfate and ammonium thiosulfate (ATS). These compounds provide readily available sources of S and are usually supplied mixed with UAN or fluid sources of P. Ammonium thiosulfate has some special characteristics which, research has shown to have effects on slowing of urea hydrolysis and nitrification of N in UAN. Recent field trials have also shown ATS banded in contact with anhydrous ammonia can slow nitrification of that material.

Micronutrients

Micronutrient sources for fluids have the same general characteristics, high solubility in true solutions. Compounds include metal sulfates, chlorides, chelates and some sequestered formulations. Phosphorus in fertilizer solutions places some definite limits on metallic micronutrient concentrations when solution pH values are near neutrality. For instance, polyphosphate solutions such as 10-15-0 and 11-16-0, can carry about 1.8-2% Zn, while ammonium orthophosphate solutions can only carry about a tenth as much. Acidified P-containing solutions can carry higher concentrations of inorganic micronutrient sources. Chelates and sequestered metal sources decompose in acids.

Suspensions

Suspensions, saturated solutions containing solid crystals of fertilizer products suspended by clay, pose one avenue of economical fluid P materials for the Australian market. These products require special mixing equipment and very specific mixing procedures to produce a quality product that will remain suspended for long periods of time. Application equipment requirements also differ because the suspended materials are likely to clog nozzles used with true solutions. Agronomically, these materials will be orthophosphates (MAP), identical to solid fertilizers, but will be superior in the uniformity of distribution.

Suspension technology also works very well with finely divided sources of lime producing a material which spreads evenly and reacts quickly to suppress aluminum toxicity. Disadvantages are relatively low rates of application and higher costs per unit of lime. Still, where lime is needed but unavailable, fluid lime may provide an opportunity for some suppliers who have access to cheap, waste products such as lime from water softening plants or cement plant stack dust.

Fluid Logistics

Over the past 50 years in North America, a logistical system for delivery of fluid products from the point of manufacture to the point of utilization has evolved to include rail, barge, pipeline and truck transportation.

This is particularly true for UAN. UAN is transported from the point of manufacture to field storage in tanks owned by the manufacturer or local dealers: Those tanks range from a few dozen tons up to thousands of tons depending on location and accessibility to transport. It is then transported to the growers' fields or on farm storage by dealers' trucks, nurse equipment for custom application services or the growers' own trucks to nurse their own applicators.

In the Australian market, UAN distribution has been and remains direct from the manufacturer to on-farm storage facilities, usually 50,000 liter tanks owned by growers.

Superphosphoric acid (super acid), produced at manufacturers' plants, is moved to dealer locations or to regional production facilities for APP production by rail and truck. At those locations, super acid is converted to ammonium polyphosphate (APP) solution by mobile reactors, which may be owned by separate businesses who provide this specific service or by mobile reactors owned by regional retailers or regional wholesalers. At these locations, regardless of whether fixed or mobile, reactors convert anhydrous ammonia and super acid into APP and provide the necessary cooling capacity to allow the APP to be stored for long periods of time. APP stored hot will quickly hydrolyze to orthophosphates, leading to all kinds of problems with sludge accumulation in tanks, off-spec analyses and application.

Now all of this is quite different in the developing Australian fluid fertilizer market, where on-farm storage is currently the norm. Just how the logistical questions will be worked out in Australia will be determined by how the market develops and in what proximity to the points of manufacture. What works or exists in North America obviously doesn't necessarily fit the Australian scene.

Custom Application

Custom application by dealers is a service provided in many areas of North America. As farming operations have grown, producers have come to depend more on the service and labor provided by their fertilizer dealers as key aspects of their operations. On the other hand, some growers are so large they own their own high flotation equipment and do their own application.

Small grain producers in the Canadian Prairies and many areas of the US Great Plains make use of either tillage implement applications of fluids or applications at seeding. Some growers who apply banded fluids pre-plant for winter wheat or apply fluids with their seeding equipment (Spring or Winter wheat) then utilize custom application by dealers for topdressing N and S, frequently in combination with herbicides. All combinations are possible and differ from region to region.

Methods of application are too diverse to discuss in this paper but suffice to say that, with the flexibility of fluids, Australian growers will determine how they best fit their operations and their application possibilities.

In the Final Analysis

With continuing industry and grower interest, and the ingenuity of Australian crop producers, fluid fertilizers will continue to develop in Australia and will be an important tool for increased production efficiency in the near future. BUT, everything must work for the greatest efficiency and best fit with the production system. There is nothing magical about fluid fertilizers, but there is nothing of muck and mystery either! Fluids have to make agronomic sense! BUT ABOVE ALL, PROFITABILITY HAS TO BE THE OVERALL KEY CONSIDERATION!