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NEW PROCESSES AND PRODUCTS--PRESENT AND FUTURE

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It has been mentioned that most manufacturers need to keep abreast of new fertilizer technology. One of the objectives of the TVA field program is to supply this need.

Statistics show that in 1964 about 129,000 tons of N, 98,000 tons of P_2O_5 , and 161,000 tons of K_2O were consumed in Florida. It has been estimated that the consumption of these primary nutrients will continue to increase at a rapid rate during the next decade. Florida has always been a leader in the use of micronutrients, and our recent work with the Florida fertilizer industry indicates that there is an increased interest in the use of micronutrients in this state. TVA is vitally interested in developing economical means of manufacturing, marketing, and distributing these plant nutrients.

One of the objectives of the TVA fertilizer programs is the development of new and improved fertilizer processes and products that will help the industry to lower the cost of the manufacture, transportation, distribution, and application of plant nutrients. Another objective of our programs is the development of new products and practices that will result in the efficient use of fertilizers.

An example of these programs is the development and production of diammonium phosphate (18-46-0 or 21-53-0) by the new TVA process. This accomplishment has resulted in a low-cost method of manufacturing an N:P grade. Because this product has a high analysis, its transportation and distribution costs have been lowered compared with the costs of other conventional fertilizers such as triple superphosphate. We have developed efficient means of using this material, such as blending. However, problems are encountered in blending, particularly the segregation of materials and the difficulty of incorporating micronutrients. We have developed means of minimizing segregation in blends and methods of adding micronutrients to them. We have been working directly with some of the Florida fertilizer blenders in developing methods whereby segregation in their blends can be minimized. We plan to work with these companies this summer in utilizing a process by which micronutrients can be stuck with oil or a fertilizer solution to granules during mixing.

Another example of the TVA programs is the development of a new ammonium polyphosphate base suspension that has a grade of 12-40-0. This material has been used by several companies in Florida, including the Plant

Products Company of Vero Beach and Compass Lake Liquid Fertilizer at Compass Lake, to produce high-analysis suspension fertilizers such as 3-10-30 and 16-8-16. Micronutrients were suspended in many of these suspension mixtures. At present another Florida fertilizer producer is using TVA's new superphosphoric acid (76 percent P_2O_5) to produce suspension mixtures that contain as much as 300 pounds of micronutrients per ton of product. We have developed simplified designs for the conversion of conventional application equipment so that it can be used for the application of suspension fertilizers to citrus and other Florida crops.

A new material that we expect to produce soon is solid ammonium polyphosphate. Figure 1 gives information concerning its composition and use. Ammonium polyphosphate (16-60-0) is produced from superphosphoric acid and ammonia. It contains about 41 percent pyrophosphate, 7 percent tripolyphosphate, and 2 percent phosphates that are more highly condensed. The remaining P_2O_5 of the product is in the conventional orthophosphate form.

Plant tests have shown that these polyphosphates will sequester micronutrients such as Zn, Mn, Cu, and B and that these micronutrients combined with ammonium polyphosphates have higher solubilities in liquids than they have in combination with orthophosphates. Test data indicate that because of their high solubilities the micronutrient polyphosphate mixtures tend to travel farther in the soil.

Agronomic data concerning micronutrient-polyphosphate mixtures are condictory; however, the data indicate that in many instances ammonium polyphosphate may be a superior carrier of micronutrients.

Another material that we expect to produce in future years is urea-ammonium phosphate. We have already developed a process for its production. Information concerning the production and use of this material is shown in Figure 2.

Cost data have shown that probably the most economical solid form of nitrogen is urea. Other production data show that ammonium phosphate is one of the most economical solid forms of both nitrogen and P_2O_5 . We at TVA have surmised, therefore, that the combination of urea and ammonium phosphate should have a low total production cost. The new TVA process for the production of urea-ammonium phosphate has actually lowered the cost of the production of urea by eliminating the necessity for a urea prilling tower. Therefore, cost studies indicate that the production cost of urea-ammonium phosphate as a chemically combined material is considerably less than the cost would be if urea and diammonium phosphate should be produced separately and then combined by dry mixing.

Urea-ammonium phosphate is produced by the reacting of CO_2 and NH_3 to form a urea-ammonium carbamate slurry. The carbamate is decomposed to ammonia and carbon dioxide. This ammonia is used to neutralize phosphoric acid in a preneutralization tank. The ammonium phosphate slurry from this tank is granulated with the urea from the decomposer in a rotary granulator. The product from the granulator is dried and cooled. The two major grades that TVA plans to produce in the proposed urea-ammonium phosphate plant are 33-20-0 and 29-29-0.

Whenever urea is mentioned as a source of nitrogen the agronomists rightly question the nitrogen volatilization losses that should occur if the material should be surface-applied. Some agronomists indicate that when urea is surface-applied in combination with phosphates there is a significant decrease in the volatilization losses from urea. We engineers will be following the agronomists' studies of volatilization loss for urea-ammonium phosphate to see the comparison of volatilization losses from urea and urea-ammonium phosphate.

Another approach to the decreasing of the volatilization loss is to coat the urea-ammonium phosphate with sulfur. The sulfur would also have some value as a secondary nutrient. The urea-ammonium phosphate-sulfur material would be produced by the passing of the urea-ammonium phosphate granules under a spray of liquid sulfur. TVA has proposed the production of limited quantities of the urea-ammonium phosphate-sulfur material for field testing. Tests have indicated that if a sufficiently thick layer of sulfur is coated onto the urea-ammonium phosphate a slow-release fertilizer can be produced. If the product is to be what is considered a slow-release fertilizer, it must contain 20 percent sulfur by weight.

We at TVA have been interested also in producing fertilizers that contain micronutrients. Figure 3 gives the names of some of our fertilizer products in which micronutrients are incorporated and which we are now producing or plan to produce for field testing. The micronutrients are incorporated into these products during manufacturing. The incorporation of micronutrients in granular fertilizers eliminates the problem of the segregation of the micronutrients from the products during shipping or handling. The method probably has economic advantages also in the production of large quantities of fertilizer containing micronutrients. A number of granular products containing incorporated micronutrients have been prepared for the TVA agronomic and demonstration programs. Some of these products are:

Concentrated superphosphate with sulfur, 0-40-0-20S
 Concentrated superphosphate with boron, 0-40-0-4B
 Ammonium nitrate with zinc, 30-0-06Zn
 Ammonium nitrate with boron, 32-0-0-0.5B
 Ammonium polyphosphate with micronutrients

Another new product that we have produced in small quantities is potassium polyphosphate. This product is produced by the reaction at 600° F. between superphosphoric acid and potassium chloride. The product is very hygroscopic. When calcined dolomite was added to the melt, however, a product containing 48 percent total P_2O_5 and 26 percent K_2O was produced. There are still many problems in this process, such as the removal of the highly corrosive byproduct hydrochloric acid gas. Also, the economics of producing this material are not comparable to the cost of other forms of phosphate and mixing them with potassium chloride. However, these difficulties will probably be overcome in the future.

Another new product that we introduced in our field programs last year is anhydrous ammonia-sulfur solution. Our research has shown that it is relatively easy to dissolve as much as 10 units of sulfur as elemental sulfur in anhydrous ammonia. The resulting product is a 74-0-0-10S.

One of the simple processes used by TVA is the adding of solid sulfur to a railway tank car and then adding liquid ammonia. The sulfur dissolves in the ammonia during shipment.

This solution is applied through conventional anhydrous ammonia application equipment. However, minor alterations in this equipment must be made.

Agronomic tests in Nebraska indicate that the sulfur in this solution is a satisfactory source of sulfur and in many fields the tests for the first year indicate that it is as effective a source of sulfur as ammonium sulfate. Some of this solution was applied in the North Florida area in cooperation with the Florida-Georgia Industries, Inc.; however, the agronomic response data from these test were not conclusive.

For the past decade we at TVA have had extensive research and development programs in both laboratory and field concerning the production, distribution, and application of liquid fertilizers. This decade of progress is shown in Figure 4. One of our objectives in the production of liquids was to raise their analyses so that their production, transportation, distribution, and application costs could be lowered. Another objective was to devise means where by sufficient quantities of micronutrients could be incorporated into the liquids.

In 1956, our covered wagon era, low-analysis grades such as 8-24-0, 6-18-6, and 4-12-8 were being produced. In 1957 real progress was started when we began the production of 76 percent P₂O₅ superphosphoric acid from which we produced base solution 10-34-0 that was used in liquid cold-mix and liquid hot-mix plants. I will not define these types of plants, but I will say that liquid cold mixing is increasing rapidly in this country, because a liquid cold-mix plant consists merely of a small batch mix tank in which 10-34-0 is mixed with nonpressure nitrogen solutions and potash.

In 1962 TVA began the production of 80 percent P₂O₅ superphosphoric acid. Because of the higher polyphosphate content of this acid the solubility relationships were improved, and it was possible to increase the analysis of the base grade from 10-34-0 to 11-37-0. The 11-37-0 base solution has been used in both liquid cold-mix and liquid hot-mix plants. From this solution it is possible to produce high-analysis grades such as 20-20-0, 7-21-7, and 5-15-10. These analyses are much higher than the analyses of the grades produced earlier.

In 1964 TVA started the first production of suspensions from 80 percent superphosphoric acid. The first base suspension produced is a 12-40-0 grade. This base suspension is now being used in our programs. I mentioned earlier some of the locations in Florida at which it is being used. With this material it is possible to produce 15-15-15, 10-30-10, and 7-21-7 suspension mixtures. These grades contain approximately twice the quantities of plant nutrients that can be kept in solution in clear liquid grades. We have found that it is possible to suspend micronutrients in suspension mixtures. Tests show that with 12-40-0 base suspension it is possible to suspend the required amounts of micronutrients for plant growth.

In 1966 we hope to enter the jet plane age and to continue our improvement of liquid fertilizers by producing suspensions of still higher analyses. Research work now indicates that we may be able to produce a 13-43-0 base suspension.

We have produced a limited quantity of 37-0-0 suspension. With this material it is possible to produce grades that contain no phosphate such as a 14-0-14 or to suspend micronutrients in the 37-0-0 material. The 37-0-0 suspension will probably be produced from crystalline urea and ammonium nitrate solution, and it should contain little or no biuret. This removes one of the main problems in using urea for citrus crops. Because of the process the biuret content of the product can be maintained at a very low level. It will provide a liquid nitrogen fertilizer of high concentration in which micronutrients can be suspended. We have conducted at other locations tests in which grades such as 16-16-16, 14-0-14, and 22-11-11 have been produced from 12-40-0 and 37-0-0 base suspensions.

Another interesting fact concerning this high-nitrogen suspension is that when it is used 16 percent more nitrogen per unit of volume can be stored than when anhydrous ammonia is used. By using this solution instead of anhydrous ammonia a farmer can apply more nitrogen per gallon of nurse-tank volume, because the high-nitrogen solution has a density about twice as great as that of ammonia. Since it is a nonpressure solution, the nurse-tank in which it is used can be filled to 100 percent capacity, whereas because of safety reasons a nurse tank can be filled with anhydrous ammonia to only 85 percent capacity.

Our technical service group hopes to introduce to you some of these new processes and products. As I have mentioned, we are now working with many fertilizer industrial companies in Florida. Our technical assistance has been given in plants that have ranged from the very small ones, such as the liquid cold-mix plants, to the large granulation plants, such as many of the new diammonium phosphate plants. These services are available, and we are interested in cooperating with you in Florida.

Ammonium Polyphosphate

composition

uses

Ortho Phosphate	50%
Pyro Phosphate	41%
Tri - Poly Phosphate	7%
Highly Condensed Phosphate	2%

Liquid Fertilizers
With Micronutrients

Solid Micronutrient
Carrier

Figure 1

Urea Ammonium Phosphate



Production

↓
Carbon Dioxide
+
Ammonia
+
Phosphoric Acid
↓
Solid Urea Ammonium
Phosphate

↓
Grades
33-20-0
29-29-0
20-20-0

Agronomy
↓
?
?

Figure 2

Fertilizers With Micronutrients

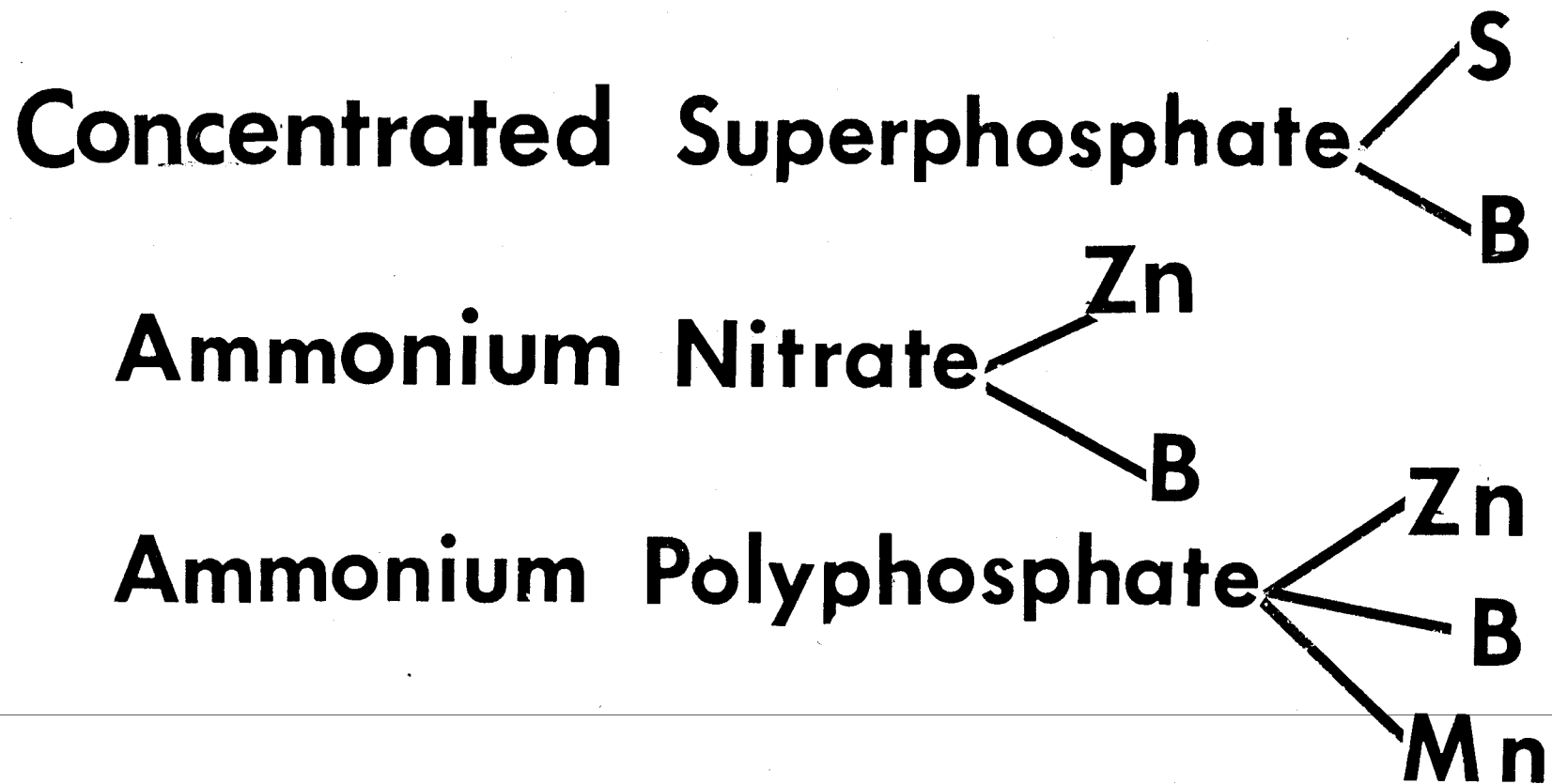


Figure 3

LIQUID FERTILIZER...TVA'S DECADE OF PROGRESS

HIGH ANALYSIS and MICRONUTRIENTS

1956

8-24-0

6-18-6
4-12-8

1957

Super Acid
76% P₂O₅

10-34-0

Cold Mix

Hot Mix

1962

Super Acid
80% P₂O₅

11-37-0

20-20-0
7-21-7
5-15-10

1964

Super Acid

12-40-0
Suspension

15-15-15
10-30-10
7-21-21

Suspend
Micronutrients

1966

Super Acid

13-43-0
37-0-0
Suspension

16-16-16
14-0-14
22-11-11

Suspend
Micronutrients

