December 20, 1979

Mr. Thomas L. Craig,
Vice President and General Manager
New Wales Chemicals, Inc.
P. O. Box 1035
Mulberry, Fl 33860

Reference: Application for Permit to Construct DAP Plant

Dear Mr. Craig:

In our October 4, 1979 letter, the Department served notice that the New Wales Chemicals, Inc. application for permit to construct a diammonium phosphate plant was incomplete. In reviewing the replies received to date from your engineering staff and consultant in response to our notice, the Bureau believes that all information previously requested has not been submitted.

Specifically, the Bureau needs the following information to complete your application.

1. Under the state PSD rule (17-2.04) you need to recommend BACT for particulate and sulfur dioxide emissions from the source and provide the Department with adequate assurance that allowable emissions, i.e. emissions at the level of recommended BACT, will not cause or contribute to ground-level concentrations in excess of any ambient air quality standard or PSD increment, and not result in a significant impact on any particulate or sulfur dioxide nonattainment area. (1st paragraph on 2nd page of 10/4/79 letter).

2. Control device information must include pollutants (particulate, ammonia, fluoride and sulfur dioxide) material balances. Include quantity of pollutants escaping from the process equipment, removed by control equipment and discharged to the atmosphere. (Technical discrepancy 3 and 7).

3. The Department requests clarification on what pollution control equipment is serving the process screens and cage mills. (Technical discrepancy 3).

Once the above information is received, your application will be complete and the Bureau can begin processing it. We must reach a decision within 90 days of receipt of the complete application. If you have any questions on these discrepancies, please contact my office.

Sincerely,

Steve Smallwood, Acting Chief
Bureau of Air Quality Management

SS/ht

cc: A. L. Girardin, III
New Wales Plant

John Koogler
Sholtes & Koogler
Environmental Consultants
1213 NW 6th Street
Gainesville, Fl 32601

New Wales Chemicals, Inc.

A Subsidiary of International Minerals & Chemical Corporation

IMC

P.O. Box 1035 • Mulberry, Florida 33860 • Phone: (813) 428-2531

November 27, 1979

Mr. W. E. Starnes
Bureau of Air Quality Management
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Dear Walt:

Enclosed please find a process description for our proposed DAP plant. I believe that this description coupled with the drawings John Koogler and I left on the 13 of November should adequately cover the DAP process.

With respect to your request for detailed information on our control devices, I regret that we do not have that information at this time. The bag collectors for the cooler have been sized to handle over 60,000 ACFM but have not been committed for purchase and can't be until we receive our construction permit. Once the plant is permitted and we have a vendor committment we will be happy to supply you final details on the collectors.

There is a similar problem with our proposed venturi and tail gas scrubbers. These are not shelf items and will have to be constructed once final specifications are selected. Current pressure drops on the venturis are projected to be 12-14" H_2O. Overall gas flows and acid flows are specified in drawing 06-F-0002 which you have a copy of, and the ultimate size of the venturis and tail gas scrubbers will be designated by Davy McKee. Davy McKee is designing the control equipment and will guarantee its performance. Once we have the final design I will be happy to supply you with this information also. In the meantime, I have asked John Koogler to supply you with some additional information regarding our selection of control equipment.

New Wales Chemicals, Inc.

In conclusion, New Wales Chemicals Inc. will be happy to supply you with the information you request, but as I have pointed out we can not commit to the purchase of any of this equipment until we are permitted to construct the plant.

Thank you for your kind consideration in this matter.

Sincerely yours,

A. L. Girardin III

A. L. Girardin III
Environmental Services Supervisor

ALG:cm
cc: Dr. J. B. Koogler

DAP PROCESS DESCRIPTION

The raw materials for manufacturing 18-46-0 (granulated diammonium phosphate) are liquid anhydrous ammonia, 42% P205 wet process phosphoric acid and 93% sulfuric acid.

30 or 40% phosphoric acid is metered to the plant and is introduced to the scrubber system. The water required to maintain the process balance is fed to the scrubber system and the resulting diluted acid is circulated through the scrubber systems to recover ammonia and dust losses from the process. 54% phosphoric acid and scrubber liquor are continuously added to the reactor. Substantial quantities of water are evaporated as a result of the heats of reaction between the ammonia and the acids.

Slurry, manufactured in the reactor is continuously transferred under controlled conditions to a rotary ammoniator/granulator. The balance of the anhydrous ammonia required to make DAP is added in the ammoniator/granulator. A circulating load of product, ground oversize and fines is fed to the ammoniator/granulator to provide the proper ammoniating and granulating conditions. The material that is discharged from the ammoniator/granulator passes through a rotary dryer where the moisture content is reduced to approximately 1%.

The dried material is elevated by elevator and fed to the screens. The product size from the screens discharges into the product bin. A controlled amount of DAP from the product bin is discharged by recycle feeder to recycle conveyor. The oversized removed by the screens is ground in cage mills and returned to the recycle conveyor system for re-processing in the ammoniator. Fines removed by the screens also are discharged to the recycle conveyor system to be returned to the ammoniator. Overflow from product bin discharges into the rotary cooler where the temperature of the material is reduced and the cooled product is elevated and discharged onto a product transfer conveyor.

Air from the reactor and from the granulator is scrubbed in the reactor-granulator scrubber using the diluted feed acid to recover ammonia/fluoride and dust. Air from the dryer, cooler and other equipment is passed through dry cyclonic dust collectors where dust is separated from the air streams and returned to recycle. The air discharged from the cyclones then passes through the cooler equipment bag collectors/dryer scrubbers for final dust removal. The effluents from the acid scrubbers are then passed through the tail gas scrubbers for final scrubbing and discharged via tail gas scrubber blower and stack to atmosphere.

FORMULATION

The DAP manufacturing plant is designed to manufacture a high grade of 18-46-0 granulated material. The raw materials required in the process are 30% P2O5, 54% P2O5 wet process phosphoric acid, liquid anhydrous ammonia, and sulfuric acid.

Formula for the manufacture of 18-46-0 diammonium phosphate based on dry basis weight of the raw materials and allowable residual moisture of 1% or 20 lbs., is as follows:

Ammonia	439 lbs.
H2SO4	31 lbs.
0-63-0	1510 lbs.
Water	20 lbs.

The meaning of the numbers "18-46-0" in describing the diammonium phosphate is 18% nitrogen, 46% available phosphoric acid (P2O5) and 0% potash (K2O) in the product. The 0-63-0 referred to in phosphoric acid is the minimum P2O5 analysis of the acid on a dry basis. That is, if all of the water is removed from the acid, the dry material remaining must analyze at least 63% P2O5.

In preparing the formula, the raw materials utilized in the plant for manufacturing 18-46-0 diammonium phosphate are as follows:

Anhydrous Ammonia	82% Nitrogen
93% Sulfuric Acid	7% Water
54% Phosphoric Acid	54% P2O5 14.3% Water
30% Phosphoric Acid	30% P2O5 52.4% Water

The calculations for determining the quantity of raw materials to manufacture 18-46-0 diammonium phosphate are as follows:

1). Nitrogen (assume all nitrogen comes from the anhydrous ammonia, 82% N).

18% x 2000 lbs. = 360 lbs. nitrogen required

360 ÷ .82 = 439 lbs. of ammonia per ton

2). Phosphate -

46% x 2000 = 920 lbs. of P2O5 required
920 ÷ .63 = 1460 lbs. of phosphoric acid (dry)

Equivalent P2O5 feed is 42% made up of equal portions of 54% H3PO4 and 30% H3PO4.

920 ÷ .42 = 2190 lbs. H_3PO_4 required (wet)
1095 x 54 = 591.5 lbs. P_2O_5 from 54% P_2O_5 acid
1095 x 30 = 328.5 lbs. P_2O_5 from 30% P_2O_5 acid

3). Sulfuric Acid -

Although sulfuric acid reacts with ammonia to form ammonium sulfate, the sulfuric acid included in the formula for 18-46-0 should be considered as a means of adjusting the grade or analysis of the granulated product. This is explained in the section titled "Grade Control".

DIAMMONIUM PHOSPHATE PLANT CHEMISTRY

The basic reactions in the manufacture of diammonium phosphate from crude phosphoric acid and anhydrous ammonia are:

$$H_3PO_4 \quad + \quad NH_3 \qquad NH_4H_2PO_4$$ mono ammonium phosphate

and since there is always a small amount of free sulfuric acid present in the wet process phosphoric acid we also get:

$$H_2SO_4 \quad + \quad 2NH_3 \qquad (NH_4)_2SO_4$$

In order to produce diammonium phosphate reaction one if further ammoniated to:

$$NH_4H_2PO_4 \quad + \quad NH_3 \qquad (NH_4)_2HPO_4$$ Diammonium Phosphate

Since wet process acid contains impurities such as complex compound of iron-aluminum fluorides and gypsum, additional sulfuric acid is needed to control the nitrogen content.

There are some side reactions as follows:

$$6NH_3 \quad + \quad H_2SiF_6 \; (2 \times X) \; H_2O \qquad 6NH_4F_4 \quad + \quad SiO_2 \quad \cdot \quad X \; H_2O$$

$$2NH_3 \quad + \quad H_2SiF_6 \qquad (NH_4)_2SiF_6$$

$$CaSO_4 \; + \; 2H_3PO_4 \quad + \quad 4NH_3 \qquad Ca(HPO_4)_2 \quad + \quad 2(NH_4)_2SO_4$$

DEFINITIONS

MOLE

A mole is the quality of a chemical whose weight is numerically equal to its molecular weight. For example: the molecular weight of NH3 is 17. One mole of NH3 weighs 17 pounds.

MOLE RATIO

Mole ratio normally refers to the moles of ammonia that have reacted with one mole of phosphoric acid. A mole ratio of 1.4 indicates the presence of monammonium phosphate with some diammonium phosphate.

pH

PH is a measure of the acidity of alkalinity of a solution. PH is the negative logarithm of the hydrogen ion concentration. The pH scale runs from 0 to 14 with pH 7 being the neutral point. PH values less than 7 indicate acidity, those above 7 indicate alkalinity.

SPECIFIC GRAVITY

A number representing the ratio of the weight of a volume of a substance to the weight of an equivalent volume of a standard substance. Usually either water or air is the standard, and the temperatures must be stated.

PROCESS OPERATIONS

The process operation will be divided into the following systems for the purpose of discussion.

A. Acid, Water and Ammonia Feed System

B. Reaction System

C. Ammoniation-Granulation System

D. Drying System

E. Screening, Milling System

F. Product Cooling System

G. Exhaust System

H. Reclaim and Recycle Feed System

A. Acid, Water and Ammonia System

Pond water and thirty or forty percent wet process phosphoric acid is added to the scrubber system. The acid is circulated through the scrubber system to recover dust lost from the cooler, dryer and equipment dust collectors and ammonia lost from the ammoniator and reactor. The resulting 22 percent acid in the system is pumped to the reactor tank at a controlled rate to maintain a constant reactor tank level.

Anhydrous ammonia is sparged under the liquid slurry in the reactor. The slurry consists mainly of mono-ammonium phosphate with diammonium phosphate, phosphoric acid and ammonium sulfate. The acid is partially neutralized in the reactor tank. The partially neutralized slurry is pumped at a controlled rate to the rotary ammoniator/granulator. Steam, ammonia and other gaseous by-products are evolved from the reactor tank as a result of the reaction between anhydrous ammonia and the sulfuric and phosphoric acids. The gases enter the reactor-granulator venturi where they are scrubbed with diluted phosphoric acid and then to the reactor-granulator tail gas scrubber for final scrubbing with pond water before being discharged to atmosphere.

B. Reaction System

The DAP plant is equipped with a stainless steel reactor tank. The 22% acid from the scrubber sump tank and 54% phosphoric acid is fed to the reactor tank which is a pre-neutralizer vessel. Anhydrous ammonia is sparged under the liquid level in the reactor.

The major reaction occurring in the reactor is the production of mono-ammonium phosphate. The phosphoric acid is only partially neutralized since it requires two mols of ammonia per mol of phosphoric acid for a complete neutralization. The reactions give off heat which in turn evaporates water from the reactor.

The reactor is normally operated at a mol ratio of 1.35 to 1.40. The mol ratio is defined as the number of mols of ammonia reacted with one (1) mol of phosphoric acid. A mol ratio of 1.35 indicates the slurry contains both mono-ammonium phosphate and diammonium phosphate.

Another control that is important in the reactor tank is the specific gravity of the slurry being transferred to the ammoniator. This should be maintained at a specific gravity of 1.53 to 1.55 at operating temperature.

The evaporation of water in the reactor tank maintains the temperature of the reactor at approximately 270° F. under normal operating conditions.

The slurry is pumped from the reactor tank to the ammoniator granulator where the remainder of the reaction takes place.

C. Ammoniation Granulation System

The DAP plant is equipped with a rotary ammoniator-granulator. The slurry from the reactor is distributed above the rolling bed of solid materials in the drum. Anhydrous ammonia is distributed under the rolling bed with a distributed under the rolling bed with a distributor pipe. The rotary ammoniator depends upon a rolling bed for efficient operation. The motion of the bed mixes the recycle materials and slurry with ammonia, and aids in agglomerating particles. It also conveys material from the feed to the discharge end. Retainer rings are at each end of the ammoniator to regulate bed depth.

The normal mol ratio of the ammoniator product is between 1.7 and 1.9 dependent upon the purity of the phosphoric acid being used. The mol ratio must be sufficiently high to produce the desired product. As the mol ratio increases, the ammonia vapor exhausted to the scrubber increases. The temperature of the material at the discharge end of the ammoniator will normally run around 185-195° F. A higher temperature may cause over-agglomeration under the same feed rate conditions whereas lower temperatures than this may cause insufficient agglomeration.

Granulated material flows from the ammoniator to the rotary dryer for moisture removal.

D. Drying System

Rotary Dryer:

The plant is equipped with a rotary dryer provided with internal lifting flights. The lifting flights distribute the solids across the hot air stream for drying. The granulated material discharges from the ammoniator to the dryer through a water-cooled chute. Hot gas inlet temperatures to the dryer will range between 300° F. and 1000° F. Gases leaving the dryer will have a temperature range between 180° F. and 225° F.

Burner:

The burner provided in the combustion chamber is equipped with a propane gas ignition assembly, an air operated modulating type control valve to control burning rate, and a flame failure protection system. The flame failure system prevents firing of the burner under unsafe conditions, and shuts off the burner if an unsafe condition occurs during operation.

Quench air enters the combustion chamber around the periphery of the combustion chamber and blends with the hot burner gases prior to the time they enter the rotary dryer.

E. Screening and Milling System

Double-deck ~~vibrating screens~~ equipped with ~~dust covers~~ are used to separate oversize and fines from the product. The oversize from the screens flows to the cage mills and the fines flow by gravity to the recycle conveyor.

Cage Mills:

Each plant is equipped with four cage mills for particle size reduction. Each mill installed is capable of handling 40 tons per hour of material to be ground. The ground oversize from the mill discharges to the recycle conveyor.

Product Bin:

Product size material from the screens is transferred by gravity to the product bin. The material required for the recycle is transferred to the recycle conveyor by a recycle feeder. That part of the product not required for recycle overflows from the product bin to the cooler. The controls for adjusting the feed rate of the recycle feeder are located in the instrument control room.

F. Product Cooling System

The DAP plant is equipped with a rotary cooler provided with internal lifting flights. The lifting flights distribute the product across the cool air stream for cooling. The product from the cooler is elevated by the product elevator and conveyed to storage by the product conveyor.

Good drying and cooling of DAP prior to storage reduces the problem of caking and bin set. Minimizing caking in storage and reducing the quantity of material requiring milling at the time of shipment reduces the quantity of fines that will have to be returned to granulation. The reduction of lumps or oversize reduces the quantity of chipped material in the product and increases product quality.

The air from the cooler is exhausted through a cyclonic dust collector and passes to two bag collectors prior to being exhausted to the atmosphere.

G. Exhaust System

The rotary dryer, cooler, and equipment exhaust systems are each equipped with dry cyclonic type dust collectors for first stage dust removal. The gas removed from each of these systems enters the dust collectors tangentially where cyclonic action spins the dust particles to the side of the cyclone chamber. Dust flows by gravity out of the cyclone discharge through a rotary valve to the recycle conveyor. The exhaust gases are discharged from the top of the cyclone dust collectors and flow to the wet gas scrubbers or bag collectors.

The cyclone dust collectors remove large dust particles. The smaller dust particles and ammonia vapors are recovered in the wet gas scrubbers or bag collectors. Periodic cleaning of the exhaust ducts and the dust collectors will be required to maintain good operation and operating conditions. Clean-out ports are provided.

H. Reclaim and Recycle Feed System

Recycle:

Mill discharge, fines, and recycle from the product bin are transferred by the drag conveyor to the recycle elevator, elevated and discharged to the granulator. Adjustment of the amount of recycle is the primary control for product granulation under balanced conditions.

The recycle load is controlled by adjusting the rheostat on the recycle feeder, which is located in the control room.

Fines Reclaim:

Fines discharge from the screens is direct to the recycle conveyor which return the fines to process.

PROCESS CONTROL SYSTEM

A. Feed Control System

Phosphoric acid feeds (54% P205 and 40% P205 or 30% P205) to the DAP plant are metered by a magnetic flow meter and controlled by air operated control valves. Flow rates are continuously recorded, controlled and totalized by the panel mounted recorder-controller and totalizers. The 54% P205 phosphoric acid coming to the plant feeds into the reactor. The 30% P205 or 40% P205 phosphoric acid feeds into the scrubber system and is then fed to the reactor under flow control using a magnetic flow meter, panel mounted recorder controller and an air operated control valve.

The flow rate of the 54% P205 acid to the reactor and the 22% P205 acid from the scrubber sump are adjusted to maintain the desired level in the reactor. The flow rates of 22% P205 and the 54% P205 acid are also adjusted to provide an equivalent concentration of 42% P205 into the reactor.

Anhydrous ammonia feed to the reactor and to the ammoniator is measured by rotameters and controlled by air operated control valves. Flow rates are continously recorded, controlled and totalized. Anhydrous ammonia is added to the reactor at a controlled rate so as to maintain the desired 1.35 to 1.40 mol ratio, and the remaining ammonia required to make the product is added in the ammoniator.

The 93% sulfuric acid is fed into the reactor. The flow rate is measured by a rotameter, recorded and controlled by a panel mounted indicator-controller and an air operated control valve. The sulfuric acid reacts with some of the ammonia to produce ammonium sulfate. The flow rate of sulfuric acid is varied only to adjust the grade of the product as outlined in the section on grade control.

A slurry flow control system is provided in the DAP plant to measure, record and control the flow rate of slurry from the reactor to the granulator. The system includes a magnetic flow meter panel mounted indicator-controller, flow recorder and an air operated control valve. The flow rate of the slurry is adjusted as necessary during operation.

PROCESS VARIABLE CONTROL

A. Reactor

The normal mol ratio in the reactor is 1.35 to 1.40 and the ~~normal temperature in the reactor is approximately 270 F.~~ The normal specific gravity for the slurry as discharged from the reactor is 1.54. The temperature of the slurry measured at the ~~granulator~~ will normally be in the range of 240 to 260 F.

The percent water in the slurry, and the specific gravity of the slurry, is effected by the concentration of the feed acid, the mol ratio of the resulting slurry and the mol ratio at which the reactor is operated. A maximum mol ratio for good plant operation of approximately 1.43 and a maximum specific gravity of 1.60 is possible.

Ammonia and acid flows may be changed as required and the proper phosphoric acid concentration may be adjusted to get the desired results by adding water to the acid scrubber sump when the concentration is too high.

The specific gravity of the slurry fed to the granulator is an important variable used to control granulation as well as production rate. The specific gravity should be controlled at 1.53 to 1.54. If the specific gravity is too low, over granulation may occur in the granulators as a result of the excess water introduced with the slurry. If the specific gravity is too high, the slurry pumps may not be able to pump the slurry to the granulator. This condition is evident when the slurry rate drops sharply from the set point on the recorder while the control valve is fully open.

Since the specific gravity varies with the mol ratio and the concentration of the feed acid, it will be changed by a changed in either. ~~The specific gravity will increase with increasing mol ratio~~ and vice-versa.

If the mol ratio is correct, but the gravity is too low, it is increased by increasing the strength of feed acid.

The adjustment must be made bearing in mind the associated effect on the reactor and scrubber levels. Thus, a proper adjustment involves consideration of the conditions existing before the change was made.

The same considerations are true in adjusting the mol ratio. If the mol ratio is too high, it is decreased by decreasing the flow of ammonia to the reactor or increasing the flow of acid to the reactor, or both. If the mol ratio is too low, it is increased by increasing the flow of ammonia to the reactor or decreasing the flow of acid to the reactor, or both.

Mol Ratio:

The mol ratio is a very critical measurement since it indicates the degree of ammoniation of the phosphoric acid in the reactor and in the ammoniator. Two methods are used for control.

The first is pH measurement which may be used as an estimate of mol ratio or degree of neutralization. Standard equipment is available for pH measurement. ~~The plant laboratory can prepare a graph plotting pH versus mol ratio~~ utilizing phosphoric acid made in the plant so that a fast indication of mol ratio can be obtained by measuring the pH.

The second method for mol ratio determination is a quick analytical method. For mol ratios greated than 1.0, as in the reactor or granulator, a 1 gram sample of material to be analyzed is mixed with 100 ml of distilled water. Methyl orange indicator is added and the resulting solution is titrated to an end point with a standard hydrochloric acid solution. The color of the solutions turns from orange to yellow at the end point. Record mls of hydrochloric acid as "A". Add phenolphtalein indicator. Titrate to a phenolphtalein end point with a standard sodium hydroxide solution and record the mls of sodium hydroxide as "B". The colorless solution turns red at the end point. Calculation for the determination of mol ratios is (A+B)/B.

For mol ratios less than 1, as in the scrubber, a 1 gram sample is dissolved in 100 mls of distilled water and methyl orange indicator is added. Titration to end point with sodium hydroxide solution is recorded as "A". The phenolphthalein indicator is added and the resulting solution is titrated to an end point with sodium hydroxide solution and this is recorded as "B". The calculation to determine the mol ratio is (B-A)/B.

The sodium hydroxide and hydrochloric acid solutions used in the titration must be solutions of the same normality.

The third method for mol ratio determination is essentially the same as the second method, but employes the pH meter instead of the titration indicators. The procedure is as follows: For the mol ratio in the reactor (mol ratio greater than 1), a 1 gram sample of material to be analyzed is mixed with 100 ml of distilled water in a 250 ml beaker and placed on the magnetic stirrer. Immerse the electrodes of the pH meter in the liquid making sure the stirring bar does not contact the delicate pH electrodes. Titrate with acid (HCL) until pH of 4.4 is reached. Record ml of acid used as "A". Then titrate with base (NaOH) until a pH of 7.8 is reached. Record ml of base used as "B". Mol ratio is then $\frac{A+B}{B}$.

B. Specific Gravity

The measurement of specific gravity is used to indicate slurry concentration. The specific gravity of the reactor slurry will be measured as follows: 100 ml of sample is poured in a previously tared graduated cylinder and weighted. The specific gravity is then equal to solution (grams)/100. The specific gravity of the slurry is a measure of the amount of water in the slurry. As the mol ratio of the slurry increases, more water is evaporated increasing the specific gravity; and as the mol ratio decreases, less water is driven off lowering the specific gravity. The concentration of the phosphoric acids added to the reactor also affects the specific gravity of the slurry. An increased total concentration of phosphoric acid results in a higher slurry specific gravity.

C. Grade Control

Sulfuric acid is included in the formulation for 18-46-0 to provide a means of adjusting the grade or analysis of the product. It reacts with some of the ammonia to form ammonium sulfate, and it has a slight affect on mol ratio and specific gravity. However, it should never be used to adjust either the mol ratio or the gravity.

The DAP product from the manufacturing plant should be analyzed on a routine basis. The product grade is adjusted based on the results of the chemical analysis by varying the feed rate of the sulfuric acid. The desired analysis is 18-46-0 or 18% nigrogen and 46% P205. There are six possible combinations if the product is off grade.

1) Nitrogen and P205 both too high--as 18.5-47.3-0. To correct, increase sulfuric acid feed rate. The additional sulfuric acid will "dilute" the nitrogen and P205 in the produce to reduce the overage.

2) Nitrogen and P205 both too low - as 17.5-44.7-0. To correct, decrease the sulfuric acid feed rate. This will reduce the "dilution" and bring the analysis back up to grade.

3) Nitrogen OK, but P205 too high - as 18-46.5-0. To correct, increase the sulfuric acid feed rate and the ammonia feed rate. Since the additional H2S04 will dilute both the N and P205, the ammonia rate must also be increased to compensate for the added filler.

4) Nitrogen OK, but P205 too low - as 18-45.5-0. To correct, decrease both the sulfuric acid and the ammonia feed rates. Since the reduced dilution will increase both N and P205 in the product, the NH3 rate must be decreased to compensate.

5) Nitrogen too high, P205 OK - as 18.5-46-0. To correct, increase the sulfuric acid feed rate and decrease the ammonia feed rate. If the ammonia alone were decreased, the P205 analysis would increase slightly; so the H2S04 must be increased slightly at the same time.

6) Nitrogen low, P205 OK - as 17.5-46-0. To correct, increase ammonia flow and decrease H2S04 flow slightly since increasing ammonia flow alone would decrease P205 analysis in the product.

In each case, the exact correction required can be calculated from a knowledge of the production rate and product analysis. However, experience gained by actually making trial adjustments and observing the effect of the change will eliminate the need of making the detailed calculations.

D. <u>Dust Scrubber</u>

The purpose of the 30% phosphoric acid that is fed to the scrubber system is to recover ammonia and dust lost from the process equipment. The recovered ammonia reacts with the acid and the sump acid temperature is increased by the heat of reaction. The mol ratio of the scrubber acid is controlled by not over ammoniating the granulator. ~~The mol ratio will normally be about 0.2 in the sump,~~ and should never be allowed to increase above 0.4 in the scrubber system. ~~The pH of the~~ sump acid will normally be ~~about 2.0 with a maximum of 4.0.~~ The sump acid can be sampled at the sample valve in the spray line on the granulator floor.

E. Ammoniator

The rotary ammoniator depends on a rolling bed for efficient operation. When the rolling action is weak or absent, wet or soupy spots develop because fresh solids no longer are brought into contact with fluid streams.

Since agglomeration is a function of the speed of rotation of the particles undergoing agglomeration, a weak rolling bed will result in the formation of large balls, or lumps. The speed of rotation of the ammoniator is constant so other variables such as moisture content, production rate, recycle rate, and steam injection with the anhydrous ammonia will change the conditions of the rolling bed.

Granulation will be controlled primarily by adjustment in the rate of recycle in addition to adjustment of the mol ratio and specific gravity of the slurry. Other factors affecting the granulation are:

1) Mol ratio of the material in the rotary ammoniator.
2) Evaporation rate in the drum.
3) Particle size, moisture content and temperature of recycle.
4) Slurry composition and quantity.
5) Temperature of the material in the drum.
6) Quantity of steam injected with the ammonia.

The recycle moisture content and temperature may be controlled by the extent of drying in the rotary dryer. The recycle rate is controlled by the recycle feeder. Slurry compositions can be varied and production rate can be varied. These are items that will be utilized to control operation of the plant.

F. Drying

Product and recycle moisture content is controlled by changing the dryer exhaust temperature. The dryer exhaust temperature is automatically controlled by the temperature recorder controller located on the instrument control panel. The temperature of the dryer gas at the exit of the dryer will normally be between 180 and 210 F.

The dryer gas exit temperature is also an indirect granulation control in that it affects the temperature of the recycle material and therefore the temperature of the rolling bed of material in the granulator. As a general rule, the dryer gas exit temperature is approximately the same as the temperature of the material discharged from the granulator. Optimum granulation is usually achieved with a granulator discharge temperature of 185 to 190 F. The best temperature will be determined by observation during actual plant operation, by varying the dryer gas exit temperature and measuring the granulation discharge temperature. If the temperature is too high, over-granulation will occur and cause the mills to overload.

To control the reactor the 22% P205 is pumped from the scrubber sump to the reactor. The ammonia is adjusted to give a mol ratio of 1.38 to 1.40. The reactor can be operated at higher mol ratios but to do so invites trouble as the system becomes increasingly sensitive and subject to freezing. Until operators have a strong feel of the plant they should hold the mol ratio to a maximum of 1.40. Pushing the plant in its early stages can lead to most numerous shut-downs. The specific gravity of the reactor slurry should be held at 1.53 to 1.54.

The reaction of the ammonia with P205 releases heat which boils off water. As the amount of ammonia is varied or the ratio of ammonia to P205 is changed, the result will be to change the amount of heat generated, resulting in a change in the amount of water boiled off, and in a change in specific gravity. Therefore, it should always be remembered that any adjustments to correct specific gravity or mol ratio will cause a change in the other and make it necessary to rebalance the system.

For proper operation of the granulator the mol ratio of the product leaving should be from 1.8 to 1.85. The bed should be slightly wet and sticky. Good product will appear to be very wet but when picking up a handful for examination it will dry quickly and crumble. Excess ammonia to the granulator will cause the mol ratio to be above 1.85; you will be able to see ammonia fumes escaping from the bed, and the discharge product will smell strongly of ammonia.