Chevron

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AMMONIUM NITRATE
AP-42 Section 6.8
Reference Number
18

March 2, 1979

Emissions Information
Ammonium Nitrate Plant

Mr. Don R. Goodwin
Director, Emission Standards & Engineering Division
U.S. Environmental Protection Agency
Office of Air Quality Planning & Standards
Research Triangle Park, NC 27711

Dear Mr. Goodwin:

Attached is a report presenting information pertaining to emissions and emission controls at the two ammonium nitrate facilities at Kennewick, Washington. This information was requested in your letter of October 2, 1978, to Mr. Glen Hopkins, Plant Manager at Kennewick, WA.

We have presented our best available information to provide answers to the questionnaire attached to your cover letter. The information was compiled by our ORTHO Research and Development staff. As previously discussed with your Messrs. Durkee and Noble, it was necessary for us to obtain clearances from two process licensors on portions of the process information.

The answers are presented in two sections. The information in the second section (pink) is highly confidential and it is so labeled. The confidential section includes information we are obligated to protect under secrecy agreements with our process licensors. It is submitted only on the condition that you accept it as such and maintain its confidential character in all respects. Please return it unopened if you do not agree to accept this material on this basis.

If there are any questions, please contact me direct (415-894-3925).

Yours truly,

H. Schuyten

H. Schuyten
Manager, Environmental Affairs

Attachments

cc: Mr. G. Hopkins - w/a
Mississippi Chemical Company - Attn: Mr. J. W. Thomson - w/o
C&I Girdler Corporation - Attn: Mr. W. E. Brown - w/o

Emissions Information
Ammonium Nitrate Plant
Kennewick, WA

The following comments are in response to an EPA request for information with a cover letter from Mr. Don Goodwin of EPA to Mr. Glenn Hopkins, Plant Manager, Kennewick, dated October 2, 1978. Information was requested concerning the two ammonium nitrate plants at Kennewick.

Presented below are our best available answers to these questions. The numbering system for the answers is the same as that used in the questionnaire.

## I GENERAL

1. Ammonium Nitrate is made in 2 plants at Kennewick. These are Plants No. 3 and No. 10. A 20% N solution is also made. Flow diagrams for these plants are attached.

2. Description of Process - Plant #3

   a. In general, vaporized $NH_3$ and 57% $HNO_3$ are mixed in a tank-type neutralizer to form 83% AN solution. The 83% AN solution is concentrated to 99% molten solution by removing water in a falling film evaporator. The molten nitrate is sprayed onto a bed of fines in a rotating drum to form solid AN granules. Also the 83% AN may be sent to a solutions unit to make 20% N solutions.

   83% AN (Plant #3)

   The Ammonia feed is vaporized in a tube and shell type heat exchanger. The $HNO_3$ feed is heated in a tube and shell exchanger to about 140°F. The acid is on the tube side and hot condensate is on the shell side. When the heated acid & vaporized $NH_3$ are mixed in the neutralizer, AN with a concentration of 83% is produced.

The $NH_3$ and $HNO_3$ enter the neutralizer through spargers in the bottom. There is a mist eliminator in the top outlet of the reactor. This traps any large AN droplets leaving with the evaporated water.

The 83% AN goes to a surge tank. From this tank it may be pumped to a solutions unit where a 20% N solution is made, or to the top of a falling film evaporator where 99% AN is made for conversion into solid AN (34-0-0).

34-0-0 (Solid Ammonium Nitrate)

The falling film evaporator is a shell and tube type heat exchanger with AN and air on the tube side and steam on the shell side. The AN solution forms a film on the inside of the tubes. Hot air from the air heater flows counter current to the flow of solution on the inside of the tubes. The solution, as it flows down the inside of the tubes is heated by steam on the shell side and water is evaporated from the solution to form molten AN of approximately 99% concentration.

Water is swept out by the hot air and goes to a scrubber. The molten AN flows through a stripper which is directly below the evaporator. The stripper is a partially packed column where the molten AN is further concentrated by hot air.

The nearly anhydrous AN flows by gravity to the 99% surge tank. It then is pumped by submerged pumps to the cold Spherodizer (TM) granulator where it is sprayed under flow control through multiple nozzles onto a bed of recycled fines. The resulting bed contains a mixture of fines, product, and oversize. The AN particles are formed in the front granulating section. They are then cooled by a stream of relatively cool air after passing over a dam separating the granulating section from the cooling section. The cooled pellets discharged from the granulator are then screened to remove over-size and under-size pellets. Over-size pellets are crushed and recycled to the granulator along with the under-size material. The product size (-6+14 mesh) pellets are conveyed to a rotary cooler where they are cooled to below 100°F and preferably below 95°F. Pellets are then sent to the coating drum where coating agent is added. After coating, the product is conveyed to a bulk storage pile in the warehouse.

Plant #3 - Dust Control

The vent from the evaporator and the granulator air stream along with air containing dust from other equipment go to a wet scrubber. The scrubber removes $NH_3$ vapors and small AN particles from the air stream. The material is returned to the process.

Coating agent dust is collected in a baghouse and is returned to the process.

Dust from the cooler is collected by a Rotoclone and is returned to the process.

b. Description of Process (Plant #10)

Plant #10 was first run in 1978. The equipment and operations are similar to those in Plant #3 with the following differences.

a. The neutralizer in Plant 10 is specially designed, patented reactor from Mississippi Chemical Co. The exhaust gases vent directly to atmosphere rather than to a wet scrubber.

b. The cooler is a fluid bed cooler rather than a rotary cooler.

c. The air from the cooler vents directly to atmosphere rather than through a Rotoclone.

c. 20% N Solution (20-0-0)

83% ammonium nitrate solution from the 83% solution storage tank is diluted with water to a strength of 57.1% ammonium nitrate (20% nitrogen). The required amount of water is added to the mix tank and the circulating pump is started. The 83% ammonium nitrate solution is added by means of an eductor in the recirculating line which draws the 83% solution from the storage tank. The mixed flow passes through the cooler and returns to the mix tank. Control of the blend is made by measurement of liquid level in the mix tank, adding 83% ammonium nitrate solution until final mix strength is reached. Periodic samples are drawn from the mix tank and the strength measured by means of a hydrometer. The pH of the solution is measured and adjusted to pH 3.0-6.0. Inhibitor is added by differential level in the inhibitor mix drum. When the batch is completed, it is circulated for 30 minutes and a sample is taken to the Control Laboratory. Finished product, upon being passed by the Control Laboratory, is pumped to storage.

Specifications

83% AN

| | |
|---|---|
| Total N | 29.0% |
| Nitric N | 14.5% |
| Ammonia N | 14.5% |

20% N Solution

| | |
|---|---|
| Total N | 20.0% |
| Ammonia N | 10.0% |
| Nitric N | 10.0% |

AN Granules (34-0-0)

| | |
|---|---|
| Total N | 34% |
| Nitric N | 17% |
| Ammonia N | 17% |
| Mesh | -6 + 14 Mesh |

3. Production Rate (Plant #3 & Solutions Plant)

Average tons per Operating Day

| | 34-0-0 | 20% Soln |
|---|---|---|
| 1975 | 279 | 243 |
| 1976 | 274 | 240 |
| 1977 | 267 | 242 |

4. Design Capacity

Plant #3 - Design capacity of the process is 300 tons per day of 34-0-0. The process can produce, in addition, 50 tons per day of 83% AN (100% basis) which is pumped to an adjoining facility for processing into AN solution.

Plant 10 - The design capacity is 515 TPD 83% AN (100% basis), a part of which is used to make 400 TPD 34-0-0 granules.

5. Days of Operations (Plant #3 & Solutions Plant)

| | 34-0-0 | 20% Soln |
|---|---|---|
| 1975 | 345 | 76 |
| 1976 | 357 | 51 |
| 1977 | 335 | 21 |

6. Dates of Initial Operations

| | |
|---|---|
| Plant 3 (as modified for cold spherodization) | 1969 |
| Plant 10 | 1978 |
| 20% N Solutions Plant | 1960 |

7. Process Flows Measured

| | Accuracy (Manufacturers Specification) |
|---|---|
| a. $HNO_3$ feed | ± 0.5% |
| b. $NH_3$ feed | ± 0.5% |
| c. 83% AN to storage | ± 0.5% |
| d. 83% AN to evaporator | ± 0.5% |
| e. AN melt to granulator | ± 1.0% |
| f. AN from granulator | ± 1.0% |
| g. AN to coater | ± 1.0% |
| h. Coating agent to coater | ± 1.0% |
| i. Product to warehouse | ± 1.0% |

# II. SOLUTION PRODUCTION

## Neutralizer

Plant #3 - Process Reference No. T-301

1. Description

   Tank Type Neutralizer

   a. Manufacturer: Brighton Corp., Cincinnati, Ohio.

   b. Feeds - added through spargers:

| | Rate | Temperature | Pressure |
|---|---|---|---|
| $NH_3$ | 6187 lbs/hr | 70°F | 90 psia |
| $HNO_3$ (57%) | 39418 lbs/hr | 140°F | 50 psia |

   c. Production Rate, 83%. 14.6 TP Hr (100% basis).

   d. pH; 5.5-6.0.

2. AN Production

| | |
|---|---|
| Concentration: | - 83% AN |
| Average rate 83% (100% basis) | - 14.6 TP Hr |
| Max. rate, 83% (100% basis) | - 16.1 TP Hr |
| Temperature: | - 260-275°F |
| Pressure: | - Atmospheric |

3. Steam Exhaust from Neutralizer - Test Data

   Steam Exhaust Rate: 13998 lbs/hr (avg) water vapor at 270°F

   Production Rate: 226 TPD
   Avg. pH: 5.5
   Emissions: The data below were taken on a similar unit and the maximum of several readings are presented:

| | |
|---|---|
| AN: | 1.4 lbs/ton |
| $NH_3$: | 4.5 lbs/ton |

   A single reading on the Kennewick Unit showed AN at 1.2 lbs/ton and $NH_3$ at 3.4 lbs/ton.

4. Emission Control

$HNO_3$ vapors are eliminated by maintaining an excess of $NH_3$ in the neutralizer.

AN droplets are eliminated by a demister pad in the exhaust line.

Steam from the neutralizer is condensed. $HNO_3$ is added to the condensate receiving tank to recover $NH_3$. pH is maintained at 3-5. This solution is returned to process.

5. Process Controls & Monitors

$NH_3$ feed is set on the recorder-controller.
$HNO_3$ is ratio controlled to the $NH_3$.
pH is also used for control.

Neutralizer

Plant #10 - Process Reference No. T-1062

1. Description

MCC Type Neutralizer. A specially designed, patented reactor.

a. Manufacturer: Mississippi Chemical Corp.

b. Feeds - added through spargers:

| | Rate | Temp | Press |
|---|---|---|---|
| $NH_3$ | 9181 lbs/hr | 185°F | 56 psia |
| $HNO_3$ | 59374 lbs/hr | 100°F | 55 psia |

c. Avg. Production Rate, 83% AN 21.5 TP hr (100% basis).

d. pH - 2-3.

2. AN Production

| | |
|---|---|
| Concentration: | 83% AN |
| Average rate 83% AN (100% basis) | 21.5 TP Hr |
| Max. rate 83% AN (100% basis) | 23.7 TP Hr |
| Temperature: | 265-280° |
| Pressure: | atmospheric |
| pH: 2-3 | |

3. Steam Exhaust from Neutralizer

Rate: 18165 #/hr @ 275°F (7967 ACFM)

Emission: The equipment supplier guarantees that losses will be no greater than the following:

| | |
|---|---|
| AN (lbs/ton AN) | 1.0 |
| $NH_3$ vapor (lbs/ton AN) | 2.0 |
| $HNO_3$ vapor (lbs/ton AN) | 0.0 |

4. Emission Control

$NH_3$ losses are controlled by running at 2-3 pH. The special design of the reactor minimizes the escape of AN aerosol.

5. Process Controls & Monitors

$NH_3$ feed is set on the recorder-controller.
$HNO_3$ is ratio controlled to the $NH_3$.
pH is also used for control.

## III. CONCENTRATOR

### Plant #3 - Process Reference No. E-304

1. Description

Manufacturer: Whitlock Manufacturing Co.
Pressure: Atmospheric
Design Capacity: See Confidential Section

Evaporation system consists of the necessary equipment and controls to concentrate 83% neutralizer solution to 99% molten AN to be sprayed into the granulator and chilled to make AN granules (34-0-0). Equipment in the system includes an 83% AN surge tank, 83% pumps, evaporator, stripper, air heater and a 99% AN tank.

The evaporator has steam on the shell side and AN and hot air on the tube side. The stripper is a steam jacketed packed vessel attached directly to the bottom of the evaporator.

2. AN Production

a. Feed Rates to Concentrator

| | Average | Maximum |
|---|---|---|
| AN (100%) | See Confidential Section | |
| Water | | |
| Temperature | 280°F | |
| Pressure | Atmospheric | |

b. Product from Concentrator

| | Average | Maximum |
|---|---|---|
| AN (100%) | See Confidential Section | |
| Water | | |
| Temperature | 345°F | |
| Pressure | Atmospheric | |

3. Off-Gas

| | Average | Maximum |
|---|---|---|
| AN (design) | 127 lbs/hr | 140 lbs/hr |
| Water | 5804 lbs/hr | 6385 lbs/hr |
| $NH_3$ | nil | nil |
| Air | 6360 lbs/hr | 6996 lbs/hr |
| Temperature | 300°F | |
| Pressure | Atmospheric | |

The off-gas goes to the wet scrubber.

4. No additives are used.

5. AN emission is estimated at 127#/hr although no actual measurements are available. The off-gas goes to a scrubber where it is cleaned before being vented to the atmosphere. The scrubber liquid is recycled to the process and becomes part of the Concentrator feed.

6. Emission Control Technique

   The wet scrubber (Scrubber AA) controls emission from the evaporator.

7. Vents

   There are no vents from the evaporator to the atmosphere.

8. Operating Parameters Monitored

   a. The pH of the solution going to the evaporator is indicated.

   b. The flow of $NH_3$ to the evaporator feed for pH control is indicated.

   c. Solution flow to evaporator is indicated and controlled. The instrument is set by a liquid level indicator controller, which indicates level in AN 99% tank. In this way, the flow controller to the evaporator maintains the proper level in the 99% tank.

   d. The steam pressure in the steam chests of the evaporator and the evaporator air heater, is indicated and controlled.

   None of the above flows is recorded.

   Emissions to the atmosphere are controlled by the wet scrubber. However, too high an $NH_3$ concentration in the feed could increase the amount of $NH_3$ to the scrubber. Also, excessive air flow to the evaporator and possible excessive temperatures or flows to the evaporator would increase AN aerosol to the scrubber.

Plant #10 - Process Reference No. E-1068

The Concentrators for Plants #3 and #10 were made by the same company so the comments on Plant #3 will, in general, apply to Plant #10, except for capacity. The Concentrator in Plant #10 is a larger unit.

   a. Design Capacity: See Confidential Section

AN Production

1. Feed Rates to Concentrator

| | Average | Maximum |
|---|---|---|
| AN (100%) | See Confidential Section | |
| Water | | |
| Temperature | 275°F | |
| Pressure | Atmospheric | |

b. Product from Concentrator

| | Average | Maximum |
|---|---|---|
| AN (100%) | See Confidential Section | |
| Water | | |
| Temperature | 350°F | |
| Pressure | Atmospheric | |

c. Off-Gas

| | Average | Maximum |
|---|---|---|
| AN (100%)(design) | 50 lbs/hr | 55 lbs/hr |
| Water | 9422 lbs/hr | 10364 lbs/hr |
| Air | 6135 lbs/hr | 6749 lbs/hr |
| Temperature | 320°F | |
| Pressure | Atmospheric | |

# IV. SOLIDS FORMATION

## (B) Spherodizer (TM) Granulator

### Plant #3 - Process Reference No. K-3160

1. **Description**

Manufacturer: Fertilizer Engineering & Equipment Company, Inc.
Design Capacity: 300 TPD 34-0-0

The granulator is a cylinder-shaped rotary vessel 12 feet in diameter and 50 feet long and is divided into 2 sections - the front or spray section is the portion where the product is formed into spheres and the back or discharge section is where the spheres are cooled and hardened. Each section has lifting flights that lift and drop the product through a stream of air. Product is discharged from the granulator by lifting buckets at the end of the cooling section, through a chute at the top of the granulator. Molten AN is sprayed through multiple nozzles onto the granulator bed. Each spray nozzle is on a 1 inch pipe and these pipes are inside a steam jacketed pipe.

2. **Feed Rates**

| | |
|---|---|
| AN (100%) | 28487 lbs/hr |
| Water | 143 lbs/hr |
| Temperature | 345°F |
| Pressure | Atmospheric |

Droplets are formed by forcing the melt through spray nozzles under pressure.

3. **Air Flow**

a. **Inlet Air**

| | |
|---|---|
| Air rate | 169,200 lbs/hr |
| Water | 1,290 lbs/hr |
| Temperature | See Confidential Section |
| Pressure | Atmospheric |

b. **Outlet Air**

| | |
|---|---|
| Air rate | 169,200 lbs/hr |
| Water | 1,390 lbs/hr |
| AN (design) | 3,744 lbs/hr |
| Temperature | 185°F |
| Pressure | Atmospheric |

None of the outlet air is recycled.

4. Typical Particle Size Distribution of Product

| | |
|---|---|
| -6+7 mesh | 20% |
| -7+8 mesh | 58% |
| -8+9 mesh | 20% |
| -9+10 mesh | 2% |
| | 100% |

5. Additives

No additives are used.

6. The granulator is inclined and the solids are removed by tumbling out over a weir or dam at the end of the granulator. They discharge onto a grizzly bar arrangement which removes chunks that could possible plug chutes. The material is discharged onto a conveyor belt.

Normal bed temperature: See Confidential Section.
Moisture content: 0.5% (max. design basis)
Production Rate: 300 TPD 34-0-0.
Particle size distribution of the total stream is not measured. Particle size of product is -6 to +14 mesh. Oversize normally runs 5-20% and fines about 10%.

7. Granulation Variables

Controlling the granulator operation is based upon the amount of oversize and fines measured from the granulator discharge. Excessive amounts of either will result in low product rates becuase of high wet recycle. Oversize normally runs 5-20% and fines 10%. The main control indication of the granulator operation is the temperature of the bed. For best operation the temperature is controlled within a narrow range. There are five control variables affecting the bed temperature: (1) amount of material maintained in the spherodizer, (2) cooling air flow, (3) cooling air temperature, (4) molten nitrate flow rate, and (5) molten nitrate concentration. The bed temperature is recorded on a temperature recorder and the element is a thermocouple located on the end of the spray boom that extends several inches into the bed.

The bed level is controlled by the amount of recycle returning to the granulator. Fines, oversize and product make up the recycle. Product recycle is the only one that is controlled, and that is controlled by diverting a portion of the product from the sizing screens back to the granulator. The recycle rate is the difference between the weight of material coming from the granulator and the weight of the product going to the coater. A weight recorder records the weight of total material from the granulator and another recorder records the weight of product to the coater.

The recycle rate affects the bed temperature in the following manner: increasing the recycle rate will lower the bed temperature and lowering the recycle rate will increase the bed temperature.

High bed temperatures cause oversize. The bed in the granulating section, at the proper temperature, is kept in a semi-plastic state. If the bed temperature is allowed to get too high, then the material becomes more plastic. In this condition, the material, as it rools over and over, tends to stick together forming a conglomerate ball. Balls can form large enough to damage the spray boom. A low recycle rate is one cause of oversize. A low recycle rate can also result in bare lifters and not enough dry material to spray on. Experience has shown that, if the recycle rate is maintained at approximately 50-55%, the spherodizer operation will run well.

Low granulator bed temperature causes excessive fines. Fines can develop in the granulating section when the temperature of the bed is low, caused by high bed level, low air temperature, or high air flow. Excessive fines could be caused by any one or all of the above. When the temperature is too low the bed will not remain in a plastic state and the molten nitrate will flash freeze. The result will be an increased wet recycle and reduced production rate.

8. Operating Parameters Monitored

The bed temperature is continuously recorded on a temperature recorder.

The bed level is controlled in part by the amount of product recycle. This is controlled by diverting a portion of the product from the sizing screens back to the granulator.

The weight of product to the coater and the weight of material leaving the granulator are continuously recorded.

The air flow rate is controlled by adjusting the Scrubber solution level or by adjusting hand operated dampers on the Scrubber blower inlet. Too high an air flow will pull more material from the granulator than can be dissolved in the Scrubber solution. Low bed temperature can cause excessive fines, which increases the chance of entraining material and carrying it to the Scrubber.

9. Uncontrolled Emission Rates

Average of 4 measurements show the following dust loading in the air going from the granulator to the wet scrubber. Production rate was 275 TPD:

| | |
|---|---|
| AN | 3,494 lbs/hr |
| Air | 34,438 ACFM |
| Temperature | 190°F |

10. Emission Control Techniques

Proper operating conditions as discussed in this section will minimize emissions from the granulator. However, any emissions are trapped in the wet scrubber and are returned to the process.

Plant #10 - Process Reference No. E-1021

Manufacturer: Stansteel Corporation, Los Angeles, CA

1. Granulator design for Plants #3 and #10 is similar so the comments made above are also applicable to Plant #10. The only exception is that the Plant #10 granulator has a design capacity of 400 TPD. Also, some fines are separated in a breeching at the front of the spherodizer and are returned to the process.

2. Feed Rates

| | |
|---|---|
| AN (100%) | See Confidential Section |
| Water | |
| Temperature | 350°F |
| Pressure | Atmospheric |

3. Air Flow

a. Inlet Air

| | Winter | Summer |
|---|---|---|
| Air Rate | 158,000 lbs/hr | 195,900 lbs/hr |
| Water | 244 lbs/hr | 124 lbs/hr |
| Temperature | See Confidential Section | |
| Pressure | Atmospheric | Atmospheric |

b. Outlet Air

| | Winter | Summer |
|---|---|---|
| Air Rate | 168,200 lbs/hr | 206,100 lbs/hr |
| Water | 389 lbs/hr | 1,467 lbs/hr |
| AN (design) | 6,452 lbs/hr | 10,000 lbs/hr |
| Temperature | 178°F | 178°F |
| Pressure | Atmospheric | Atmospheric |

None of the outlet air is recycled.

4. Typical Particle Size Distribution of Product

| | |
|---|---|
| -6+7 mesh | 53% |
| -7+8 mesh | 45% |
| -8+9 mesh | 2% |

9. Uncontrolled Emission Rates

Average of 4 measurements show the following dust loading in the air going from the granulator to the wet scrubber. Production rate was 388 TPD.

| | |
|---|---|
| AN | 4,447 lbs/hr |
| Air | 53,140 ACFM |
| Temperature | 177°F |

## V. COOLER

### Plant #3 Process Reference No. E-306

1. **Description:**

Manufacturer: Edward Renneberg & Sons Co., Baltimore, MD.
Design Capacity: 300 TPD 34-0-0

The cooler is a horizontal rotary drum, 8 feet in diameter and 35 feet long. The inlet is slightly higher than the outlet. Product is fed into the inlet and flows countercurrent to chilled air. Air is drawn across tempering coils and pulled through the cooler by a blower (called a "Rotoclone"). The Rotoclone is actually a dust collector blower.

2. **Residence time of solids**

10 - 15 minutes.

3. **Cooling**

The unit is cooled by drawing air across cooling coils. The cooling coils are chilled by an $NH_3$ vaporization system.

4. **AN Flow**

AN inlet Temperature 140°F. (Design)
AN outlet Temperature 85°F. (Design)
Moisture Content 0.4-0.6% (Design)

5. **Air Flow**

a. **Inlet Air**

| Inlet Air | Winter | Summer |
|---|---|---|
| Air Rate | 53,400 lbs/hr | 71,921 lbs/hr |
| Water | - | 455 |
| Temperature | 40°F | 55°F |

b. **Outlet Air**

| Outlet Air | Winter | Summer |
|---|---|---|
| Air Rate | 53,400 lbs/hr | 71,921 lbs/hr |
| Water | - | 455 lbs/hr |
| AN (design) | 245 lbs/hr | 245 lbs/hr |
| Temperature | 95°F | 97°F |

6. **Operating Parameters Monitored**

Air temperature to the Cooler is indicated and controlled. Air temperature leaving the Cooler is indicated. Weight of product from the Cooler is continuously recorded.

Too high an air flow would increase the amount of AN solids carried to the rotoclone.

7. Emissions from Cooler to Rotoclone

No actual measurements are available. Design to Rotoclone was 245 #/Hr. AN.

8. Emissions Control

Emissions to atmosphere are controlled by the Rotoclone.

Plant #10 - Cooler - Process Reference No. E-1024

1. Description

Manufacturer: Strong Scott Mfg. Co., Minneapolis, Minnesota
Design Capacity: 400 TPD 34-0-0

Mechanically, a fluid bed consists of a long narrow box separated into two parts by a plate perforated by thousands of 1/32 inch diameter holes called a bed plate. Air is pushed through the inlet duct into the bottom of the box called the inlet plenum, up through the bed plate, and through the bed of solid particles into the outlet plenum. It is then sucked out through a blower in the outlet duct. Hot solids drop into one side of the long narrow box and displace the fluidized particles along the bed causing material to spill over the end of the bed plate and out the outlet chute.

To eliminate the need for seals on the inlet and outlet chutes, a push/pull blower system is used. The push blower sucks in outside air across an ammonia chilling coil, which cools the air. The blower supplies just enough pressure to push the air up through the bed sheet and bed. The pressure above the bed should be atmospheric. A pull blower is then needed to provide the motive force to suck the air off the top of the bed and discharge it. Adjusting the dampers on the suction side of the push and pull blowers controls the air flow. The pressure drop across the bed and the outlet plenum pressure is checked and dampers adjusted accordingly. If the air flow rate across the bed is restricted, the bed will collapse and the inlet side of the bed plate will fill up.

2. Residence time of Solids

Approximately 1 minute.

3. Cooling

The unit is cooled by drawing air across cooling coils. The cooling coils are chilled by an $NH_3$ vaporization system.

4. AN Flow

| | |
|---|---|
| AN inlet temperature | 140°F |
| AN outlet temperature | 90° |
| Moisture Content | 0.4 - 0.6%(Design) |

5. Air Flow

a. Inlet Air

| | Winter | Summer |
|---|---|---|
| Air Rate | 106,822 lbs/hr | 132,607 lbs/hr |
| Water | 165 lbs/hr | 1,126 lbs/hr |
| Temperature | 76°F | 82°F |

b. Outlet Air

| | Winter | Summer |
|---|---|---|
| Air Rate | 106,822 lbs/hr | 132,607 lbs/hr |
| Water | 165 lbs/hr | 1,126 lbs/hr |
| AN (Design) | 0.1 gr per SCF* | |
| Temperature | 102°F | 103°F |

* It is estimated that this grain loading is met.

6. Operating Parameters Monitored

The product temperature from the cooler is recorded continuously. Product weight from the cooler is recorded continuously. The air temperature to the cooler is indicated and controlled to give the desired product temperature.

Assuming air flow is kept within reasonable limits, there are no variables which should appreciably increase the amount of dust going to atmosphere from this unit.

7. Emissions

It is estimated that AN emissions to atmosphere will not exceed 0.1 grain per SCF. No actual measurements are available.

8. Emission Control

No additional emission controls are necessary.

## VI. COATER

### Plant #3 - Process Reference No. K-312

1. Description

Manufacturer: Edward Renneberg & Sons Co., Baltimore, MD. Thirty five lbs. of Celatom coating agent is used per ton of product. The coating agent is added to the product as it tumbles in a rotating drum.

2. Handling of Coating Agent

Coating Agent Transfer

Celatom is received by bulk railcars and trucks, then stored in a silo outside Plant #3 and Plant #10 buildings. It is then penumatically transferred into storage hoppers inside the plants. The hopper for Plant #3 is equipped with a bin activator. The hopper may also be called a live bottom hopper. Live bottom means the bottom portion of the hopper moves in a circular motion. The purpose of the "live bottom" is to prevent bridging of material in the hopper. The exhaust air vented from the hopper passes through a small bag dust collector.

Celatom is transferred from the storage silo to the plant hopper in the following manner:

A. The operator first determines the number of batches needed to fill the hopper to the desired level.

B. The batch preselect counter, located on the plant control panel, is set for the number of batches needed.

C. Start the transfer.

D. The transfer of Celatom is as follows:

1. First is the fill mode. In this mode, Celatom falls from the silo through two butterfly valves into a conveyor fluidizing pump. This continues until the pump reaches a set weight of Celatom to be transferred per batch. When this weight is reached, the two butterfly valves from the silo close.

2. Second - Air is blown into the pump to fluidize the Celatom. The pump is pressurized.

3. Third - The discharge valve opens and the fluidized Celatom is pneumatically blown to the plant hopper. Then the pump drops to a set pressure.

4. The fourth mode starts. At this time, the discharge and air valves both close. A purge valve then opens to blow any Celatom that is left in the transfer line into the plant hopper.

The above is the sequence that the system goes through for the number of batches selected, i.e., if ten batches are dialed on the pre-select instrument, then the transfer sequence is repeated ten times. Each transfer of a single batch takes approximately six minutes to complete. The fill mode takes 1 minute, activate 1/2 minute, discharge 4 minutes and purge 1/2 minute.

E. Coating Agent Control

The coating agent feed control system consists of: (1) Coater product feed scale, (2) coating agent screw conveyor and gyrator, and (3) coating weigh belt. A board mounted controller receives the product weight signal and based on the set point then varies the speed of the screw conveyor to bring the proper amount of coating agent to the coating weigh belt.

3. Uncontrolled Emission

No data is available on emission between the coating drum and the dust collector.

4. Emission Control

An exhaust fan draws air containing coating agent from the coating drum through a dust collecting bag house. The dust is then returned to the process.

Plant #10 - Process Reference No. K-1025

Manufacturer: Stansteel Corp., Los Angeles, CA

The coater in Plant #10 operates the same as that in Plant #3. The only difference is in the design rate. The coater in Plant #3 has a design rate of 300 TPD 34-0-0. That in Plant #10 has a design rate of 400 TPD.

# VII. CONTROL EQUIPMENT

## Plant #3 - Dust Collector Rotoclone - Reference No. KK

1. **Description**

Manufacturer: American Air Filter
Size and Type: Size 24; Type W.

The Rotoclone receives dust laden air from the cooler. The Rotoclone is actually a dust collector blower. It collects dust from the cooler air and returns it to the process. The exhaust is discharged to atmosphere. A small flow of water is pumped from the dust sump (T-305) into the center and outside edge of the Rotoclone blades. Dust, carried in the air stream, is dissolved in the water. This weak nitrate solution goes through a small cyclone in the exhaust line where the solution drops out and drains back to the dust sump. Part of this solution is then fed to the Joy Wet Scrubber. Any make-up water required is added to the dust sump.

2. The Rotoclone controls exhaust from the cooler (Ref. E-306)

3. **Gas Streams**

A. Air Stream from Cooler to Rotoclone

| | Summer |
|---|---|
| Air Rate | 71,921 lbs/hr |
| Water | 455 lbs/hr |
| AN (design) | 243 lbs/hr |
| Temperature | 97°F |

B. Exhaust from Rotoclone

| | Summer |
|---|---|
| Air Rate | 71,921 lbs/hr |
| Water | 709 lbs/hr |
| AN (0.1 grain per SCF*) | |
| Temperature | 81°F |

* It is estimated that this grain loading is met. No actual measurements are available.

4. **Liquid Streams**

A. AN Solution from Dust Collector Sump

| | |
|---|---|
| Water | 8,260 lbs/hr |
| AN (design) | 436 lbs/hr |
| Temperature | 77°F |

B. AN Solution Back to Dust Sump

| | |
|---|---|
| Water | 8,006 lbs/hr |
| AN (design) | 671 lbs/hr |
| Temperature | 81°F |

C. Scrubbing Medium: AN Solution

D. Liquid to Gas Ratio: Liquid to gas ratio is about 0.11 to 1 by weight.

E. AN Concentration in Scrubbing Liquor: Approximately 5% AN.

F. Fraction of Liquor Recycled: All liquor is recycled for recovery of AN.

G. Liquor Temperature: Design is 77°F.

5. Parameters Monitored

Scrubbing water to the rotoclone is controlled by a rotameter. Hourly checks are made to assure that water is being sprayed into the Rotoclone.

6. Effect of Parameters on Efficiency

If there is no water to the Rotoclone, the dust will not be dissolved and will be exhausted to atmosphere.

7. Stack

There is a 36" x 20' stack going through the roof from the Rotoclone.

Plant #3

A. Wet Scrubber - Process Reference No. - Scrubber FF

1. Description

Manufacturer: Joy Manufacturing Co.
Model No: Type T "Turbulaire".
Date of Installation: 1969.

During operation, air from the granulator carries small particles of ammonium nitrate. These enter the scrubber and are directed down to the solution level through four round tubes. The tubes extend almost to the solution level and as the air passes by a cone in the bottom of each tube the velocity of the air increases, causing the air and dust to penetrate the solution. The nitrate is dissolved. The solution in the scrubber is kept slightly acidic so that any ammonia vapor is absorbed. The driving force for the air is provided by the scrubber blower.

2. Process Equipment Controlled

The Joy Scrubber removes and reclaims small AN particles from the granulator (K-3160) air stream and $NH_3$ vapors from the evaporator (E-304). Also, tramp dust from other equipment (elevators, etc.) is transferred to the scrubber along with the granulator air.

3. Gas Streams

a. Air Stream from Granulator to Scrubber

| | Summer | Winter |
|---|---|---|
| Air Rate | 168,200 lbs/hr | 150,000 lbs/hr |
| Water | 1,390 lbs/hr | - |
| AN | 3,744 lbs/hr | 3,744 lbs/hr |
| Ammonia | - | 65 lbs/hr |
| Temperature | 185°F | 185°F |

b. Air Stream from Evaporator to Scrubber

| | |
|---|---|
| Air Rate | 6,360 lbs/hr |
| Water | 5,725 lbs/hr |
| AN | 121 lbs/hr |
| Temperature | 300°F |

c. Exhaust from Scrubber

| | Summer | Winter |
|---|---|---|
| Air Rate | 176,730 lbs/hr | 156,360 lbs/hr |
| Water | 7,300 lbs/hr | 7,300 lbs/hr |
| AN | (o.1 grain per SCF*) | |
| Temperature | 112°F | 115°F |

* It is estimated that this allowable grain loading is met.

No data is available on particle size distribution.

Pressure drop at the Scrubber is between 8" and 10" of water.

4. Liquid Streams

a. AN Solution from Dust Collector Sump

There is a dust collector sump in the system. This sump contains water and dissolved AN which is collected from the cooler dust collector (Rotoclone). This liquid from the sump contains about 5% AN and is split into two parts. Part is recirculated through the cooler dust collector and part goes to the wet scrubber.

4. b. Liquid from Scrubber Back to Neutralizer

Liquid from the Scrubber is returned to the Neutralizer for recovery of AN.

| | |
|---|---|
| Water | 1,674 lbs/hr |
| AN | 3,907 lbs/hr |
| Temperature | 110°F (min) |

c. Scrubbing Medium: AN Solution.

d. Liquid to Gas Ratio: Not applicable. This is an impingement type scrubber.

e. AN Concentration in Scrubbing Liquor: Normal scrubber concentration is about 70% AN.

f. Fraction of Liquid Recycled: All liquor is recycled to neutralizer.

g. Liquor Temperature: 110° minimum.

h. Liquor Level Limits: Air flow rate is dependent upon requirements of the granulator operation and is controlled by the liquid level in the scrubber. Normal air flow from the granulator is in the range of 168,000 to 178,000 #/hr.

5. Parameters Monitored

The operation of the Joy Scrubber is controlled by adjusting air flow, solution concentration, scrubber solution level and solution pH.

Air flow rate is dependent upon requirements of the granulator operation needs and is controlled by the level and/or blower inlet damper setting. Normal air flow from the granulator is 168,000 to 178,000 lbs/hr.

Scubber level is controlled by pumping scrubber solution to the neutralizer through a recycle heater. The level is set by a level indicator-controller. There are two scrubber solution pumps; one is used at all times during operation and the other is an in-line spare. These pumps provide four functions in the scrubber operation: (1) transfer liquid to the neutralizer, (2) provide liquid flush to the scrubber inlet tubes, (3) provide make-up water to the scrubber, and (4) provide a sample stream to the pH analyzer.

The scrubber solution concentration is measured by a nuclear density meter and is cascaded with a water make-up controller. Concentration will normally be set to control the concentration at approximately 70%.

6. Effect of Parameters on Efficiency

If pH gets too high, $NH_3$ will escape. If air flow is too great, excessive entrainment may occur to the scrubber.

7. Stack Dimension

| | |
|---|---|
| Diameter: | 45 inches |
| Height: | 69 feet |

8. Measured Emissions from Granulator to Scrubber

Average of 4 readings taken by Isokinetic Sampling

| | | |
|---|---|---|
| Air rate | 27,230 | SCFM (dry) |
| Temperature | | 190°F |
| Grain loading | 15.0 | gr/dry SCF |
| Product rate | | 11.48 tons/hr |

Plant #10

Wet Scrubber - Process Reference No. - Scrubber AA

This scrubber was manufactured by the same company as the unit for Plant #3, so the method of operation and control is the same. Flow rates, however, are different because of plant size. The unit was installed in 1978.

3. Gas Streams

a. Air Stream from Granulator to Scrubber

| | Summer | Winter |
|---|---|---|
| Air rate | 206,100 lbs/hr | 168,200 lbs/hr |
| Water | 1,467 lbs/hr | 389 lbs/hr |
| AN | 10,000 lbs/hr | 6,452 lbs/hr |
| Temperature | 178°F | 178°F |

b. Air Stream from Evaporator to Scrubber

| | Summer | Winter |
|---|---|---|
| Air rate | 6,135 lbs/hr | 6,135 lbs/hr |
| Water | 9,503 lbs/hr | 7,962 lbs/hr |
| AN | 50 lbs/hr | 50 lbs/hr |
| Temperature | 320°F | 320°F |
| Pressure | atmospheric | atmospheric |

c. AN Tank Vents and Air Sweep from Elevators, etc.

| | Summer | Winter |
|---|---|---|
| Air rate | 13,139 lbs/hr | 13,139 lbs/hr |
| Water | 112 lbs/hr | 20 lbs/hr |
| Temperature | 98°F | 45°F |

d. Exhaust from Scrubber

| | Summer | Winter |
|---|---|---|
| Air rate | 229,374 lbs/hr | 191,474 lbs/hr |
| Water | 14,137 lbs/hr | 11,499 lbs/hr |
| AN | (0.1 grains per SCF*) | |
| Temperature | 131°F | 130°F |

*It is estimated that this allowable grain loading is met.

No data is available on particle size distribution.

Pressure drop at the Scrubber is between 8" and 10" of water.

4. Liquid Streams

a. Liquid from Scrubber Back to Neutralizer

| | Summer | Winter |
|---|---|---|
| Water | 4,289 lbs/hr | 3,273 lbs/hr |
| AN (design) | 10,007 lbs/hr | 6,468 lbs/hr |
| Temperature | 129°F | 128°F |

b. Scrubbing Medium: AN Solution.

c. Liquid to Gas Ratio: Not applicable. This is an impingement type scrubber.

d. AN Concentration in Scrubbing Liquor: Normal Scrubber concentration is about 70% AN.

e. Fraction of Liquor Recycled: All liquor is recycled to neutralizer.

f. Liquor Temperature: 110°F minimum.

g. Liquid Level Limits: Air flow rate is dependent upon requirements of the granulator operation and is controlled by the liquid level in the scrubber. Normal air flow is in the range of 191,000 to 229,000 lbs/hr.

7. Stack Dimension

| | |
|---|---|
| Diameter: | 6 feet |
| Height: | 100 feet |

8. Measured Emissions from Granulator to Scrubber

Average of 3 Readings Taken by Isokinetic Sampling

| | | |
|---|---|---|
| Air rate | 42,915 | SCFM (dry) |
| Temperature | | 177°F |
| Grain loading | 12.1 | gr/dry SCF |
| Product rate | | 16.18 T.P.H. |

B. Mist Eliminators

Plant #3

1. Demister pad No. HH

Manufacturer: Otto H. York & Co., Parsippany, NJ
Style: 421 with top and bottom grids.
Dimensions: 20" O.D. by 6" thick.
This unit removes mist from neutralizer - (T-301)

2. Demister pad No. JJ

Manufacturer: Metal Textile Corp.
Style: Metex Open Density Herringbone
Dimensions: 36" O.D. by 6" thick.

This unit removes mist from concentrator No. E-304.

Plant #10

1. Demister Pad No. CC

Manufacturer: Otto H. York & Co.
Style: 421
Dimensions: 43" dia. x 8" thick.

This unit removes mist from Neutralizer No. T-1062.

2. Demister Pad No. EE

Manufacturer: Otto H. York & Co.
Style: 421
Dimensions: 6" thick.

This unit removes mist from the Concentrator No. E-1068.

3. Demister Pad No. BB

Manufacturer: ACS Industries, Woonsocket, RI
Dimensions: 30" x 53" x 6" thick

This unit removes mist from the Scrubber No. AA.

C. Bag Filters

Plant #10

1. Coating Agent Dust Collector No. DD

Manufacturer: Flex-Kleen Corp., Chicago, IL
Type: 84-WRA-64 (III)
Installed: 4/26/78

2. This bag filter controls dust from the coating agent drum K-1025.

3. 

| | |
|---|---|
| Gas Flow: | 3440 ACFM |
| Air to Cloth Ratio: | 5.38/1 |
| Operating Pressure | 15.8" W.G. neg. |
| No. of bags: | 64 |
| Cloth area: | 640 sq.ft. |
| Operating Temperature | 98°F |
| Bag Material: | Polyester Felt |

4. Frequency of bag replacement: Have not been replaced since installation.

5. No emission measurements available.

6. Stack: 12" dia. by 22' - 6" long (Approximately 13' of this length is in a horizontal run.)

C. Bag Filters

Plant #3

1. Coating Agent Dust Collector No. KK

Manufacturer: Flex-Kleen Corp., Chicago, IL
Type: 100-WRC-64 (III)
Installed: 9/25/78.

2. This bag filter controls dust from the coating agent drum K-312.

3. 

| | |
|---|---|
| Gas Flow: | 3040 ACFM |
| Air to Cloth Ratio: | 3.96/1 |
| Operating Pressure: | 15" W.G. Neg. |
| No. of bags: | 64 |
| Cloth area: | 768 |
| Operating Temperature: | 100°F |
| Bag Material: | Polyester Felt |

4. Frequency of bag replacement: Have not been replaced since installation.

5. No emission measurements available.

6. Stack: 15" x 6' tall.

## X. ENERGY CONSUMPTION

1. Total energy consumption excluding pollution control equipment.

   Plant #10

   4030 kw hr/day electricity
   $4.0 \times 10^8$ Btu/day steam
   Production rate 400 TPD

   Plant #3

   5015 kw hr/day electricity
   $2.6 \times 10^8$ Btu/day steam

   This data is estimated. No measurements are available.

2. Energy consumption for pollution control systems.

   Plant #10

   4300 kw hr/day electricity. No further breakdown is available.
   Production rate - 400 TPD.

   Plant #3

   3500 kw hr/day electricity.

   This usage is estimated. No measurements are available.

## XI. COST INFORMATION

### Plant 3

A. (1 and 2) Cost of Systems to reduce air pollution

| Equipment | Materials of Construction | Equip. Cost | Installed Cost | Purchase Date | |
|---|---|---|---|---|---|
| Scrubber (Roto-clone & Joy Scrubber) | 304 SS | * | | 1968 | Retrofitted |
| Dust Collection Ducts | 304 SS | $ 2,000 | $ 5,000 | 1959 | Original |
| Scrubber Stack | FRP | $ 8,000 | $13,000 | 1976 | Retrofitted |
| Baghouse | CS | $ 8,250 | $53,000 | 1977 | Replaced Original |
| Cond. Pump & System | 304 SS | $79,000 | $118,000 | 1976 | Retrofitted |

* Scrubbers part of 1968 expansion by C&I Girdler. We have no cost.

A. (3) Annual operating costs for above equipment = $85,000

### Plant 10

A. (1 and 2) Cost of Systems to reduce air pollution

| Equipment | Materials of Construction | Equip. Cost | Installed Cost | Purchase Date |
|---|---|---|---|---|
| Joy Scrubber | 304SS | $125,000 | $375,000 | 1977 |
| Scrubber Stack (est) | FRP | $ 18,000 | $ 36,000 | 1977 |
| Coating Agent Baghouse | CS | $ 12,000 | $ 24,000 | 1977 |
| Dust Collection Ducts | 304SS | $ 80,000 | $160,000 | 1977 |

All equipment is part of an original plant

A. (3) Annual operating costs = No actual data is available, and there is insufficient operating experience to make a good estimate.

# POLLUTION CONTROL EQUIPMENT
# PRODUCT SAVED

I. Plant 3

A. Joy Scrubber

3800 #/hr A.N. (design) (assume 300 TPOD rate)

* (3800 #/hr)($68.92/ton)(1/2000 #/ton)(8160 hrs/yr) = $1,068,535/yr.

B. Neutralizer Condenser

1605 #/hr A.N. (assume 300 TPOD rate)

(1605 #/hr)($68.92/ton)(1/2000 #/ton)(8160 hrs/yr) = $451,133/yr.

C. Celatom Dust Baghouse

385 #/hr max. (design of original B.H.)

179 #hr min. (design of original B.H.)

High - (385 #/hr)($68.38/ton)(1/2000 #/ton)(8160 hrs/yr) = $107,411/yr.

Low - (179/hr)($68.38/ton)(1/2000 #/ton)(8160 hrs/yr) = $49,939/yr.

II. Plant 10

A. Joy Scrubber

Summer - 9,957 #/hr A.N. (design)

Winter - 6,418 #/hr A.N. (design)

Summer - (9,957 #/hr)($68.92/ton)(1/2000 #/ton)(7920 hrs/yr) = $2,716,400/yr.

Winter - (6,418 #/hr)($68.92/ton)(1/2000 #/ton)(7920 hrs/yr) = $1,750,914/yr.

B. Celatom Dust Baghouse

80-800 lb/hr (design for rotary valve)

AVG = (440 #/hr)($68.38/ton)(1/2000 #/ton)( 920 hrs/yr) = $119,145/yr.

Value of A.N. = $68.92/ton. Value based on out-of-pocket cost.

Excludes indirect and fixed costs.

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Value of Celatom = $68.38 /Ton

* Basis

1978 performance of Plants 3 and 10

Op. Days/Year -

| Plant | Days | Hrs. (Days x 24) |
|---|---|---|
| 3 | 340 | 8160 |
| 10 | 330 | 7920 |

XI. C.

| | Date Installed | Capitalized Value |
|---|---|---|
| Plant 3 | 1969 | $2,895,000 |
| Plant 10 | 1977 | 5,500,000 |
| | | $8,395,000 |

Total annual operating cost for both plants = $1,750,000 (excludes raw materials but includes depreciation and taxes.)

## XII. MODIFICATION/RECONSTRUCTION

There are no plans for modification or reconstruction of existing A.N. facilities within the next 5 years.

## XIV. GENERAL OPERATION

A. Production Equipment

1. Periodic maintenance includes lubrication of equipment and calibration of instruments.

2. Most troublesome equipment relative to breakdowns are elevators and pumps.

   Most common equipment malfunctions are - usual plugging problems associated with solid and slurry handling equipment.

   Most common cause of upsets is occasional instrument failure.

3. 83% A.N. plug valves have to be replaced yearly. (Only the valve internals are replaced.

4. There are no normal breakdowns but abnormal situations occasionally occur as listed in item 2 above.

5. Factors influencing the choice of major processing units were costs, emissions and product specifications.

6. If EPA promulgated a standard for new sources based on types of processes with low uncontrolled emission rates in conjunction with control equipment (e.g. granulation instead of prilling), there would be no effect on our ability to produce a marketable product as our A.N. plants are presently producing granulated product. Our customers are accustomed to the present quality of granulated product.

7. There are less pollutants emitted to the atmosphere from an MCC type neutralizer as used in Plant #10 than there are from a tank type neutralizer as used in Plant #3.

8. We would expect that uncontrolled emissions from solution forming and concentration steps would be greater for a 99+%A.N. melt than for a 95% A.N. melt.

9. Uncontrolled emissions would be affected by the number and type of solution forming and concentration steps used to produce a 99+% A.N. melt.

10. We have no experience to make comparison of emission potential of different AN coating materials.

11. We would expect a significant difference in the amount of coating applied at different plants because of difference in product quality, marketing requirements, types of coating agents used, and atmospheric conditions of marketing area.

B. Emission Control Equipment

1. Lubrication is performed periodically on emission control equipment.

2. All materials from emission control equipment are recycled.

3. Visual stack opacity measurement by trained personnel is the primary means of checking operation of the control units for proper efficiency. Instrumentation around the scrubber indicates scrubber concentration (density) and make-up water flow rate. These are important for proper operation of the scrubber.

4. The principal control device is the Joy Scrubber. It was purchased because it represented the state of the art at the time of design of Plant 10. It was added to Plant 3 to increase reclamation of product. Reasonable cost and the fact that the vendor supplying the equipment gave a performance guarantee were other factors.

5. We have no experience with solid urea plants.