

# IFA Technical Conference

**New Orleans, Louisiana, USA  
1-4 October 2000**

## **GRANULATION KT'S PROGRESS USING FLUIDIZED DRUM GRANULATION (FDG) TECHNOLOGY**

Denis LAUCHARD\*, Marie-Astrid KORDEK\*\*  
Kaltenbach-Thuring S.A, France

KT a une grande expérience de l'industrie des engrais et a mis au point sa technologie de granulation applicable maintenant à plusieurs types d'engrais.

Les procédés de granulation KT sont décrits avec les principaux avantages offerts par cette technologie.

Plusieurs produits nouveaux ont été granulés en atelier pilote et nous présentons ci-après certains de nos nouveaux développements tels que :

- Granulation en FDC de solution d'urée à 95 – 96%
- Granulation de nitrate d'ammonium poreux
- Granulation de soufre dégradable

Des détails sur des unités réceptionnées récemment utilisant la technologie FDG seront présentés :

- Kutina en Croatie
- Agronitrogenados au Mexique
- Hankook en Corée

### ***ABSTRACT***

Kaltenbach-Thuring has a wide experience in the fertilizer industry and has developed its granulation technology which is now applicable to several fertilizer products.

KT granulation processes will be described together with the main advantages offered by this technology.

Several new products have been granulated in the pilot plant and we are presenting hereunder some of our new developments such as :

- 95-96% urea solution granulation in FDG
- Porous ammonium nitrate granulation
- Degradable sulfur granulation

Details on recently commissioned plants using FDG technology will be developed :

- Kutina in Croatia
- Agronitrogenados in Mexico
- Hankook in Korea

## **1 - KT HISTORY IN THE FERTILIZER GRANULATION SECTOR**

The activities of Kaltenbach-Thuring (KT) have been well known in the fertiliser industry for decades.

In fact, Kaltenbach-Thuring was created in 1976 by merging of Kaltenbach and Serice Thuring companies existing respectively since 1903 and 1962.

Kaltenbach-Thuring experience first started with achievements in the nitrogen industry at the beginning of the century and has been extended to all the products used in fertiliser industry and in various fields of chemistry and related plants such as handling, crushing, leading to recognised know-how and experience together with a large list of references in more than 20 countries all over the world.

We can offer a wide range of services :

- process and basic engineering package
- detail engineering
- equipment supply
- turn-key plant

As far as ammonium nitrate is concerned, we are proud of having the largest references list in the world. In addition to fertiliser grade products, we offer a specially easy to operate and reliable process for production of industrial porous ammonium nitrate.

Furthermore, Kaltenbach-Thuring has reinforced its development department for pursuing research and development of new processes in a laboratory and a pilot plant that is unique in the world.

One of the technologies developed in the pilot plant is the Fluidized Drum Granulation (FDG) which already has numerous industrial references in rounding up or fattening, or granulating of several products such as urea, ammonium nitrate, calcium ammonium nitrate, ammonium sulfate, sulfur, etc....

## **2 – BRIEF DESCRIPTION OF KT'S CURRENT GRANULATION PROCESS (FDG)**

The heart of the process is a cylindrical granulating drum, fitted internally with lifters. The drum rotates about its axis in a conventional manner, but differs from the conventional drum granulator by having an internal fluidized bed (see figure). This comprises a flat, slightly inclined, perforated plate through which fluidizing air is blown. In some cases air can be used directly from the atmosphere ; in other cases prior air conditioning is required.

Seed material, which may be recycled off-size, prills or compacted product requiring rounding off, is fed to the granulator and subjected to size enlargement and cooling/drying. This occurs progressively in a cyclical sequence.

The lifters raise the seed material to the upper part of the drum, whereupon it falls onto the surface of the fluidized bed and is cooled or (when the feed material is a slurry) dried. Product flows down the inclined base of the bed and falls into the lower part of the drum, where it is sprayed with the feed melt or slurry. The coated granule is then lifted back to the

fluidized bed, where the new surface layer solidifies by cooling or evaporation of its moisture content. The same cycle is then repeated as many times as necessary to reach the desired grain size.

Various additives such as fillers or micronutrients can be added to the feed melt or slurry.

An external fan draws air out of the granulator.

### **3 – KT's PROCESS MAIN ADVANTAGES**

FDG technology is now a mature process giving high quality products with great roundness, high impact resistance and low caking tendency.

The main advantage of this process is its universal character which allows to use this technology to granulate any type of products provided it can be molten, dissolved or suspended in the form of a pumpable liquid or slurry.

KT has references in granulating the following products : urea, CAN, AN, calcium nitrate, ammonium sulfate, lysine, caprolactam purge (oxime and lactame).

An impressive list of other products has been tested successfully in our pilot plant among which we can quote : sulfur, sulfur + swelling agent, sulfur coated urea, urea formaldehyde resin, potassium nitrate, magnesium chloride, starch.

Another very important advantage is the possibility to use the FDG as a coater. By passing a product once through the FDG, a melt can be sprayed on the entering particules to make a composite product, for example :

- Urea coated with sulfur,
- TSP coated with sulfur,
- AS crystals coated with purge from caprolactam plant,
- AS crystals coated with ammonium nitrate melt plant,
- AS crystals coated with sulfate urea slurry,
- PK granules coated with nitrogen containing melt or slurry, etc...

The ratio between the core and the coating material can vary as required (between 0 and 100% of the input).

Nutrients and micronutrients can be fixed by layering on granules surface and to become available for the plants.

By this process, a slow release or controlled release fertiliser can be produced by selecting an appropriate coating product. Sulfur is a typical product for this purpose.

A particular case is the coating of urea (or ammonium nitrate) by the melt or solution of the same product. This process is generally called fattening (Figure 1).

The core is supplied by prills from an existing prilling tower and a part of the solution is spread in the FDG instead of being prilled.

Fattened urea prills compete on the international scene with products obtained from conventional granulation plants which require a much higher investment cost.

The fattening process reduces dust emissions from the prilling tower by approximately 40% and improves the hardness and friability. The enlargement of prills by FDG enables the weight of prills to be multiplied by a factor ranging from two to five.

Assuming an existing plant giving prills with a diameter of 1.6 mm at the bottom of the prilling tower, installation of the fattening process will enable to increase the mean diameter to increase to 2.1 mm at the bottom of the tower. The prills are then fattened further in the FDG to reach a mean diameter of 2.7 mm.

Although the product size is not as large as granules, the investment cost is about 40% lower than for a full granulation plant. Therefore, this technology allows to produce a product acceptable for bulk blending at a reduced price.

#### **4 - RECENT IMPROVEMENTS AND NEW DEVELOPMENTS AT R&D STAGE**

Last year, R&D activities have mainly been directed in the following fields :

- Granulation of urea starting from 95-96% FDG without further drying,
- Production of granulated porous ammonium nitrate with FDG technology,
- Degradable sulfur granulation.

##### **4.1. 95-96% UREA SOLUTION GRANULATION IN FDG (FIGURE 2)**

A recent development in KT's pilot plant now allows to propose granulation of urea from 95-96% urea solution.

Based on the pure urea granulation process, new operating parameters have been determined to use a 95-96% urea solution.

\* Main advantages :

- Reduction of steam consumption by deleting final evaporator,
- Reduction of air flow by water evaporation during crystallisation,
- Reduction of biuret by handling a more dilute solution.

\* Results :

- Steam saving in evaporation section : 20 to 25% in the case of pure granulation, 10 to 12% in the case of prills fattening,
- Air flow saving in FDG : 30 to 40%,
- Final product humidity : 0.2%.

##### **4.2. POROUS AMMONIUM NITRATE GRANULATION (FIGURE 3)**

KT patented this new process using FDG to produce porous ammonium nitrate granules.

The use of an additive allows to get a dry product at the FDG output without passing through a dryer.

\* Main advantages :

- No more prilling tower,
- Less air to scrubber and better pollution control,
- Lower unit price.

\* Results :

- Final product humidity : 0.25%
- Density : 0.7 - 0.8
- Granulometry : 90% between 1.7 and 2 mm
- Oil absorption : 8%

### 4.3. DEGRADABLE SULFUR GRANULATION (FIGURE 5)

The lack of sulfur in soils has involved an increasing demand in fertiliser containing sulfur. Pure sulfur granules need too much time to be transformed in sulfate ions directly available for plants. Swelling agent in sulfur granule in presence of water allows to burst out granules in fine particles which are easily oxidised in sulfate ions by micro organism.

Price for degradable sulfur granules can be estimated to 300 USD/t.

\* Main advantages :

- Round granules,
- Can be used for bulk blending,
- Not dusty.

\* Results :

- |                        |   |                                   |
|------------------------|---|-----------------------------------|
| Moisture               | : | 0,15%                             |
| Friability             | : | 0,89% (according to Sudic method) |
| Crushing strength      | : | 3,3 kg                            |
| Time to dispersibility | : | < 24 hours                        |
| Tapped density         | : | > 1240 kg/m <sup>3</sup>          |

## 5- DETAILS ON RECENTLY COMMISSIONED PLANTS USING THE FDG TECHNOLOGY

### 5.1. AGRO NITROGENADOS (MEXICO) : UREA GRANULATION

The plant has been commissioned on May 1998. It has been designed for 1875 MTPD. The FDG process is using prills as seed material instead of crushing and screening techniques.

\* Results :\* Utilities consumption :

Steam (kg/ton of final product) : 12 (21 bar abs)  
 Electricity (kWh/ton of final product): 23 (including the air conditioning unit)

\* Urea granules characteristics :

Size distribution : 90% between 2.4 and 4.5 mm  
 Mean diameter (mm) : 3.0 - 3.1  
 Moisture (%) : 0.2  
 Hardness (kg) : 2 to 3

Physical aspect : Round smooth particles

## **5.2. HANKOOK (KOREA) : AMMONIUM SULFATE/AMMONIUM NITRATE (ASN) GRANULATION FROM CAPROLACTAM PLANT PURGES**

This plant has been commissioned on September 1999. It has been designed to granulate a by-product from a caprolactam plant which is a mixture of ammonium sulfate, ammonium nitrate, water and organics (oxime purge).

It has replaced a costly existing system of disposal consisting in calcination mainly.

Producing granules used for bulk blending, this process allows to add value to the purges and save cost.

The by-product to granulate has the following approximate composition :

AS : 20%  
 AN : 30%  
 Water : 50%

The plant capacity is 65 MTPD of granulated product.

\* Results :\* Utilities consumption :

LNG (Kcal/ton of final product) : 1 200 000  
 Electricity (kWh/ton of final product): 200

\* ASN granules characteristics :

Size distribution : 80% between 2 and 2,85 mm  
 Moisture (%) : 0.3

Hardness (kg) : 1

Physical aspect : round smooth particles

\* Effluents :

Gaseous effluent : 10 ppm ASN dust

## **6 - KUTINA STARTING-UP AND COMMISSIONING**

### **6.1.PETROKEMIJA KUTINA SITUATION BEFORE THE REVAMPING, OBJECTIVES OF THE REVAMPING AND TECHNOLOGY SELECTION**

Petrokemija Kutina is a well known fertilizer producer in Croatia. Petrokemija has a production capacity of 1.5 million tons that ranks it among medium sized European and world producers of mineral fertilizers.

Petrokemija had a CAN prilling plant designed by KT in operation for more than thirty years. In that plant, the 95% ammonium nitrate solution leaving the first evaporator was mixed with the filler before being sent to a final type evaporator on top of prilling tower and then crystallized in the prilling tower.

Since 1976 an emission monitoring was performed, showing that the emission was below the legal limit requested by regulation but nevertheless still high, especially in waste gas after final evaporator. Petrokemija has decided to revamp that plant in order to decrease the level of emission and in the same time to improve quality of product.

KT has considered two options to fulfill the target : either a classical granulation using a pugmill and a dryer, or a FDG.

An economical and a technical study was performed and the conclusion was that the FDG technology was more interesting because of :

- Low recycling rate (1 instead of 2 for pugmill)
- No need of a dryer drum
- Easier operation
- Possibility to perform pure AN granulation without modification of the process
- Better quality of product (size, crushing strength)

### **6.2. PROJECT SCHEDULE AND GRANULATION PLANT DESCRIPTION**

#### **6.2.1. Project schedule**

The contract has been signed in June 1997 and had a 14 month schedule execution time.

KT has supplied the basic engineering package and the proprietary equipment. The package has been delivered within five months and the equipment was sent in Croatia within 10 months.



The detail engineering and erection have been done locally and supervised by Petrokemija Kutina.

The overall project was completed within 20 months.

The granulation plant has been implemented in the existing building originally dedicated to the prilling plant.

### 6.2.2. Plant description (Figure 4)

95% ammonium nitrate solution mixed with the solution from the scrubber is concentrated in a KT air swept evaporator above 99.9%. Ammonium nitrate melt after addition of filler is sprayed in the granulator on recycle from the screening section with a part of commercial product crushed as seeds. From the granulator product is screened. Fines and coarses are molten and recycled through the AN melt tank. In an existing building, marketable product is cooled down in a fluidized bed cooler and coated before being sent to the storage.

Air from granulator and evaporator is cleaned in a wet scrubber before being sent to the atmosphere. The resulting solution is recycled to the evaporator reducing the liquid effluent of the plant to nil.

### 6.2.3. Start-up conditions

The plant was started for the first time on January 24<sup>th</sup>, 1999, operated with pure AN for a short time and has reached its present operating capacity of 600 MTPD of CAN one month later.

The main adjustments during the commissioning are described here under.

- \* FDG granulator : The FDG has been designed with two headers allowing a spraying pattern optimization. The spraying nozzles have been modified during start-up to reduce the abrasion from dolomite. The FDG has been in operation for over 1 year without any washing step. Every week the plant is shutdown during one hour. Checking of spraying nozzles can be done during operation by removing one header while the other one is still working.
- \* Crusher operation : The crusher operation has been optimized during the initial start-up to cope with problems of seeds generation.
- \* Evaporator operation : The concentration at the outlet of the air swept evaporator has been decreased to 99.3% as the « drying » effect of the FDG is sufficient to obtain a good moisture content of marketable product (0.1%).
- \* Remelt tank : The level of the agitator impeller has been modified in order to achieve a better mixing in the tank allowing an easier melt of off-spec product.
- \* Wet scrubber : Abrasion of the spraying nozzles of wet scrubber was noticed ; a change of material solved the problem.

### 6.2.4. Actual plant operation and product quality

The plant is operating at 600 MTPD.

We are presenting on Table I the main consumption and effluents figures :

<b>TABLE I</b>	
<b><u>Utilities consumption :</u></b>	
Steam (kg/ton of final product)	213 (12 bar abs)
Electricity (kWh/ton of final product)	16.8
Process condensates (kg/ton of final product)	155
<b><u>Effluents :</u></b>	
Gaseous effluent	20 ppm NH <sub>3</sub> and 20 ppm AN dust
Liquid effluent	Nil

The low utilities consumption of the plant have to be noticed.

For the product quality, the main characteristics are shown on Table II.

<b>TABLE II</b>	
<b>CAN GRANULES MAIN CHARACTERISTICS</b>	
<b><u>CAN granules :</u></b>	
Size distribution	98% between 2 mm and 5 mm
Mean diameter (mm)	3.27
N content (%)	27%
Moisture (%)	0.1
Hardness (kg)	4 to 6 on mean size product
<b><u>Physical aspect :</u></b>	Round smooth particles

The main observations we have made on the above mentioned figures are the following :

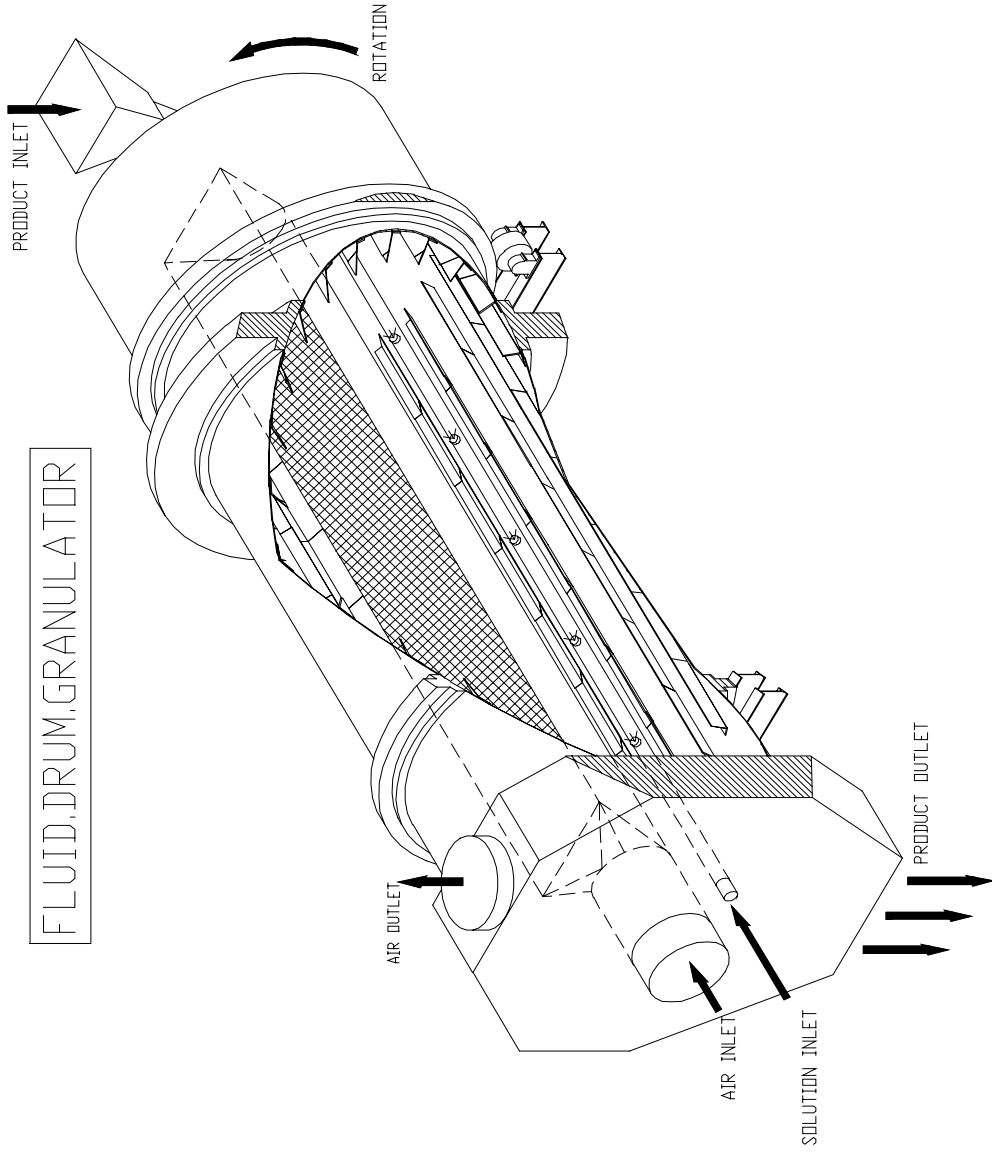
- The FDG dries the product without addition of any additives and of any extra equipment, since a moisture of around 0.1% is obtained from a ammonium nitrate melt of around 99.3%. This leads to a better product.
- Based on the combined action of drum and fluidization, the final product is very round and smooth.

### CONCLUSION

Present in the fertiliser world for decades, KT has developed its FDG to make a reliable technology, able to form a great number of products, not only classical fertilisers like urea and ammonium nitrate, but also new products which are called to be fertilisers of tomorrow.

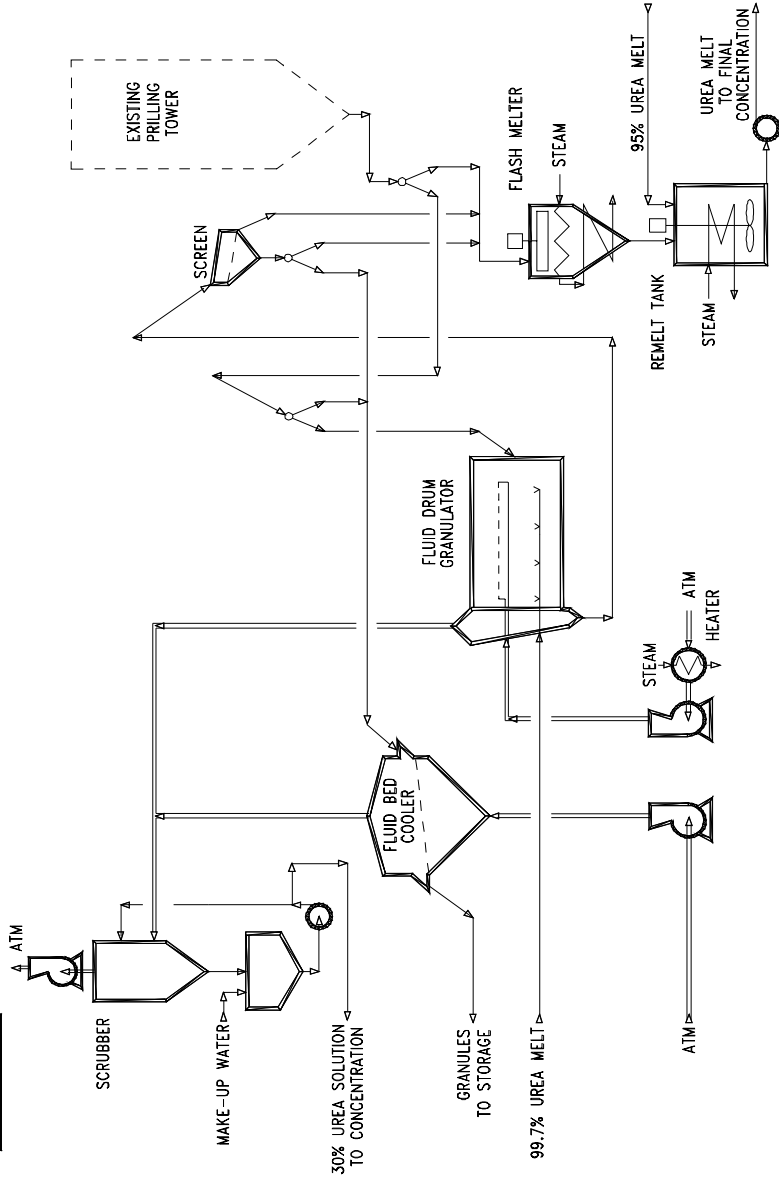
The last KT's references for Petrokemija in Croatia, Agro Nitrogenados in Mexico and Hankook in Korea show well how mature the FDG technology has become and how easy it is to adapt to any kind of products.

FLUID DRUM GRANULATOR



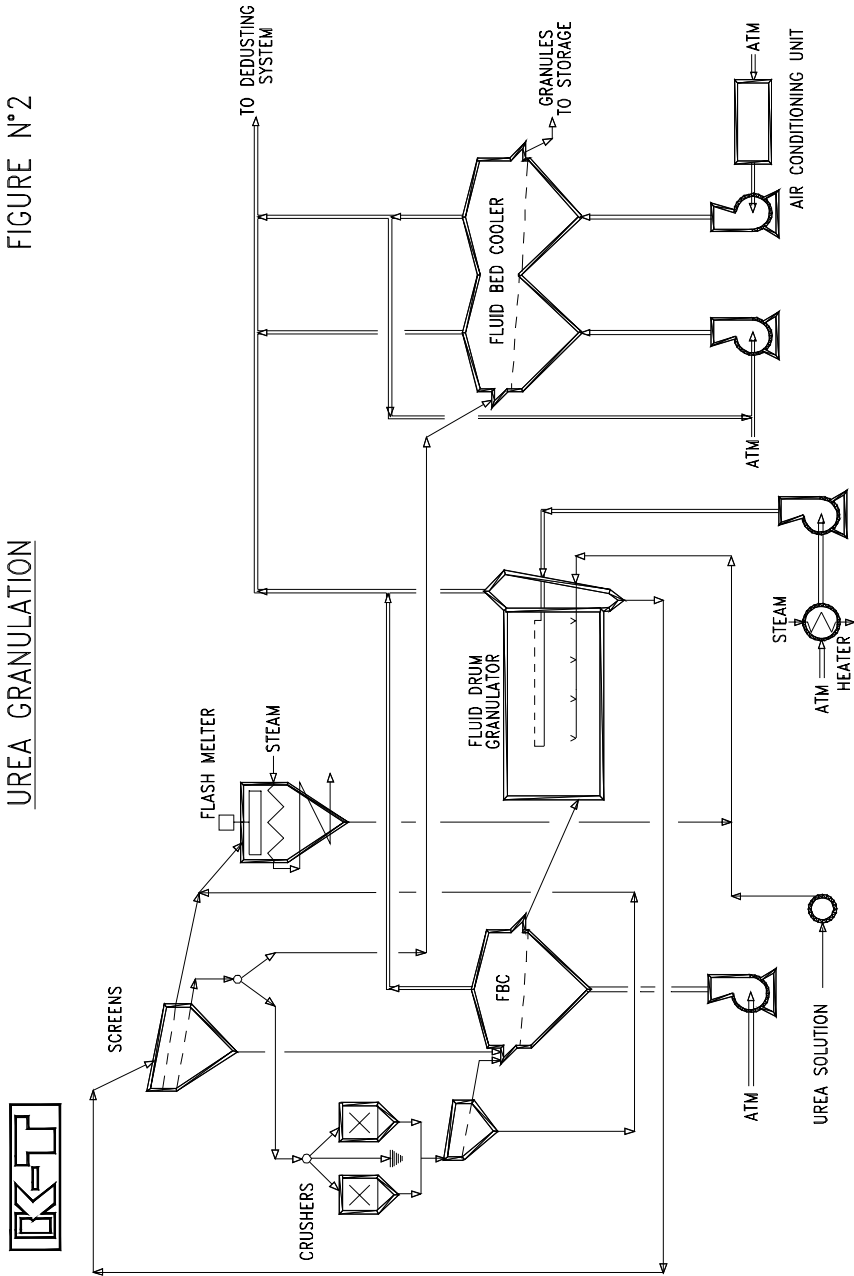
UREA FATTENING

FIGURE N°1



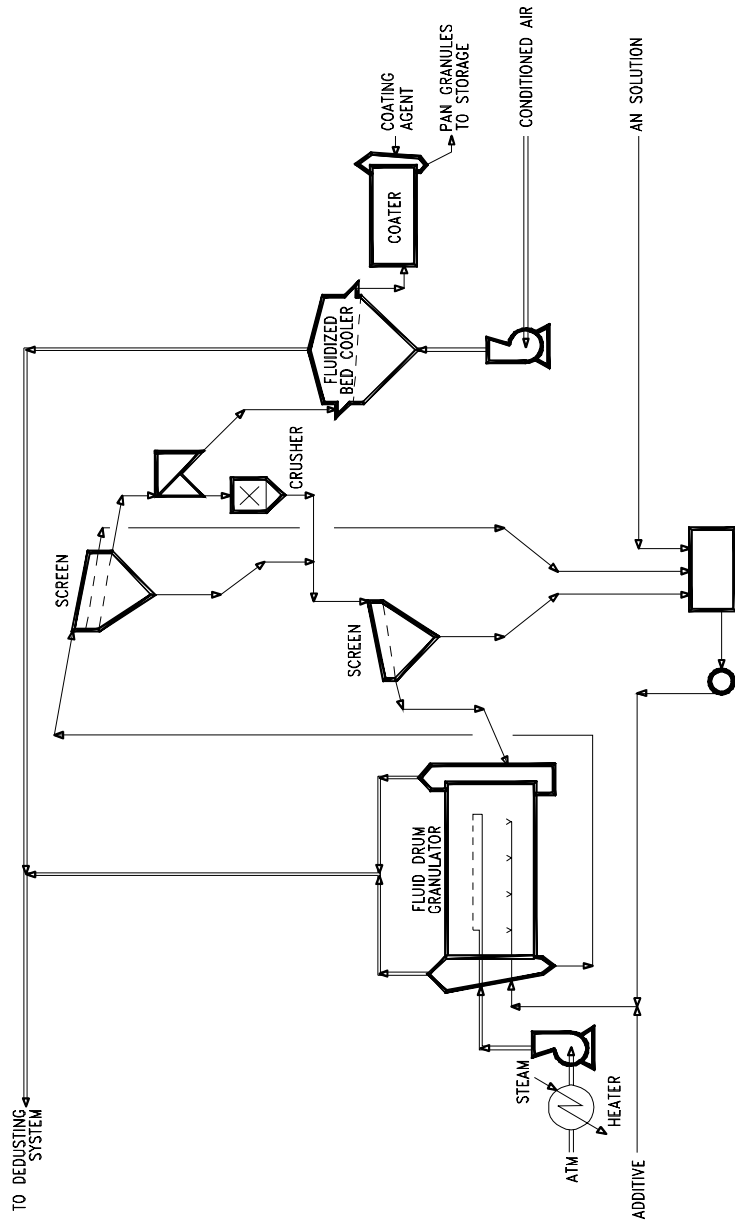
O-KT-PUB74

UREA GRANULATION  
FIGURE N°2



KT-DAO-PUB73

POROUS AMMONIUM NITRATE GRANULATION



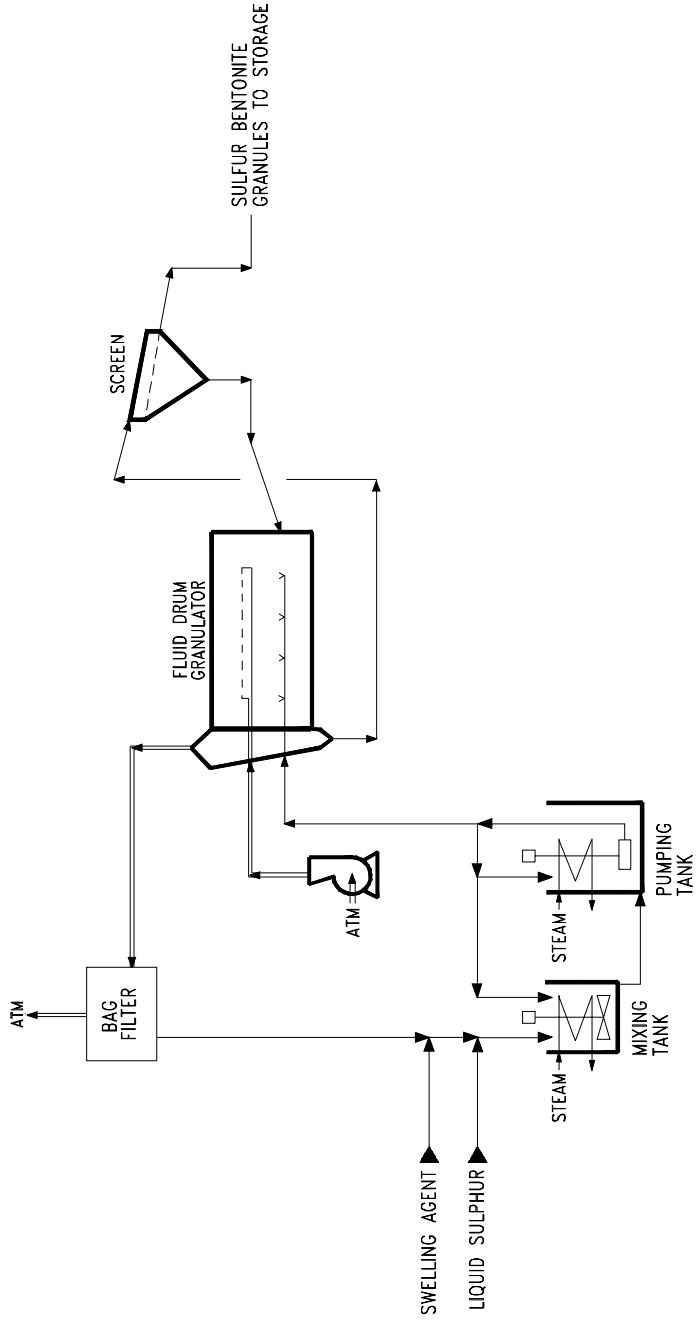
KT-DA0-PUB75

FIGURE N°3



DEGRADABLE SULFUR GRANULATION

FIGURE N°4



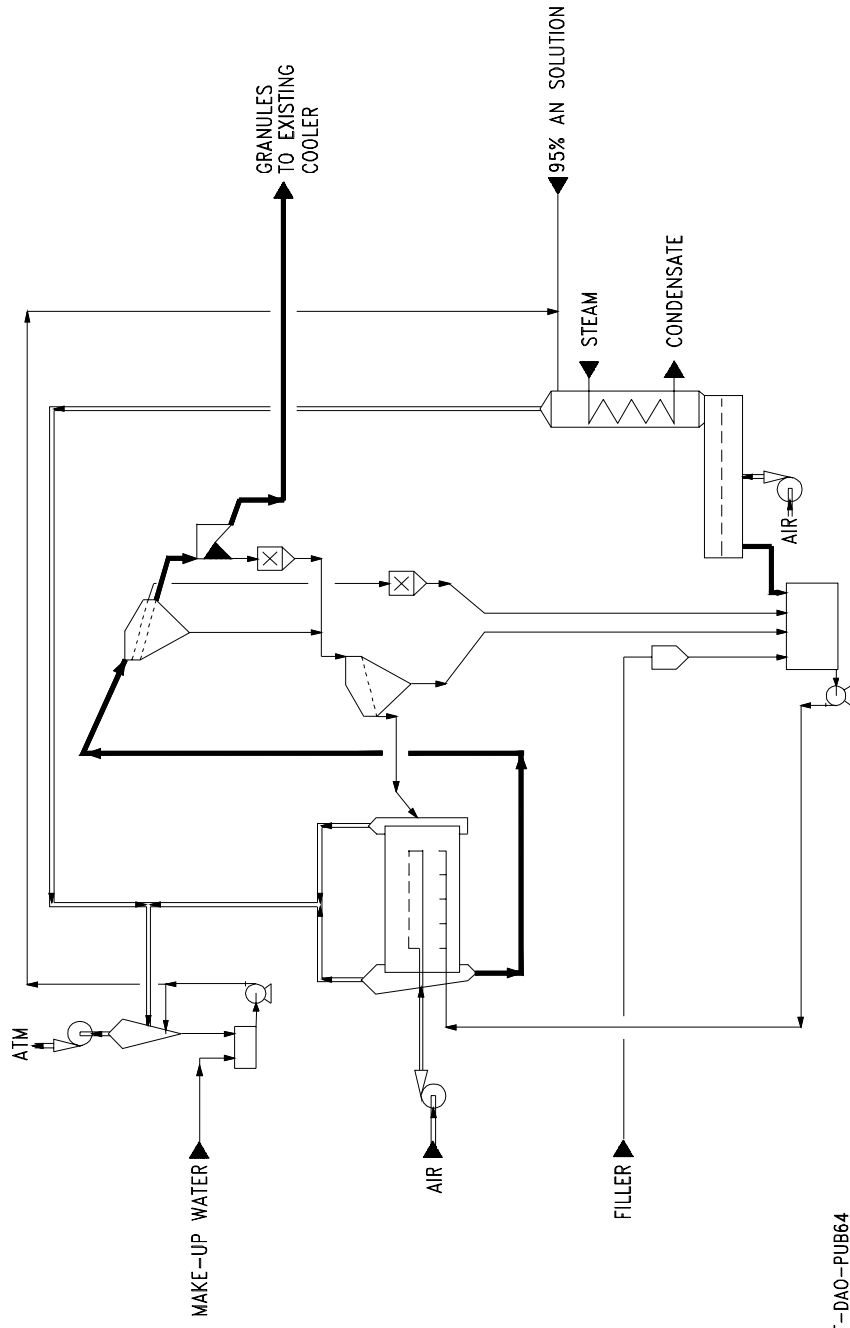
KT-DAO-PUB95-I-CI47001





PETROKEMIJA KUTINA CAN PLANT

FIGURE N°5



KT-DAO-PUB64