



## Asian Nitrogen + Syngas 2016

# Prilling and granulation. Prilling towers: revamping concept and new prilling towers. Granulation in the High-Speed Drum Granulators.

**RINAT ANSERZHANOV, NIKOLAY SHESTAKOV**

NIIK (Research&Design Institute of Urea)

*Dzerzhinsk, Russia*

*Conventional prilling towers seem not to meet all the requirements of up-to-date regulations and market demand. The main disadvantages are low yield of the finished product, uneven prillometric composition, rather small size of prills, environmental problems connected with ammonia and urea dust emissions to the atmosphere. R&D Institute of Urea (NIIK) has developed improved revamp methods for old designed prilling towers including installation of a new designed priller, high-efficient scrubber and fluid-bed cooler for prills cooling. The positive effect is achieved by increase of prills fall height and enhancement of cooling air velocity inside the stack.*

*Beside the prilling tower concept NIIK has its own granulation technology in the High-Speed Drum Granulator (HSDG) for the production of urea-based fortified fertilisers. Compared to conventional drum granulators HSDG has additional advantages of combining the process of surface crystallization and fattening of particles as well as intensification of heat and mass transfers which makes the technology extremely advantageous.*

### **PRILLING TOWERS DESIGNED AND MODERNIZED BY NIIK**

Most prilling towers being in operation over long periods of time have become outdated and do not satisfy the requirements for overall performance, uniformity of prills, their size, temperature and urea and ammonia emissions from the tower. All these means that concept of conventional prilling towers needs improvement.

To maximize the profits by increasing capacity, offering better quality of the end product and reducing emissions NIIK suggests the following options:

- Install a dispergator (vibropriller) of a new design
- Install a new high efficient scrubber
- Install a fluid-bed cooler for prills cooling

The positive effect is achieved by increase of prills fall height and enhancement of cooling air velocity inside the stack.

NIIK has developed the concept of conventional prilling towers revamping aimed at finished product quality enhancement (bigger and stronger prills) and emission abatement.

The CAPEX is low due to the fact that new metal stack is integrated with the existing concrete stack (constructed inside the existing one). A fluid-bed cooler

is installed in the bottom of the prilling tower, the blower fans for air supply to the fluid-bed. On the top of the prilling tower an injection-type scrubber is installed. The air is first washed with urea solution in the gas-liquid injectors and then with cleaned wastewater. The urea solution is collected in the scrubber basin and delivered for processing. The described scrubber has the following advantages: its design fits well in the prilling tower, high-efficiency scrubbing, low energy consumption, no ID fans are required.

Prilling tower of NIIK's design is made of steel and concrete, it has internal diameter 16 m and prills fall height 80 m.

#### The tower is equipped with:

- vibropriller installed inside the prilling tower at the top;
- integrated fluid-bed cooler installed at the bottom inside the prilling tower;
- injection-type scrubber installed on the top of the prilling tower (from out-side of the prilling tower).

#### THE MAIN BENEFITS OF NIIK'S PRILLING TOWER CONCEPT ARE THE FOLLOWING:

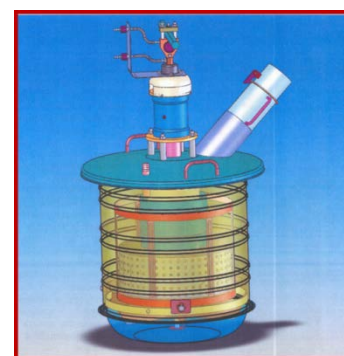
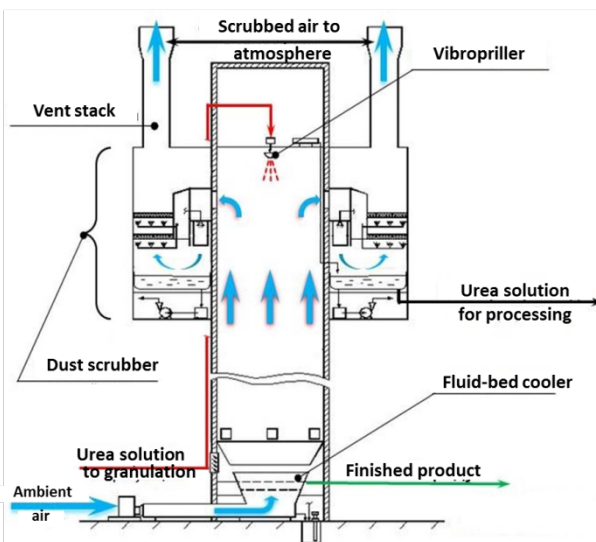
- wide capacity range;
- simple design and reliable in operation, prilling tower can be shut-down for turnaround once a year;
- energy and resources efficiency: constant steam consumption and low-temperature agents are not required, zero formaldehyde, low energy consumption for process needs;
- minimizing OPEX and maintenance cost;
- environmental friendliness: low emissions, no acids;
- enhanced product quality: resistance to mechanical stress during delivery and storage, anti-caking properties, optimal size and roundness of prills, product monodispersity which is important for dry blending and homogeneous application to the soil.

#### The positive effect of using vibrating priller:

Priller is one of the main sections in the prilling tower, since the prills size distribution depends on the design and operation of the priller. The enhanced prills are produced by a vibropriller having magnetic vibrator with vibration frequency automated control. Vibropriller ensures equal distribution of urea droplets spraying cone inside the tower.

Production of uniform prills allows:

- to optimize thermal conditions inside due to equal spraying of urea



droplets in the cross-section area of the prilling tower.

- to minimize cracking and shelling of prills during their storage in bulk and loading;
- to abate emissions from the prilling tower to atmosphere;
- prills size distribution from 2-5 mm, main fraction content – 95 %;

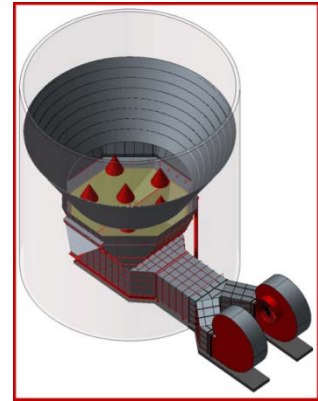
Operation principle of a vibropriller is the following: jets sprayed from the priller's holes fall into equal droplets due to regular vibrations. Use of magnetostrictive vibrator with automated control ensures stable operation of the section in the frequency range from 200 to 1200 Hz. The frequency can be adjusted by microprocessor controller depending on the load.

### **The main advantages of fluidized bed system.**

To avoid prills caking and degradation of the product quality during storage and delivery, it must be cooled to the required temperature. With this purpose the fluid-bed cooled built in the prilling tower is used. Its operation is based on intensive mixing of prills in the fluid-bed, the air flows turbulently, due to heat-exchange between the prills and air, the heat is removed from the prills and consequently the finished product achieves the required temperature.

The main advantages of the integrated fluid-bed cooler are the following:

- extended contact surface between the product and air which increases heat-exchange process;
- high heat-exchange abilities which ensure required temperature of the finished product;
- safe and easy operation and maintenance;
- finished product having improved quality.



### **The advantages of the scrubber system.**

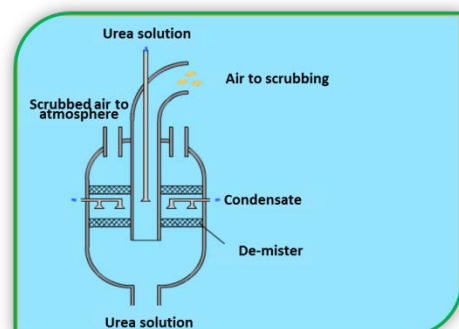
NIIK's revamping philosophy considers the environmental safety of its concepts. Therefore a special attention is drawn to emissions reduction from prilling towers. The urea dust is effectively scrubbed only by wet scrubbers due to high hygroscopicity and water solubility of urea.

Air scrubber must ensure high scrubbing effect with low hydraulic resistance and low energy consumption, having high efficient mist eliminators. Scrubbers developed by NIIK meet all the requirements. Injection-type scrubbers allow scrubbing not only of urea dust, but of ammonia as well avoiding ID fans which reduces power consumption.

Injection-type wet scrubbers have 2 scrubbing zones. The 1st zone comprises in-jection devices with spraying nozzles. The 2nd zone is sprayed with wastewater and has mist eliminators. After the 2nd scrubbing zone the clean air is emitted through the vent pipe to the atmosphere.

Thus the advantages of NIIK's scrubbing systems are the following:

- efficient scrubbing of urea dust – 98-99 %;
- partial scrubbing of ammonia, no acidic scrubbing;
- safe and easy operation and maintenance;
- simple design – access to all elements of the scrubbing system;
- resource saving – recovery of urea and ammonia for reprocessing.



NIIK has also experience of design of new urea prilling towers. In 2012 a new prilling tower of NIIK's design, capacity 1500 TPD was commissioned at Phosagro Cherepovets (Russia). At the moment NIIK is working at design of 3 new prilling towers for Togliatti Azot, Uralchem Perm and Metafrax Gubakha, all in Russia.

## NIIK EXPERIENCE IN GRANULATION. HIGH SPEED DRUM GRANULATOR.

### DESIGN AND PRODUCTION PROCESS.

NIIK is a licensor of several urea technologies. One of the technologies developed by NIIK is a High-Speed Drum Granulation (HSDG) technology for the production of urea-based fortified fertilisers. This has both Russian and international patents.

The main distinguishing feature of the HSDG design is that the material is recycled internally by means of a built-in classifier and a screw conveyor.



The HSDG consists of an outer drum inside which there is an internal drum with blades and a classifying screen. Between the outer and internal drums there is a reverse screw for internal product recycling. At both ends of the drum there are input and discharge chambers.

The drum is equipped with feed pipe to supply seeds and a spraying nozzle.

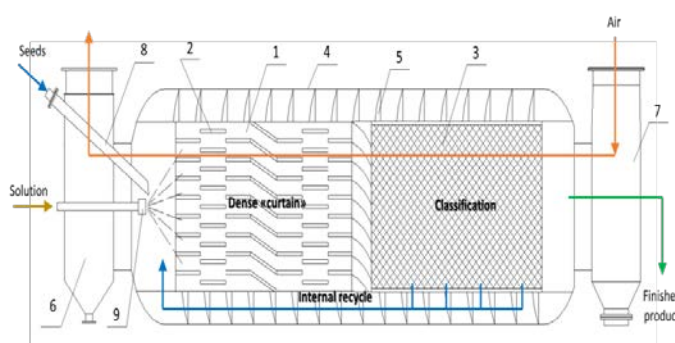
During the drum's operation the seeds (prills or crystals) are introduced into the main drum. While the drum is rotating, the seeds create "a curtain" inside the drum, and the nutrient solution is sprayed over "the curtain" through the spraying nozzle.

The blades on the inner surface of the drum are continuously lifting and throwing the seeds across the drum internal section thus making curtain uniform.

As a result, the product in the drum undergoes multilayer fattening– every seed is sprayed upon many times until it achieves the desired properties.

From the spraying chamber the product moves to a classifying screen inside the drum. Undersize granules fall through the screen and are returned to the beginning of the drum by a reverse screw.

The surplus water from the solution is evaporated during crystallization and removed with the air leaving the drum. The product of the desired size passes over the screen and fed to the cooling phase.



Fine particles returned to the main drum undergo the same process – they are repeatedly sprayed with the solution again and again until they have attained the required size and thus pass over the screen.

The HSDG has various applications:

- 1) It is used for production of granulated fertilizers (urea, ammonium nitrate etc.)
- 2) It is used for production of urea-based fortified fertilizers (urea with ammonium sulfate, urea with sulfur etc.)
- 3) It is used for fattening of prilled product improving its properties.

### KEY ADVANTAGES OF THE HSDG

Small volume of air is required.

- The HSDG is easy to install on the existing site – it has relatively small size and weight.

- The internal product classification and recycling of the material result in excellent product uniformity. The material external recycle does not exceed 10% of the total amount of granulated product.
- Dense curtain of the product being rotated inside the main drum which reduces sticking of the product to the drum walls and blades.
- Universality of the technology.

One of the main benefits of the technology is its flexibility. A wide range of fertilizers depending on the market demand can be produced on one and the same unit with minor modifications. Urea with sulfur, urea with ammonium sulfate and other urea-based fertilizers fortified with various nutrients can be produced in the HSDG upon customer's request.

The fortified fertilizers are forecast to be applied more widely in the next future because of their advantages as compared to conventional fertilizers:

- higher concentration of nutrients and low content of inefficient substances (thus not available for plant growth) results in a balanced application and consequent increase in yield and reduced environmental impact;
- fortified fertilizers have better properties as compared to the conventional ones.
- and also because of diversification of the fertilizer production based on the market demand, depending on soil content and crops;

The emerging market of slow release and controlled release fertilizers is becoming more popular due to the intense competition on the straight fertilizers market and drop of urea price. In addition to the above advantages of fortified fertilizers for end-users there are also benefits for fertilizer producers:

## References

NIIK has its own laboratory scale HSDG unit where NIIK's specialists produce new fertilizer samples and carry out various tests. Its capacity is 100 kg/h and it is located on one of NIIK's sites.

To date NIIK has also implemented four HSDG units:

- two commercial-scale HSDG units, total capacity of each unit is 500 TPD for fattening of urea in **Kemerovo (Russia)** and ammonium nitrate in **Actau (Kazakhstan)**;
- two pilot HSDG units, capacity of each unit is 100 kg/h (2.4 TPD) for production of fortified fertilizers in **Vietnam (Petrovietnam)** and **Qatar (QAFCO)**.

The pilot HSDG at **QAFCO, Qatar** (capacity – 2,4 TPD) was designed for production of the following fertilizer types:

1. Urea with ammonium sulfate with different ammonium sulfate contents in the finished product.
2. Urea with sulfur (inclusive of SCU – a slow-release fertilizer).

NIIK also implemented the pilot HSDG, capacity 100 kg/h at **Petrovietnam Fertilizer & Chemicals Corporation (Vietnam)**. Before the Contract for the pilot HSDG, NIIK had carried out research work for production of the samples according to the recipes provided by Petrovietnam at NIIK's laboratory scale HSDG unit. The pilot HSDG unit in Vietnam was designed to produce the required four formulations of fortified urea-based fertilizers, the component ratios in which can vary and other fertilizer types can be produced on the customer's request.

The commercial-scale HSDG unit, total capacity 500 TPD in **Kemerovo (Russia)** is designed for the fattening of prills in order to improve the quality of the finished product. The finished product is bigger, stronger and more uniform (less granules smaller than 2mm) and has better anticaking properties.

Another commercial-scale HSDG unit, total capacity 500 TPD was implemented at **KazAzot (Kazakhstan)** for production of granulated ammonium nitrate. The ammonium nitrate produced in NIIK's HSDG unit has a high quality in terms of uniformity, density and anti-caking properties.

NIIK's scope of works for the HSDG unit includes the following:

- a license for the technology;
- design works
- equipment procurement;
- contract and field supervision and commissioning;
- guarantee performance test.

HSDG technology suitable for installing into existing site enables producers of fertilisers to produce material comprised of hard, consistent spherical granules. It also results in a flexible production facility, able to switch between different types of product. It is obvious that using NIIK's HSDG the flexibility of plants will be increasingly advantageous.