Prilling and granulation
Prilling towers:
revamping concept and new prilling towers.

Granulation in the High-Speed Drum Granulators
Company structure comprises the following departments:

- **R&D**: technologies, revamping concepts, technical solutions, research work, design of proprietary equipment, inspections, equipment repairs
- **Engineering and design**: design documentation, engineering, adaptation of foreign licensors’ documentation to Russian norms and regulation, getting approval for design documentation from Russian authorities
- **Equipment procurement**: procurement of materials and equipment
- **Project management**: project coordination, turn-key projects
NIIK’s scope of works for EPCM projects:
engineering and design, equipment procurement, construction management and commissioning
Disadvantages of conventional prilling towers:

- Small fall height of prills
  - Small size of prills
- Low density of urea droplets sprayed from a conventional priller
  - Low yield of urea prills
- Ammonia and urea dust emissions
- Low linear velocity of cooling air
  - Low heat removal
  - Insufficient cooling of prills in hot season
- Low strength of prills
- Prills caking
- Prills deformation and breaking when fall down to the conveyer
Improvements of conventional prilling towers:

1. State-of-the-art vibropriller
2. Increase of prills fall height
3. Increase of cooling air linear velocity inside the prilling tower
4. Fluid-bed cooler integrated inside the prilling tower
5. Scrubbing of exhaust air from ammonia and urea dust
6. Injection-type scrubber, no ID fans
Revamping concept of prilling tower

- Equipment before the revamp
- Equipment installed during the revamp

Cleaned air to atm.
Vibro-priller
Urea solution
Vent pipe
Cleaned wastewater
Scrubber
Urea solution for processing
+70.00
+40.00
ID fan (to be removed)
Fluid-bed cooler
Ambient air
Finished product
**Process Flow Diagram and photo of modern prilling tower:**

- **Ambient air** to prilling
- **Urea solution** to prilling
- **Dust scrubber**
- **Scrubbed air** to atmosphere
- **Vibropriller**
- **Urea solution** to processing
- **Fluid-bed cooler**
- **Finished product**

**Urea prilling tower, capacity 1500 TPD:**
**Phosagro Cherepovets (Russia)**
### NIIK’s prilling tower concept:

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Distinctive features</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Wide capacity range</td>
<td>✓ Product monodispersity (main fraction content -95%)</td>
</tr>
<tr>
<td>✓ Simple design</td>
<td>✓ Average size of prills is rather big (2 - 4 mm)</td>
</tr>
<tr>
<td>✓ Non-waste process</td>
<td>✓ Cooling of prills in hot season down to 40-50°C</td>
</tr>
<tr>
<td>✓ High-efficient process</td>
<td>✓ High strength of prills (1,0 kgf/prill min.)</td>
</tr>
<tr>
<td>✓ Resources efficiency</td>
<td>✓ Product resistance to mechanical stress during delivery and storage</td>
</tr>
<tr>
<td>✓ Energy efficiency</td>
<td>✓ Scrubbing of the exhaust air from ammonia and urea dust: 40 mg/Nm3 and 25 mg/Nm3 respectively</td>
</tr>
<tr>
<td>✓ Environmental friendliness</td>
<td>✓ Low energy consumption for prilling process and air scrubbing</td>
</tr>
</tbody>
</table>
Technical solutions of NIIK’s concept: Vibro-priller

1 – vibrating sprayer, 2 – bucket, 3 – vibrating mechanism, 4 – magnetostrictive vibrator, 5 – vibro-prilling section
Advantages of the vibro-priller:

✓ Uniform spraying with urea droplets of prilling tower cross-section

✓ Prills size distribution 2-4 mm, content of main fraction – 95 % min.

✓ Minimization of prills shelling and cracking

✓ Optimization of thermal conditions inside the prilling tower

✓ Dust emissions abatement
  - Load reduction of scrubbing system
  - Reduction of urea dust emissions to atmosphere
Product after the vibro-priller:

Prills monodispersity

Prills size distribution:
2-4 mm – 95%
< 1 mm – 1 % max.
Technical solutions of NIIK’s concept

Integrated fluid-bed cooler
Advantages of NIIK’s fluid-bed cooler

- Safe and easy in operation
- Easy in maintenance
- Product of the improved quality
- Extended contact surface between the product and air
  - Heat exchange intensification
  - Temperature of the finished product is 45-50°C max.
Advantages of the integrated fluid-bed cooler

Structure of the prills produced in prilling towers without the fluid-bed cooler

Structure of the prills produced in prilling towers with the fluid-bed cooler
Technical solutions of NIIT’s concept:

Injection-type scrubber
Advantages of the injection-type scrubber

- Efficient scrubbing
- Safe and easy operation and maintenance
- Simple design
- Resource saving

PFD of the injection-type scrubber

- Urea solution
- Air to scrubbing
- Cleaned air to atmosphere
- Condensate
- Demister
- Urea solution
<table>
<thead>
<tr>
<th>№</th>
<th>Company / country</th>
<th>Year</th>
<th>Product</th>
<th>Scope of works</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Metafrax (Russia)</td>
<td>2018</td>
<td>urea</td>
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<td>2</td>
<td>Togliatti Azot (Russia)</td>
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<td>3</td>
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<td>4</td>
<td>Eurochem NevAzot (Russia)</td>
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<td>Grodno Azot (Belarus)</td>
<td>1986</td>
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<tr>
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<td>23</td>
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<td>24</td>
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</table>
NIIK has developed the innovative technology for production of urea-based fertilizers in the HSDG.

The fertilizers produced on the HSDG are strong uniform round granules. The finished product doesn’t make dust.
Patents
High-Speed Drum Granulator (internal design)

1- main drum; 2- blades; 3- classifying screen; 4- outer drum; 5- reverse screw; 6- input chamber; 7- discharge chamber; 8- feed pipe; 9- spraying nozzle
Granulation of straight fertilizers (urea, ammonium nitrate)

Fattening of prilled urea – quality improvement (urea, ammonium nitrate)

Production of urea-based fortified fertilizers (urea + ammonium sulfate, urea + sulfur etc.)
Advantages of the HSDG production process:

- 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
  - product uniformity
  - small recycle of the product, use of equipment with low energy consumption
- Dense curtain of the product being rotated inside the main drum which reduces sticking of the product to the drum walls and blades
- Technology flexibility (wide range of fertilizer types produced in the HSDG)
Technology flexibility: fertilizers produced on the HSDG

<table>
<thead>
<tr>
<th>Urea + sulfur</th>
<th>Urea + ammonium sulfate</th>
<th>Urea-based fortified fertilizers</th>
<th>Other fortified fertilizers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Urea + sulfur" /></td>
<td><img src="image2" alt="Urea + ammonium sulfate" /></td>
<td><img src="image3" alt="Urea-based fortified fertilizers" /></td>
<td><img src="image4" alt="Other fortified fertilizers" /></td>
</tr>
</tbody>
</table>
Advantages of fortified fertilizers’ application

- High concentration of nutrient
- Wide range of fertilizer types
- Improved properties
Benefits of fortified fertilizers for fertilizer producers

1. High market demand

2. Added value

3. Diversification of fertilizer production
Laboratory-scale HSDG: tests and samples production
Reference-list of the HSDG projects

1. PetroVietnam Fertilizer & Chemicals Corporation, Vietnam
   Pilot HSDG. Products: 4 recipes based on the customer’s request. Capacity – 2.4 TPD.

2. Kemerovo Azot, Russia
   HSDG for urea fattening. Total capacity – 500 TPD.

3. KazAzot, Kazakhstan
   HSDG for ammonium nitrate granulation. Total capacity – 500 TPD.
HSDG for production of fortified fertilizers based on the customer’s recipes, capacity – 2.4 TPD at PetroVietnam Fertilizer & Chemicals Corporation, Vietnam
Fortified fertilizers produced at PetroVietnam

The HSDG unit was designed for production of 4 fertilizer types based on the customer's formulations, their nutrients' ratios can be changed by the customer, the unit can be modified to produce other fertilizer types in future.
Undersize prills (smaller than 2 mm) after the prilling tower are fattened (spherodized) in the HSDGs. Result: no undersize prills, finished product with improved properties.
HSDG for granulation of ammonium nitrate, capacity – 500 TPD at KazAzot. Kazakhstan

HSDGs are used for ammonium nitrate granulation.

Result: finished product with improved properties.
NIIK’s scope of works for the HSDG project

- Technology license
- Basic and detailed design, 3D design
- Equipment procurement
- Contract and field supervision, commissioning
- Guarantee performance test
Thank you for attention!

For any questions, please, contact me: andreev_av@niik.ru

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