High speed drum granulation technology as a method for urea unit capacity increase and urea quality improvement

Author:
RINAT ANDERZHANOV
NIIK, R&D Institute of Urea
Dzerzhinsk, Russian

Summary:
NIIK as a leading engineering company in Russia and FSU countries working in the field of urea and related products is always looking to improve its technologies. This paper illustrates how NIIX apply its advanced High Speed Drum Granulator granulation technology when modernizing the finishing section of urea production plant promoting it to updated performance level.

One of the most promising technologies designed by NIIX is a granulation technology in HSDG. The use of this technology for production of compound fertilizers and ammonium nitrate was presented during Nitrogen+Syngas 2013.

Alternative option is using HSDG (High Speed Drum Granulation) technology for prills fattening. This is the case when the prilling tower limits the further capacity enhance. The part of prilled urea is getting treated by urea melt in HSDG which results in growth in productivity. At the same time the size of prills/granules increases and they are obtaining improved strength characteristics at minimal cost.

The first commercial-scale of High Speed Drum Granulation unit designed for prills product fattening was installed in Kemerovo (Russia) for «Azot» company.
High speed drum granulation technology as a method for urea unit capacity increase and urea quality improvement

RINAT ANDERZHANOVA
NIIK, R&D Institute of Urea
Dzerzhinsk, Russian Federation

One of the most promising technologies designed by NIIK is a granulation technology in HSDG. The use of this technology for production of compound fertilizers and ammonium nitrate was presented during Nitrogen+Syngas 2013.

Alternative option is using HSDG technology for prills fattening. This is the case when the prilling tower limits the further capacity enhance. The part of prilled urea is getting treated by urea melt in HSDG which results in growth in productivity. At the same time the size of prills/granules increases and they are obtaining improved strength characteristics at minimal cost.

The first commercial-scale High Speed Drum Granulation unit designed for prills product fattening was installed in Kemerovo (Russia) for «Azot» company. The startup of the unit is scheduled for the end of 2014.

NIIK as a leading engineering company in Russia and FSU countries working in the field of urea and related products is always looking to improve its technologies. Our professional experience and knowledge in construction and modernization of urea facilities enable to offer a full range of services comprising technology development, feasibility studies, design and packaged delivery of equipment, development of tailor-made revamp concepts etc.

This paper illustrates how NIIK apply its advanced High Speed Drum Granulator granulation technology when modernizing the finishing section of urea production plant promoting it to updated performance level. One of the reason for revamping is poor efficiency of the unit. Usually cost-effective and reliable revamping measures resulting in 15-20% operational efficiency increase are required. Higher efficiency levels (more
than 20%) for the finishing section (prilling, granulation, Fig. 1, 2) cannot be achieved considering equipment limitations, high revamp costs and long shut down period during retrofitting.

Recent interest to compact granulating equipment for production of commercial urea is justified because such methods do not require vast air volumes and improve significantly product quality. The mentioned equipment should have such important options as easily assembly on the existing urea sites, space saving design, availability of granules fattening. The main goal of this equipment is production of large uniform granules of urea with high mechanical strength and 100% friability.

NIIK owns proprietary flexible technology for urea production in a High Speed Drum Granulator. The technology is unique and meets all relevant requirements. Drum granulation technology has significant advantages over other granulation technologies and first of all reduced amount of inside drum recycle product which means little space and few additional equipment items and thus minimum investments.

We are glad to suggest alternative way of finishing section upgrade with the use of High Speed Drum Granulation Technology (Fig.3). Being applied for capacity enhancement HSDG does not interfere with the main production process, there is no need to shut-down the plant when installing. Capital and operational costs are much lower compared with installation of the new granulation unit or new prilling tower.
High speed drum granulation technology as a method for urea unit capacity increase and urea quality improvement

Technical and economic advantages of HSDG:
• space saving design
• easy assembly and erection on the existing facility site
• low volume of air needed
• low steam consumption
• low capital and operational cost
• operation and adjustment within a wide capacity range

The principle of HSDG is shown in Fig.4.
During the drum’s operation the granules or crystals used as seeds are introduced into the main drum. While the drum rotates the product inside the drum creates a curtain in its cross-section. The blades lift the granules which are moving along a parabolic curve (Fig.5). The high rotation speed of the drum as well as the nozzle design maintains the uniformity of the curtain.
The curtain is being sprayed by the solution/melt by means of the nozzle (Fig. 6).

As a result the product in the drum undergoes multilayer fattening - the same granule is sprayed over many times until it reaches the design characteristics.

After the spraying chamber the product moves to a classifying screen inside the drum. Fine particles fall through the screen and are returned to the beginning of the process. Product of the desired size passes the screening and the granulated product is forwarded to the cooling section.
The fine fraction returned into the main drum undergoes the same process – it is sprayed over the solution again and again, gradually becoming larger due to gradual fattening unless the granules diameter reaches the intended result and pass through the screen inside the drum. The product undergoes the cycle many times.

The main distinguishing features of the HSDG are:

- the falling curtain across the inner section of the drum
- internal screening and recycle of the product
- intensification of production due to the increased speed of drum rotation

A pilot (laboratory-scale) continuous-type High Speed Drum Granulation Unit (Fig. 7) is located in the head-office of R&D Institute. It was developed for production of trial batches of granulated urea and wide range of fortified urea-based fertilizers. It has been used for optimization of the production process (fertilizer granulation in real plant conditions) of new and existing types of fertilizers and initially all samples are produced on it.

![Laboratory scale HSDG unit](image)

To fulfill the revamping objects «Azot» (Kemerovo, Russia) urea plant prilling section is modernized to run with increased capacity. The implemented HSDG granulation technology permits a capacity increase to 1700 TPD and guarantees improved finished product quality.

During the warm period of the year when the air temperature is rising up to 15-20°C the existing prilling tower does not provide the required quality of the product at the stated capacity. It makes necessary to reduce the load of the tower to 1500-1600 TPD.

HSDG helps to reduce the load of the prilling tower to design value of 1500 TPD creating a more stable working environment which enables to reduce the amount of off-spec granules and increase the main fraction by fattening the small granules (granules less than 2 mm). Thus the amount of the fraction less than 1 mm is minimized. The finished product is also characterized by higher static strength ensuring improved resistance to mechanical effects while transporting or storing.

Urea melts after evaporation unit is divided into two streams. The first is directed to dispersgators of the prilling tower (in an amount of 1500 TPD in finished product equivalent). The second is fed into HSDG unit at 100 TPD for each drum granulator in finished product equivalent. HSDG unit for pilled urea fattening is presented below (Fig. 8).
Before feeding to HSDG the melt is diluted by hot condensate to 96-98 per cent.
Prilled urea is delivered by conveyor to the classifying screen (1) where the product is divided into granules less than 2mm, finished product of 2-4 mm and granules under 4 mm (large granules). The finished product is delivered for cooling into fluidized bed cooler. Large granules are sent for dilution. Fine granules in the amount of ~300 TPD are fed to the dosing hopper. Fine product discharge is continuously compensated for by prilled urea being introduced from the hopper.
Atmospheric air and cooling water are sent to HSDG to maintain required temperature (Fig. 9). The air can be preheated by means of steam.

Fig. 8: Principle diagram of HSDG unit for prilled urea fattening
The exhaust air containing ammonia and urea dust is supplied to wet-type scrubbing unit. The urea melt from dissolution and scrubbing unit is supplied to vacuum evaporator.

In case of HSDG shut down prilled urea is delivered to the classifying screen (2) where the product is divided into granules less than 1 mm, finished product of 1-4 mm and granules under 4 mm. The finished product is delivered by conveyor for handling and packing. Granules less than 1 mm and under 4 mm are sent for dilution.

The applied technical solutions enable to receive the product with the following characteristics (Table 1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before the revamp</td>
<td>After the revamp</td>
</tr>
<tr>
<td>Size distribution</td>
<td></td>
</tr>
<tr>
<td>Main fraction volume, %:</td>
<td></td>
</tr>
<tr>
<td>- &lt;1 mm</td>
<td>1 max</td>
</tr>
<tr>
<td>- 1-4 mm</td>
<td>98 min</td>
</tr>
<tr>
<td>- 2-4 mm</td>
<td>92 min</td>
</tr>
<tr>
<td>- remaining granules 6 mm</td>
<td>none</td>
</tr>
<tr>
<td>Static strength, kgf/granule</td>
<td>0,8 min</td>
</tr>
<tr>
<td>Final product temperature, °C</td>
<td>50 max</td>
</tr>
<tr>
<td>Other characteristics</td>
<td>acc. to GOST 2081-2010</td>
</tr>
<tr>
<td>acc. to GOST 2081-2010</td>
<td>acc. to GOST 2081-2010</td>
</tr>
</tbody>
</table>

Thus upgrades of existing system and application of HSDG granulation technology promote quality, efficiency and productivity at a relatively low cost.