Production of compound fertilizers

Helen Aksenova, chief engineer for JSC NIIK, discusses the production of compound fertilizers and ammonium nitrate in the company's new high speed drum granulator

Both demand and supply of compound fertilizers are seeing tremendous growth at the moment, and both are expected to steadily increase in the future, outstripping the average demand increase for other types of fertilizers. The market success enjoyed by compound NP and NPK fertilizers - production exceeded 65 million t/a in 2011 – can be explained by the following reasons:

- compound fertilizers contain a higher overall concentration of nutrients, decreasing production, handling and transportation costs per tonne, and the cost for soil application;
- compound fertilizers have better physical, chemical and mechanical properties compared to regular fertilizers;
- compound fertilizers offer a wider variety of options and can be adjusted to satisfy demand in accordance with particular soil compositions.

Increased demand for NPK gives fertilizer producers the challenge of finding the most cost-effective solution to diversify their range of products with the possibility of adjusting to changing market trends and the requirements of their customers. They would also want to be the first to give their customers more choices before competitors accumulate additional profits via more added value products. The ideal solution would be a single multifunctional unit with low capex and opex, moderate energy consumption, and occupying a small footprint area so that it can be installed at an existing plant and – most importantly – providing the flexibility to produce different types of fertilizers depending on market requirements.

The R&D Institute of Urea (NIIK) has developed a unit that satisfies these aforementioned requirements; the high speed drum granulator (HSDG), designed to granulate urea and compound fertilizers. Depending on the fertilizer type, either fertilizer melt is sprayed over crystals or granules of nutrient compound (for example urea melt over ammonium sulphate) or nutrient compound is melted and sprayed over fertilizer granules or crystals (for example, sulphur melt over urea granules). The HSDG has been successfully tested to produce granulated urea, ammonium nitrate, urea based fertilizers (*Urea+* fertilizers), compound and NP and NPK fertilizers.

Design and production process

The external surface of the HSDG is an outer drum (see Figure 1), inside of which an internal drum in which blades and a classifying screen are installed. Between them there is a reverse screw for internal product recycle. There are fixed loading and discharging chambers at both ends of the drum, and on the loading chamber's wall there is a loading tube and an inlet nozzle.

During the drum's operation the granules or crystals of product 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 and fertilizer or compound solution is sprayed over the curtain through the spraying nozzle. The blades on the inner surface of the drum serve several purposes: they lift the granules or crystals and maintain the uniformity of the curtain, and they move the product through the granulator.

As a result the product in the drum undergoes multilayer fattening – the same granule is sprayed over many times until it reaches the designed 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 by a reverse screw. Product of the desired size passes the screening and is discharged to storage or for handling.

The fine fraction returned into the main drum undergoes the same process – it is transported by the blades inside the drum as a part of the curtain and sprayed over with the solution again and again until it has achieved the required size and can pass through the screen inside the drum. The product undergoes this cycle many times. To remove heat from the process and cool the product, atmospheric air is introduced into the drum and the outer surface is cooled with water. To remove surplus water from the solution the air introduced into the drum can be heated, and heated air can be also directed to the nozzle.

The main distinguishing features of the HSDG are thus:

1. The falling "curtain" across the inner section of the drum;
2. Internal screening and recycle of the product;
3. Compact size and intensification of production (compared to conventional drum granulation) due to the increased speed of drum rotation (up to 28-35 rpm).
4. Diversity of product range and possibility to expand it by installing additional nozzles.

State of development

A mobile HSDG unit was developed for production of trial batches of new products in a laboratory, but it has been successfully tested in industrial use and can be connected to an existing plant and its utilities. It has been used for optimisation of the production process of new and existing types of fertilizers, and initially all samples are produced on it. In cooperation with one Russian urea manufacturer, R&D Institute of Urea (NIIK) has also installed an industrial pilot unit to further improve the process of fertilizer granulation in the HSDG in real plant conditions.

The following fertilizers have been produced in the HSDG: granulated urea (size distribution 3-5mm), granulated ammonium nitrate (size distribution 3-5 mm). The mobile HSDG unit was taken to Kazakhstan and integrated with existing production of ammonium nitrate; 96% ammonium nitrate solution was granulated into a product whose strength was 4-5 times higher than the strength of prilled ammonium nitrate that was produced at the same site. The HSDG was also used for production of calcium- (from a 75% solution) and magnesium nitrate with size distribution 1.5-2 mm.

Fig 1: **Internal construction if HSDG**

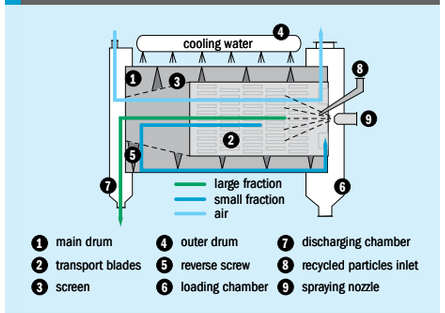
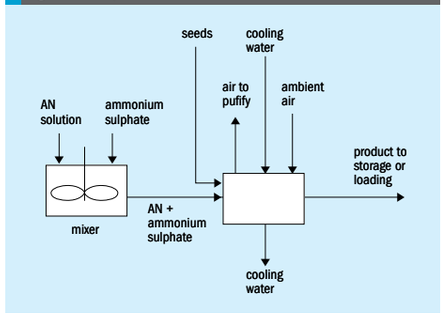


Fig 2: **HSDG process schematic**



Thus a large spectrum of fertilizers with macro- and micronutrients, having been tested for trial batches of urea with phosphogypsum, MAP with sulphur, NP and NPKs of different composition.

Production process

For better explanation of the production process in HSDG we will use ammonium nitrate with sulphur as an example (see Figure 2). Sulphur for *urea+sulphur* fertilizer can be produced using regular sulphur or ammonium sulphate that is commonly found in many plants at relatively low cost.

Installation of such a unit at an existing plant requires low capital investment, little space or additional equipment and can be performed in a very short time following equipment manufacture. The production process is very similar for all compound fertilizers. For example, urea can be used instead of AN, and potassium chloride instead of sulphur. Any granules, prills or crystals can be used as seeds and sprayed with nutrient containing solution, melt or slurry.

Fertilizers produced in HSDG

The mobile HSDG unit has been used to produce urea with zinc, copper and iron, the most essential micronutrients for both plants and living organisms. To produce urea with copper we sprayed urea prills with copper sulphate pentahydrate, for urea with iron, we sprayed with iron sulphate heptahydrate.

Urea with phosphogypsum is a brilliant solution for utilisation of phosphogypsum and maintaining the profit level for urea. Urea with phosphogypsum has a positive impact on soil, structuring it, deoxygenating it and bringing additional nutrients to it.

Ammonium nitrate and ammonium sulphate combine the features of the most affordable fertilizers and add the safety of ammonium sulphate to ammonium nitrate, making it much safer to handle, store and transport. Considering that regulations against the use of ammonium nitrate are spreading, it can be easy to switch to production of ammonium nitrate combined with ammonium sulphate. The HSDG can replace conventional drum granulators and dryers for production of ammoniated superphosphate or MAP. Also, the HSDG can be used for combining several nutrients to create a compound fertilizer with a set balance of nutrients. The HSDG has been tested for production of ammoniated superphosphate (NP-fertilizer) and an NPK that consists of urea, MAP and potassium chloride.

Technical and economic advantages

At the present moment the majority of plants offering NP and NPK fertilizers use a conventional drum granulator and dryer that occupies a vast area, gulps energy resources and which is considered to be an outdated technology. The HSDG, when compared to conventional technologies for NP and NPK production, has the following advantages:

- a smaller footprint area at the same capacity due to the intensification of the process.
- easy to install at an existing plant with limited space;
- low capital and operational costs;
- flexibility.

The HSDG can be used to diversify the range of fertilizers offered; depending on market requirements the producer decides what fertilizer is best suited to satisfy market demand and has a higher added cost value, and can adjust the HSDG accordingly for production of a particular fertilizer blend. The range of applications for the HSDG technology is infinite, and the R&D Institute of Urea (NIIK) is open for suggestions from fertilizer plant owners to trial production of new types of products in our mobile HSDG unit.

References

At the present moment pre-commissioning work is in progress in an AN production plant in Kazakhstan. The HSDG unit has two drums installed for granulation of 500 t/d of ammonium nitrate from a 95-96% solution. The AN properties will be:

- strength ≥2,5 kgf/cm2,
- size distribution 2-4 mm (at least 95% of the total production volume).

The basic engineering package has been developed for a calcium and magnesium nitrate HSDG unit, and technical solutions have been prepared for granulated urea, urea+ (with sulphur and ammonium sulphate) and potassium and magnesium nitrate and urea for an HSDG unit for the Eurochem plant in Novomoskovsk. Technical solutions have also been prepared for a urea granulation unit at the Sibur plant in Kemerovo.

CONTENTS
What's in issue 321
COVER FEATURE 1
Nitrogen+Syngas Conference, Berlin
COVER FEATURE 2
Europe's energy markets
COVER FEATURE 3
Ammonia storage tank integrity
COVER FEATURE 4
Urea and melamine integration

NITROGEN+SYNGAS
ISSUE 321
JANUARY-FEBRUARY 2013

BCInsight
Southbank House, Black Prince Road
London SE1 7SJ, England
Tel: +44 (0)20 7793 2567
Fax: +44 (0)20 7793 2577
Web: www.bcinsight.com
www.bcinsightsearch.com