CUTTING DOWN TO SIZE

Christophe Chiron, Comessa, France, provides an overview of the equipment and processes required for fertilizer granulation.

A granulation plant for fertilizers (typically di-ammonium phosphate [DAP], mono-ammonium phosphate [MAP], triple super phosphate [TSP], nitrogen, phosphorus and potassium [NPK] and calcium ammonium nitrate [CAN]) generally includes a rotary granulator, a rotary dryer, a rotary cooler or a fluidised bed cooler, and a rotary coater (Figure 1).

The aim of granulation is to obtain granules of a marketable size, usually between 2 and 4 mm in diameter, from a mixture of finely ground raw materials.

For some applications (NPK, CAN or single super phosphate [SSP]), a pre-mixer or a pre-granulator, such as a double shaft paddle granulator, can be used (Figure 2). This type of equipment is composed of two shafts in parallel positions, each of them equipped with paddles, and rotating in counter direction inside a static trough. The paddles can be easily replaced and are fitted with wearing plates for the handling of abrasive products.

The wet granulation is then performed in a rotary granulator (Figure 3). The raw materials introduced into the granulator aggregate as a result of the rotation of the shell and the addition of water, steam or slurry (steam granulation or chemical granulation).

The rotary granulator is equipped with internal pipes and ramps for the spraying of liquid, liquor, slurry or ammonia directly inside the layer of product.

As the product inside the granulator is sticky, it is important to have an appropriate declogging system. Depending on the type of fertilizer and the process, several types of systems can be used, including:

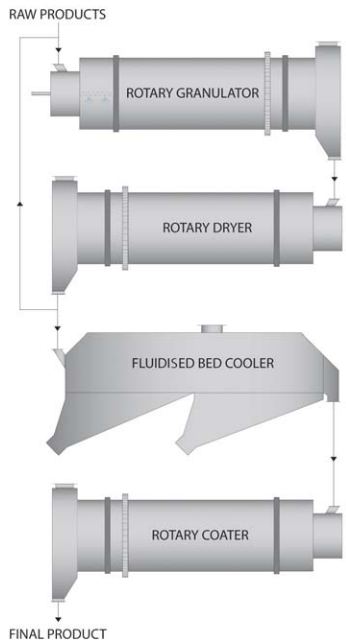

Figure 1. Typical granulation process.

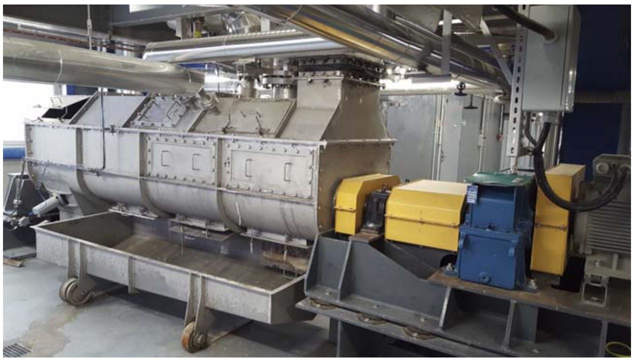

Figure 2. Double shaft paddle granulator.

Figure 3. Rotary granulator.

- An internal rubber lining, made of soft and ductile rubber.
- An external hammering device, made of mechanical knockers or rotating balls.
- A scraping device.

A grizzly rotating screen is generally positioned at the outlet of the drum in order to break the biggest lumps.

In the case of urea, it can be granulated in a rotary granulator with special internals. At present however, it is most commonly granulated in a fluidised bed granulator.

The granulated product is then dried in a rotary dryer (Figure 4), which removes a considerable amount of the internal moisture and increases the hardness of the particles.

The granules arriving from the granulator are very sticky. Consequently, a vibrating chute or a chute with an air declogging system can be used for the transfer of the product from the granulator to the dryer.

Hot air is introduced co-currently into the dryer. The shell is equipped with a set of internal lifters specifically designed and adapted to each operating condition. The role of these lifters is to create a curtain of product and then increase the contact between the hot air and granules, which optimises the thermal efficiency of the dryer.

Some processes involve the use of the same equipment for granulation and drying. This is the case for the rotary spherodiser, which consists of a drum divided into two sections: in the first section slurry is sprayed on the curtain of product, and in the second the granules are dried.

In the case of ammonium nitrate, there is generally a pre-drying step and a final drying step, both achieved by rotary tubes. In some cases, a combined rotary tube can be used in order to perform both steps in the same machine.

The product is heated during the drying operation, and can reach a temperature of up to 90 – 100˚C. It is then necessary to cool it down, in order to:

- Stop the residual water contained in the granules from being released during storage.
- Prevent undesirable crystallographic modifications.
- Remove transition heat.
- Prevent the product recovering moisture.

Depending on the application, the type of fertilizer and the ambient conditions, it is often necessary to decrease the humidity of the cooling air in order to prevent the product recovering moisture. This is particularly pertinent for products containing nitrogen and urea.

The hot product is first screened in order to remove fine particles and lumps, and is then cooled in a rotary cooler or in a fluidised bed cooler. The cooling process in a rotary cooler is performed countercurrently.

The fluidised bed cooler technology offers several benefits, including:

- Optimum level of contact between the air and product.
- The possibility for the cooled product to reach a lower final temperature.
- The cooling air is divided into several zones, which minimises the quantity of treated air.
- The possibility of air recycling from one zone to another, which minimises the quantity of air sent to the dedusting system.
- No erosion of particles.

Figure 4. Rotary dryer.

Figure 5. Fluidised bed with heat exchangers.

- No mechanical maintenance.

However, the rotary cooler is still used in many cases because it is usually better known by end users and simpler in term of process.

In some situations, it is also possible to use a fluidised bed with immersed heat exchangers fed with cold water that is located directly inside the layer of fluidised product (Figure 5). This process minimises the quantity of cooling air that can be divided by at least 50%.

Before final storage or packing, the product can be coated. An anti-caking agent is sprayed on the granules in a coating drum.

Drying, cooling and coating technologies can also be used to complement the prilling and compaction processes, either through fluidised bed technologies, or with rotary tubes.

Case study: Morocco

Since the 1960s, the demand for fertilizers has increased significantly, and the size of production facilities has increased proportionately: fertilizer units in the 1960s could typically produce approximately 250 000 tpy, whereas the output of present units can now exceed 1 million tpy. A fertilizer production line with such a capacity therefore requires very large equipment, which in turns creates many challenges in terms of logistics, mechanics and processes.

Comessa recently supplied equipment for four granulation lines to a plant in Morocco, in collaboration with a Moroccan engineering, procurement and construction (EPC) company. From a logistical point of view, it was necessary to handle, transport and assemble parts that weighed over 130 t in total. Another challenge was to deliver these components for the four lines within a time period of two years. The lines began operating within the past four years, and each has been designed for 1 million tpy capacity, DAP equivalent.

The last of the original four lines commenced operating in 2018. The supply for this line was composed of:

- A rotary granulator, complete with internals composed of a rubber lining, internal slurry pipe, ammonia pipe and internal support, as well as outlet grizzly rotating screen.
- An intermediate chute with declogging system.
- A rotary dryer, with internals specially designed for the application, a hammering device and outlet grizzly rotating screen.
- A fluidised bed cooler with blowing system.
- A rotary coater, with coating agent spraying ramp.

The client has since ordered a further three lines, which are now under construction.

Conclusion

Wet granulation of fertilizers usually involves a rotary granulator, as well as other technologies such as rotary tubes, fluidised beds, and fluidised beds with exchangers. As well as granulation, other necessary processes include mixing or pre-granulation, drying, lump breaking, cooling and coating. A constant challenge is to design larger and larger equipment, in order to respond to the increase in global fertilizer demand. WF