FORMULATING FOR SUCCESS

Michael Jacob, Glatt Ingenieurtechnik, Germany, explains why fluid bed systems are key to producing specialty fertilizers.

Fertilizers – both liquid and powder – can pose multiple challenges during handling. Liquid solutions can be unstable and their transport can be complex in many ways. Very fine powders can behave hygroscopically and can be extremely dusty, making storage and application difficult. However, fluidised bed technology can help to overcome all of these challenges. Additionally, it offers an enormous spectrum of possibilities for optimising the properties of fertilizers, enhancing their functionalisation, and broadening their scope of application across agriculture.

From improving durability and flowability through dust reduction to a pronounced depot effect or a targeted nutrient supply via better active ingredient distribution, fluidised bed technology can deliver many benefits. The shape and size of the fertilizer granules can be determined within a defined range. The quantity of fertilizer components delivered to the soil can be adapted optimally, and significantly higher product qualities can be achieved. Solubility and protection against external influences can also be markedly improved. In addition, fluidised bed processing, which has been in use since the 1960's, is one of the most effective drying techniques. The technology is particularly suitable for the manufacture of products that require safe handling and dosing – whether this is a high performance fertilizer, an artificial fertilizer, or a standard fertilizer based on regular components or recycled raw materials. One of the most interesting advantages of fluidised bed technology is that all of the necessary production steps can be carried out in a single continuous process without interruptions or machine changes.

Custom particle design

A fluidised bed occurs when process air flowing upward lifts a layer of solid particles and fluidises them. The process air is used to generate the fluidised bed state and it also supplies the thermal energy required for particle production at the same time. In addition to the thermal

A new way forward: fluidised bed granulation produces phosphate fertilizer from sewage sludge

Phosphorus is an important raw material for every biological organism. It cannot be produced synthetically, but its salts and esters – phosphates – are recyclable. To ensure the accessibility of this precious mineral for the future, phosphate recovery became a legal requirement in Germany for precautionary reasons in October 2017. Working with a partner, plant manufacturer and engineering specialist, Glatt Ingenieurtechnik has developed a two-step process that initially releases phosphate from sewage sludge and subsequently transforms it into ready-to-use fertilizer granules using a fluidised bed spray granulation process. This highly efficient system meets today's market demands for the production of ready-to-use standard and multicomponent fertilizers based on recycled phosphate, whereby the ashes can be reused to provide a 100% waste-free product.

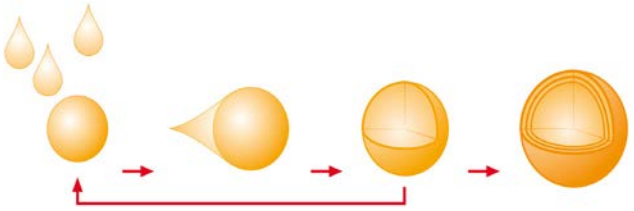

Figure 1. In spray granulation, liquid is sprayed layer by layer around a particle up to the desired particle size.

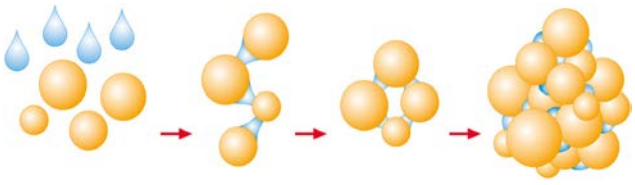

Figure 2. In the fluid bed, small particles are sprayed with binder liquid and combine to form larger agglomerates. Typical grain sizes between 200 µm – 3 mm.

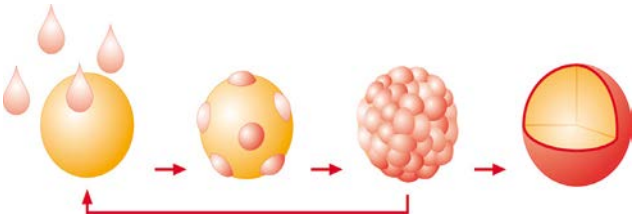

Figure 3. A spray coating, in which the particles are coated with a solid-containing spray liquid, can be applied at the end of the production process.

Figure 4. Fertilizer granules before and after coating.

treatment of solid materials, fluidised bed processes are used for drying tasks, to form granules from powders (spray agglomeration) or liquids (spray granulation), and to coat particles (spray coating). All particles are always mixed together so intensively that a uniform treatment temperature is ensured across the entire fluidised bed. This means that not only is the drying process very easy to control, but the gentle handling of temperature-sensitive materials is also ensured. Parameters such as granule size, residual moisture content, and solids content can be specifically influenced to achieve a wide variety of product properties. In trials, different process conditions and recipes can be tested and compared using variables such as, different process inserts, spray pressures, fluidised bed volumes, temperatures, process gas volumes, residence times, and choice of raw materials.

Compact, dust-free granules from liquids

Spray granulation with fluidised bed technology is among the leading processes when it comes to particle design, precisely adjusted particle sizes, dust-free and safe handling, and perfect dosing. It is an optimum process for the manufacturing of fertilizer granules from liquids and powders. The uniform round granules dissolve exactly according to the desired time and ambient conditions and do not segregate during transport or storage. Granule formation and subsequent drying can be carried out in a single process step. This facilitates the production of round pellets with a homogeneous structure, dense surface, and high resistance to abrasion. Furthermore, spray granulation enables the drying of liquids, while simultaneously forming dust-free granules. Liquids are sprayed onto fluidised particles and dry on their surface, thereby creating a layered accumulation of particles (Figure 1). The small particles required to maintain the granulate build-up are generated in the process itself; the only raw material required is the liquid. It is also possible to add specific powder form or fine particle solids to the process in order to integrate them homogeneously into the granule structure or to use them as external starter cores for granule accumulation.

Porous, optimally dispersible granules

Spray agglomeration makes it possible to produce highly soluble fertilizer granules directly from a liquid. Spray agglomerated granules can be used as a temporary condition for liquid fertilizer by first transforming the fertilizer solution into agglomerates for transportation and storage and then liquefying it again before spreading. Another interesting application is fine fertilizer agglomerates, which are applied directly to plants and dissolve immediately so that they are available to the plants on contact with water. Fluid bed spray agglomeration also improves flow behaviour and eliminates negative effects such as dust formation. Fertilizer granules therefore behave in a similar way to instant products: they dissolve quickly and are applied in liquid form. In addition, the segregation effects of powder mixtures can be prevented by joining them into agglomerates. Wettable, loose granules with good wetting behaviour, and which dissolve very well, are produced for

instant applications. In spray agglomeration in the fluidised bed, powder is sprayed with liquid until sufficient bonding forces are created between the particles (Figure 2). The agglomerate structure is directly reinforced with simultaneous drying. In accordance with the required properties of the raw material or product, water or any other liquid auxiliary material can be used for granule construction and structure formation.

Functional layers

By applying a coating, granules can be protected against external influences, coloured or equipped with additional values – for example, for controlled release. Fluid bed spray coating covers each particle with a defined layer in order to provide optimum protection for active substances or to functionalise the particle surfaces (Figure 3). The application of the coating material by spraying the liquid containing the solid materials onto the fluidised particles, as well as the drying and reinforcement of the film, are carried out in a single process step. A wide range of different coating layers can be realised in a variety of ways, depending on the required product properties. In hotmelt coating, for instance, the particle shell is formed by solidifying a sprayed-on melt. This method is ideal for fast layer application. Other applications require minimal layer thicknesses (Figure 4). In this regard, solvent-based processes are an alternative to water-based methods. Suitable fertilizer coatings here would include, for example, amino acids or polymers.

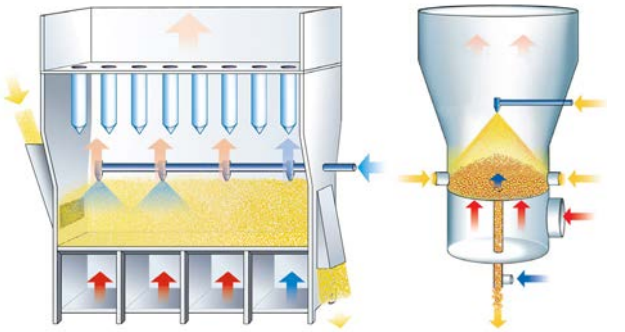

Figure 5. The geometry of the process chamber influences the properties of the fluidised bed and should be extensively tested in early stage trials for application purposes.

Fluid bed granulators and coaters

Systems featuring a fluidised bed with a circular bottom plate are used primarily for particularly intensive mixing. The diverse array of possible configurations includes different filter systems, various nozzle and spray systems, different solid inputs, granule discharges, and the classifying discharge for continuous operation (Figure 5). Glatt GFG fluidised bed granulators, featuring an elongated, rectangular fluidised bed, enable targeted material movement through the process chambers. If necessary, the bed can be divided into zones. This allows the particles to be subjected to various process conditions one after the other in a targeted way, enabling multiple process steps – such as granulation, drying, and cooling – to be undertaken in the same system. And all of this can be done during continuous operation. Whether it is simple particle coating using the top-spray method or functional film coating via the bottom-spray method, it is always important that the spraying of the particles is as even as possible. A special, cleverly designed process chamber construction, in combination with high quality spray systems, makes this possible. But whether the geometry of the apparatus is circular or rectangular, the chamber can also be divided into multiple zones or further chambers if necessary. How decisive the geometry of a multi-chamber system is for the success of a production process has already been shown in an article on methylene urea published earlier this year.[1]

Table 1. Advantages of granules and pellets in comparison to powder and liquids.

Granules (homogenous structure)	Agglomerates (porous structure)	Coated particles (composite)
Dust-free	Dust-free	Defined alteration of:
Spherical pellets	Good free flowing properties	Chemical stability
Excellent free flowing properties	Good dosing properties	Storage stability
Good dosing properties	Porous structure	Hygroscopicity
Compact structure	Good dispersibility	Release profile
Decreased hygroscopicity	Excellent re-wettability	Surface structure
High bulk density	Low bulk density	Solubility
Closed surface	Adjustable grain size and distribution	Appearance
Adjustable grain size and distribution		Hardness
Little abrasion		Composition (layered structures)
↓	↓	↓
Spray granulation	**Spray agglomeration**	**Spray coating**

Summary

There are numerous technologies available on the market that can produce standard fertilizers effectively and efficiently. However, when it comes to enhancing fertilizers with special properties or making them easier and safer to handle, fluidised bed technology offers advantages and freedom. Fluidised bed technologies deliver maximum flexibility in particle forming processes where precisely adjusted properties are key. And, last but not least, several manufacturing steps can be combined into one economical process – a point at which several other technologies reach their limits. WF

Reference

1. WASKOW, M., 'A Fluid Bed Approach', *World Fertilizer*, January/February 2018, pp. 53 – 56.