



**PROCESS & PLANT ENGINEERING + INNOVATIVE PROCESS TECHNOLOGY**

**FUNCTIONALIZATION OF GRANULES AND PELLETS**



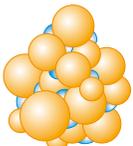
## OPTIMAL PROCESSES FOR OPTIMAL PRODUCTS

High-quality granules and pellets made of solid and/or liquid starting materials.

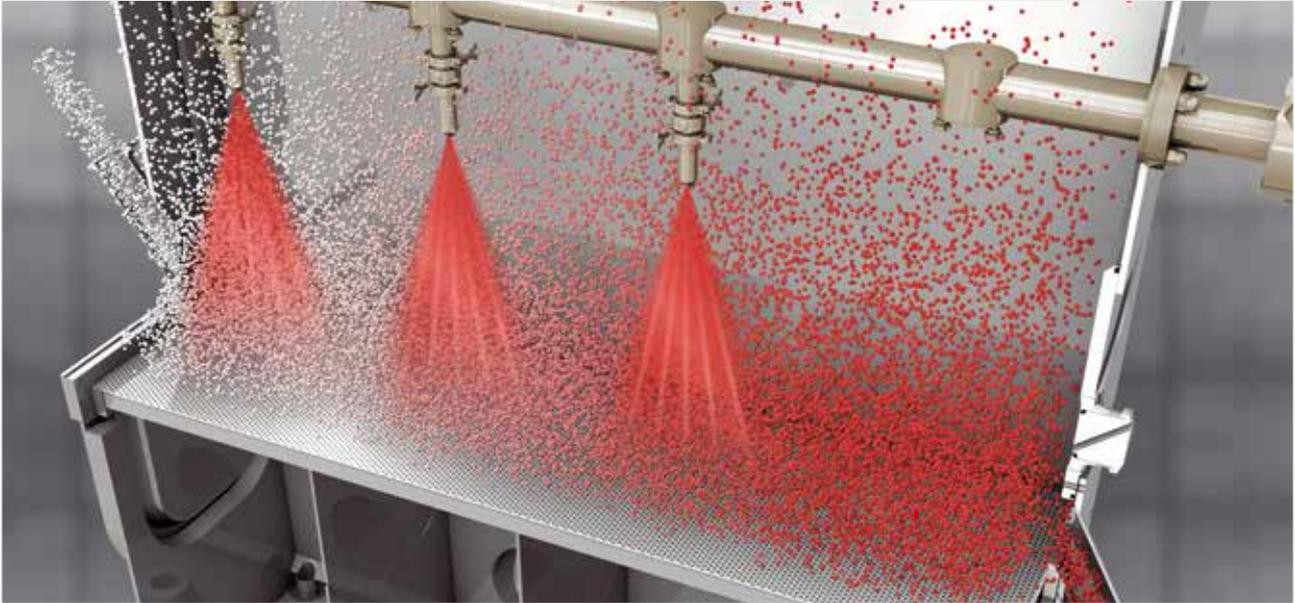
General advantages of granules and pellets

<b>Dust-free</b>	» High level of safety in handling and application
<b>Flowability</b>	» Optimum dosing, good flow behavior
<b>Adjustable particle size and size distribution</b>	» Optimum application properties and visual attractiveness
<b>Adjustable particle structure</b>	» Bulk density, wetting behavior, dispersion properties, dissolution time, particle porosity
<b>Optimum stability and homogeneity</b>	» Elimination of segregation in multi-component systems, increase in storage stability and shelf life
<b>Reduction in volume</b>	» Concentrated and compact product form, ideal handling, and easy to transport

Particle structure      Product example

		<b>Spray granulation</b> Granules from liquids	<ul style="list-style-type: none"> <li>» Round pellets with a compact structure</li> <li>» High density with low specific surface area</li> <li>» High particle hardness and abrasion resistance</li> <li>» Adjustable particle sizes and size distribution</li> </ul>
		<b>Spray agglomeration</b> Granules from powders	<ul style="list-style-type: none"> <li>» Porous structure with low density</li> <li>» Excellent wettability, optimum instant behavior</li> <li>» Adjustable particle sizes and size distribution</li> <li>» Homogeneous component distribution</li> </ul>
		<b>Spray coating</b> Coating or encapsulation of particles	<ul style="list-style-type: none"> <li>» Functionalization of particles, granules, pellets</li> <li>» Targeted control of product properties</li> <li>» Release control (various mechanisms)</li> <li>» Odor and taste masking</li> </ul>
		<b>Spray encapsulation</b> Encapsulation of valuable materials from the liquid	<ul style="list-style-type: none"> <li>» Adjustable valuable material content in the final product</li> <li>» Homogeneous, compact granules made from liquid raw materials</li> <li>» Porous granules due to loading of solid auxiliary materials</li> <li>» Various carrier systems</li> <li>» Optimum functionalization</li> <li>» Combination of granule formation and release control in a single step</li> </ul>

## INNOVATIVE FLUIDIZED-BED AND SPOUTED-BED TECHNOLOGY



### *Fluidized bed – an ideal solution for custom particle design*

A fluidized bed occurs when process air flowing upward lifts a layer of solid particles, fluidizing the particles. The process air is used to generate the fluidized-bed state, and also supplies the required thermal energy for the particle processes at the same time.

In addition to the thermal treatment of solid materials, fluidized-bed processes are used for drying tasks, for forming granules from powders (spray agglomeration) or liquids (spray granulation), and for the coating of particles (spray coating).

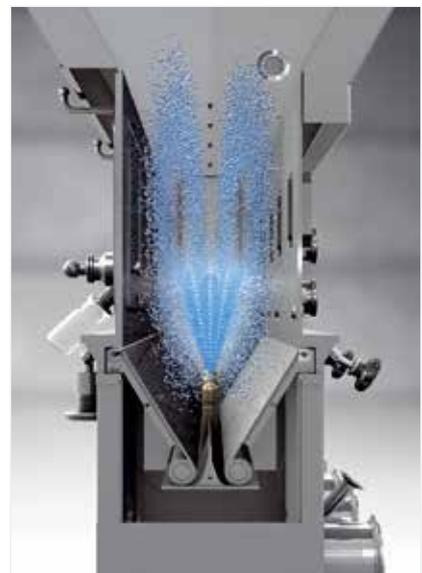
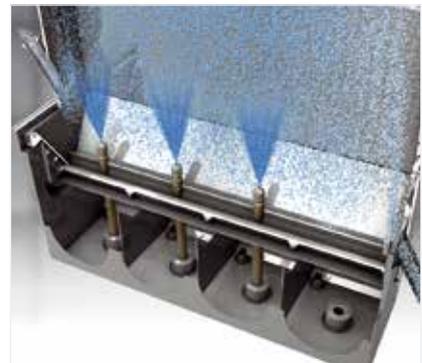
All particles are always mixed together so intensively that a uniform treatment temperature is ensured across the entire fluidized bed. This enables not only a drying process that is very easy

to control, but also the gentle handling of temperature-sensitive materials.

### *Spouted bed – an effective solution for special requirements*

The spouted-bed technology is also based on the fundamental principle of the fluidization of particles by upward-flowing process air.

The key difference is the patented design of the process air inlet as pores in combination with special flow profiles and a rapidly widening process chamber. This results in significantly higher heat and material transfer rates for the processing of sensitive products with short retention times.



## UNIQUE PRODUCT EXPERTISE FOR YOUR APPLICATIONS

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### *More performance for your product*

In processes featuring innovative fluidized-bed and spouted-bed technologies from Glatt, you have virtually unlimited options in terms of optimized particle design and suitable functionalizations of granules.

Whether it is spray granulation, spray agglomeration, spray encapsulation, or coating – the key to the ideal product is choosing the right process parameters, along with the multitude of combination options for these parameters.

### *Tailored to your application*

Various applications with a variety of requirement profiles: Should the product dissolve quickly, slowly, or not at all? Are instant properties or maximum particle stability required? What role does bulk density play when it comes to application, handling, storage, and packaging? Maximum options for functionalization? Users, product developers, and technology specialists must work together closely to produce an ideal product effectively.

### *Safety during handling*

Example: Flowable, abrasion-resistant plant protection agent – spray-granulated from a suspension of various components for manufacturing granules with homogeneous component distribution which can redisperse in the application.

### *Improved properties*

Example: Agglomerated baby food or drink powders consisting of many individual components, some of which are hydrophobic – homogeneous component distribution, no segregation effects, quick wetting and dissolving.

### *Homogeneity ensured*

Example: Animal feed mixing – several mineral components are processed into compact, homogeneous, and abrasion-resistant granules.

### *Protection for valuable substances*

Example: Essential oils in a granule matrix – spray encapsulation of an oil-in-water emulsion directly produces a flowable product which has high long-term stability and resistance to oxidation.

### *Integrated functionality*

Example: Coated detergent component – no reaction with other components in the packaging, better chemical stability, and release only during application.

### *Stability is essential*

Example: Immobilized probiotics – convert liquid cultures into a solid dosage form by means of spray granulation and subsequent application of a coating layer for gastric juice resistance and controlled release in the intestine.

### *Batch mode or continuous operation?*

Example: Functional film coating for release control of a nutritional supplement as a batch process – protective coating as moisture protection for a detergent component as a continuous process.

### *Drying and shaping in a single step*

Example: Dust-free, storable feed component – replacement of a multi-stage process for filtration, concentration, drying, and agglomeration with a continuous-operation spray granulation process.

### *It all depends on the appearance*

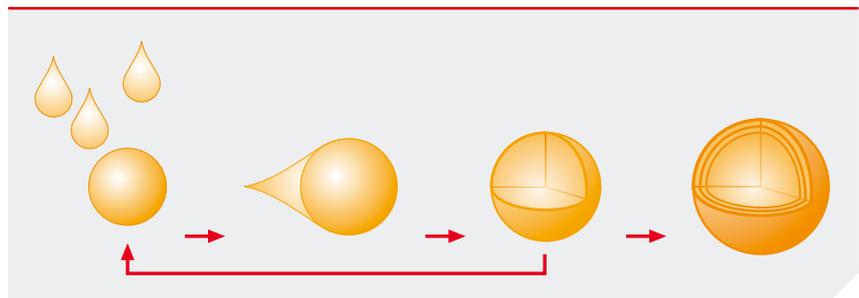
Example: Food additives – spray granulation of liquid formulations for adjusting size and bulk density, and for coating with colorings, so that the granules are visually consistent in final mixtures and so that segregation effects during packaging and application are prevented.

## SPRAY GRANULATION



### *Compact, dust-free granules from liquids*

With Glatt spray granulation, you can produce round pellets with a homogeneous structure, dense surface, and high resistance to abrasion.



The process enables the drying of liquids while simultaneously forming dust-free granules. Liquids are sprayed onto fluidized particles and dry on their surface, thereby creating a layered accumulation of particles. The small particles required to maintain the granulate build-up are generated in the process itself. Only the liquid raw material is required.



Detergent – ideal spray granule

### *Addition of solids*

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.

### *Product properties*

- » Dust-free, round pellets
- » Compact structure
- » High particle and bulk density
- » Low specific surface area
- » High particle hardness
- » High resistance to abrasion
- » Narrow and adjustable particle size and particle size distribution
- » Very good dosing
- » Excellent flow behavior
- » Good solubility
- » Good dispersibility
- » Low hygroscopicity

## SPRAY AGGLOMERATION



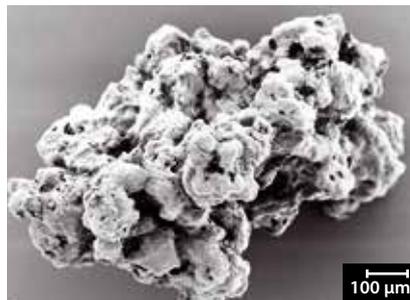
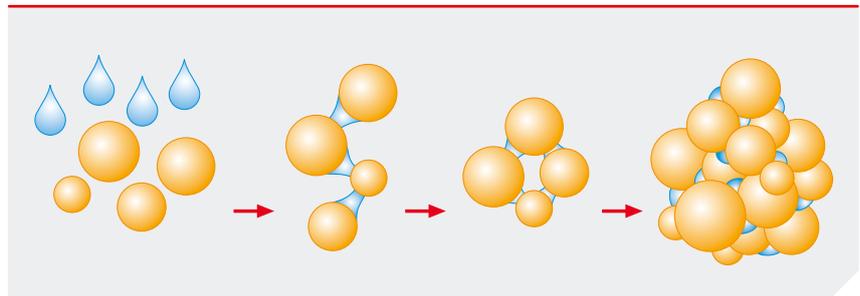
### *Porous, optimally dispersible granules from powders*

In Glatt spray agglomeration in the fluidized or spouted bed, powder is sprayed with liquid until sufficient bonding forces are created between the particles. 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.

This process improves flow behavior and eliminates negative effects such as dust formation.

The segregation effects of powder mixtures can be prevented by joining them into agglomerates.



Curcuma agglomerate

Wettable, loose granules with good sinking behavior and which dissolve very well are produced for instant applications.

### *Product properties*

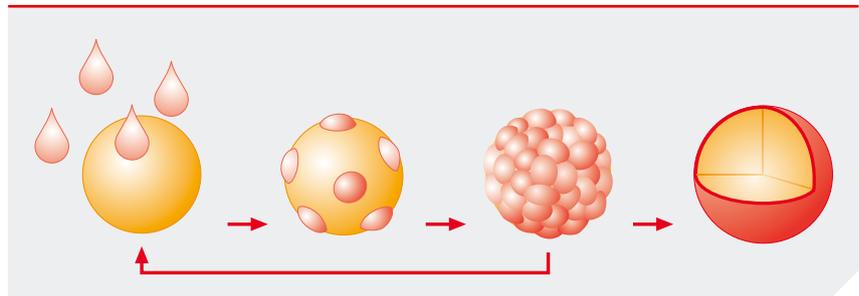
- » Dust-free particles
- » Porous structure
- » Low bulk density
- » Excellent wettability
- » Optimal instant behavior
- » Easy to form into tablets
- » Adjustable particle size and particle size distribution
- » Very good homogeneity with ideal component distribution
- » Good dosing
- » Good flow behavior

## SPRAY COATING



### *Uniform casing with defined layer*

The coating covers each particle with a defined layer in order to provide optimum protection for active substances or to functionalize the particle surfaces.



The application of the coating material by spraying the liquid containing the solid materials onto the fluidized particles, as well as the drying and reinforcement of the film, are carried out in a single process step.

### *A wide range of variants*

Coating layers can be realized in a variety of different ways, depending on requirements in terms of product properties.

In hotmelt coating, the particle shell is formed through the solidification of a sprayed-on melt. It is well suited to fast layer application. Other applications re-



Coated enzyme pellet

quire minimal layer thicknesses. In this regard, solvent-based processes are an alternative to water-based methods. The spouted bed or Wurster method is suitable for coating very fine or irregularly structured particles.

### *Targeted control of:*

- » Release behavior
- » Odor/ taste
- » Storage compatibility
- » Visual attractiveness
- » Surface structure
- » Solubility
- » Flow behavior
- » Sorption behavior/ hygroscopicity
- » Thermostability
- » Chemical compatibility
- » Oxidation stability
- » Mechanical durability
- » Multi-layer coating for graded functionality

# SPRAY ENCAPSULATION



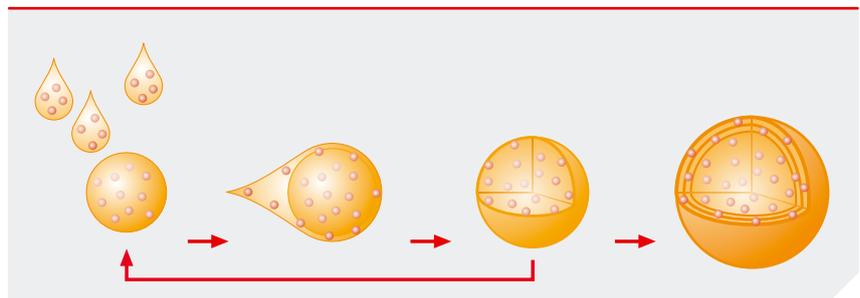
## Perfect protection for sensitive substances

Valuable materials which must be specially protected often exist in the form of a powder or even a liquid. With Glatt spray encapsulation on the basis of spray granulation, these substances can be embedded with homogeneous distribution in a compact protection matrix.

## Encapsulation from liquid

Substances in powder form must be sufficiently well dispersed in the matrix liquid and insoluble liquids must be emulsified. During subsequent granulation, the finely dispersed valuable materials are fixed in the solid carrier matrix.

As an alternative to encapsulation in homogeneous, compact matrices, the spray liquid can also be sprayed onto the carrier particles. Suitable powders or inert carrier granules, for example,



Granule with oil encapsulated in the matrix

can be used as base materials. By means of targeted variation of the formulation and processing parameters, the particle structure can be adjusted to your specific requirements.

## Product properties

- » Adjustable valuable material content in the finished product
- » Compact granules made from liquid raw materials
- » Porous granules due to the loading of solid auxiliary materials
- » Various carrier systems
- » Optimum functionalization
- » Combination of granule formation and release control in a single step
- » Dust-free
- » Good flow behavior
- » Good dosing

## TECHNOLOGY COMPETENCE



### *System concepts*

Glatt boasts a uniquely broad portfolio of different system concepts for implementing product ideas with a diverse array of requirements. Batch-mode or continuous operation, single or multi-stage process management, vertical or

horizontal material flow – these many options allow us to work together with you and pursue an open-ended approach to process development and systems engineering. Each system series was developed for specific areas of application, thereby allowing you to achieve your product developments.

### *Granulators*

Systems featuring the round fluidized-bed floor are used primarily when it comes to particularly intensive mixing of the fluidized bed. The diverse array of configurations includes different filter systems, various nozzle and spray systems, flexible solid inputs, granule discharges, and the classifying discharge for continuous operation.



### *Fluidized or spouted bed*

Both concepts can be used for all process options. Nevertheless, they have very different properties in terms of fluid mechanics and process dynamics, opening up the possibility of additional potential for innovative particle engineering and product design.

Glatt GFG fluidized-bed granulators, featuring the elongated, rectangular fluidized bed, enable targeted material movement through the process chamber. If necessary, this 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 to be undertaken in the same system (e.g. granulation, drying, and cooling). And all this can be done in continuous operation.

**AGT 200 system for continuous granulation drying with replaceable process inserts for fluidized-bed spray granulation and coating**



The ProCell series combines the innovative spouted-bed concept with the flexibility and multi-zone concept of a GFG. The main areas of application are the granulation of fine particles, processing of materials that are sensitive to temperature and retention time, and processing of sticky materials.

### Coaters

Whether it is simple particle coating in the top-spray method or functional film coating in the bottom-spray or Wurster method – it is always important that the spraying of the particles is as even as possible in all coating processes.

A special, cleverly designed process chamber construction, in combination with high-quality spray systems, makes this possible. Whether with round or rectangular apparatus geometry, the chamber can also be divided into multiple zones or chambers if necessary.



### Effective with guarantee

Benefit from ideal processes for manufacturing high-quality granules and pellets, which may be structured and functionalized according to specific customer requirements.

Glatt guarantees process parameters and product properties such as capacity, particle size, or bulk density to ensure the reproducible quality and cost-effectiveness of your system.

Spray system for the GFC 2200 fluidized-bed coater

## PROCESS DEVELOPMENT AND SCALING UP



Glatt laboratory units

A variety of system sizes, from laboratory models to production-scale versions, are used for these purposes.

Our fluidized-bed and spouting-bed systems operate in the development scale from 0.1 to 20 kg or produce sample amounts as pilot productions from 50 to 1,000 kg. In addition, contract manufacturing is possible on the larger scale of tons.

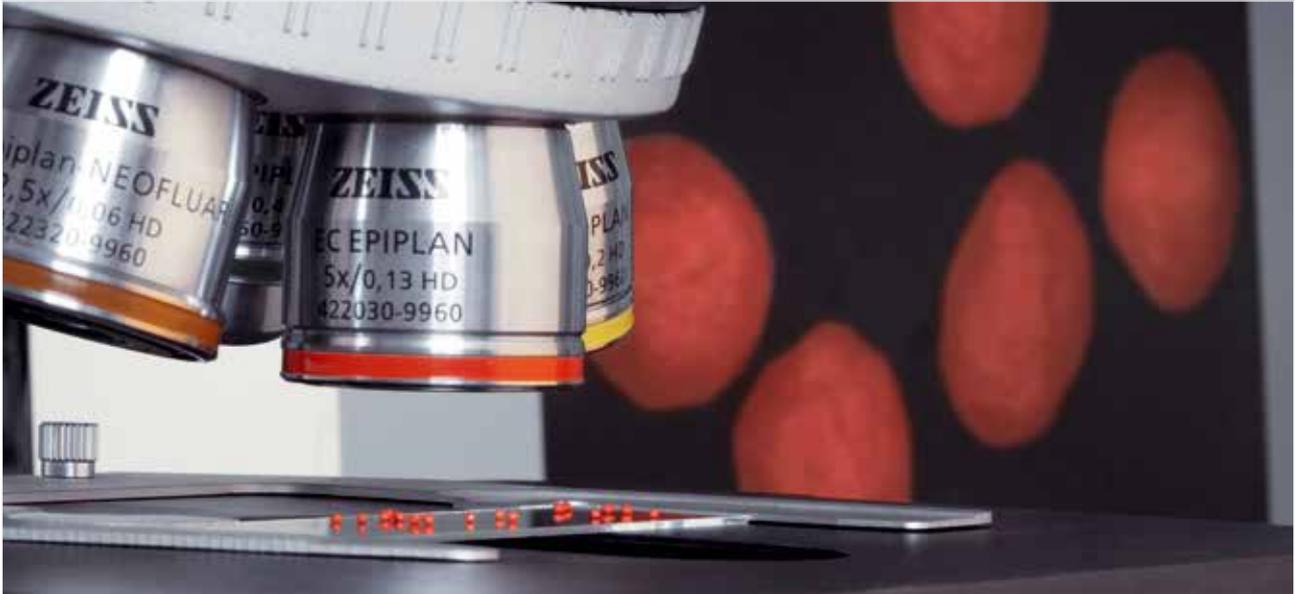
### *From the lab to production*

In its own technology centers, Glatt offers you the possibility of developing processes and thereby adapting systems to your specific requirements. You can benefit from our many years of experience in process optimization.

Modern systems and our team of highly qualified, interdisciplinary process engineers are available to develop new product forms in feasibility tests or to optimize the properties and manufacturing processes of already established products in application investigations.



ProCell pilot system in the Glatt Technology Center, Weimar



### *Modern analysis for optimum results*

The Glatt technology centers provide modern devices for characterizing substances and determining product properties and compositions.

Our range of services includes the characterization of a diverse array of particles and particle systems with regard to their physical, chemical, and mineralogical properties.

### *Characterization of product properties (selection)*

- » Particle size and size distribution (laser diffraction, image analysis)
- » Particle shape and shape distribution (image analysis)
- » Moisture content (halogen/infrared, Karl Fischer method, drying oven)
- » Bulk density (DIN ISO)

### *Characterization of material properties (selection):*

- » pH and resistivity value
- » Liquid rheology
- » Thermal analysis (TGA/DSC)
- » Chemical/elemental analysis (ICP-OES, CHNS)
- » Phase analysis (XRD)
- » Specific surface area (BET)
- » Pore sizes, pore volumes (nitrogen adsorption)
- » Vapor or solvent sorption/desorption (DVS)
- » Loss on ignition



## PLANT DESIGN AND IMPLEMENTATION



### *Complete solutions for implementing your product idea*

Glatt has at its disposal the entire technical know-how required for the production and handling of your product.

We provide you with a finished concept which integrates all components of the production process. Requirements with respect to protection against explosions and fire, heat recovery, energy efficiency, hygienic design, and ease of cleaning are also taken into account in addition to the minimization of emissions in air and water.

Filters built into the granulator minimize dust emissions and maximize the product yield. The correct selection of material and operating regime has a considerable influence on system availability, even with regular downtimes.



Installation planning  
of the AGT 250 fluidized-bed granulator



*We design our granulation all-rounders directly in accordance with your preferences.*

In addition, our experienced project management also coordinates assembly and start-up.

In addition to the fluidized-bed or spouted-bed machine, the standard scope of delivery includes all equipment that enables the process, such as pumps, fans, solids handling, treatment of supply and exhaust air, and process control over the entire system.

Additional equipment for both upstream and downstream processes can also be included in the scope of delivery – up to a turn-key factory including the building.

ProCell 500 spouted-bed production system

## INTEGRATED PLANT ENGINEERING



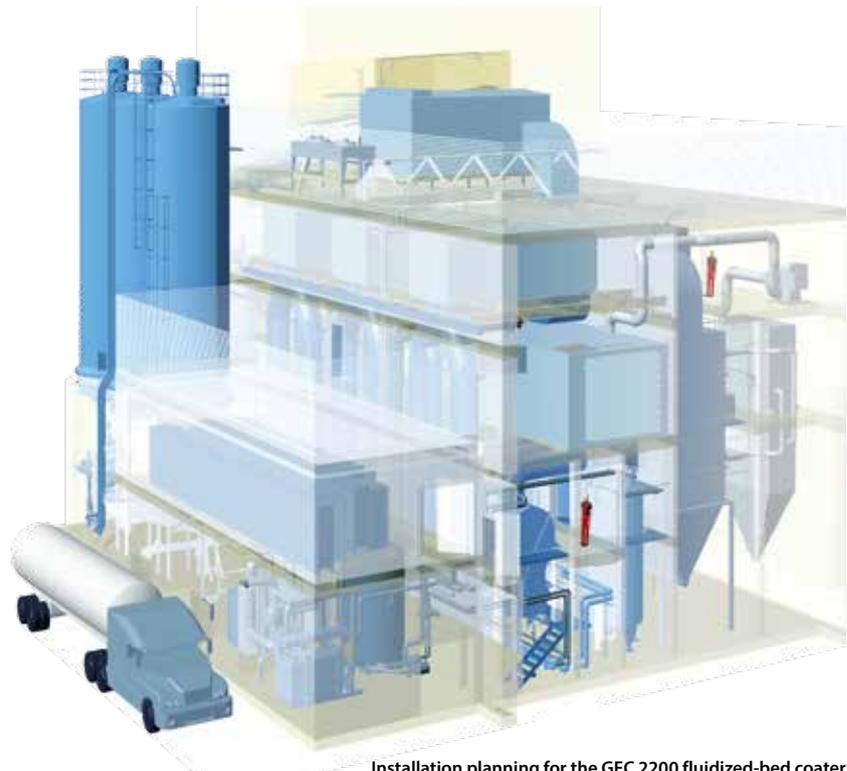
*We combine professional engineering with in-depth technology expertise!*

Glatt is your engineering and technology partner with more than 60 years of process expertise. We accompany you from the initial idea through the consultation stage at the time of process and general planning, all the way to start-up of turn-key production.

Whether it be new construction, modernization, expansion or relocation of production site – we develop a tailored solution that meet your specific needs.

### *Technologies in focus*

At the center of attention are your products and their manufacturing. We integrate your technologies or pioneering Glatt technologies. Depending on the requirement, we supplement the process know-how



Installation planning for the GFC 2200 fluidized-bed coater

through the procurement of licenses of international partners.



*Range of engineering services*

- » Consulting and feasibility studies
- » Conception, basic and detailed engineering
- » Project management for planning and execution
- » Government agency management and financing concepts
- » Planning, management, supervision for construction, assembly, start-up
- » EPCM projects
- » Support with FAT and SAT



**Middle:**  
Bringing in the GFC 2200 fluidized-bed coater

**Bottom:**  
Transport of the AGT 250 fluidized-bed granulator



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