

Innovative Technologies for Granules and Pellets



- Granulation
- Agglomeration
- Coating
- Encapsulation
- Instantizing
- Pelletizing
- Drying



We set the standard

Innovative Technologies

**Agglomeration.
Granulation.
Pelletizing.
Coating.
Competence for
all processes.**

Replacing powders and liquids with dust-free granules and pellets is the target of many applications, in numerous industries. Better product properties, easier handling, accurate dosing and significant lower handling hazards are advantages demanded, by the market for bulk products. By means of functional coatings the qualities of the granules can be influenced.

Glatt has been granulating powder in fluid bed equipment since 1960. Alternative technologies, like granulation in the vertical granulator, pelletizing, spray granulation and different coating processes have been introduced or improved by Glatt. The cooperation with the customer is a key issue for Glatt - the product know-how of the customer is linked with the process and equipment know-how of Glatt.

Using Glatt laboratory equipment custom-designed processes are developed for the production of new granules and pellets. Feasibility and various size scale-up equipment is utilized for this development.

Utilizing contract manufacturing facilities, at the Glatt company IPC, these next generation products can be introduced to the market even before production sized equipment is installed. Glatt knows that a couple of weeks can be decisive for the success of a new product.

Glatt - innovation meets tradition.

Glatt was established in 1954 in Binzen (Southern Germany) and developed fluid bed equipment for drying of pharmaceutical products in the late 1950's. Soon nozzles were



**Werner Glatt
and his first WSG**

integrated into the fluid bed making granulation and coating processes possible.

The founding and acquisition of new technology centres enlarged the variety of offered technologies:
1971: Glatt AG in Pratteln/Switzerland with drum coaters,

1991: Glatt Ingenieurtechnik in Weimar with continuous processes and Glatt Systemtechnik in Dresden



ACT 400 constructed in 1981 (Weimar)

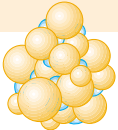
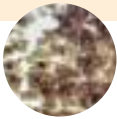


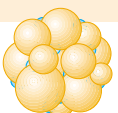
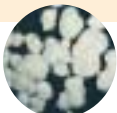


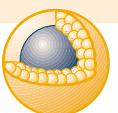



with vertical granulators, pelletizer and handling equipment. A world wide network of sales representatives is offering service to our customers at their own site, supported by process specialists from the technology centers.

**Agglomeration.
Granulation.
Pelletizing.
Coating.
Using the right
technology for an
optimized product:**

general advantages of granules and pellets

- dust-free
- excellent free flowing properties
- good dosing properties
- adjustable grain size and bulk density
- good dispersibility
- decreased handling hazards
- mass and volume smaller compared to liquids
- no crystallization or precipitation of solutions and suspensions

CONTENT

particle structure	product example	specific advantages using optimal technology:	
		<ul style="list-style-type: none"> • excellent solubility • porous structure • good tableting properties • wide grain size distribution 	agglomeration 4-5 of powders and immobilization of liquids
		<ul style="list-style-type: none"> • spherical pellets with a compact structure • closed surface with little abrasion • good solubility at decreased hygroscopicity • narrow grain size distribution 	spray granulation 6 of liquids and encapsulation of liquids
		<ul style="list-style-type: none"> • compact structure • good solubility at decreased hygroscopicity • good tableting properties • wide grain size distribution 	wet granulation 8 of powders
		<ul style="list-style-type: none"> • spherical pellets with compact structures • good solubility at low hygroscopicity • smooth surface with little abrasion • narrow grain size distribution • attractive appearance 	pelletizing 9-10 of granules and extrudates
		<ul style="list-style-type: none"> • spherical pellets with compact structures • good solubility at low hygroscopicity • smooth surface with low abrasion • narrow grain size distribution • attractive appearance 	powder layering 11 of seeds
		<ul style="list-style-type: none"> • influencing product qualities 	coating 12-13 encapsulation of granules with liquids
			process and product development 14
			plant design and construction 15
			contract manufacturing 16
			Glatt service program 17

Agglomeration

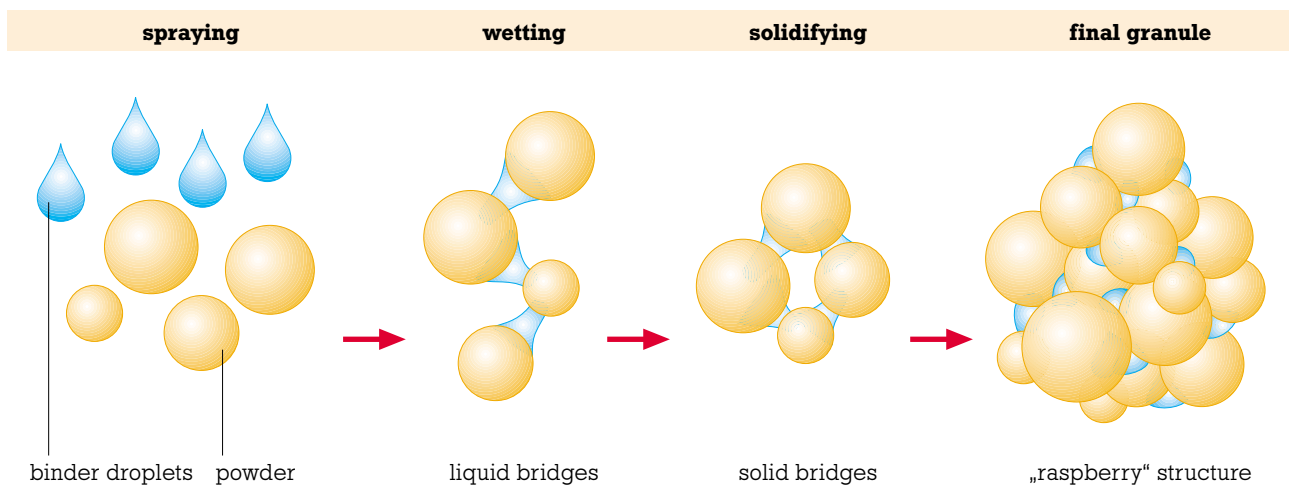
Building particles from powder. Immobilization of liquids.

Agglomeration in the fluid bed has been used for a long time to form granules from a powder. The fluidized powder is wetted until liquid bridges are formed between the particles. Water, solutions, suspensions or melts can be sprayed to meet the desired product quality.

Using this technology the amount of dust is decreased, the flowability and the dispersability in water are improved.

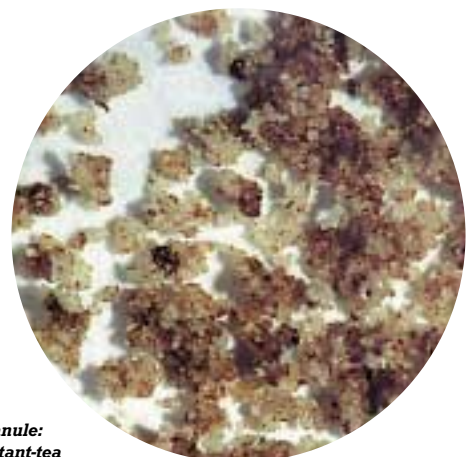
Segregation of powder mixtures do not occur since the different powders are glued together on a micro-scale. Since the impinging forces in the fluid bed are small, weak granules are formed with an excellent solubility (instant products). Spraying more binding liquid results in stronger granules (also refer to page 7 - Adding solid raw materials).

The agglomeration process can also be used as an immobilization process for liquids. A powdery adsorbent is used as a carrier and saturated with the liquid. The product is a liquid integrated into a dry, free flowing agglomerate. This process is also called encapsulation.



product properties

- dust-free granule
- good free flowing properties
- good dosing properties
- good dispersibility
- excellent solubility
- porous structure
- good tableting properties
- low bulk density
- wide grain size distribution



granule:
instant-tea

Agglomeration

WSG - batch operation

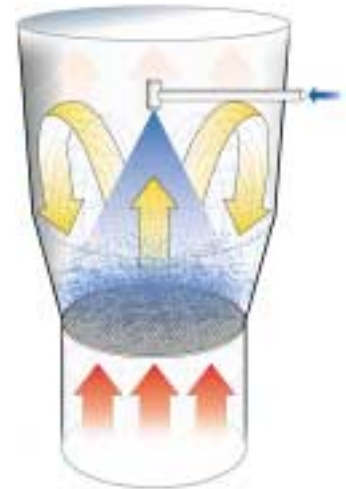
Powder is charged into the processing chamber of the fluid bed granulator (WSG). In the first process step the fluidized powder is wetted until agglomeration occurs. As soon as the desired grain size is reached, spraying is stopped and the granules are dried. Frequently the product is cooled before discharge.



fluid bed granulator WST/WSG PRO 120



single arm nozzle with six heads



principle of discontinuous agglomeration process, WSG

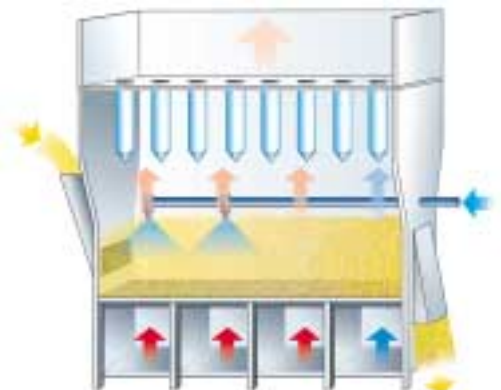


GF - continuous fluid bed

The different steps - in the batch process separated by time - are separated by space in the Glatt Fluid bed Granulator (GFG). Powder is fed continuously into the processing chamber. In the first part of the chamber liquid is sprayed into the bed and the powder is agglomerated. The wet granules are dried and cooled in the following parts of the processing chamber. The different processes are determined by different process air qualities in different inlet air chambers. If necessary the processing chamber can be separated into zones by weirs.



Glatt fluid bed granulator GFG 1200



principle of continuous agglomeration process, GFG

Spray granulation

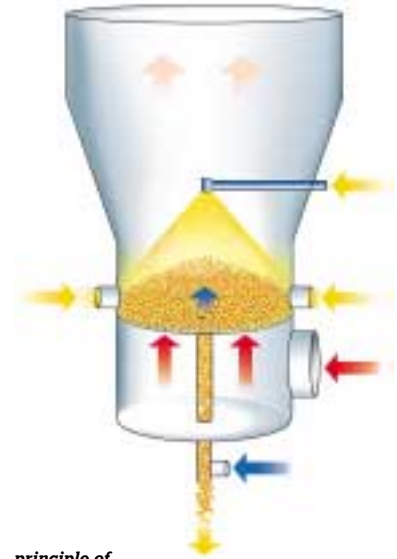
Building particles from a liquid.

Spray granulation is the drying of liquid while simultaneously building particle size. Seeds for the granulation can be charged (external seeds). Alternatively the seeds are formed within the processing chamber by abrasion (internal seeds). Compared to agglomerates these granules are harder and more dense. The spray granulation process was developed in the early 1980's at what is now Glatt Ingenieurtechnik. Since that time Glatt is one of the leading vendors within this technology.

GPCG, AGT and GFG - fluid bed

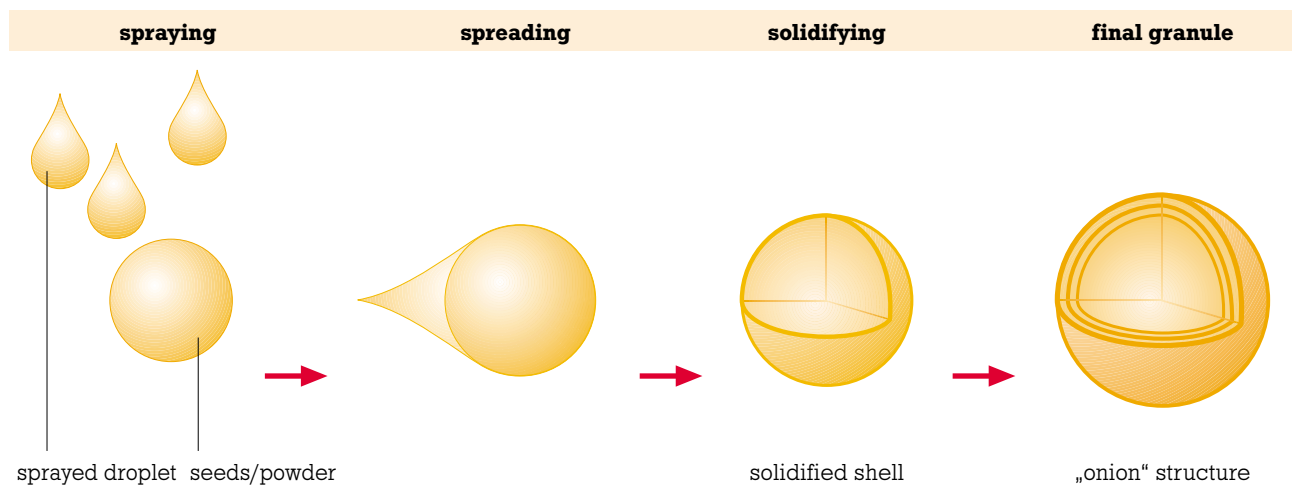
For small quantities the process can be run in batch mode in the GPCG. The undersized particles of the previous batch are screened off and used as starting material (also refer to page 13 - Wurster).

Continuous processes are more efficient since they can be run with a constant bed height in the processing chamber. According to the process the entire fluid bed is mixed and the product is discharged through a central discharge pipe (AGT-process), or a plug flow is



principle of continuous spray granulation process, AGT

created in the GFG. Using the GFG, drying and cooling of the granules can be accomplished in the same equipment as in the agglomeration process.



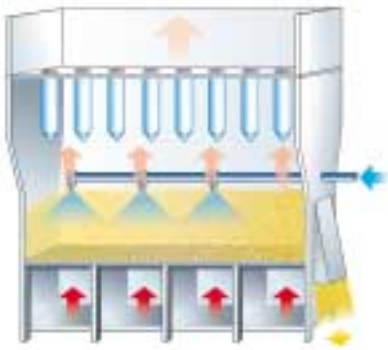
product properties

- dust-free granule
- spherical pellets
- excellent free flowing properties
- good dosing properties
- good dispersibility
- good solubility
- compact structure
- decreased hygroscopicity
- high bulk density
- closed surface
- narrow grain size distribution
- little abrasion

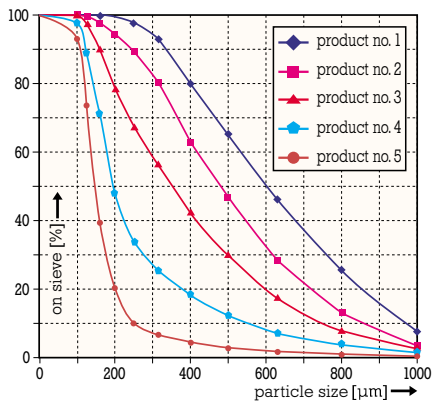


granule: potash

Spray granulation



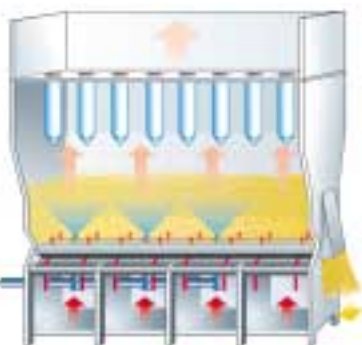
principle of continuous spray granulation process, GFG



analysis of particle size - GFG 500 - adjustable grain size of sodium phosphate

ProCell - spouted bed

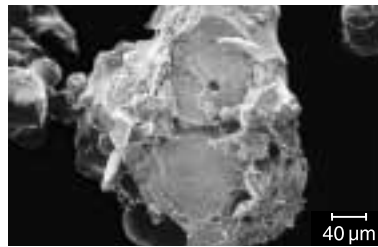
In the ProCell the process air enters the processing chamber through a slot. By this means very small particles can be generated (product particle size of 50 μm). When processing sticky materials the high air velocity in the slot prevents lumping. Compared to the fluid bed, the residence time can be decreased resulting in a very gentle process for temperature sensitive materials.



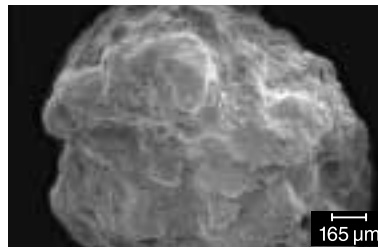
principle of continuous spray granulation process, ProCell

Adding solid raw materials

If solids are added to the spray granulation process they are integrated into the onion structured granules. Adding more and more powder shifts the spray granulation process towards agglomeration. It is also possible to form small granules from the liquid raw material which are agglomerated to larger particles in the same processing chamber.



instant-tea - ideal agglomerate



lysine - hybride



detergent component - ideal spray granule

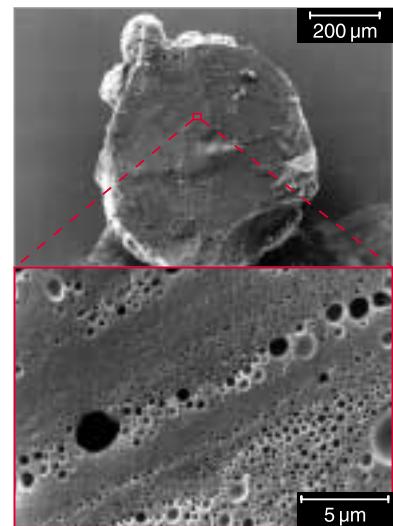
Ideal agglomerates and ideal spray granulates are the two extremes of a continuous scale. By changing the process parameters both processes occur simultaneously and form different structures. Since agglomerates have a smaller bulk density than spray granulates the bulk density of the granules is adjustable.



pilot plant ProCell 20

Encapsulation of liquids

Mixing different liquid raw materials before spray granulation they will be very evenly distributed in the granules. By this means liquids can be encapsulated into a matrix of solid material. This encapsulation-process is mainly applied in the food industry. If necessary the particles can be finally encapsulated with a secondary coating (refer to page 12 - Coating).



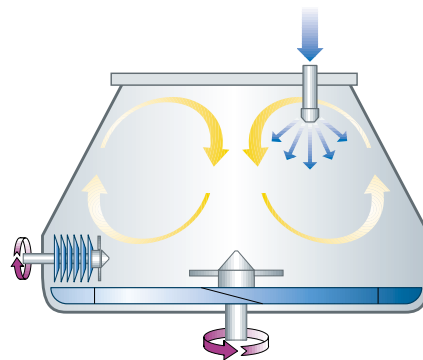
droplets encapsulated in a spray granule

VG - Wet granulation

**Strong particles
made from powder.**

Powder is charged into the product bowl of the vertical granulator (VG) and wetted by heavy spraying of a liquid or a melt. At the same time the product is vigorously mixed by a mixer and a chopper. Since the powder is physically forced together the agglomerates formed in this process are harder and more dense than in the fluid bed agglomeration process. In many cases the granules are discharged into a cone mill (e.g. the Glatt sieve) to crush oversized particles before they are dried or cooled in a fluid bed dryer (WST).

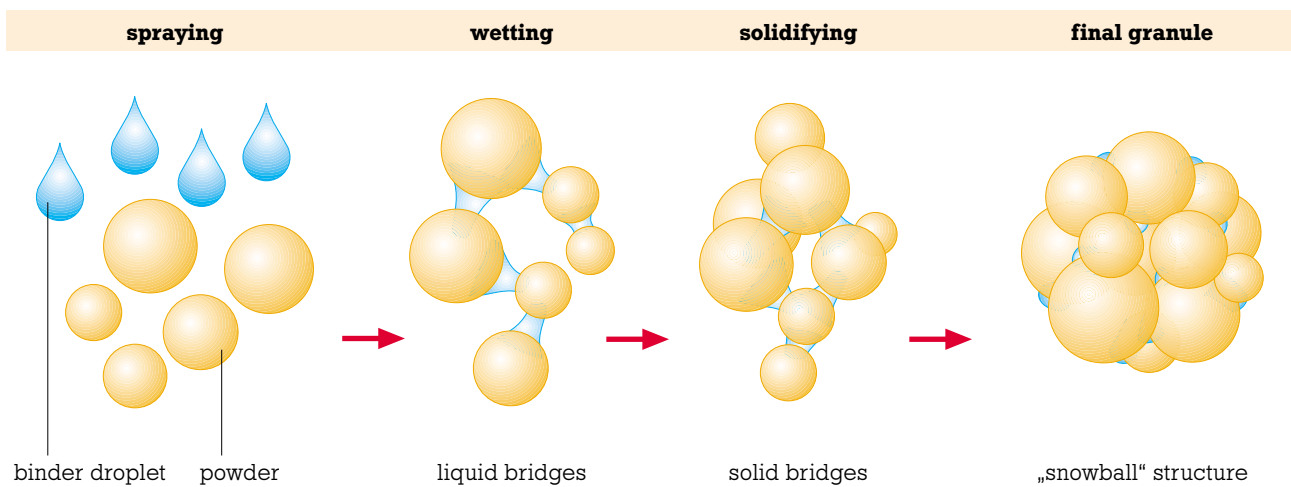
At much lower productivity the drying or cooling can also be accomplished in a modified VG.



principle of wet granulation process, VG

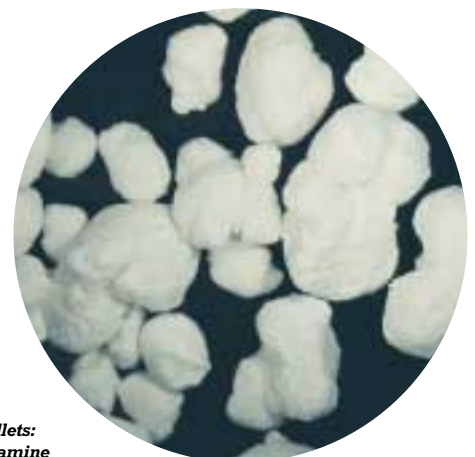


vertical granulator
VG 300



product properties

- dust-free granule
- good free flowing properties
- good dosing properties
- good dispersibility
- good solubility
- good tableting properties
- compact structure
- decreased hygroscopicity
- high bulk density
- wide grain size distribution



pellets:
vitamine

Pelletizing

Spheronizing wet granules.

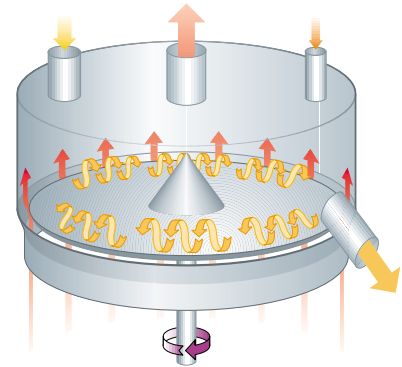
Granules with a rough surface can be spheronized by means of the pelletizer.

The snowball structured granules made in the VG are transferred into the pelletizer while they are still wet to ensure that they are elastic and do not break during the spheronization process. Dust created in the pelletizer is rolled up and integrated into the pellets.

The fast spinning of the pelletizer disk forces the granules to the rim of the disk and at the same time into the spinning direction. This results in a rolling movement of the granules in two dimensions - similar to a helix. This intense rolling is smoothing the surface. The residence time in the pelletizer is short - usually several minutes.

The gap between the pelletizer disk and the wall is closed by means of an air stream which also supports the spinning movement.

If agglomeration occurs in the pelletizer a separating agent can be added. If dust is created the integration of the dust into the pellets can be supported by addition of a binder.

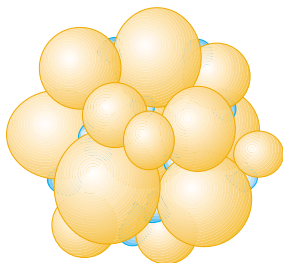


principle of spheronizing process

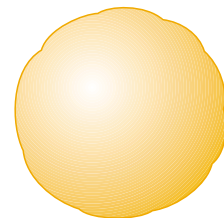
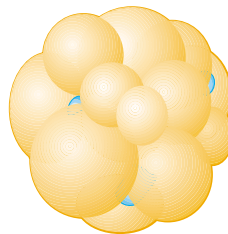
granule

spheronizing

pellet



„snowball“ structure



product properties

- dust-free granule
- round pellets
- good free flowing properties
- good dosing properties
- good dispersibility
- good solubility
- compact structure
- decreased hygroscopicity
- high bulk density
- closed surface
- narrow grain size distribution
- little abrasion
- attractive appearance



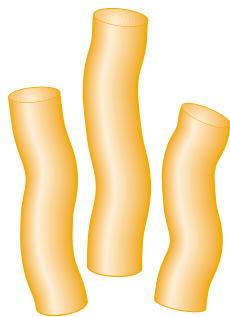
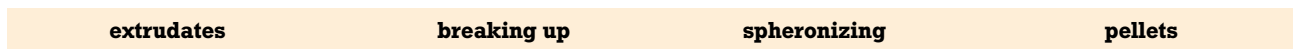
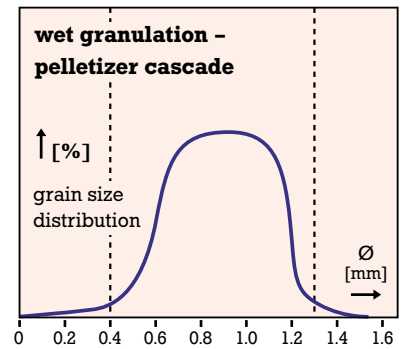
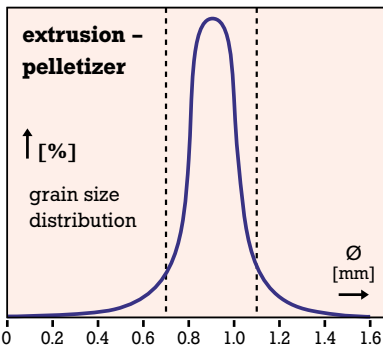
*pellets:
vitamine*

Pelletizing

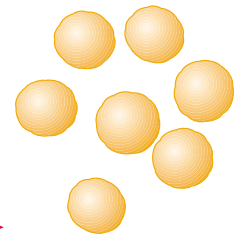
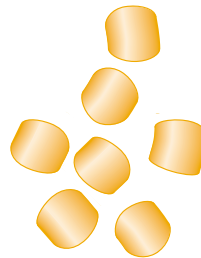
Spheronizing extrudates.

When forming pellets from extrudates the extrusion process is optimized, so that the extrudates break into pieces with the same length as their diameter. Also the extrudates need to be wet when entering the pelletizer.

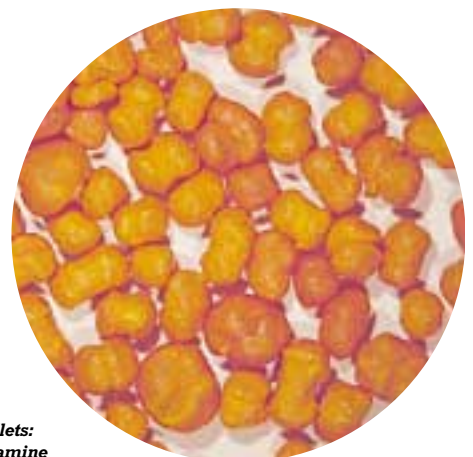
to make sure that they can be spheronized without further breakdown. The structure of the granules is dependent on the granulation process prior to spheronization. The product quality of the pellets can rather be influenced by changing the recipe and the process parameters during granulation process, than during the spheronizing process. By means of multiple pelletizers arranged in a cascade the spheronization can be run continuously. Changing the height of the discharge weir changes the amount of product in the pelletizer. If the throughput remains at the same level the residence time in the pelletizer is influenced, resulting in a different quality of the pellets.



long rods



extrudates:
vitamine



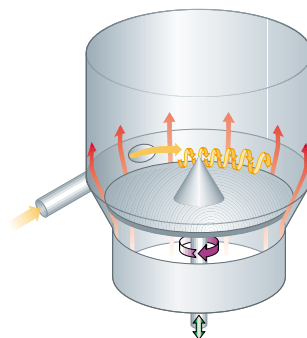
pellets:
vitamine

Powder layering

Building pellets from powder.

This process is a combination of the fluid bed and the pelletizer. The rotor is integrated into a Glatt Particle Coater Granulator (GPCG). Seeds are charged onto the rotor disk and moved by the spinning of the disk and the air flow through the gap at the wall of the process chamber. Powder and binding liquid is sprayed tangentially into this bed of material. The powder is rolled up to the seeds, the rolling movement ensures spherical particles. The air flow at the wall is drying the pellets - allowing for more binding liquid.

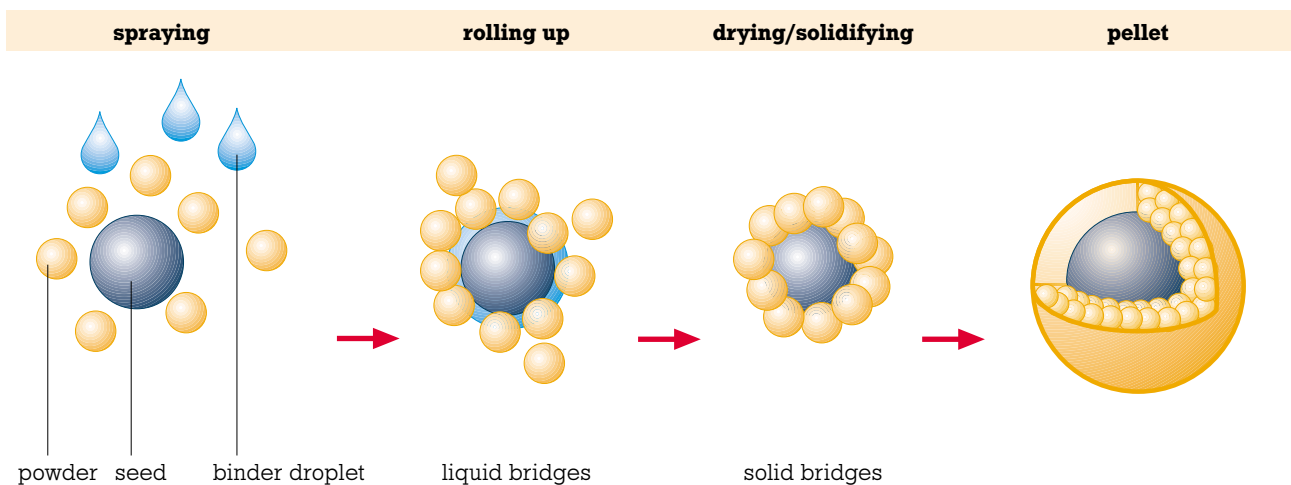
It also is possible to add several layers of powder onto the seeds within one batch. After building the first layer the pellets are dried and the next layer is added with its specific binder.



principle of powder layering, rotor



rotor-granulator



product properties

- dust-free granule
- round pellets
- good free flowing properties
- good dosing properties
- good dispersibility
- good solubility
- compact structure
- decreased hygroscopicity
- high bulk density
- closed surface
- narrow grain size distribution
- little abrasion
- attractive appearance



Coating

Coating and encapsulation of particles.

Particles are coated in order to change their surface properties and by this means the behavior of the particles. Glatt offers different processes for the coating of different particles. This equipment choice allows the customer to choose specific levels of coating quality.

The coating liquid can be a solution, suspension or melt. In all processes the coating liquid is sprayed onto the particles. Low viscosity and small

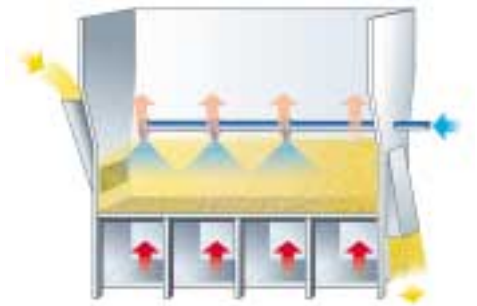
droplets are required to ensure even spreading of the coating liquid on the surface of the particles.

GPCG, AGT and GF - fluid bed

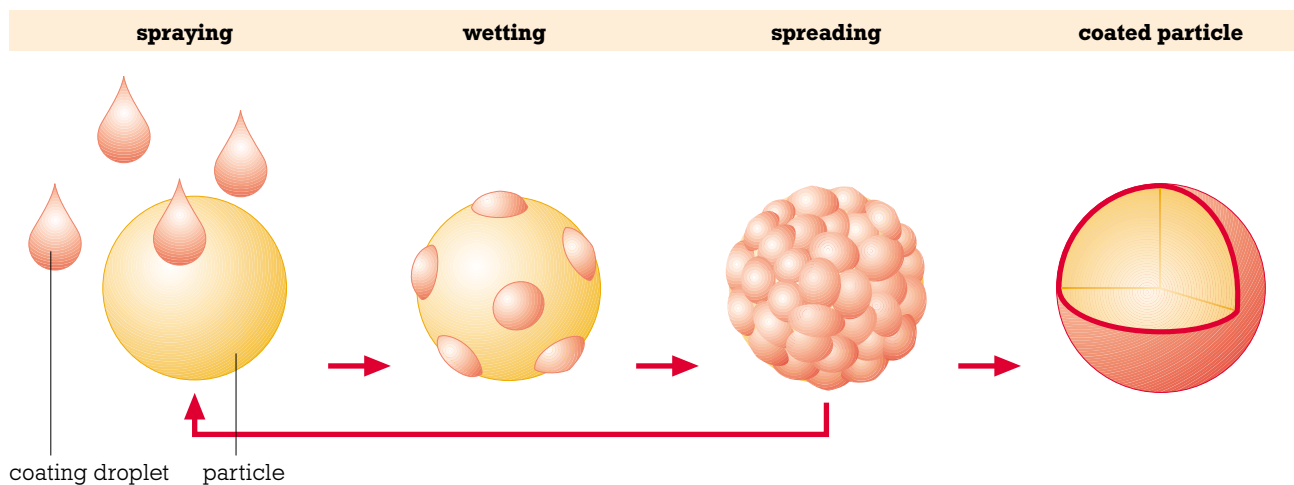
When coating in the fluid bed the particles are fluidized and the coating liquid is sprayed into the bed while drying the particle. No over-wetting is allowed in order to prevent agglomeration of the particles. For many applications this technology is sufficient. A complete coverage of the particle surface requires a lot of coating material. Depending on the throughput, batch or continuous units can be used.



Glatt fluid bed coater, GFC 750



principle of continuous coating process, GFC



sugar - uncoated

defined alteration of product properties

- like:
- stability in storage
 - hygroscopicity
 - free flowing property
 - surface structure
 - solubility
 - appearance
 - taste
 - odor

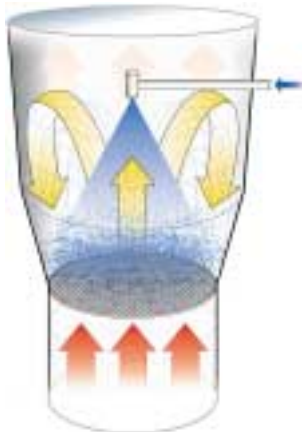


sugar - coated

Coating



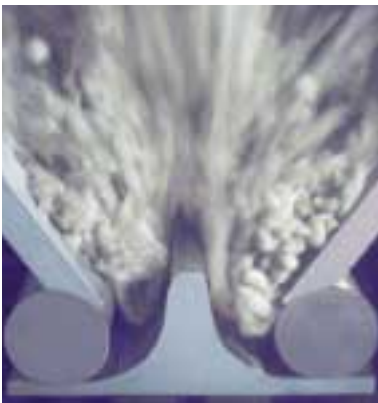
top spray coating, GPCG 30



principle of top spray coating, WSG and GPCG

ProCell - spouted bed

Compared to the fluid bed, the residence time in the ProCell is shorter, resulting in a more even coating in



view into the processing chamber, ProCell

the continuous process. Also irregular particles (e.g. ceramic catalyst rings) can be coated since they are moved by the high air velocity in the slot.



principle of continuous coating process, ProCell

Wurster

The Wurster process allows a 100% coating with small amounts of coating material. The particles in the fluid bed are passing the bottom spray nozzle in an ordered flow pattern. While quickly moving upwards within the Wurster compartment they can be wetted without the danger of agglomeration. While moving downwards outside the Wurster compartment they dry and another layer of coating can be supplied. The exactly controlled residence time in the coating zone ensures a very uniform coating.



processing chamber GPCG 200 wurster



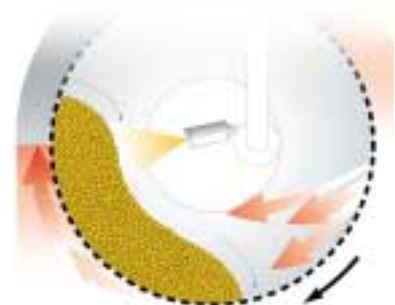
principle of bottom spray coating, Wurster

Drum Coating

Using the drum coater large particles (e.g. tablets) can be coated with a high quality film. The particles are moved by means of the rotating drum. The coating liquid is sprayed into this bed of material. The particles are dried by means of an airflow through the perforated drum.



the unique Glatt coating drum



principle of drum coating

Process and product development

A difficult task is an interesting challenge.

Processes and formulations can be developed in Glatt laboratories. Trials are frequently needed in order to adjust process and equipment to the specific requirements of the product of the customer. Decades of experience with granulation processes in the Glatt group can be accessed by the customer.



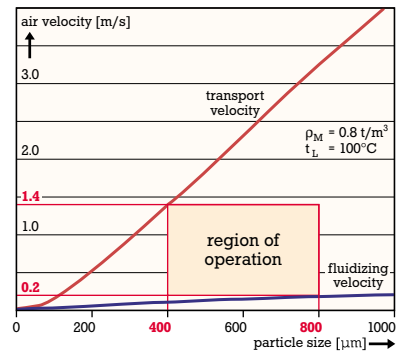
pilot plant for continuous processes ProCell 20



fluid bed lab unit GPCG 2

Processes are established in laboratory units at a small scale of 1-2 kg. In the next step optimal parameters for the production size equipment are determined using scale-up units (50-200 kg per batch or per hour).

The processes are developed in close cooperation with the customer. The product know how of the customer and Glatt's know how of process and technology are combined to meet the requirements of the new product. Understanding the potential of the different granulation processes helps the customer to use all possibilities to achieve the right qualities and develop the next generation product.



analytical laboratory

In the Glatt laboratories modern equipment is available to determine product parameters and product composition.



table mixer granulator lab unit TMG 1



lab unit for continuous processes ProCell 5



drum coater lab unit GMPC 1

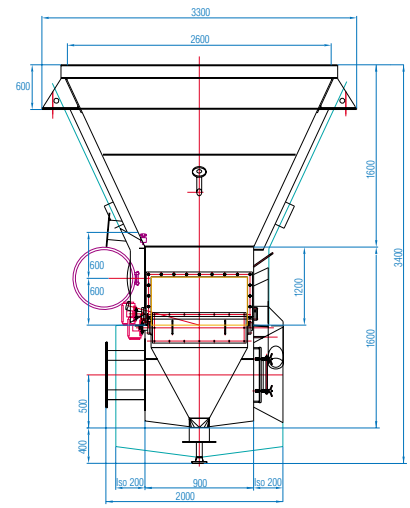
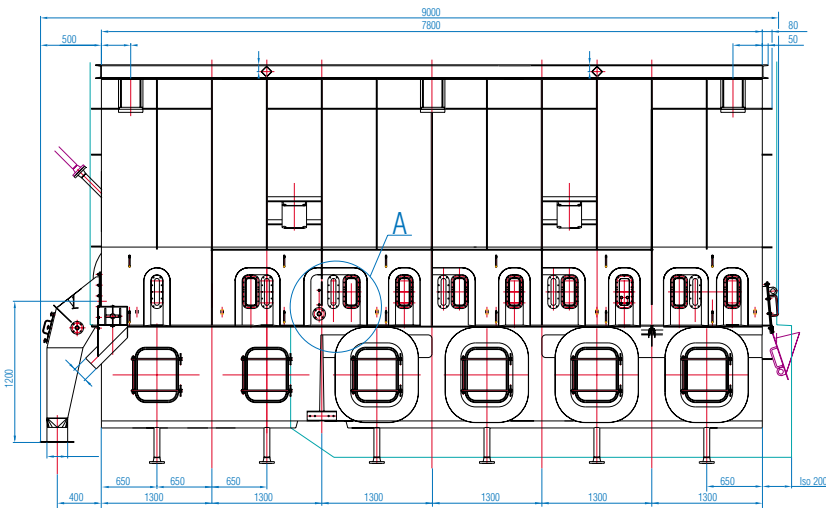
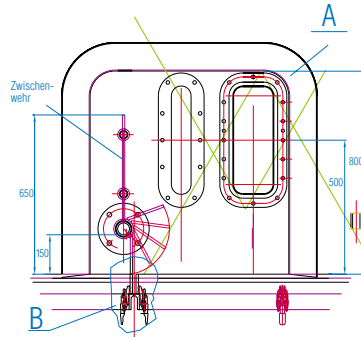


pelletizer lab unit P 50

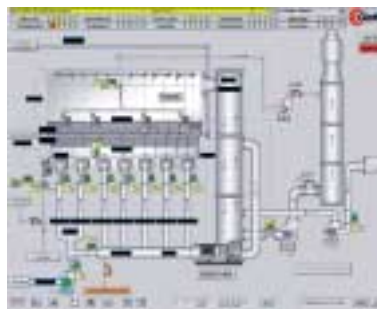
Equipment design and construction

Glatt designs and constructs high quality plants for customers in all industries.

Plant construction has been the core business of Glatt since 50 years. The experience in design and manufacturing generates customer



confidence in delivery and the continuing operation of Glatt equipment. Usually all equipment necessary for the process are delivered by Glatt - pumps, fans, inlet air and exhaust treatment as well as the control system. Further equipment can be delivered by Glatt - upstream or downstream of the Glatt unit - up to the delivery of a turnkey plant including the building. Glatt equipment is installed by in-house personnel, thus insuring that the project is handled with Glatt-know how until the handover of the fully operating plant.



Contract manufacturing

Glatt offers contract manufacturing with Glatt equipment.



IPC Process Center GmbH, Dresden

Time to the market is the key for the success of new products. Until the new Glatt production equipment is installed the newly developed products can be produced at the Glatt company IPC. The latest Glatt technology is immediately available for our customers, at this company.

If the demand of the market does not require new production facilities, installed equipment runs at full capacity or the market shall be tested with product samples - contract manufacturing is the answer.



wet granulation, vertical granulator VG 800



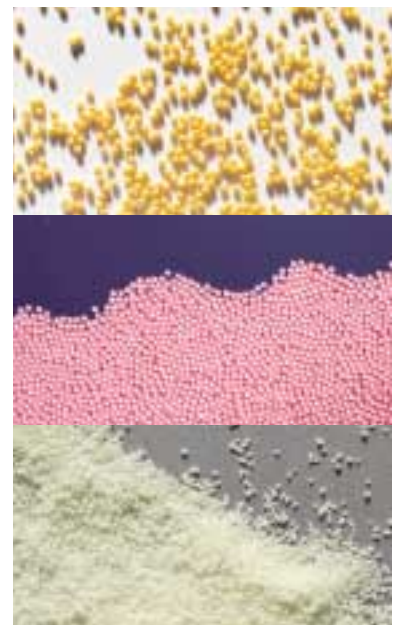
GPCG 200



Charging the Bag-in-Box



finished goods store



Glatt Service Program

**Equipment,
engineering and
services, out of
one source.**

Glatt Equipment

Fluid Bed Equipment

as dryer, with spraying system as granulator, with Wurster insert for coating, with rotor insert for powder layering.

Pan Coaters GC

for film coating of tablets.

Vertical Granulators VG

for wet granulation of powders.

Pelletizers

for spheronization of extrudates.

Sieves

for reducing of oversized granules to a defined grain size.

Product Handling

containers, container blenders, lifting systems, transport and pneumatic conveying systems, filling and discharging systems, docking systems, isolation flap systems, component weighing systems, dosing systems, washing systems, validation and documentation.

Equipment for the preparation of liquids

for oral, topical, sterile and aseptic products, supply of complete modules for CIP, SIP, WFI and other pure media.

Engineering and Service

Product Development

development and optimization of your products in Glatt laboratories

Engineering

Glatt engineers and commissions production lines up to turn key projects.

Assembly, Installation, Start-up

Glatt realizes new plants and retrofits with in-house personell.

Qualification and Validation

Glatt supplies all documents needed for a comprehensive qualification and validation of the equipment.

Contract Manufacturing

Glatt also manufactures product with Glatt equipment.

Training

Glatt offers courses on specific subjects or organizes individual training programs.



Training and Technology Center Binzen



Training and Technology Center Binzen, seminar room



Training and Technology Center Binzen, auditorium



Addresses

**World wide service
to the customer.**



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**We set
the Standard**