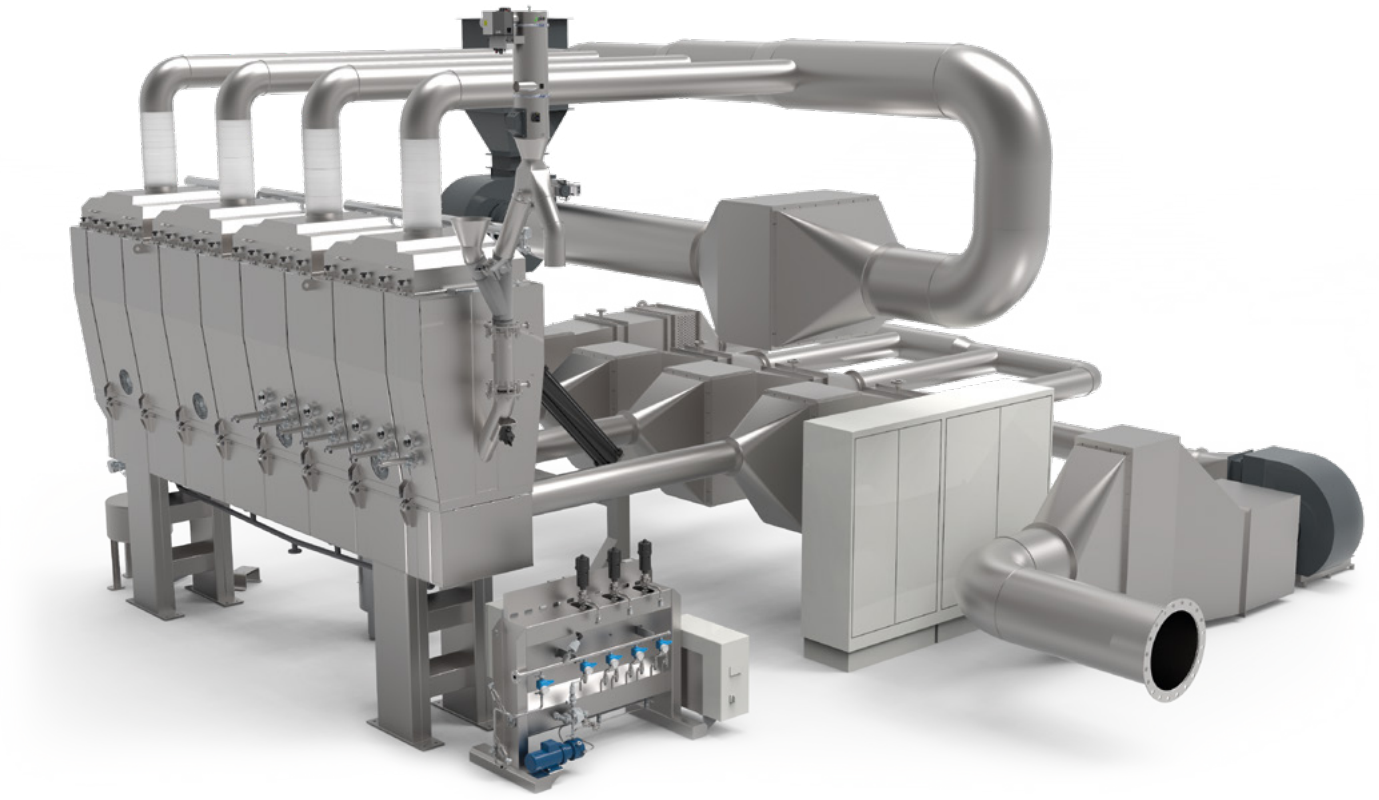
KAHL

FLUIDIZED BED TECHNOLOGY

BRINGING IDEAS IN MOTION



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FASCINATION FLUIDIZED BED

More than hot air

A roaring hurricane – waves build up and collapse before the eye can perceive them. Mist hovers over the surface, individual dots gleam and disappear performing pirouettes ...

What happens inside a fluidized bed plant is not only fascinating to behold. Above all it is a technology that can be used in many ways. Our fluidized bed processes can change the material properties of powdery and liquid substances. Granules, agglomerates and coated or micro-encapsulated particles with improved application behaviour and innovative added value will be produced. Storage stability, dosability, instantisation, dust reduction, solubility, micro-encapsulation of active ingredients or coating – the fluidized bed technology offers an enormous spectrum for optimising products and processes.

Your starting product is a powder or a liquid the application properties of which are not yet ideal for your needs. We provide a holistic concept and configure the most effective plant as well as the best process for you. Many years of experience in plant engineering and process technology enable us to ensure efficient, reproducible and reliable processes. We ensure engineering by dedicated process engineers with detailed knowledge of the industry, reliability in a spirit of partnership and the high quality of a German machine manufacturer.

Looking inside a fluidized bed plant reveals the pure fascination of technology

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CONTENTS

PARTICLES, PROCESSES, PARAMETERS

Applications of the fluidized bed technology

In the fluidized bed, the conditions for intensive heat and mass transfer are optimum. From the bottom, a gas, usually air, flows through the particles, which at rest are present as bulk solids. As a result, the particles are thoroughly agitated and form a fluidized bed. Now, the entire surface of the individual particles is exposed to the respective medium. Fluidized bed drying is one of the most effective drying processes of all. Still, much more is possible in the expanded fluidized bed. By injecting liquids, various innovative processes such as granulation, agglomeration, coating or micro-encapsulation can be performed.

With a multitude of individually modifiable parameters and the proper selection or combination of suitable processes, there are practically unlimited possibilities for developing entirely new recipes and for optimising the application properties of your existing products.

Efficient drying

For example extrudates: Extrudates from wet masses can be dried very efficiently and gently in the fluidized bed.

Protection of flavours

For example lemon oil: By spray granulation and micro-encapsulation, the liquid lemon flavour is embedded in a solid matrix and homogeneously distributed. The final product consists of dust-free, compact, light and oxidation-protected flavour granules.

Solidification of active substances

For example enzymes: A liquid enzyme ferment is sprayed onto a carrier and dried gently. The enzyme activity is preserved. The final active substance granules are free-flowing and can be easily processed.

Stabilisation of mixtures

For example for drinks machines: Powder blends of milk powder, sugar, instant coffee and flavourings become a highly soluble, segregation-free compound with a defined bulk density.

Binding of fine dust

For example pesticides: Through agglomeration or granulation, a dust-free product is obtained that is safe to handle and easy to dose.

Instantisation of beverages

For example chocolate drinks: Production of dust-free, easily dosable and highly soluble agglomerates that dissolve quickly in the liquid. A very homogeneous product with an intensive dark colour.

Enabling tabletting

For example pharmaceuticals: Granulation of a mixture of active ingredients in order to obtain a homogeneous distribution of active ingredients and a defined particle size distribution.

Improvement of the solubility

For example curry powder: The starting product is poorly soluble due to the high fat content; as instant powder it can be prepared in hot water quickly and free of lumps.

Shaping of liquids

For example malt extract: The concentrated extract can be converted into a dry granulate, making it more stable, durable and versatile than the liquid form.

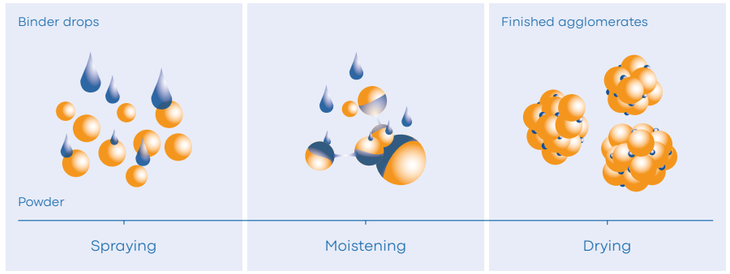
Fluidized bed drying / cooling

Fluidized bed technology makes the thermal treatment of bulk materials particularly effective. The intensive heat and mass transfer in the fluidized bed creates optimum conditions for fast and economical drying and cooling.

Agglomeration

For agglomeration, a powdery starting product is fluidized with air in the fluidized bed plant. In this state, the individual particles are accessible all around for liquids that are sprayed on by means of the nozzles of the device. Due to the surface moisture and, if necessary, a binder, the particles stick together to form agglomerates. The products are more easily soluble and segregation of individual powder components is prevented.

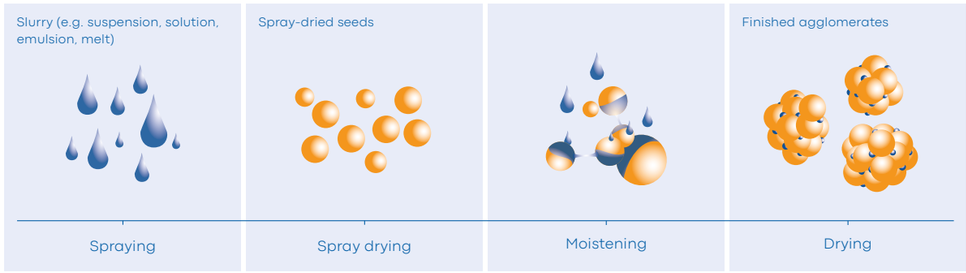
Besides water, also vitamins, fats or lecithin can be used as spray solutions to achieve additional benefit of the product. Agglomeration can be used to precisely determine decisive particle or product properties: porosity, particle size distribution, bulk density, dust content and solubility.



↑ Fluidized bed granulation / agglomeration

Spray drying agglomeration

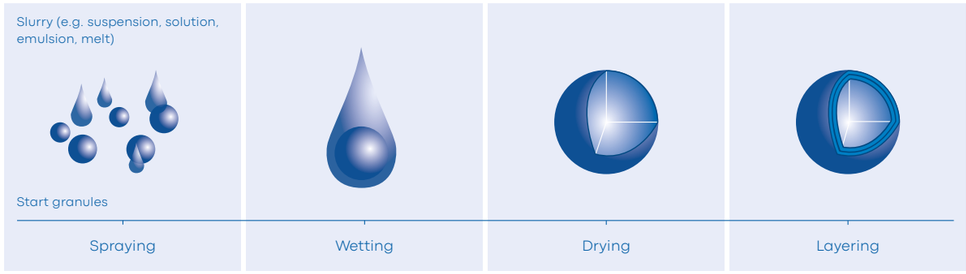
The combined process of spray drying and agglomeration produces free-flowing, dust-free agglomerates with ideal instant properties. In the first process step, a slurry is atomised, the liquid evaporates and spray-dried granulation seeds are produced. In the second step, these fluidised particles are further sprayed with the slurry. This causes liquid and solid bridges to form between the individual particles, which in turn causes the growth of the agglomerates.
By combining both methods, a particularly wide range of parameter settings is possible.



↑ Spray drying agglomeration

Fluidized bed spray granulation

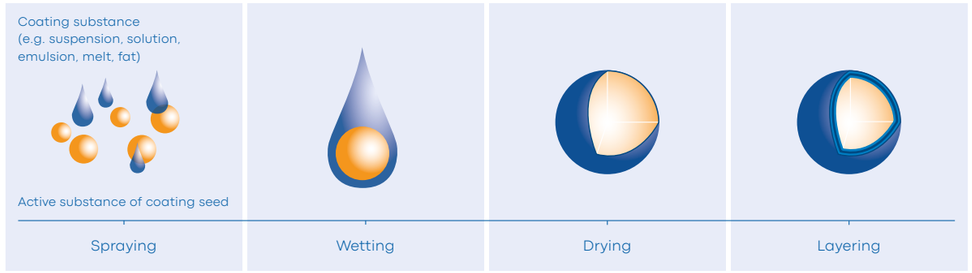
This process allows compact, almost round granules with excellent physical properties to be produced. Slurries are atomised and the obtained drops hit the granulation seeds. This causes the liquid to evaporate, and the solid builds up on the granulation seed forming a coating. The process is repeated continuously in the fluidized bed so that layered granules are produced. Parameters such as particle size, residual moisture and solids content can be set very precisely in the spray granulation method. The process is suitable for all applications in which a homogeneous, dust-free product with a high bulk density is to be achieved.



↑ Fluidized bed spray granulation

Coating

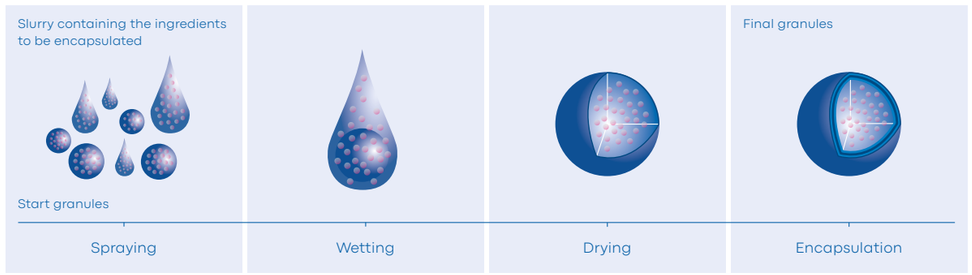
This process creates a fine, uniform coating that for example protects granules against external influences, such as light, oxygen (oxidation) or moisture. Solid particles can also be provided with a coating layer for visual improvement, colour differentiation or taste masking. During the coating process, the particles are wetted with the coating liquid in the air stream. A layered film is produced which provides the separated particles with a homogeneous, stable shell.



↑ Coating

Micro-encapsulation

By means of micro-encapsulation, solid or liquid active substances can be homogeneously incorporated into a carrier substance. Particles with a well-defined state are produced which are resistant to external influences. This enables the targeted and time-delayed release of active pharmaceutical ingredients or flavours, for example.

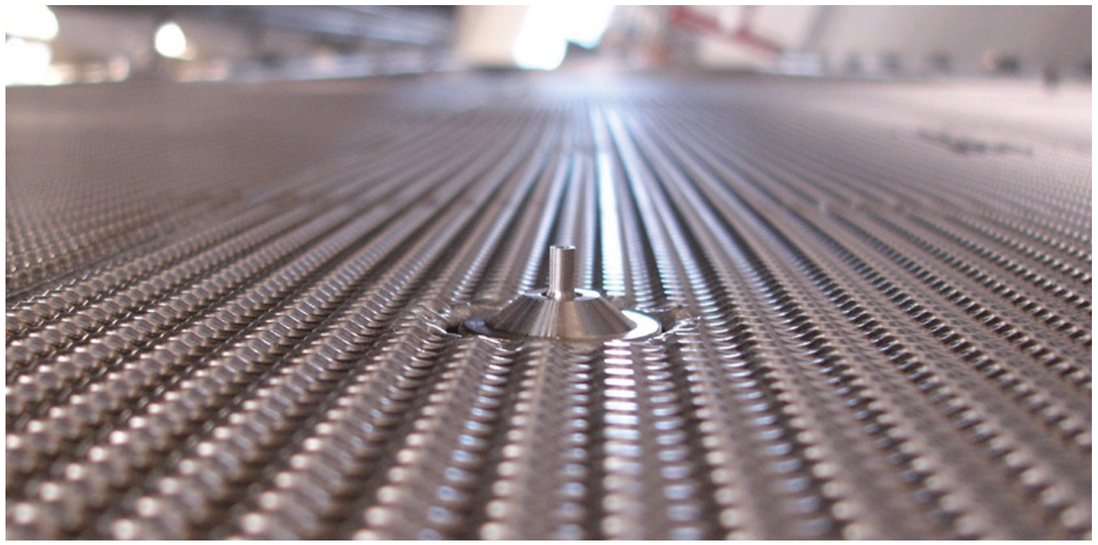


↑ Micro-encapsulation

Process overview

Process	Primary products	End products	Product benefits	Product examples
Drying	**Wet product** (e.g. granules, powders, pellets, filter cake)	**Dry product**	· Extension of durability · Product preservation · Enhancing of storage stability · Short drying times · Controlled, gentle and homogeneous drying · Drying at defined temperatures/ temperature profiles · Preservation of functional properties such as enzyme activity	· Plastic granules · Pharmaceutical granules · Starch · Caffeine extrudate · PTFE powder · Lecithin · Vitamins · Silica gel · Pollen granules · Cellulose · Aluminium oxide
Agglomeration	**Fine powder** or **powder blending** **+ binder** (e.g. water, suspensions)	**Agglomerates**	· Good instant properties · Good solubility · Low-dust product · Good flowability and spreadability · Good flow properties · Reduction of segregation · Defined particle size distribution · Defined bulk density · Porous particle structure · Good dispersibility · Good tabletability	· Instant drink powders · Soups and sauces · Baby food · Cocoa drinks · Cappuccino · Starch · Milk powder · Cellulose · Sugar substitutes · Lactose · Pharmaceutical products
Spray granulation	**Start granules** (seeds from original or secondary material) **+ suspensions, emulsions, solutions** or **melts**	**Granules**	· Nearly round particles · Dust-free product · Good flow properties · Good flowability and spreadability · Good dosability · Narrow particle size distribution · High bulk density · Compact particle structure · Abrasion-proof particles · Production of solid particles from a liquid	· Aromas · Calcium lactate · Aluminium oxide · Starch · Sodium silicate · Zirconium oxide · Urea · Ammonium sulphate · Detergents · Menthol granules · Calcium carbonate
Micro-encapsulation	**Start granules** (seeds from original or secondary material) **+ suspensions, emulsion** or **solutions with active substances**	**Micro-encapsulated granules**	· Enhanced storage stability · Fixing of volatile compounds · Optical effects (colour, gloss) · Protection against chemical reactions · Protection against oxygen or light · Protection against humidity · Depot effect · Narrow particle size distribution · High bulk density · Production of solid particles from liquid products	· Scent oils · Aromas · Perfumes · Vitamins · Lactic acid bacteria · Enzymes · Starter cultures · Omega-3 fatty acids, fish oils · Probiotics · Amino acids · Minerals
Spray drying agglomeration	**Start granules** (seeds from original or secondary material) **+ suspensions emulsions, solutions** or **melts**	**Agglomerates**	· Good instant properties · Good solubility · Low-dust product · Good flowability and spreadability · Good flow properties · Defined particle size distribution · Defined bulk density · Good dispersibility · Production of innovative products through any combination of solid and liquid primary products	· Malt drink · Plant protectants · Ginseng · Collagen hydrolysate · Vitamins · Plant extracts · Spore ferments · Instant coffee · Proteins · Beverage powders · Enzymes
Coating	**Granules, pellets, extrudates, powders** or **tablets** **+ coating material** (e.g. suspensions, polymers or fats)	**Coated product**	· Enhanced storage stability · Defined solubility · Optical effects (colour, gloss) · Reduction of hygroscopicity · Protective functions · Modification of taste · Modification of odour · Functional properties · Defined surface structure · Depot effect · Enteric coating	· Tablets · Cereals · Sugar · Dietary supplements · Seeds · Aspartame · Citric acid · Ascorbic acid · Pharmaceutical products · Enzymes · Aromas

FROM THE MACHINE TO THE OVERALL SYSTEM



↑ Bottom spray nozzle

The fluidized bed plant is the core component of the entire system which is completely planned by AMANDUS KAHL – including the entire air handling, product supply, product discharge, and control system. In addition, we also act as general contractor for the design of complete production lines.

- → Closed systems
- → Supply air / exhaust air treatment
- → Heat recovery systems
- → Automation solutions

Further optional components

- → Feeding systems for raw materials
- → Conveying units
- → Storage in silos
- → Mechanical granulation systems
- → Grinding of primary products and of final products
- → Screening of the fine and coarse fraction, return systems
- → Transport and bagging of finished products

CONTINUOUSLY OR IN BATCHES?

Individual solutions for your requirements

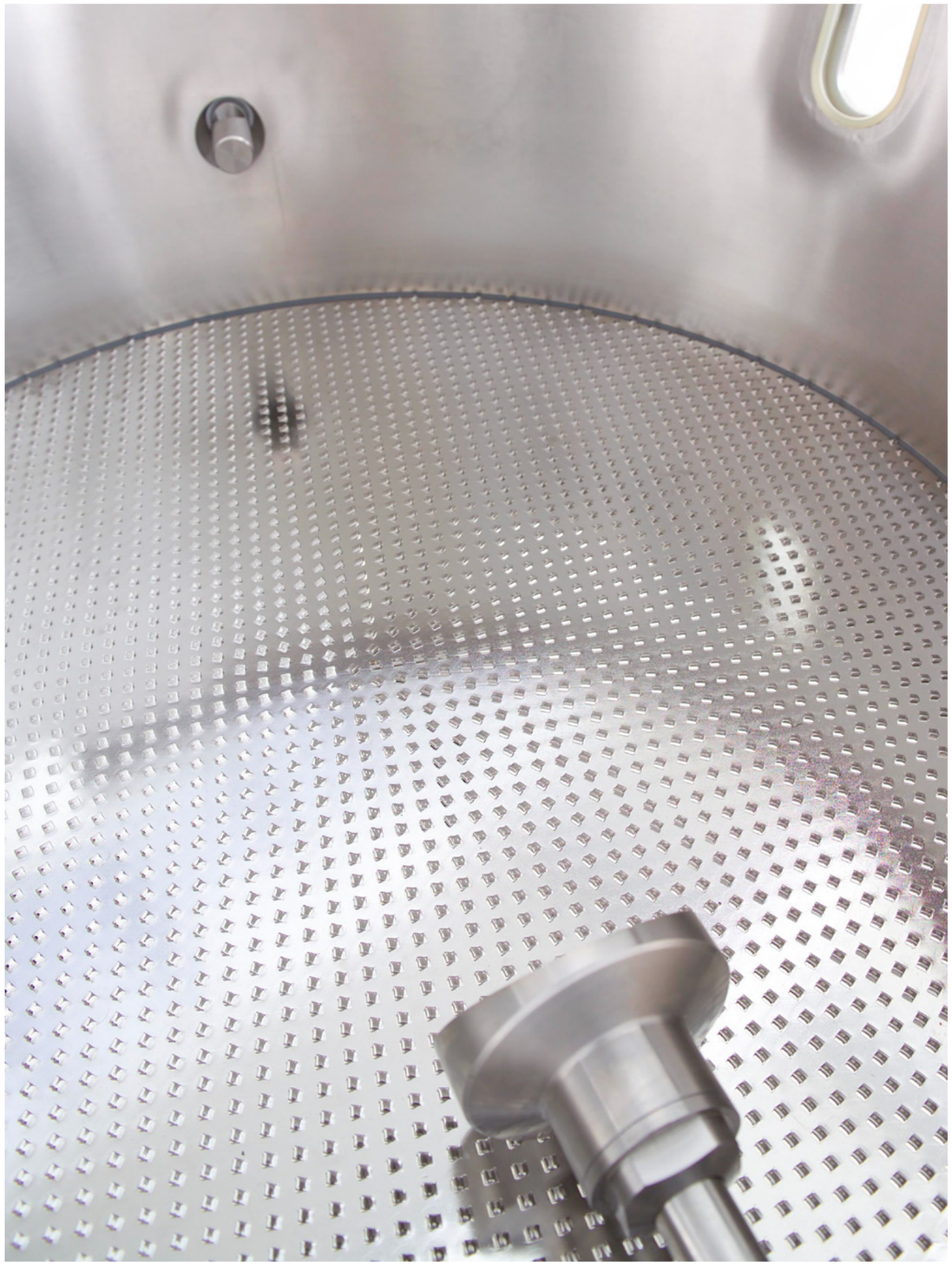
↑ Continuous fluidized bed plant

↑ Fluidized bed batch agglomerator with vertical product flow

The modular design and expandable configurations ensure the sustainability of your investment for the future. You can choose between continuous and batch processing.

Our Batch FB fluidized bed plants are ideally suited for batch processing of fixed product quantities. In cost-effective mass production, however, our continuous Conti FB plants are used.

We offer both operating modes and configure your plant exactly according to your needs



↑ Air distribution plate with open purging valve

QUALITY ABOVE STANDARD

Our expertise for your plant

↑ Continuous fluidized bed plant with optimum accessibility

Our fluidized bed plants meet the highest internal and external quality criteria and comply with all current international standards. Our plants can be configured according to any requirement.

The AMANDUS KAHL fluidized bed plant combines proven expertise in process technology with practical process control and maximum flexibility in the construction and functionality of the plants.

Advantages

- Dust and gas-tight plants
- Design according to GMP guidelines
- CIP or WIP solutions
- Inert gas operation and closed-loop operation
- Economic operation and high availability
- Explosion protection according to ATEX

CONTI FB

Continuous fluidized bed units

↑ Pull-out nozzles

The basic concept of the Conti FB fluidized bed unit is based on a modular design with separate inlet and exhaust air zones. This opens up a wide range of possibilities for setting and optimising the process parameters.

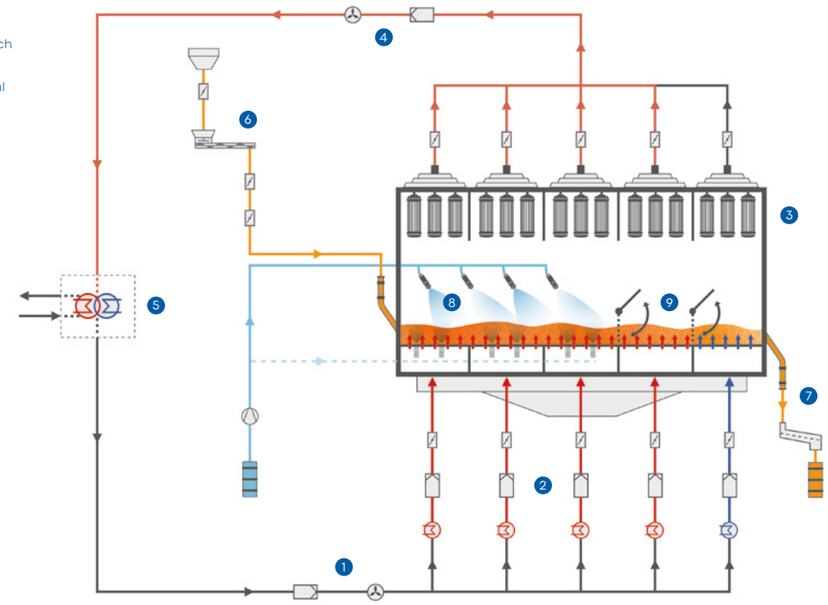
Continuous fully automated operation of the plant requires only few operators and a minimum of handling effort. The plant can be used with different recipes and for performing different processes.

It affords maximum flexibility and is suitable for a wide range of products and applications. Conti FB plants can be used, for example, as driers, agglomerators or for continuous spray granulation and they ensure reproducible product quality.

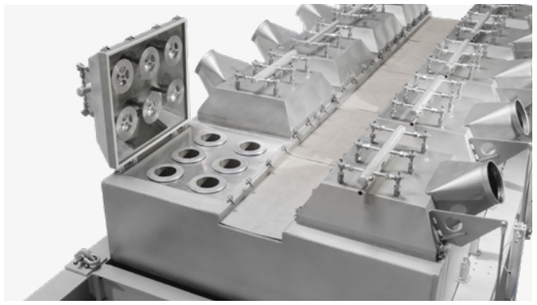
Advantages

- Multi-stage operation
- Top or bottom spray
- Internal or external filtration system
- Vibrating or static systems
- Nozzles in every section, height adjustable, removable
- Product weirs for sectioning
- Through-the-wall installation: separation of technical / production area

1. Prefilter and inlet air fan
2. Individual inlet air conditioning in each zone, heating / cooling
3. Integrated filter cartridges or external filter (cyclone / total separator)
4. Afterfilter and exhaust air fan
5. Heat recovery
6. Continuous product supply
7. Continuous product discharge with screening or grinding stage
8. Top spray / bottom spray systems
9. Product weirs



↑ Example of a functional diagram
Continuous fluidized bed plant with 5 sections and top or bottom spray equipment



↑ Exhaust air hood

↑ Pharmaceutically compatible design

↑ Static version with explosion suppression

↑ Easy access to the plant

BATCH FB

Discontinuous fluidized bed units

↑ Swivelling product bin

↑ Double-chamber vibrating filters

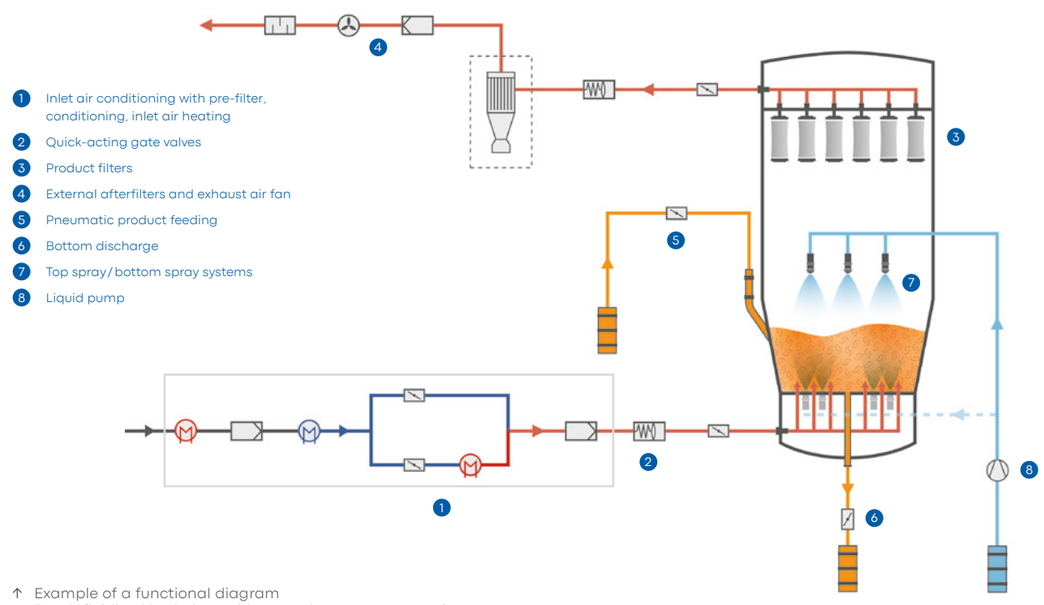
The batch technology is an alternative when fast throughput times are not important while fixed batch sizes are to be processed or frequent product changes are planned. Unlike in continuous fluidized bed plants, the individual processes of the batch process take place time-staggered and not simultaneously. This means that even complex process sequences and recipes can be handled.

Batch plants are less complex than continuously operating systems. The more efficient and flexible a batch plant is to be, however, the more important the entire engineering becomes, from process technology to the selection of the suitable peripheral equipment.

In addition to the main component – the Batch FB fluidized bed unit – AMANDUS KAHL supplies the entire peripheral equipment. It includes spray tanks, binder preparation, cleaning stations, calibrating mills, lifting columns and more. The entire equipment can be integrated into the overall control system.

Advantages

- Pressure shock resistant design up to 12 bar
- Single-chamber, double-chamber vibrating filters, exhaust filter systems
- Top or bottom spray
- Wurster processes/spouted bed coating
- Various product feeding and discharge concepts



↑ Example of a functional diagram
Batch fluidized bed plant with top or bottom spray equipment

↑ Automated product feeding with closed product bin

LABORATORY AND PILOT PLANTS

For continuous and batch-wise processing in different versions

Our laboratory equipment helps you to improve your processes, determine parameters, test recipes and optimise product handling before starting mass production. Conduct feasibility studies, develop special substances and innovative products – a reliable scale-up of results gives your R&D department all options for cost-effective, successful product management and support at every stage of production.

Our laboratory and pilot plants

Conti FB Pilot: for all continuous fluidized bed processes from about 5 to 50 kg/h

LFB Batch: a flexible and mobile batch plant for product quantities of up to 20 kg

LFB mini: a flexible and mobile laboratory plant for product quantities of up to 2 kg

Highly specialised pilot plant

In our modern pilot plant we offer the possibility of testing your products and processes with reliable results. We start on a laboratory scale using batch plants and scale up your process to pilot or production plants that are operated continuously or batch-wise.

↑ LFB Batch (Laboratory Fluidized Bed)

↑ Conti FB Pilot

↑ LFB mini

ENGINEERING AND PLANTS

Made in Germany

AMANDUS KAHL specialises in the construction of process plants for the food industry, the fine chemicals industry, the chemical and pharmaceutical industries and biotechnology. Our fluidized bed systems are based on the technologies of HEINEN DRYING® and are characterized by a high degree of flexibility in construction and functionality of the plants. We cover all tasks from process development up to the production of single machines or complete solutions including all peripheral devices. We plan and develop your individual process solution hand in hand with you.

AMANDUS KAHL GmbH & Co. KG
Fockestrasse 67
27777 Ganderkesee
Germany

+49 (0)4221 859-520
info@akahl.de
akahl.com

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