

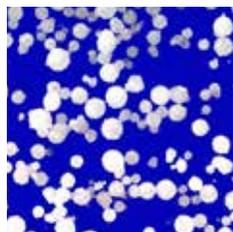
# GEA SPRAY DRYING

Small-scale solutions for R&D  
and production



## CONTENT

|   |    |
|---|----|
| Expect more                                   | 02 |
| Process and equipment expertise               | 03 |
| Atomization                                   | 04 |
| Configurations                                | 05 |
| MOBILE MINOR®                                 | 06 |
| PRODUCTION MINOR®                             | 08 |
| VERSATILE-SD®                                 | 10 |
| Closed-cycle spray drying                     | 12 |
| FSD® and FSD Granulator®                      | 14 |
| Process control                               | 16 |
| Cleaning solutions                            | 17 |
| Environmental, health and safety requirements | 18 |



Single particles



Agglomerates



Granulates

# Expect more

It all adds to your success, expertise, equipment and support

### Getting it right from the start

With more than 3,000 references for spray drying plants for R&D and small production units, GEA has unmatched expertise within small-scale spray drying technology. Which means that we have the know-how to help you choose exactly the right process and equipment. Many of the world's leading manufacturers and their R&D departments, independent research centers and universities work with GEA, and they all gain from our process and product knowledge.

### There when you need us

We are a truly global supplier, but we believe service is a local business. With GEA, you never have to go far for assistance or overcome time or language barriers. We are there whenever and wherever you need us. And not just with representatives, but with our own staff, stocks of spare parts and service engineers.

### Flexible solutions

Working with GEA gives you access to the most advanced spray drying technology on the market. We offer versatile, multi-purpose plants for the food, dairy, chemical and pharmaceutical industries.

# Process and equipment expertise

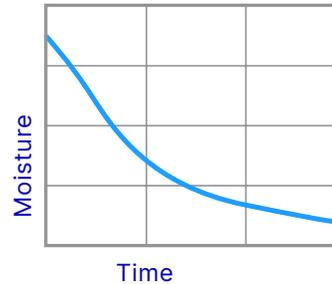
## Testing and spray drying solutions

### DRYNETICS® ANALYSIS BY GEA



#### 1 Single droplet experiments

- Temperature
- Size and position
- Morphology



#### 2 Advanced data analysis

- Drying kinetics
- Density
- Stickiness



#### 3 CFD simulations

- Velocities
- Temperatures
- Moisture
- Deposits

### The world's largest pool of talent specialized in tackling spray drying challenges

Want a drier powder? An easier flowing powder? Agglomerates with fewer fines? With more than 35 pilot plants in GEA test centers worldwide and an international team of test engineers and process technologists, GEA represents the world's largest pool of talent specialized in spray drying.

We provide powder engineering expertise and process verification through laboratory and pilot plant testing. We also offer the industry's most advanced analytical capabilities, including dynamic flow modelling based on the drying properties of a single droplet.

### Analytical accuracy maximizes performance

Our capabilities include single droplet drying applied to test the feasibility of spray drying and to address basic formulation questions at a very early stage of the development phase. With GEA's DRYING KINETICS ANALYZER DRYNETICS®, it is possible to conduct exploratory tests with only a few milliliters of material available.

This technique also allows real-world measurements (e.g. drying time of a given feed) to be incorporated into Computational Fluid Dynamics (CFD) simulations. This makes it possible to establish the spray dryer performance by precisely analyzing the results of single droplet drying experiments. GEA's DRYNETICS® analysis is used to investigate product formulations, and to optimize spray drying plant designs – for new or existing spray drying plants.

# Atomization

## Different atomization modes

One of the most important choices in a plant configuration is choosing the right atomization and powder discharge method. We offer a wide range of solutions, as illustrated.

### Rotary atomizer

In rotary atomization, the feed is centrifugally accelerated to high velocity in the atomizer wheel before being discharged into the hot drying gas. The degree of atomization and particle morphology depends upon peripheral speed, feed rate, liquid properties and atomizer wheel design. Particle size is adjusted by changing the peripheral speed. The rotary atomizer, considered the most flexible atomizing device, is suitable for a wide range of products. Rotary atomizers will generally deliver a narrower particle size distribution and more free flowing powder than two fluid nozzles.

### Two-fluid nozzle, co-current or fountain mode

Two-fluid nozzle atomization is achieved pneumatically by high-velocity compressed air/gas impacting the liquid feed. Particle size is controlled by varying the nozzle flow ratio between atomizing gas and feed. When operating in co-current mode, the nozzle tip is placed close to the outlet of the ceiling air disperser. The co-current mode is selected when drying heat-sensitive products. When coarse particles of a non-heat-sensitive feed are required, the two-fluid nozzle in fountain mode is appropriate.

### Pressure nozzle, co-current or fountain mode

With a pressure nozzle, atomization is the result of the conversion of pressure energy within the liquid feed into kinetic energy of a moving thin liquid sheet. Pressure applied to the liquid within the nozzle forces the liquid out of the orifice creating the atomization. A pressure nozzle can be operated in co-current mode or in fountain mode. Particle size is adjusted by changing the feed pressure and nozzle size. Pressure nozzles will generally deliver a narrower particle size distribution and coarser particles than other atomizer types.

### COMBI-NOZZLE®

In some applications, there is a need for both narrow particle size distribution and small particle size. GEA has developed the COMBI-NOZZLE®, which combines the best features of pressure nozzles and two-fluid nozzles. As an added benefit, the energy consumption will typically be less than for a conventional two-fluid nozzle.



Rotary atomizer



Co-current nozzle



Fountain nozzle



COMBI-NOZZLE®

# Configurations

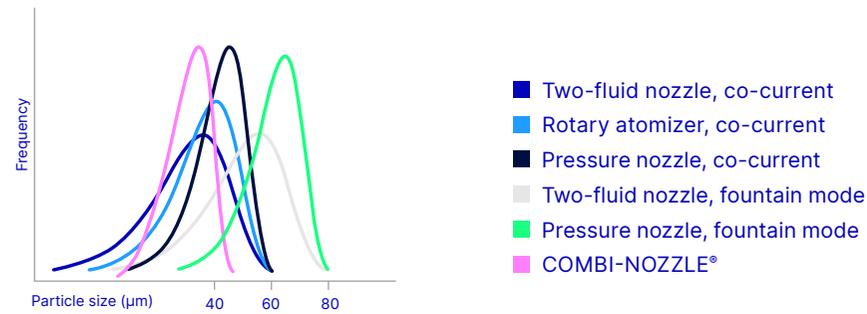
When configuring a plant, it is essential to choose the most appropriate mode of operation, equipment design and powder collection system. We offer a wide range of solutions and configurations to meet your specific requirements.

**Please note**

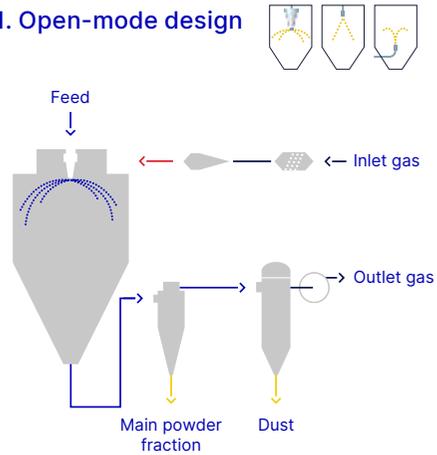
For operation with feeds based on flammable solvents or powders subject to explosion risk, dedicated designs are available.

## Particle size distribution

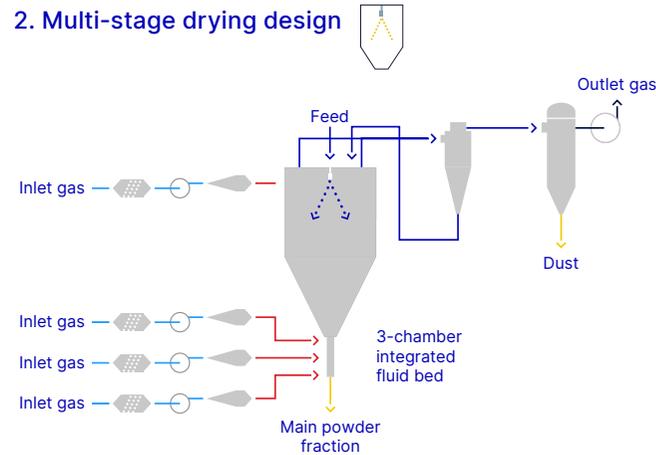
with different atomization systems under comparable conditions



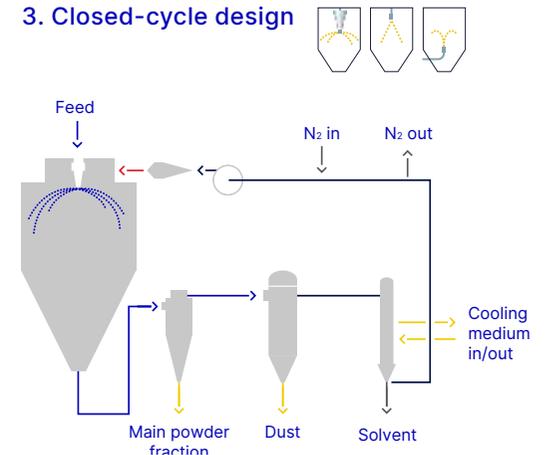
### 1. Open-mode design



### 2. Multi-stage drying design



### 3. Closed-cycle design



# MOBILE MINOR®

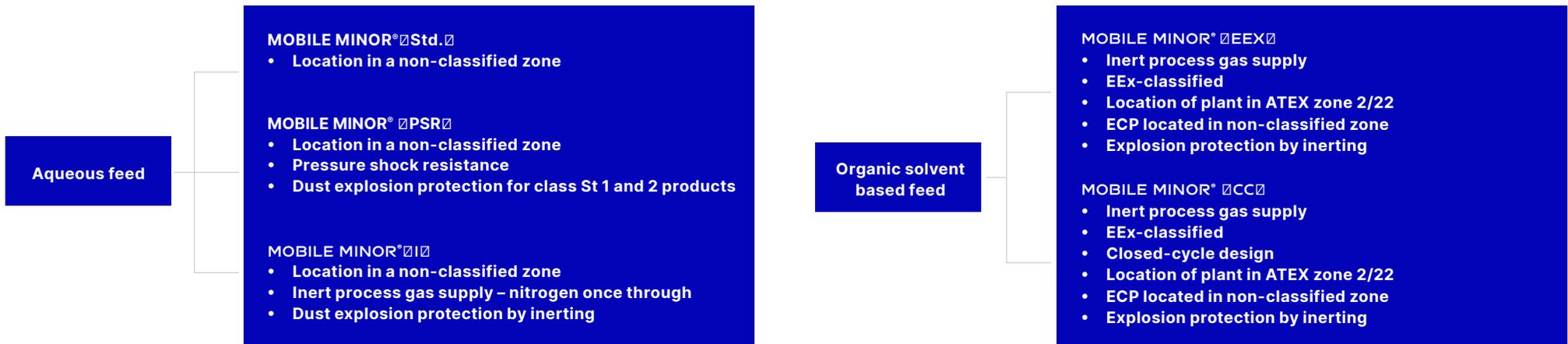
## Multi-purpose spray dryer

The MOBILE MINOR® is the perfect choice for carrying out test work and exploring the possibilities of spray drying. It meets the demand for a safe, sanitary, flexible, modern and easy-to-handle laboratory spray dryer. In the MOBILE MINOR®, small quantities of solutions, suspensions or emulsions can be dried into representative powder samples, and the process data required for scale-up to industrial production can be retrieved.

GEA has developed 5 different types of the MOBILE MINOR® in order to accommodate our customers' different requirements.

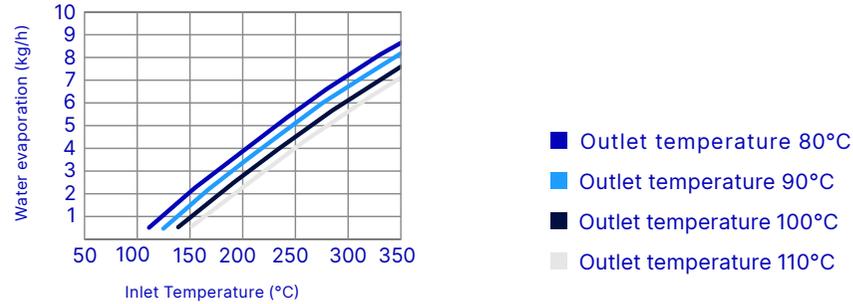


The MOBILE MINOR® has a pneumatically liftable chamber roof for easy inspection and cleaning.



## MOBILE MINOR®

co-current atomization



| Key figures                          | MOBILE MINOR® |
|--------------------------------------|---------------|
| Nominal main process gas flow (kg/h) | 100           |
| Water evaporation capacity (kg/h)    | 0.5 – 8       |
| Typical mean particle size (µm)      | 5 – 80        |
| Space requirements, L × W × H (m)    | 2.5 × 2 × 2.3 |

### Options

- Rotary atomizer
- Two-fluid nozzle
- Feed pump (manual/automatic)
- Pneumatic hammer
- Explosion membrane
- Explosion suppression system
- Flame arrester
- Cartridge filter
- Bag filter
- Wet scrubber
- HEPA filter



# PRODUCTION MINOR® and VERSATILE-SD®

## Foundation for flexible production

GEA's PRODUCTION MINOR® and VERSATILE-SD® belong to a range of versatile production-scale spray drying units. They can be used in the production of a wide range of products – from advanced ceramics and catalysts to flavors, herbal extracts and food ingredients.

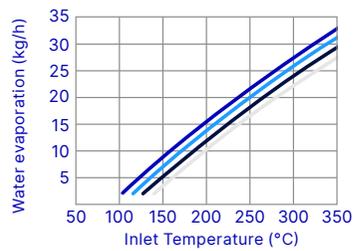
The PRODUCTION MINOR® is a flexible spray dryer that can be used for both R&D – where a larger capacity is required – and for small-volume productions. The capacity of the PRODUCTION MINOR® makes it suitable for a wide range of products. It is a standard spray dryer in a sanitary design with several modules and options available.

The VERSATILE-SD® spray dryers are modular spray dryers designed to utilize the same modules and configurations for different capacity levels and product requirements. With several modules and options available, they can be designed to meet almost every customer requirement.

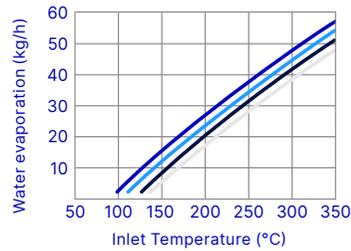


VERSATILE-SD®, size 12.5 with bag filter

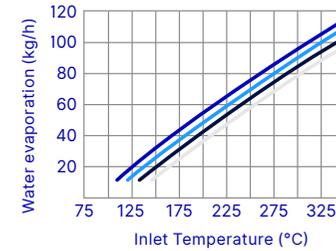
**PRODUCTION MINOR®**  
co-current two-fluid-nozzle atomization



**VERSATILE-SD® size 6.3**  
co-current pressure atomization



**VERSATILE-SD® size 12.5**  
co-current pressure atomization



| Key figures                          | PRODUCTION MINOR® |
|--------------------------------------|-------------------|
| Nominal main process gas flow (kg/h) | 360               |
| Water evaporation capacity (kg/h)    | 5 – 30            |
| Typical mean particle size (µm)      | 10 – 90           |
| Space requirements, L × W × H (m)    | 4.4 × 2 × 2.7     |

| Key figures                          | VERSATILE-SD® size 6.3 |
|--------------------------------------|------------------------|
| Nominal main process gas flow (kg/h) | 630                    |
| Water evaporation capacity (kg/h)    | 10 – 55                |
| Typical mean particle size (µm)      | 10 – 130               |
| Space requirements, L × W × H (m)    | 5.5 × 4 × 6.3          |

| Key figures                          | VERSATILE-SD® size 12.5 |
|--------------------------------------|-------------------------|
| Nominal main process gas flow (kg/h) | 1,250                   |
| Water evaporation capacity (kg/h)    | 20 – 110                |
| Typical mean particle size (µm)      | 20 – 140                |
| Space requirements, L × W × H (m)    | 6.5 × 4 × 6.8           |

**Options**

- Rotary atomizer
- Two-fluid nozzle
- Pressure nozzle
- Feed pump
- Pneumatic hammer
- Explosion membrane
- Explosion suppression system
- Bag filter
- Wet scrubber
- HEPA filter
- Double flap valve
- Fire extinguishing equipment
- Powder cooling systems
- Air broom
- JET SWEEP®
- External fluid bed

# VERSATILE-SD®

From pilots to industrial units

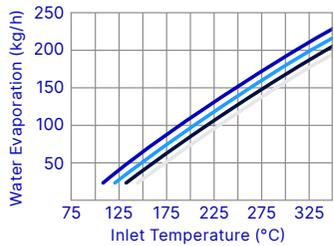
The VERSATILE-SD® sizes 25 and 50 are standard, semi-industrial plants based on standard modules. The applications are many, thanks to the flexibility of the atomization system, even including spray congealing applications, where a melted feed stock is atomized and turned into a free-flowing powder.

To develop the right process and select the ideal size, configuration and equipment, the GEA test centers are available for process development and carrying out tests and trial productions.



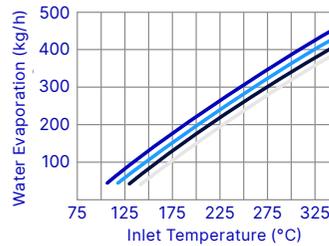
## VERSATILE-SD®, SIZE 25

co-current atomization



## VERSATILE-SD®, SIZE 50

co-current atomization



■ Outlet temperature 80 °C    
 ■ Outlet temperature 90 °C    
 ■ Outlet temperature 100 °C    
 ■ Outlet temperature 110 °C

| Key figures                          | VERSATILE-SD® size 25 |
|--------------------------------------|-----------------------|
| Nominal main process gas flow (kg/h) | 2,500                 |
| Water evaporation capacity (kg/h)    | 40 – 220              |
| Typical mean particle size (µm)      | 40 – 150              |
| Space requirements, L × W × H (m)    | 10 × 5 × 9            |

| Key figures                          | VERSATILE-SD® size 50 |
|--------------------------------------|-----------------------|
| Nominal main process gas flow (kg/h) | 5,000                 |
| Water evaporation capacity (kg/h)    | 80 – 440              |
| Typical mean particle size (µm)      | 80 – 160              |
| Space requirements, L × W × H (m)    | 11 × 6 × 11.7         |

### Options

- Rotary atomizer
- Two-fluid nozzle
- Pressure nozzle
- COMBI-NOZZLE®
- Feed pump
- Pneumatic hammers
- Electrical heater, steam heater or indirect gas heater
- Explosion venting, flame arrester or suppression system
- Double-flap valve or rotary valve for powder discharge
- Bag filter or wet scrubber
- HEPA filter
- Fire extinguishing equipment
- Powder cooling systems
- Air broom
- JET SWEEP®
- External fluid bed

# Closed-cycle spray drying

Designed for safe production

The complete range of GEA spray dryers are also available for operating in closed cycle. This ensures safety, protects the environment and enables solvent recovery.

A wide range of products suspended or dissolved in organic solvents cannot be spray dried in a standard dryer with atmospheric air, due to the risk of an explosion or fire. These products must be spray dried in a plant set-up, where an inert gas, e.g., nitrogen, is used for eliminating fire and explosion risk.

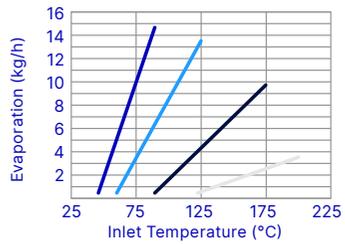
For environmental protection, spray drying of products that are dissolved in organic solvents is done in a closed-cycle spray drying system where the organic solvent is recovered in a condenser unit. The same type of plant set up can also be used where oxidative degradation of the product must be avoided.

Spray dryers in closed-cycle design are available for all capacity requirements and can also be applied for products that are suspended or dissolved in water (water based feeds).

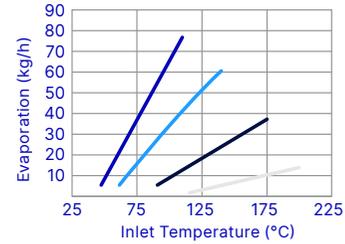


MOBILE MINOR®, closed-cycle plant

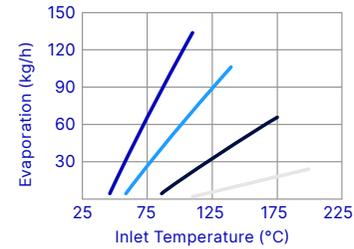
### MOBILE MINOR®



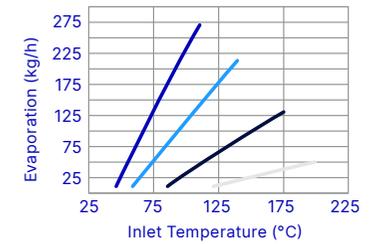
### PRODUCTION MINOR®



### VERSATILE-SD®, SIZE 6.3



### VERSATILE-SD®, SIZE 12.5



■ Methylene chloride evaporation rate at outlet gas temperature 40 °C

■ Acetone evaporation rate at outlet gas temperature 50 °C

■ Ethanol evaporation rate at outlet gas temperature 70 °C

■ Water evaporation rate at outlet gas temperature 90 °C

#### Options

- Rotary atomizer
- Two-fluid nozzle
- Pressure nozzle
- Feed pump
- Pneumatic hammer
- Bag filter
- Wet scrubber
- HEPA filter
- Double flap valve
- Powder cooling systems

# FSD® AND FSD GRANULATOR®

## Multi-stage spray drying technology

The Fluidized Spray Dryer FSD® is an efficient multi-stage dryer with an integrated fluid bed. It combines spray drying and fluid bed technology in one plant, with the same qualities as a multi-stage dryer with external fluid beds but with great space saving.

Drying and agglomeration take place in a single operation, allowing the production of coarse, dustless and free-flowing particles. This technology is especially well suited to food applications, including sticky, hygroscopic, aromatic and heat-sensitive products.

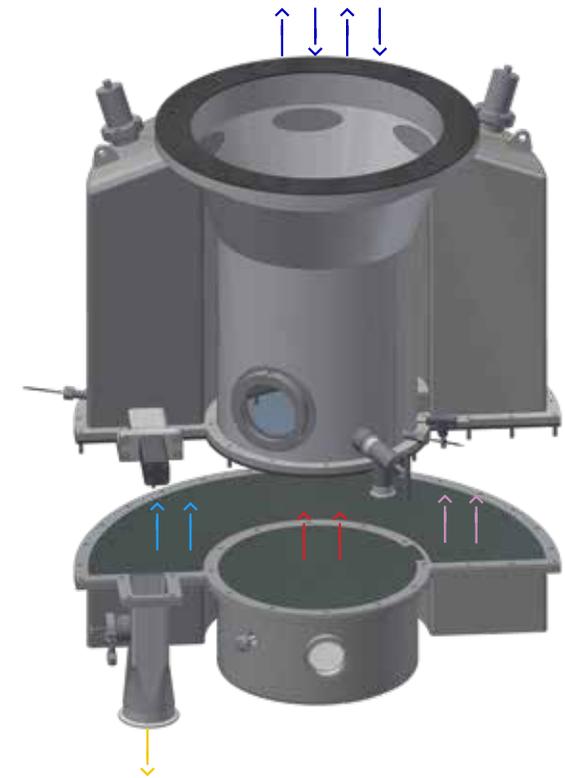
Agglomeration improves the dispersability of the powder and considerably reduces bulk density.

The integrated fluid bed can have up to three sections. The center bed, or agglomeration section, is where the still moist particles collide to form agglomerates. A second section is used for post-drying and a third section for post-cooling.

### FSD-GRANULATOR® (patented)

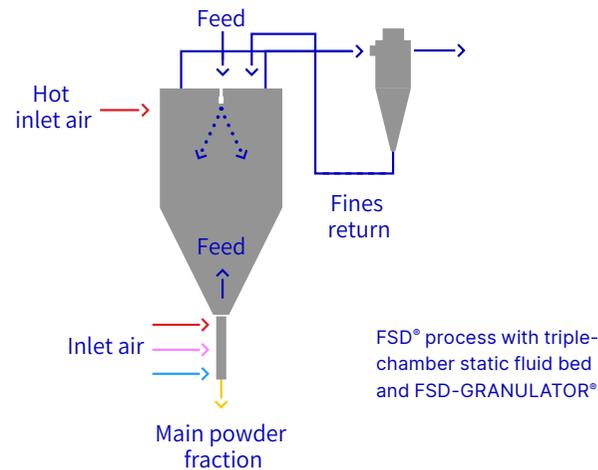
Agglomerates are, notably sometimes, fragile, and any mechanical action can result in breakage of the particle structure. It is possible to improve the strength of the obtained particles by implementing the FSD-GRANULATOR® system inside the center fluid bed. The FSD-GRANULATOR® also allows the production of larger agglomerates.

The FSD-GRANULATOR® injects liquid feed into the agglomeration area, which adds an additional layer to the formed agglomerates. The structure obtained is then stronger, still keeping a low bulk density and good dispersability.



GEA triple-chamber static fluid bed is mounted below the drying chamber

- Powder/fines to and from spray drying chamber
- 1<sup>st</sup> section, main fluid bed gas
- 2<sup>nd</sup> section, post-drying fluid bed gas
- 3<sup>rd</sup> section, cooling fluid bed gas
- Final product



| Key figures                          | FSD® – 6.3    |
|--------------------------------------|---------------|
| Nominal main process gas flow (kg/h) | 630           |
| Water evaporation capacity (kg/h)*   | 10 – 40       |
| Typical mean particle size (µm)      | 50 – 300      |
| Space requirements, L × W × H (m)    | 8 × 4.5 × 6.5 |

| Key figures                          | FSD® – 4.0 |
|--------------------------------------|------------|
| Nominal main process gas flow (kg/h) | 400        |
| Water evaporation capacity (kg/h)*   | 5 – 20     |
| Typical mean particle size (µm)      | 50 – 300   |
| Space requirements, L × W × H (m)    | 6 × 4 × 5  |

| Key figures                          | FSD® – 12.5 |
|--------------------------------------|-------------|
| Nominal main process gas flow (kg/h) | 1,250       |
| Water evaporation capacity (kg/h)*   | 20 – 70     |
| Typical mean particle size (µm)      | 50 – 300    |
| Space requirements, L × W × H (m)    | 9 × 4 × 7   |

\* Assuming single bed fluid bed with inlet temperature identical to chamber outlet temperature

### Options

- Two-fluid nozzle
- Pressure nozzle
- Feed pump
- Pneumatic hammers
- Explosion venting, flame quenching or explosion suppression system
- Bag filter or wet scrubber
- HEPA filter
- Fire extinguishing equipment
- Powder dosing equipment
- Powder cooling systems
- Air broom
- JET SWEEP®
- Equipment for traditional spray drying
- Single-double-or triple-chamber fluid bed
- External fluid bed
- FSD-GRANULATOR®
- Equipment

# Process control

## Process overview at a glance

Process control and automation is a vital part of any type of processing plant and, with decades of experience, GEA's tried-and-tested process control and automation systems provide safe, flexible operations with full transparency.

Our GEA stand-alone process control system features an integrated touch-screen interface and ensures easy, simple and safe operation of your plant. Our control systems come in a range of options to suit different requirements, from those offering basic operating functionality to advanced automatic systems. However, what all GEA control systems, from simple to advanced automated, have in common is that they are based on proprietary modules combined with standard software. Physically, the control panels are compact units with limited space requirements and can be installed next to the spray dryer.

In terms of functionality, the operating panel provides a single-screen overview of all process values and offers multiple options for monitoring and operating parameters. For added protection, alarms can be set to automatically detect and allow response to abnormal process conditions. The control panel also provides access to detailed information about plant operation and gives the operator total control to intervene as needed in order to keep a process running smoothly.



Control panel for spray dryer

# Cleaning solutions

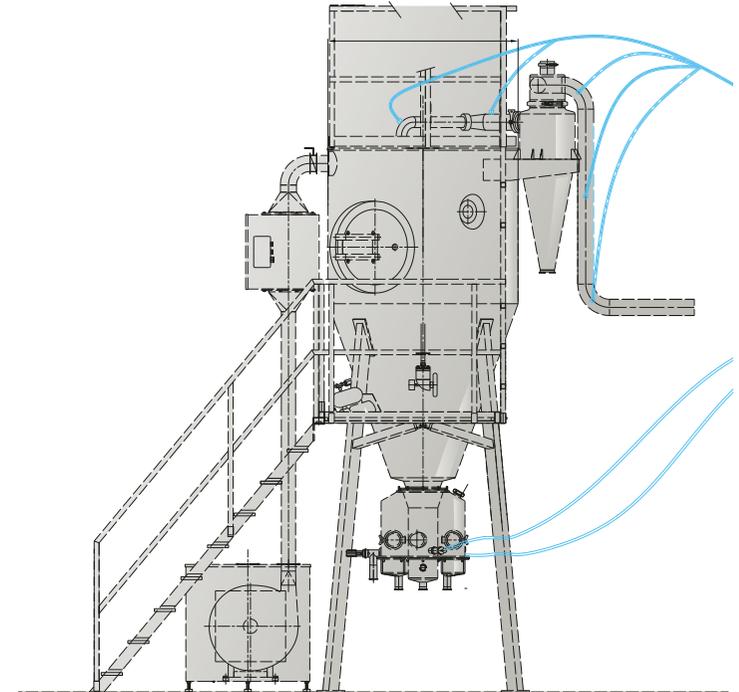
## Define your requirements

Cleaning requirements for small-scale dryers can vary from manual to automatic cleaning. GEA has defined three levels of cleaning solutions as standard options for our small-scale plants:

- Manual: The chamber is cleaned by manual insertion of a cleaning device, as are the cyclone and bag filter. Ducts are dismantled and cleaned by hand.
- Semi-automatic: Cleaning nozzles are manually inserted into ducts, and an orbital cleaner with impact jets is manually inserted into the chamber, cyclone and bag filter after manual removal of filter bags.
- A WIP tank or trolley with circulation pump allows the collection and recirculation of liquid.
- Automatic: Pop-up nozzles in ducts and automatically inserted rotating impact cleaners in chamber, cyclone and bag filter after manual removal of filter bags. Cleaning sequences can be programmed in the control system.

Semi-automatic and automatic systems are recommended for larger plant sizes, whereas manual and semi-automatic cleaning systems are more suitable for smaller designs due to limitations on duct sizes and plant arrangement.

A custom-made solution is also available within the described items.



GEA tank cleaning equipment ensures efficient cleaning of drying chambers and feed tanks. The cleaner is driven by the pressure of the CIP liquid and ensures complete cleaning of the entire inner surface (of drying chambers or tanks).



When not in use, the retractable CIP nozzle sits flush with the inner wall. This ensures that it does not disrupt operations. The nozzle is pneumatically activated and ensures efficient cleaning (of fluid beds, ducts, tanks etc.).

# Environmental, health and safety requirements

## Setting industry standards

All GEA plants are designed to meet the strictest requirements for health and safety and environmental protection, so working with us provides you with the safest solutions on the market. We examine your product and its properties, analyze the risks according to well-established safety procedures and recommend the safety concept that is best suited to your situation.

Safety precautions have to be taken for both aqueous and non-aqueous feeds, but for different reasons. With aqueous feeds, dust explosion risk must be evaluated. Most inorganic powders are not dust explosive, so no further precautions have to be taken. However, almost all organic powders are liable to dust explosion and further precautions always have to be taken.

Organic products such as flavours, carbohydrates, herbal extracts, milk, etc. are all powders that are liable to dust explosion. This means that when such powder is suspended in air, a dust cloud can lead to an explosion.

Organic powders are classified as St1, St2 or St3. St1 powders have  $K_{st} < 200$  bar m/s, St2  $< 300$  bar m/s and St3  $< 450$  bar m/s and can even be hybrid products.

### GEA offers different precautions:

- Explosion membrane
- Flame arrester system
- Suppression
- Plant inertization

### ATEX zoning

One ATEX zone classification is available for gases and one for dust. The following definitions are used for gas/dust:

- Zone 0/20 – An explosive mixture is frequently present during normal operation (often defined as more than 50 % of the time).
- Zone 1/21 – An explosive mixture is occasionally present during normal operation.
- Zone 2/22 – An explosive atmosphere is normally not present and, if it is, it is only for short periods and typically due to plant/operational failures.



Explosion membrane



Flame arrester system

### VERSATILE SPRAY DRYER PLANT ZONING

Designed for non-classified area

Aqueous feeds and non dust-explosive products

Design for operation with dust-explosive products is an option – Zone 22, 1 meter around powder outlet

### FLUIDIZED SPRAY DRYER PLANT ZONING

The plant is designed to operate with class St1 products, Kst <200 bar m/s. Design for operation with higher St classes is an option

Aqueous feeds only

Designed for non-classified area – Zone 22, 1 meter around powder outlet

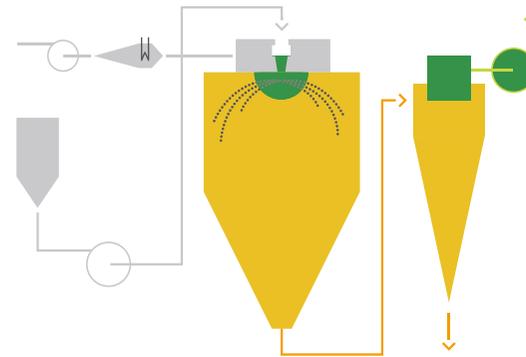
### CLOSED-CYCLE PLANT ZONING

The plant is designed for operation with solvents with an auto-ignition temperature of more than 300 °C. Design for operation with solvents with an auto-ignition below 300 °C requires customization

Non-aqueous feeds

Within 1 m from the plant the space is hazardous categorized as zone 2 as well as zone 22 1 meter from powder outlets and below.

## ZONING OF SPRAY DRYER



■ Zone 20 ■ Zone 22 ■ Non-classified area



For reducing powder emission and collecting powder in one operation, a bag filter system is widely used.



For removing residual powder, particulates and odor, a specially designed wet scrubber system could be the optimal solution.

### Emission and noise control

- Protecting the environment is everybody's responsibility. Industries world-wide are facing increasing pressure to comply with strict environmental regulations while meeting growing production demand.
- This means reducing possible powder emissions and noise from process plants.
- For over a century GEA has been developing components and optimized processes to fulfill these requirements.
- By way of example, powder emission from a spray dryer can be reduced considerably by installing a wet scrubber or bag filter system.
- To counteract noise from various fans, for example, special noise attenuators can be installed to reduce the noise to an acceptable level.



For reducing noise from fans, a noise attenuator is an effective solution.

**GEA Process Engineering A/S**  
Gladsaxevej 305  
2860 Soeborg, Denmark

Tel +45 39 54 54 54  
[gea.com/contact](http://gea.com/contact)

**BTC0100-EN0124**

Trademarks shown in this brochure are registered in several countries worldwide. Published on 09/22/2023

Subject to modifications.