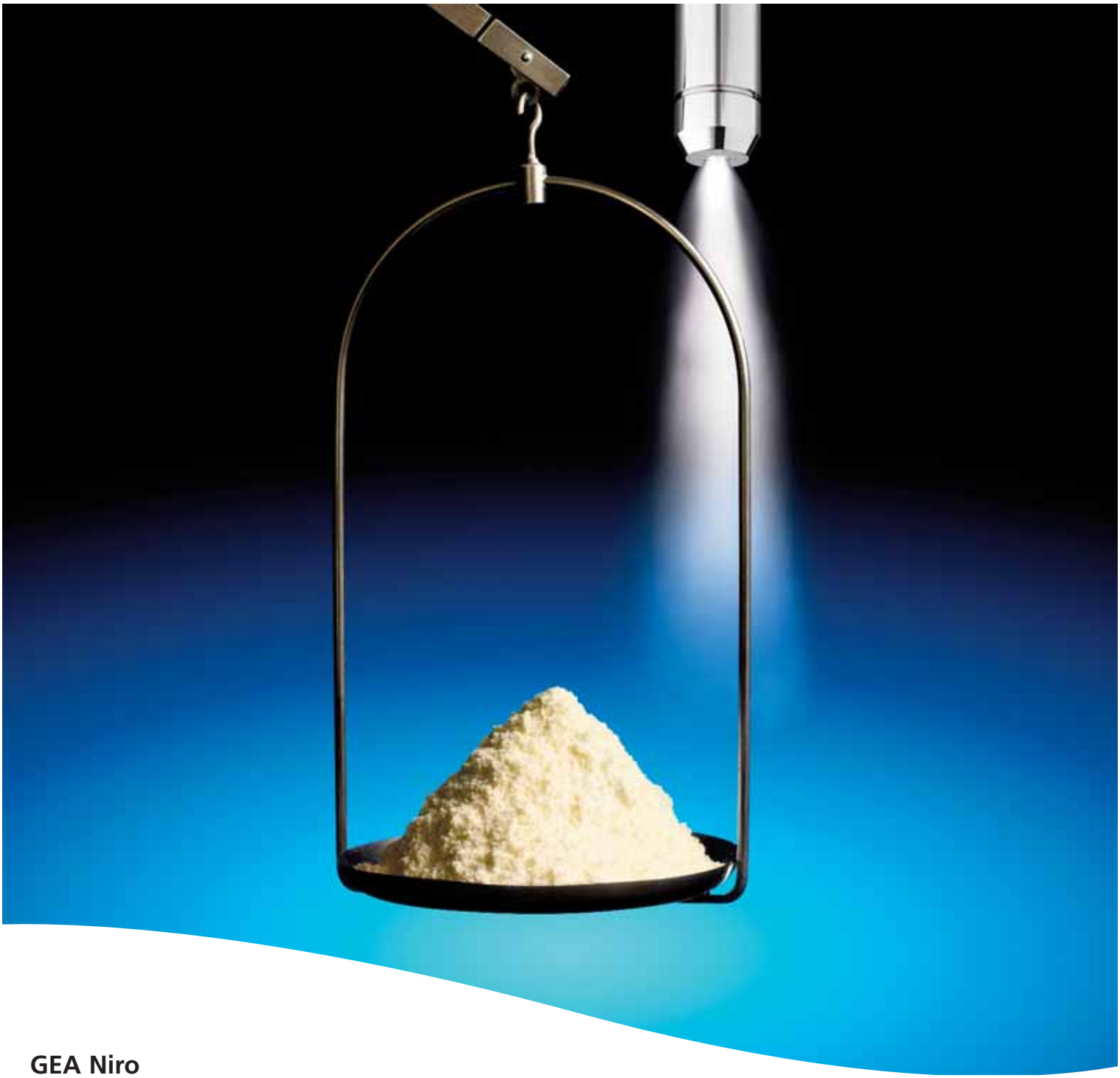
Small-scale spray drying

from the industry's leading supplier, for R&D and small-scale production



GEA Niro

Experience

Everything you need, wherever you need it – standard equipment or tailor-made solutions

The world leader in spray drying
No one knows more about the role of industrial spray drying than GEA Niro. With data gained from more than 75 years of experience, a reference list of some 10,000 plants across the globe and 30,000 test reports from our test centers, we're equipped to engineer the properties you want into your products – and the processes needed to produce them.

Whether you're conducting R&D or interested in small-scale or industrial production, you can depend on GEA Niro. We offer powder engineering solutions and proof of concept through laboratory and pilot plant testing, unmatched scale-up experience and global project execution according to your specifications.

When selecting a spray dryer and atomizer, it's important to carefully understand the properties of the liquid to be dried and the expectations for the powder to be produced. GEA Niro's versatile range of spray dryers makes an excellent choice for development and small-scale production.

Contents

Equipment

R&D and small-scale spray dryers

Our series of small-scale dryers goes from the popular MOBILE MINOR™, with a water evaporative capacity from below 1 kg/h, to the VSD-12.5, with a capacity of up to 110 kg/h, depending upon the feed properties and temperature profile.

Rotary atomizer

Co-current nozzle

Fountain nozzle

Different atomization modes

Atomization results from an energy source acting on a liquid. Resultant forces build up to a point where liquid break-up and disintegration occurs and individual droplets are created. Different atomization techniques apply different energy forms to the liquid feed.

Rotary atomizer

In rotary atomization, the feed is centrifugally accelerated to high velocity in the atomizer wheel before being discharged into the hot drying air/gas. A selection of wheels of different designs for non-abrasive and/or abrasive feeds is available. The degree of atomization and particle morphology depends upon peripheral speed, feed rate, liquid properties and atomizer wheel design. Particle size is adjusted by change of peripheral speed. The rotary atomizer is considered the most flexible atomizing device, suitable for a wide range of products.

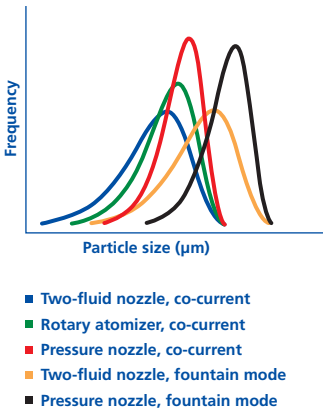
Two-fluid nozzle, co-current or fountain mode

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

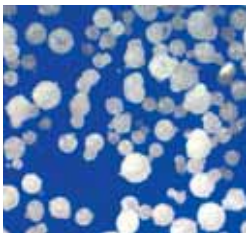
With a pressure nozzle, atomization is the result of the conversion of pressure energy within the liquid feed into kinetic energy of moving thin liquid sheet. Pressure applied to the liquid within the nozzle forces the liquid out of the orifice creating the atomization. A pressure nozzle can be operated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

Particle size distribution with different atomization systems at comparable conditions



Expertise

Engineering the powder, testing the process



Powders

Agglomerates

GEA Niro tailors the drying process to the particulate size, structure, moisture content and other properties needed for your application.

Powder engineering means tailoring the drying process to achieve the particulate size, structure, moisture content and other properties needed for your application. Want a drier powder? An easier flowing powder? Agglomerates with fewer fines? With more than 75 pilot plants in GEA Niro Test Centers worldwide and an international team of test engineers and process technologists, GEA Niro represents the world's largest pool of talent specialised in tackling challenges within spray drying.

GEA Niro Test Centers

GEA Niro offers formulation advice and process verification through laboratory and pilot plant testing. Our test facilities and accompanying analytical laboratories allow you to establish the feasibility of using GEA Niro equipment and optimise process conditions.

GEA Niro Test Centers conduct three core services: feasibility studies, pilot tests and laboratory analyses. Beyond our traditional services, GEA Niro is open to using the test centers in alliances of all types, including collaborations with universities, research institutions and private-public joint ventures. So even if your project doesn't fall under one of our traditional services, we're always happy to discuss new partnership opportunities that reflect your particular needs.

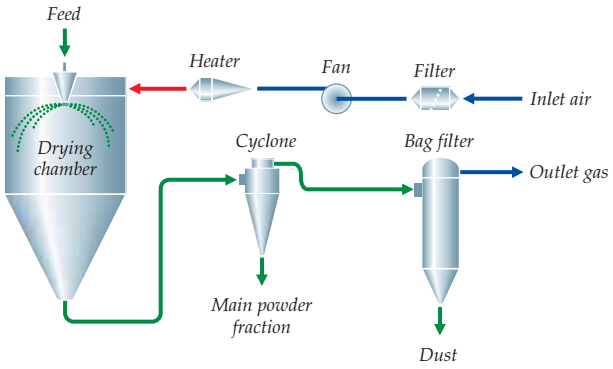
With 75 years of experience, 10,000 plants in operation and 30,000 test reports, GEA Niro knows how to engineer the properties you want into your products and the processes needed to produce them.

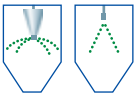
Configurations

Three conventional spray drying configurations

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

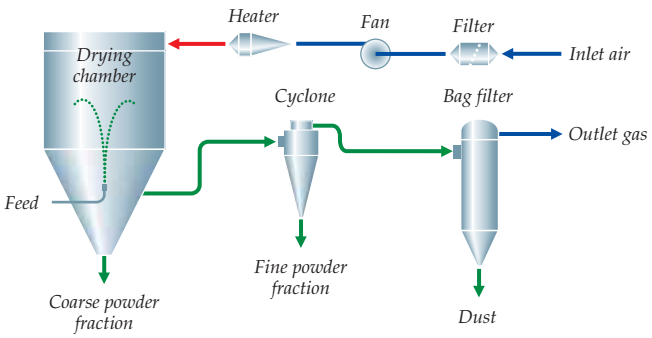
Open-mode design with single-point powder discharge

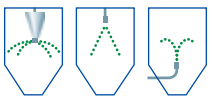




Atomization options

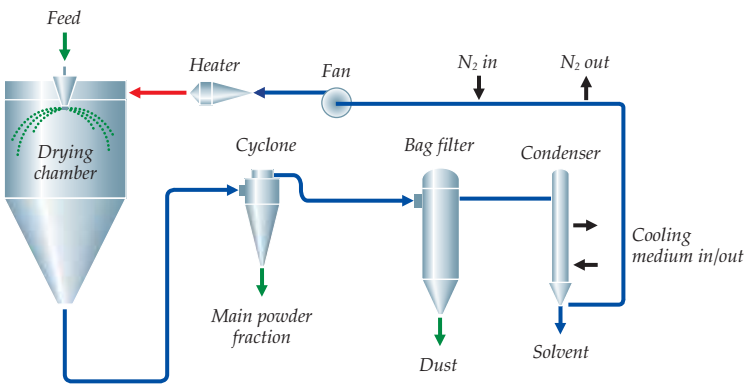
Open-mode design with two-point powder discharge

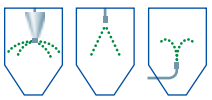




Atomization options

Closed-cycle design with single-point powder discharge





Atomization options

Solutions

A wide range of versatile small-scale solutions

Since drying characteristics and product specification vary from product to product, there is no one process or dryer design suitable for all applications. By offering a full range of processes and designs, GEA Niro impartially selects the most suitable equipment.

GEA Niro delivers main components such as drying chambers, cyclones and bag filters pre-produced in a single piece for easy installation.

Small-scale plants – process and available equipment

CHARACTERISTICS	Nominal main process gas flow, kg/h	Water evaporation capacity, kg/h	Typical mean particle size range, micron
PLANT TYPE			
MOBILE MINOR™	80	0.5-6	5-80
PRODUCTION MINOR™	360	5-30	10-90
VSD-6.3	630	10-55	10-130
VSD-12.5	1250	20-110	20-140
FSD MINOR™	80	0.5-6	30-300
FSD™-4.0	400	5-25	50-300
FSD™-6.3	630	10-50	50-300
FSD™-12.5	1250	20-90	50-300
IFD MINOR™	80	0.5-6	30-300
IFD™-4.0	400	5-25	50-300
IFD™-6.3	630	10-50	50-300
IFD™-12.5	1250	20-90	50-300
SWF MINOR	80	0.1-6	5-150
VIBRO-FLUIDIZER™ 0.3/6.3	630	1-10	100-2000
VIBRO-FLUIDIZER™ 0.3/12.3	1250	2-15	100-3000
FMD-12.5	1250	15-60	400-1000

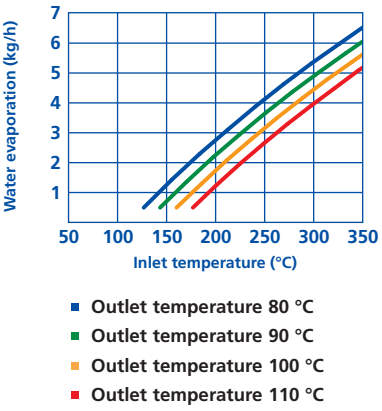
EQUIPMENT

Feed pump	x				x	x	x	x	x	x	x	x	x	x	x	x
Screw feeding device		x	x	x												
Rotary atomizer, pneumatically driven																x
Rotary atomizer, high-frequency motor													x	x	x	
Two-fluid nozzle, co-current	x				x	x	x	x	x	x	x	x	x	x	x	x
Two-fluid nozzle, fountain													x	x	x	x
Pressure nozzle	x				x	x	x	x	x	x	x	x	x	x	x	
Static fluid bed, single chamber					x	x	x	x	x	x	x	x				
Static fluid bed, 2 or 3 chambers					x	x	x		x	x	x					
Electrical heater	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Steam heater with optional electrical booster	x	x	x		x	x	x		x	x	x		x	x	x	
Combustion gas heater													x	x	x	
Drying chamber with main powder discharge	x	x	x										x	x	x	x
Cyclone with main or secondary powder discharge													x	x	x	x
Powder discharge from static fluid bed					x	x	x	x	x	x	x	x				
Cartridge filter, fine powder collection				x												x
Bag filter, main, secondary or fine powder discharge	x	x	x	x					x	x	x	x	x	x	x	x
Wet scrubber	x	x	x						x	x	x	x	x	x	x	x
Control panel / MCC panel, combined - push buttons				x												x
Control panel / MCC panel, combined - PLC with LC HMI	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x

MOBILE MINOR™

A flexible, easy-to-handle laboratory spray dryer

Space requirements, open mode
LxWxH: 2.5x2.0x2.3 m



The MOBILE MINOR™ version with pneumatically liftable chamber roof. Here equipped with fountain two-fluid nozzle and two-point powder collection. Drying chamber size: Ø 800x620 mm, 60° cone.

MOBILE MINOR™ connected to a combined feed/CIP tank.

MOBILE MINOR™ bag filter for powder collection and cleaning of exhaust gas. Various designs available.

Cartridge filter for MOBILE MINOR™ for cleaning of exhaust gas.

The MOBILE MINOR™ "basic version" with limited options and a different design with side door is available for customers with limited requirements.

Since the introduction of the first MOBILE MINOR™ in 1948, more than 2,100 units have been supplied. Today's versions meet the increasing demand for safe, sanitary, flexible, modern and easy-to-handle laboratory spray dryers.

In the MOBILE MINOR™, small quantities of solutions, suspensions or emulsions can be dried into representative powder samples. Test results from the MOBILE MINOR™ provide important information for establishing process data.

Three alternative atomizing systems ensure you benefit from the solution that is most well-suited to the task:

- **Rotary atomizer**, located in the center of the chamber roof. An air turbine drive requiring 6 bar compressed air supplies energy to the atomizer wheel.
- **Co-current two-fluid nozzle**, located in the center of the chamber roof. Atomization is created by compressed air at a pressure of 0.5-6.0 bar.
- **Fountain two-fluid nozzle**, located in the cone of the drying chamber, spraying upwards. Atomization is created by compressed air at a pressure of 0.5-6.0 bar.

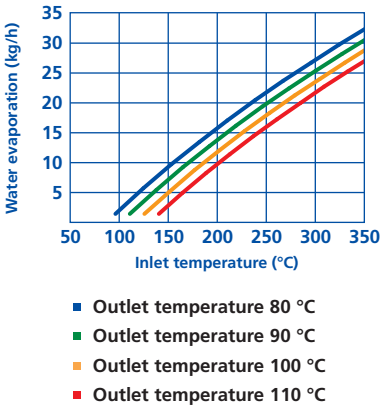
For operation with feeds based on flammable solvents or powders subject to explosion risk, special designs are available.

PRODUCTION MINOR™

Versatile drying with interchangeable atomization and powder discharge systems

Space requirements, open mode
LxWxH: 4.4x2.0x2.7 m

PRODUCTION MINOR™ with powder collection under the cyclone. Drying chamber size: Ø 1200x745 mm, 60° cone. (Also available with extended cylinder: Ø 1200x1500 mm.)



The PRODUCTION MINOR™ is a standard spray-dryer design with modules available to offer a wide range of dryer configurations. A versatile dryer in a sanitary design, it is ideal for in-house research and small-scale production. Various powder specifications can be met by selecting the optimum configuration and atomization technique.

Choose from three basic atomizer alternatives:

- **Rotary atomizer** variable speed, located in the ceiling air disperser. Type FS-1 is for aqueous-based feeds and type FX-1 is for locations where explosion-proof equipment is required. Atomizer wheels for non-abrasive feeds or abrasive feeds can be selected. Powders produced typically have a mean particle size ranging from 20-50 µm depending on product and operation parameters.
- **Co-current two-fluid nozzle**, located in the ceiling air disperser; ideal for heat-sensitive feeds. This atomizing device can handle both low- and high-viscosity feeds. Atomization occurs by compressed air at 1.0-6.0 bar. Powders produced have a mean particle size in the range of 10-40 µm.
- **Fountain nozzle**, located in the cone of the drying chamber, spraying upwards. The fountain mode produces more free-flowing powders typically of a mean particle size in the range of 60-90 µm. Atomization occurs by compressed air at 1.0-6.0 bar or by pressure. This is used for non-heat-sensitive products.

All atomization options can be supplied for a single plant if you're interested in alternative operations. Closed-cycle design for operation with organic solvents or reinforced design with venting or suppression for dust explosion protection is also available.

VERSATILE-SD™ size 6.3 and 12.5

Wide range of standard spray drying modules configured to meet your specific requirements

Space requirements, open mode

VSD-6.3:
LxWxH: 5.5x4.0x6.3 m

VSD-12.5:
LxWxH: 6.5x4.0x6.8 m

VSD-12.5-CC spray dryer with a rotary atomizer. Closed-cycle design using nitrogen as drying gas. Drying chamber size: Ø 2500x2000 mm, 60° cone.

VSD-6.3-P with rotary atomizer, cyclone and exhaust fan in noise attenuation box. Drying chamber size: Ø 1600x800 mm, 60° cone.

The VSD spray dryers have been developed over the years to utilise the same design and configurations for different capacity levels. The modules even include different drying chamber designs for the same process gas flow capacity to match various atomization systems and product requirements.

There are two models available, the VSD-6.3 and the VSD-12.5. To select the ideal configuration and equipment type, GEA Niro process technologists often will perform and analyse trials in GEA Niro Test Centers.

Both sizes of the VERSATILE-SD™ spray dryers can use five types of atomizing devices:

- Rotary atomizer
- Two-fluid nozzle, co-current
- Two-fluid nozzle, fountain mode
- Pressure nozzle, co-current
- Pressure nozzle, fountain mode

A spray dryer can be equipped with several alternative atomizing systems, allowing you to switch product while still having the optimum process solution.

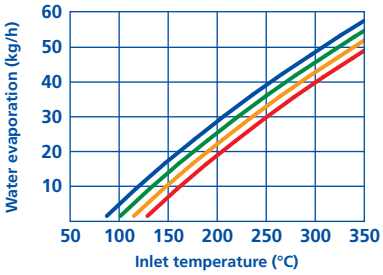
Closed-cycle design for operation with organic solvents or reinforced design with venting or suppression for dust explosion protection is also available for both sizes.

The plants can also be equipped for spray congealing applications.

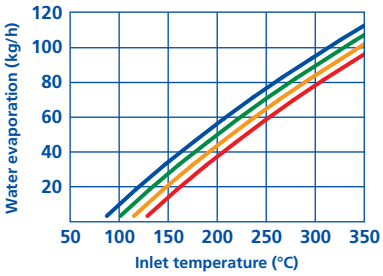
VSD-6.3-R, designed for rotary atomization.
Drying chamber size: Ø 2500x1000 mm, 60° cone.

VSD-Plant, designed for co-current pressure nozzle atomization.

VSD-6.3 co-current atomization



VSD-12.5 co-current atomization



- **Outlet temperature 80 °C**
- **Outlet temperature 90 °C**
- **Outlet temperature 100 °C**
- **Outlet temperature 110 °C**

FSD™ size 0.8 to 12.5

Multi-stage drying technology

Space requirements, open mode

FSD-0.8
LxWxH: 3.0x2.5x3.0 m

FSD-4
LxWxH: 6.0x4.0x5.0 m

FSD-6.3
LxWxH: 8.0x4.5x6.5 m

FSD-12.5
LxWxH: 9.0x4.0x7.0 m

FSD™-6.3 with triple chamber static fluid bed. Installed in GEA Niro Test Center, Copenhagen. Drying chamber size: Ø 1600x800 mm, 40° cone.

FSD™-4.0 with single chamber static fluid bed. Drying chamber size: Ø 1200x750 mm, 40° cone.

FSD MINOR™, size 0.8. Drying chamber size: Ø 800x620 mm, 40° cone.

Multi-stage drying technology

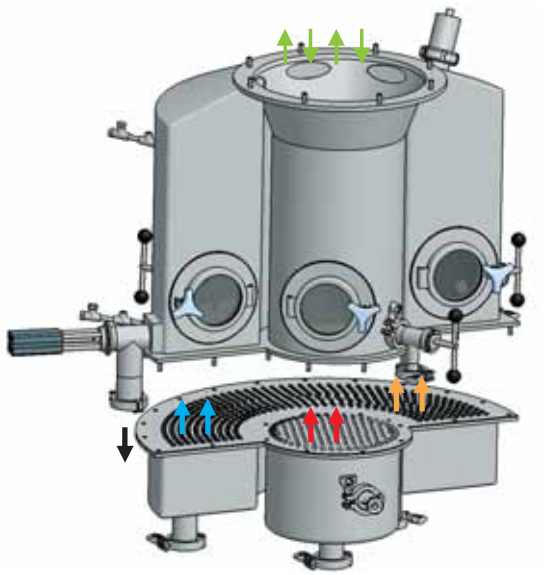
The FSD™ Fluidized Spray Dryer features special multi-stage drying technology that is ideal for small-scale production of coarse, dustless and free-flowing agglomerates. Heat-sensitive and aromatic products can be successfully dried. Sticky and hygroscopic products are handled efficiently in a continuous operation. The FSD™ process has been further developed, resulting in the IFD™ concept, where the bag filter has been integrated in the drying chamber. See page 14.

Mode of operation

The feed is sprayed from the atomization nozzle (two-fluid or pressure nozzle) mounted in the ceiling of the drying chamber into the hot drying air introduced through the process gas disperser. The vigorous fluidization of moist powder in the fluid bed, located at the chamber base, plus recycle of fines from the cyclone or bag filter attachment leads to spray drying taking place in a powder-laden atmosphere, resulting in agglomeration.

Agglomeration

Small single particles dissolve instantly in water. Powder consisting of small particles is, however, difficult to disperse. Large particles are easy to disperse in water, but dissolve only partially. Agglomeration optimises quick dispersion



The triple chamber static fluid bed offers the possibility of a three-stage post treatment of the spray dried powder in a continuous operation in a very compact system:

- **1st stage, inner bed: Final agglomeration, sizing, drying of agglomerates and de-dusting**
- **2nd stage, ring bed, first chamber: Post drying and continued de-dusting**
- **3rd stage, ring bed, second chamber: Cooling and final de-dusting**

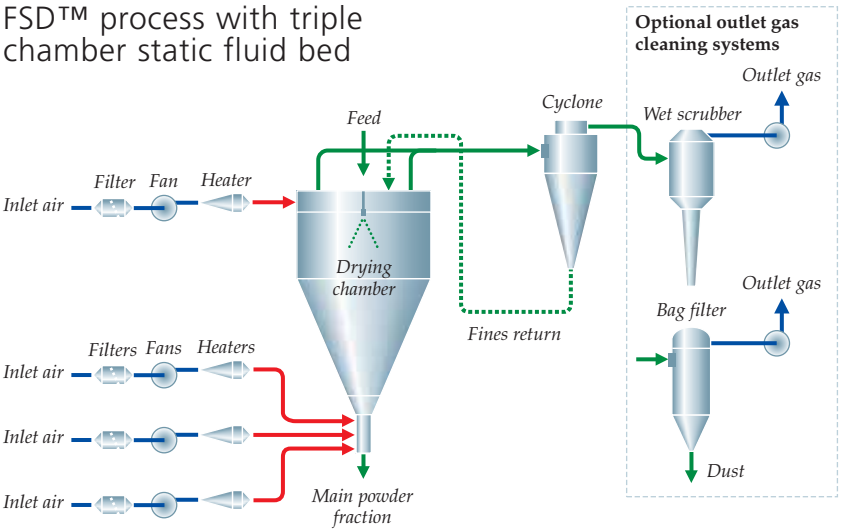
All three chambers can have separate process gas supply systems.

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

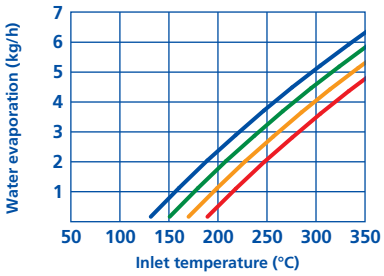
of the agglomerates as well as quick and complete dissolution of the small particles forming the agglomerate. Furthermore, agglomeration improves the product's flowability and reduces dust problems during powder handling.

Agglomeration is a result of wet and/or semi-dry particle collision. Control is achieved by adjusting atomization, temperatures and fluidization velocity and by returning dry fine powder to the wet spray.

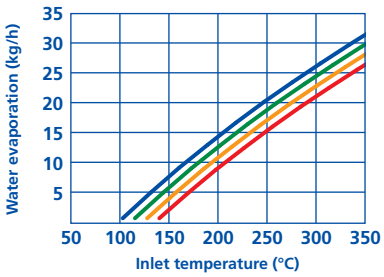
FSD™ process with triple chamber static fluid bed



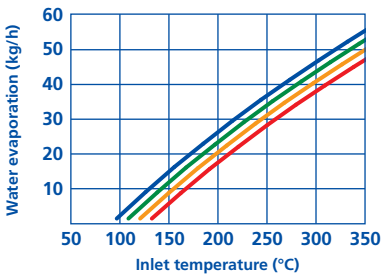
FSD MINOR™ – 0.8



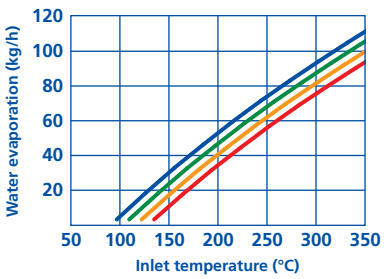
FSD™ – 4.0



FSD™ – 6.3



FSD™ – 12.5



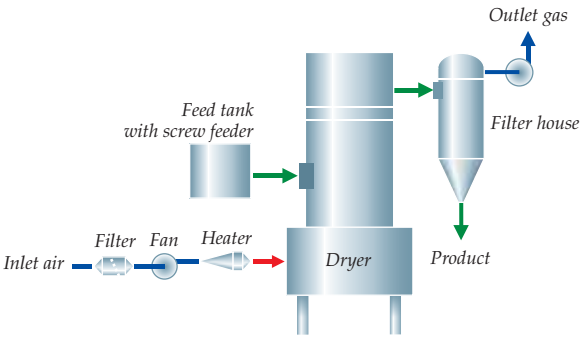
- **Outlet temperature 80 °C**
- **Outlet temperature 90 °C**
- **Outlet temperature 100 °C**
- **Outlet temperature 110 °C**

Additional plants and equipment

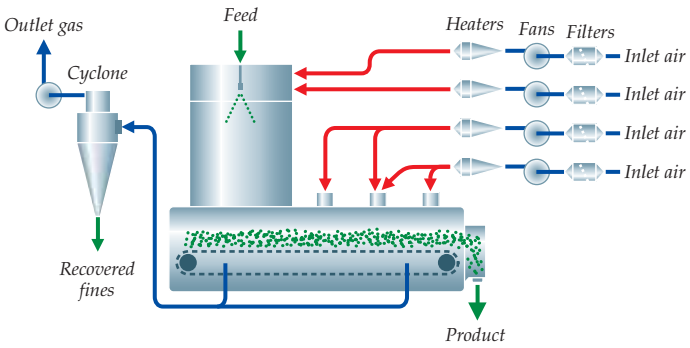
Everything you need to complete the process

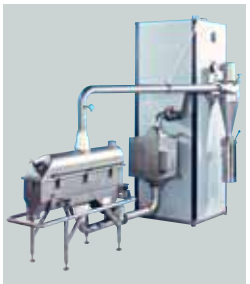
With GEA Niro's wide range of standard modules and process equipment, it's possible to design a process that meets your requirements. Below you will find a brief description of other processes where "small-scale" plants are available:

Use the SWIRL FLUIDIZER™ to obtain a fine, homogenous and non-agglomerated dry product from pastes, filter cakes and highly viscous liquids. The small SWF MINOR-0.8 is an ideal laboratory unit for optimising the process and establishing data for scale-up to industrial size.

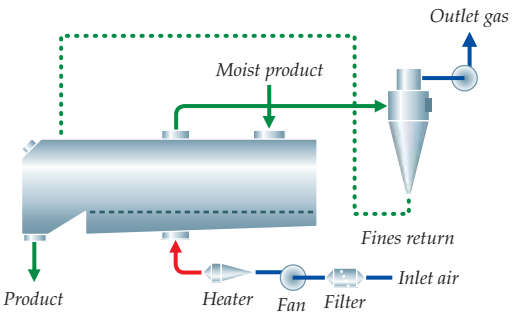


The FILTERMAT™ spray dryer successfully dries most sticky, hygroscopic, thermoplastic, slowly crystallising or aromatic products into free-flowing, agglomerated powders. The FMD-12.5 is the smallest unit for this process. It can be used for development and small-scale production of specialist powders.





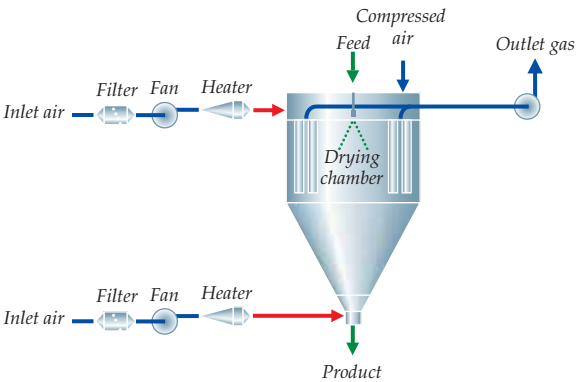
The VIBRO-FLUIDIZER™ is for final treatment of powders, agglomerates and granulates. It can be operated as a separate post-drying or cooling unit and is often associated with a spray drying system for production of agglomerated instant powder or can act as a powder conditioning plant.



IFD MINOR™-0.8

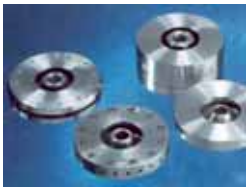
The IFD™ Integrated Filter Dryer features spray drying and agglomeration, second-stage drying, powder cooling and powder separation integrated in a compact unit. The IFD™ concept is available in sizes 0.8, 4.0, 6.3 and 12.5.

- *High level of containment*
- *Simplified powder handling (no cyclone or external bag filter)*



Rotary atomizer

The patented FS-1 atomizer is powered by a high-frequency, high-speed motor integrated in the unit. The flexible spindle compensates for fluctuations in feed rate and other imbalance during operation. The bearings are of grease-lubricated, high-speed design to prevent any product contamination by lubricants. With a feed capacity of 120 kg/h, it is suited for the Production Minor™, VSD™-6.3 and -12.5.



Wheel types: 24 straight vane wheel, for non-abrasive feeds, bushing wheel and PIN-wheel for different abrasive feed stocks, and sanitary nozzle wheel for food and pharma applications.

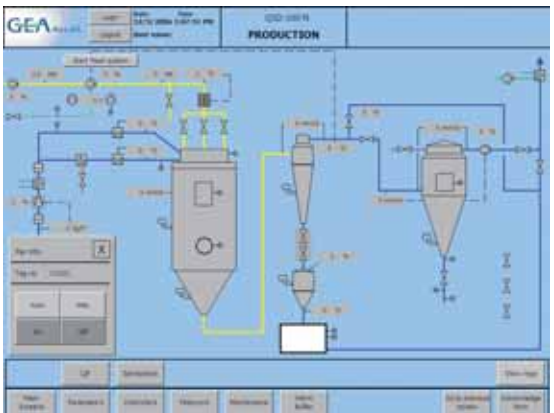
The elegant air-driven rotary atomizer for MOBILE MINOR™ spray dryers takes up to 10 kg/h feed. Available wheel types are as described under the FS-1 atomizer, but are smaller.

Wet scrubber

The wet scrubber type SHE consists of a scrubber head including venturi diffuser, separator with tangential bottom inlet for impingement and precipitation of water and particulate matter, water tank and recycling pump – all in one contained unit. The main purpose of a wet scrubber is to remove particulate matter and reduce dust emission from the outlet gas. Various sizes are available.

Bag filter

Final cleaning of the outlet gas is usually performed in bag filters containing a number of filter bags. Continuous cleaning during drying operation ensures that the pressure drop across the filter is maintained at a level suitable for the process flow. Size of filter house and filter bags varies with the volume of outlet gas from the dryer. Bag filters can also be used for primary and/or secondary powder collection.



Process control

GEA Niro has developed well-proven control and automation systems that provide safe, flexible operations with full visibility. Options range from a rather simple push-button panel to advanced PLC / HMI solutions.

Experience

GEA Niro has contracted and installed more than 10,000 plants worldwide

GEA Niro is a world leader in industrial drying, with spray drying, spray cooling/congealing, flash drying, freeze drying, granulation and fluid bed processing as core technologies. Having installed more than 10,000 plants around the globe, GEA Niro is known for delivering solutions that meet customers' exact requirements. The GEA Niro companies are part of the Process Engineering Division of the GEA Group.

Process Engineering

GEA Niro

Gladsaxevej 305, PO Box 45, DK-2860 Soeborg, Denmark
Tel +45 39 54 54 54 Fax +45 39 54 58 00
E-mail: chemical@niro.dk Website: www.niro.com