GEA
Powder Technology
Division

Niro

Fluidized Spray Dryer
FSD™

Fluidized Spray Dryer FSD™

The Fluidized Spray Dryer FSD™ is one of the most successful designs of spray dryers ever developed. It is used to dry a wide variety of products many of which are extremely difficult to produce in powder form using conventional drying technologies.

Niro patented and introduced the FSD™ concept in the early 1980s and has continued to develop the design according to the needs of industry, i.e. a dryer that meets operational safety and environmental protection standards, produces powders of better quality and handling characteristics, is easier to operate, and has lower operational costs.

The FSD™ combines fluidization and spray drying technologies, enabling the size and structure of particles to be easily controlled. Therefore, the FSD™ is often used as a spray dryer agglomerator or spray dryer granulator. Drying is completed while very low powder temperatures are maintained, another important feature which makes this concept ideal for producing heat sensitive products in dried form.

Advantages

- Produces free flowing powders in agglomerated or granulated form.
- Produces powders having a very low content of small particles (dustless).
- Dries many thermoplastic and hygroscopic products that are problematic in other designs.
- Ideal for heat sensitive products as particle temperatures are kept low throughout the drying process.
- Drying is completed at low outlet drying temperatures, giving high energy utilisation efficiencies.

The companies of the Niro Group form the Powder Technology Division of GEA, an international engineering group with head office in Bochum, Germany. The local presence of over 30 Niro companies throughout the world is central to providing the best of customer service.

Mode of Operation

The feed liquid, which can be a solution, suspension or an emulsion, is pumped to an atomizer located in the air disperser at the top of the drying chamber.

The atomizer sprays the liquid into a high velocity stream of drying air and the resulting spray droplets are dried as they are carried downwards in the central air jet towards the integrated fluid bed.

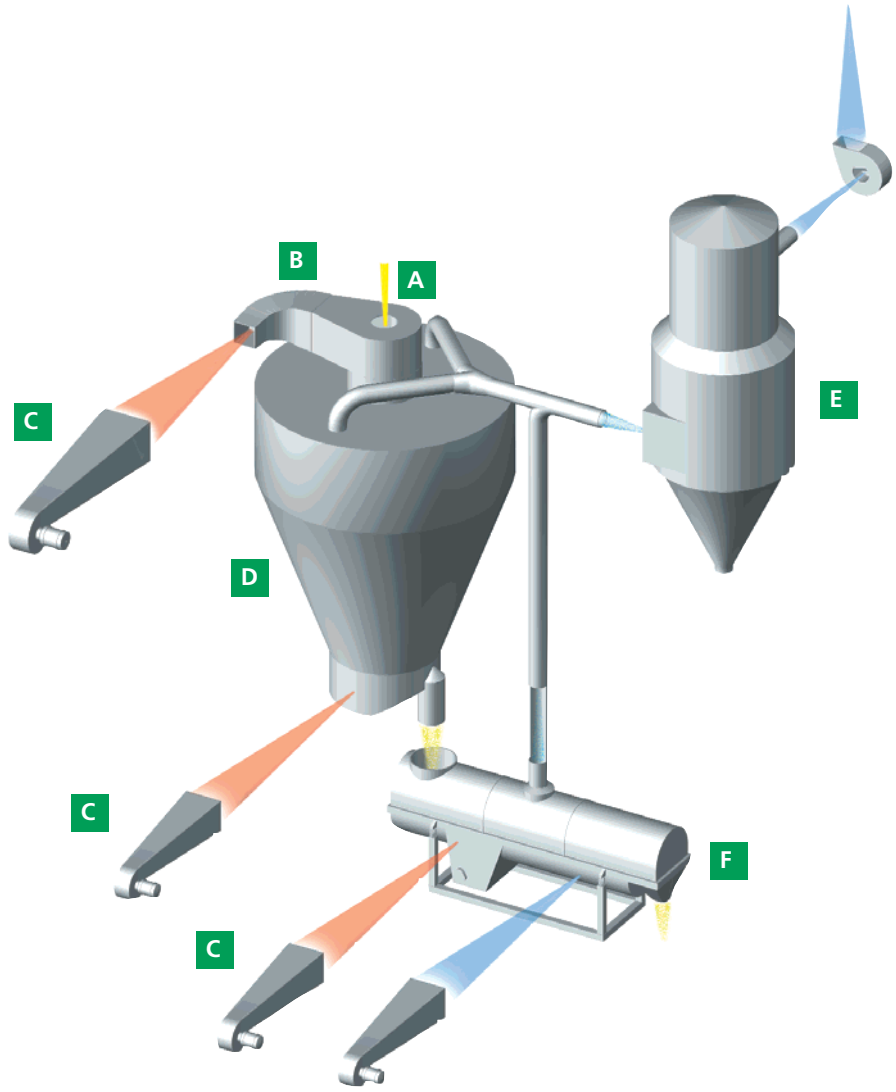
Particles enter the fluid bed while the air flow reverses upwards to be exhausted from the top of the drying chamber.

The finer particles separated from the exhaust air are recycled to the drying chamber.

The fluidization of particles in the fluid bed, fines recycle, and particle movement in the air flow result in spray drying taking place in a powder-laden atmosphere which is much denser than in conventional drying systems. Particles of higher moisture content can then be handled as the resulting powdering effect overcomes problems of surface stickiness of the drying particles.

The moisture content of particles entering the fluid bed can be controlled to the level required for achieving the desired particle size increase and structural change (agglomerating or granulating).

When required, final drying and cooling of the product takes place in a fluid bed connected to the outlet of the integrated fluid bed.



A **Atomizer**
Nozzle or rotary atomizers are used to spray the feed liquid into droplets.

B **Air disperser**
A roof-mounted design controls the air flow pattern in the drying chamber.

C **Hot air system**
Provides hot air for drying. Incorporates oil, gas, steam, and electrical heating units.

D **Drying chamber**
Cylindrical chamber with a fluid bed mounted in the conical base.

E **Exhaust air system**
Separates airborne particles from the drying air leaving the drying chamber. Cyclones and/or bag filters are used.

F **Powder handling**
In pneumatic or vibratory systems, or externally mounted fluid beds.

FSD™ is the trademark of Niro for Fluidized Spray Dryers used in all industries except for the dairy industry where the MSD™ trademark is applicable.

Controlling Particle Size Structure and Powder Properties

By combining spray drying and fluid bed drying into the same process chamber, it is possible to operate the dryer over a wider range of particle sizes, moisture contents, and drying air temperatures. This gives greater control over the degree of particulate agglomeration or granulation achievable.

In the FSD™ there are three zones in the drying chamber where atomized droplets and dried particles interact to build an agglomerate or granular structure:

- Primary zone around atomizer: droplet-droplet contact
- Secondary zone in drying chamber: droplet-dried particle contact
- Tertiary zone in and above fluid bed: moist particle-dried particle contact

The higher the available contacting energy and moisture content of the interacting droplets and particles, the larger and more compact is the final agglomerate or granule.

Fine particle grades are therefore achieved with higher outlet drying temperatures which lower the moisture content level of the particles in the drying chamber and reduce the agglomerating effect. Cool air is used in the integrated fluid bed.

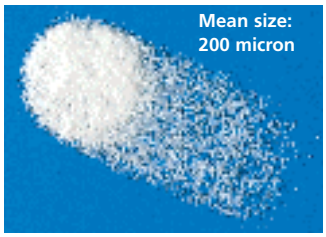
Coarse powder grades are achieved by using lower outlet drying temperatures, thereby increasing the moisture content level of the particles in the drying chamber and increasing the agglomerating and granulating effects. Warm air is used in the integrated fluid bed.

It is thus possible to convert liquid feeds into coarse agglomerates and granules, and also into fine powders which are normally associated with other spray dryer designs.

The FSD™ can also operate with powder feeds as a rewet agglomerator.

Comparison of FSD™ dried products with products dried on other systems

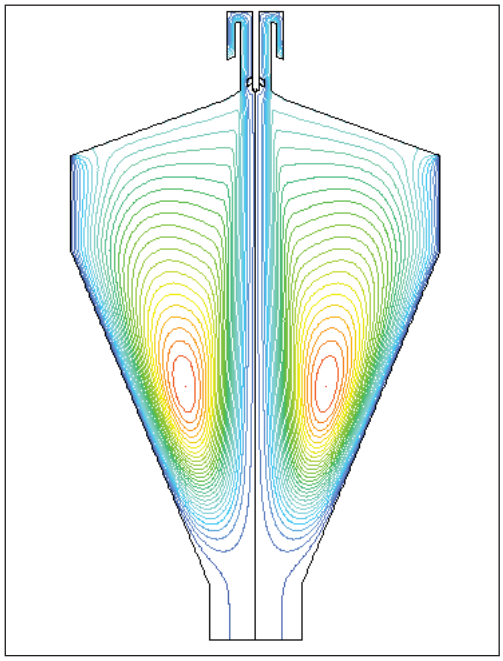
FSD™ with either nozzle or rotary atomizer



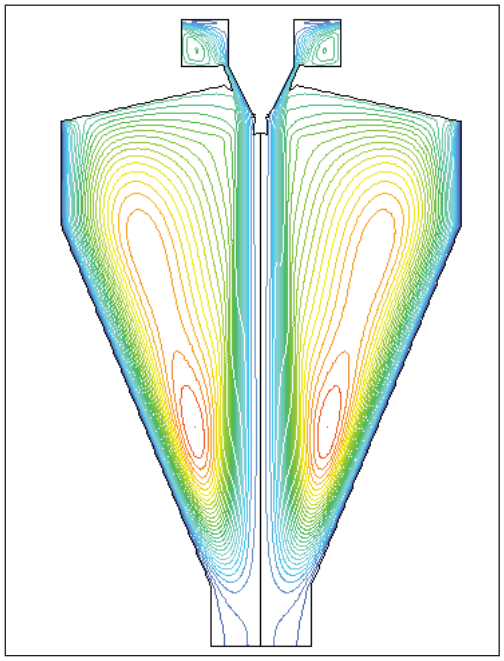
Conventional spray dryer with nozzle atomizer

Conventional spray dryer with rotary atomizer

Flow profile in FSD™ with nozzle atomizer.

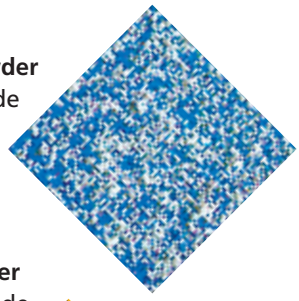


Flow profile in FSD™ with rotary atomizer.

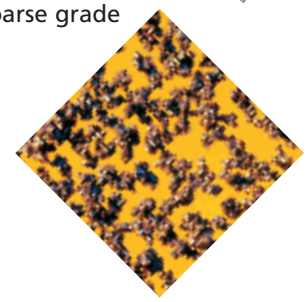


Computational fluid dynamics (CFD) simulations give an excellent understanding of air flow, droplet evaporation, and particle movement in spray dryers. CFD is used to optimise dryer size and design components vital to dryer performance

FSD powder
Fine grade



FSD powder
Coarse grade



System Layouts

The FSD™ can be incorporated in different layouts to suit the requirements of the product application:

With external collection and recycling of fines

Widely used where fines collected in externally mounted cyclones or bag filters are returned

- to the atomization zone
- to the integrated fluid bed
- to the air space above the fluid bed

The arrangement depends upon the fines amount and the degree of agglomeration required.

With a fluid bed attached to the base of the drying chamber

Used where particles formed in the integrated fluid bed require after-drying and cooling. This is done in the externally mounted fluid bed.

With internal collection and recycling of fines

Used where fines handling outside the drying chamber is problematic and/or where total containment of powder within the drying chamber is a requirement.

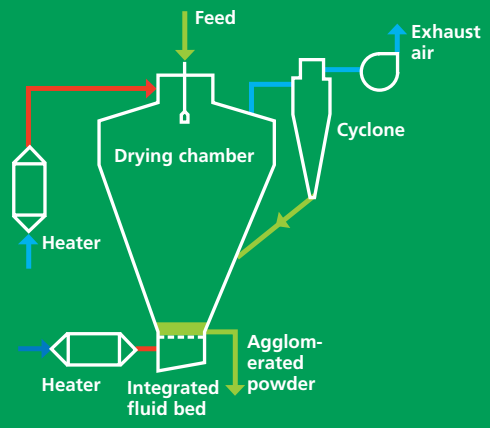
Open and Recycle Layouts

Open layouts
For aqueous feeds where air is the drying medium. Components of special hygienic design are incorporated to meet the requirements of the dairy, food and pharmaceutical industries.

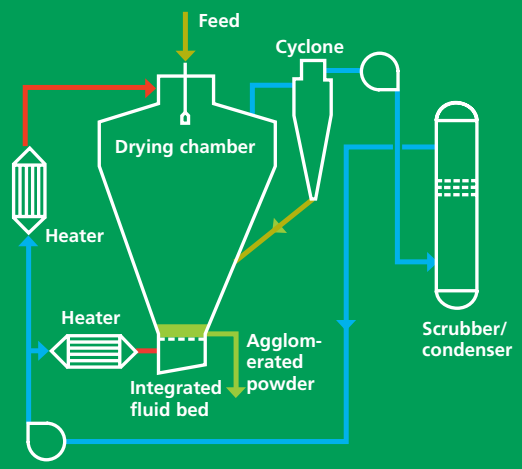
Closed cycle layouts
For solvent feeds where nitrogen is the inert drying medium that eliminates any possibility of fire or explosion due to the presence of solvent vapour in the dryer. There is complete recovery of solvent evaporated from the spray during the drying process.

Self-inertising layouts
For aqueous feeds where powders exhibit explosion characteristics in air. Direct fired heating of the drying air produces a low oxygen level in the dryer, thereby creating an inert drying medium without the need for a nitrogen source.

Open layout

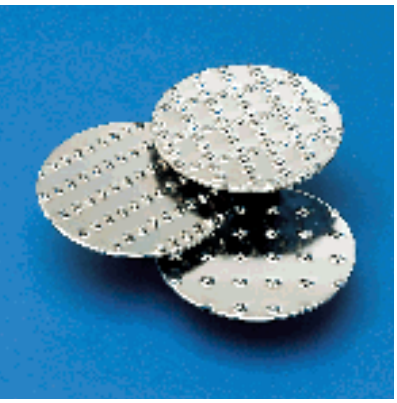


Closed cycle layout



Special Design Features

Dryer operating with either nozzle or rotary atomizer



Air distributor plates

Suppressant safety system

The success of the FSD™ is due to its flexibility of operation and to the availability of special components that meet individual processing needs.

Atomizers

- Atomizer wheels for abrasive feeds (patented).
- Oil-free rotary atomizer drives for preventing product contamination by lubricant (patented).
- Interchangeable nozzle assemblies (pressure, two-fluid) and rotary atomizers in same air disperser.

Air disperser

- For single or multi-nozzle assemblies.
- For rotary atomizer operation.
- For interchangeable atomizer modes.

Integrated fluid bed

Back-mix, plug flow design (patented) for in-place cooling and size classification of powders. Equipped with air distributor plate giving powder directional flow control. The special NON-SIFTING GILL PLATE™ (patented) further prevents powder from falling though the plate during plant operation and shutdown.

Safety

- Dryer designed to pressure shock resistant specifications.
- Suppressant systems where safety directives for vent/vent ducting are difficult to fulfil.

Integrated filters

Metallic or fabric filters, with CIP capability, mounted in the roof of the drying chamber to contain all particles inside the drying chamber and optimise droplet/dry powder mixing (patent pending).

Removable insulation

Simplifies chamber wall inspection. Prevents local condensation and gives dry wall operation. Reduces heat losses.

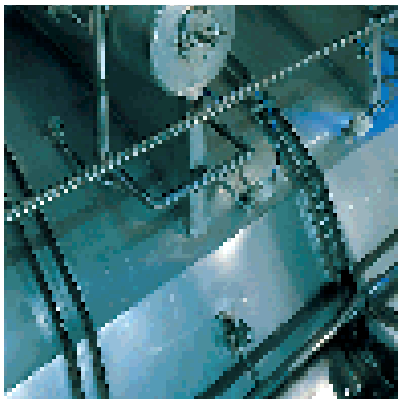
Fines return system

Fines return system recycling fines through the integrated fluid bed (patent pending) for obtaining optimum mixing effects with the air-borne particles in the drying air flow.

In-place cleaning

Washing systems for automatic cleaning of the entire plant.

Removable insulation panels on drying chamber



CIP nozzles for in-place cleaning

A new FSD™ plant supplied by Niro is designed to take advantage of the latest technology and industrial experience that has resulted from the intensive investment by Niro in systems development - an investment which has maintained Niro in the forefront of spray drying and the associated liquid and powder handling.

Product Applications

Chemicals

Detergents
Dyestuffs
Fertilisers
Inorganic and organic salts
Pesticides
Tannins

Pharmaceuticals

Analgesics
Antibiotics
Blood plasma
Enzymes
Vitamins

Polymers

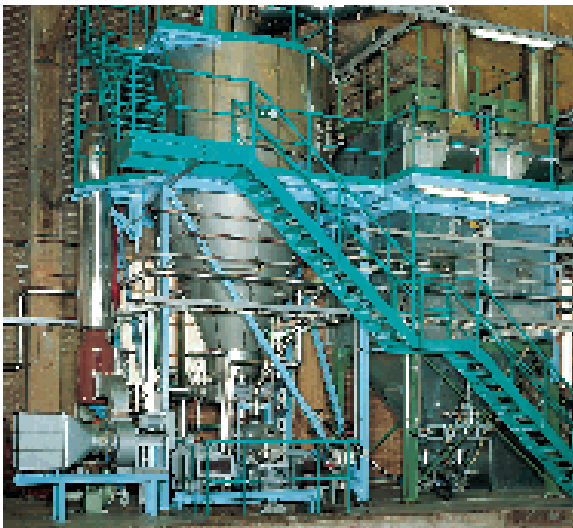
e-PVC
Styrene copolymers
UF, PF resins

Food Products

Coffee
Dairy products
Eggs
Fermentation products
Flavours
Malt extract
Maltodextrine
Soup mixes
Vegetable proteins (hydrolysed)
Yeast

Industrial and pilot plants
Niro has over 200 Fluidized Spray Dryers operating world-wide on products that range from dyestuffs to coffee, polymers to pharmaceuticals. No other spray dryer supplier can offer such experience. A most comprehensive reference list gives the best possible basis for offering customers the latest in design, engineering expertise, total project management service, and project financing.

Customer product testing facilities
Niro offers facilities in Denmark, Japan and USA for test drying of customer products on the FSD™ concept. These facilities will establish the feasibility of applying FSD technology, determine optimum process conditions, and provide product samples for market analyses.



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