

Spray Drying

NIRO is an international company specializing in the development, design and engineering of liquid and powder processing equipment for the manufacture of products in liquid, powder, granular or agglomerate form. Spray dryers and coolers, fluid bed systems, freeze concentrators, evaporators, homogenizers, membrane filtration systems, agglomerators, granulators and coating units feature in a comprehensive delivery programme marketed worldwide through an extensive network of subsidiaries and representatives.

Today's plants are designed for operational and environmental safety, featuring concepts that give the lowest energy consumption, while achieving the highest product qualities. Many of the world's leading manufactures are NIRO customers.

Substantial product and process know-how, commitment to customers, a qualified staff, and a flexible organization have been important elements in establishing a good international reputation. With this strategy the company has achieved an important world market presence with more than 7500 spray dryer installations supplied to many industries. A major objective of NIRO is not only to expand its activities through internal research and development, but also to identify and participate in the development of technology in associated fields. NIRO is a member of the GEA Group that serves the energy, environmental and process industries.

Spray dryers for the production of:

- Agro- chemicals
- Biochemicals
- Catalysts
- Ceramics
- Coffee
- Dairy products
- Detergents
- Dyestuffs
- Enzymes
- Fine/ bulk chemicals
- Flavours
- Foodstuffs
- Mineral concentrates
- Pharmaceuticals
- Polymers
- Proteins

in powder granular or agglomerate form.

Spray dryers in waste management:

- Effluents
- Sludges

Process

Spray drying is the most widely used industrial process involving particle formation and drying. It is highly suited for the continuous production of dry solids in either powder, granulate or agglomerate form from liquid feedstocks as solutions, emulsions and pumpable suspensions. Therefore, spray drying is an ideal process where the end-product must comply with precise quality standards regarding particle size distribution, residual moisture content, bulk density, and particle shape.

Spray drying involves the atomization of a liquid feedstock into a spray of droplets and contacting the droplets with hot air in a drying chamber. The sprays are produced by either rotary (wheel) or nozzle atomizers. Evaporation of moisture from the droplets and formation of dry particles proceed under controlled temperature and airflow conditions. Powder is discharged continuously from the drying chamber. Operating conditions and dryer design are selected according to the drying characteristics of the product and powder specification.

Principles

Every spray dryer consists of feed pump, atomizer, air heater, air disperser, drying chamber, and systems for exhaust air cleaning and powder recovery. Widely varying drying characteristics and quality requirements of the thousands of products spray dried determine the selection of the atomizer, the most suitable airflow pattern, and the drying chamber design.

Atomization

The formation of sprays having the required droplet size distribution is vital to any successful spray dryer. Atomization is a high technology area where Niro has played a central role in the development and use of nozzles and rotary atomizers in spray drying.

Airflow

The initial contact between spray droplets and drying air controls evaporation rates and product temperatures in the dryer. There are three modes of Contact:

Co- current

Drying air and particles move through the drying chamber in the same direction. Product temperatures on discharge from the dryer are lower than the exhaust air temperature, and hence this is an ideal mode for drying heat sensitive products. When operating with rotary atomizer, the air disperser creates a high degree of air rotation, giving uniform temperatures throughout the drying chamber. However, an alternative non- rotating airflow is often used in tower or Filtermat- type spray dryers using nozzle atomizers with equal success.

Counter- current

Drying air and particles move through the drying chamber in opposite directions. This mode is suitable for products, which require a degree of heat treatment during drying. The temperature of the powder leaving the dryer is usually higher than the exhaust air temperatures.

Mixed flow

Particle movement through the drying chamber experiences both co- current and counter- current phases. This mode is suitable for heat stable products where coarse powder requirements necessitate the use of nozzle atomizers, spraying upwards into an incoming airflow, or for heat sensitive products where the atomizer sprays droplets downwards towards an integrated fluid bed and the air inlet and outlet are located at the top of the drying chamber.

Spray Dryer Chamber Design

As drying characteristics and product specifications vary from product to product, there is no one spray drying chamber design suitable for all applications. By offering a full range of designs, NIRO impartially selects the most suitable type of plant.

Spray Drying Systems

The essential elements of the spray dryer: atomizer, air disperser, drying chamber, inlet and exhaust air handling are combined into a system that meets individual operational safety, environmental protection, and powder handling requirements. All systems can be provided with post- treatment equipment: fluid bed dryer/cooler, agglomerator, de-duster and conveyor.

Open

Featuring once- through airflow with exhaust to atmosphere. The majority of industrial spray dryers handles aqueous feedstocks and uses this system. Both direct and indirect airheating are applicable. Exhaust air cleaning in cyclones, bag filters, electrostatic precipitators, and scrubbers.

Closed cycle

Featuring drying in an inert gas atmosphere where nitrogen recycles within the dryer. This system must be used for the sprat drying of feedstocks containing organic solvents or where the product must not contact oxygen during drying. Closed cycle plants are gas and powder tight, and are designed to the strictest safety standards. The inflammable solvent vapours are fully recovered in liquid form.

Semi-closed cycle

Featuring either the partial recycle mode (recycle of up to 60% of the exhaust air as inlet air to the dryer, for effective waste heat utilization) or the self- inertizing mode, where direct air heating and a minimal air bleed create the low oxygen atmosphere necessary for drying aqueous feedstocks that form explosive powder-air-mixtures. If **odour** is generated during drying, the small volumes of air vented from the system can be effectively and economically incinerated.

Aseptic

Featuring sterile feed atomization and air filtering systems. These dryers are used where any form of powder contamination must be avoided. They are fabricated to special standards of finish and operate under a slight pressure. Fully automatic cleaning and sterilization systems are available. Plant layout is integrated with the laminar flow packing room.

Features to meet special design specifications

Air dispersers for rotary and nozzle atomizer assemblies

Pressure shock resistant drying chambers with venting or suppression for explosion protection

Semi- or fully automatic cleaning systems (CIP)

Components designed to international sanitary standards

Conventional or computerized control systems

Air/air or air/liquid/air waste heat recovery units

Air- broom and air-sweep attachments for drying chamber

Noise attenuation of components

Weatherproof finish for outdoor installations

Rotary atomizers with inert gas purging

Semi- or fully automatic solvent cleaning systems

Gas tight: package plant test erected prior to shipment

Available with cyclones or bag filters

Condenser systems to $\pm 30^\circ$.

Atomizers

Three types of atomizers are used in industrial drying:

Rotary

Atomization by centrifugal energy

Pressure nozzle

Atomization by pressure energy

Two-fluid nozzle

Atomization by kinetic energy

The choice of atomizer depends upon the properties of the feed and dried product specification. In cases where more than one atomizer type is suitable, the rotary atomizer is generally preferred due to its greater flexibility and ease of operation. The advantages include:

Handling of high feed rates without need for atomizer duplication

Handling of abrasive feeds

No blockage problems

Low pressure feed system

Ease of droplet size control through wheel speed adjustment

NIRO offers a range of rotary atomizers, including the world's largest, covering feed rates up to 200t/h and power requirements up to 800kW.

Spray Dryers for Industrial Production

Pharmaceutical Industry

Pharmaceuticals in powder or agglomerate form:

Analgesics Antibiotics

Enzymes

Plasma/plasma substitutes

Vaccines

Vitamins

Yeasts

Spray dryers designed specially for integration into batch or continuous operations under sanitary or aseptic conditions. Systems also available for taste masking and encapsulation. Dryers with integrated fluid beds are ideal for producing non-dusty powders for perfect tableting.

Other equipment supplied to the pharmaceutical processing industries includes fluid bed tablet coaters, granulators and dryers, microwave dryers, concentrators (thermal/freeze), homogenizers and powder blenders.

Food and Dairy Industry

Foodstuffs and dairy products in powder or agglomerate form:

Baby food

Cheese/ whey products

Coconut milk

Coffee/ coffee substitutes

Coffee whitener

Eggs
Flavours
Maltodextrine
Mild
Soup mixes
Soy- based food
Spices/ herb extracts
Sugar-based food
Tea
Tomato
Vegetable protein

Spray drying is ideal for these heat sensitive products, where selection of system and operation is the key to high nutritive and quality powders of precise specification. "Instant", highly soluble powders are a speciality of spray dryers featuring integrated belts or fluid beds. All components in contact with product comply with hygienic processing standards. Today's plants have special sanitary features, automatic cleaning (CIP) and bagging-off systems.

Associated equipment includes agglomerators, evaporators, freeze concentrators, homogenizers, lecithination units and powder blenders.

Complete processing lines for instant coffee, coconut milk, baby food and dairy products are part of the NIRO delivery programme.

Chemical Industry

Speciality chemicals:

Catalysts
Detergents
Dyestuffs
Fine organic/inorganic chemicals

Agro- chemicals

Chelates
Fungicides
Herbicides
Insecticides

Spray dryers for the chemical industries produce a variety of powdered, granulated and agglomerated products in systems that minimize formation of gaseous, particulate and liquid effluents.

High efficiency scrubber systems and high performance bag filters prevent powder emission, while recycle systems eliminate problems of handling solvents, product toxicity, and fire explosion risks. Special component designs (e.g. atomizers) are available for abrasive and corrosive feedstocks. High thermal efficiencies, low maintenance costs, full environmental protection, computerized control, dust-free working area are some of the features of today's spray dryers.

Polymer Industry

ABS
e-PVC
PMMA

UF/MF resins

Polymer dispersions and solutions in water or organic solvents are spray dried under closely controlled operating conditions, producing powders to precise particle size, heat treatment, and redispersibility specifications. Low softening point products are produced continuously in plants with air-brooms, air-sweeps or integrated fluid beds. For drying moist polymer powders, NIEO offers fluid beds.

Ceramic Industry

Advanced ceramic formulations

Carbides

Ferrites

Nitrides

Oxides

Silicates

Steatites

Titanates

Spray drying is applicable to tile and electronic press powders, and plays an important role in the industrial development of high performance (advanced) ceramics. The ability to meet particle size distribution requirements, produce a spherical particle form, and handle abrasive feedstocks is an important reason for the widespread use of spray dryers in the ceramic industries.

Spray dryers for testing and small scale industrial production

- comprehensive range of series produced and package units available

The MOBILE MINOR™ is the smallest unit for in-house research and development projects. Plant configurations for aseptic production or closed cycle drying of feeds containing organic solvent are available.

The PRODUCTION MINOR™ and the larger 6.3 spray dryers offer a choice of atomizers, heating systems and powder discharge. Closed cycle versions are custom made.

The Fluidized Spray Dryer – FSD™ - with integrated fluid bed and with or without integrated filters – and the FILTERMAT®

Spray dryer with integrated belt produce dustless and agglomerated powders representative of powders processed on large industrial scale dryers.

All industrial size package units have a fixed layout and are supplied complete with supporting structure. Available with rotary or nozzle atomizers, cyclones, exhaust air filters or scrubbers. A range of package closed cycle plants is also available.

Service to Industry

Product testing and process evaluation

Design and engineering

Plant delivery, erection and commissioning

Establishing a close collaboration with customers secures successful spray dryer operation in the shortest possible time.

Product testing and process evaluation

Pilot plant test facilities with accompanying analytical laboratories are available in Brazil, Denmark, United Kingdom, Mexico and USA for establishing the feasibility of

using NIRO equipment, optimizing process conditions and providing samples for market analyses.

Design and engineering

With process data confirmed during testwork, the spray dryer is specified and designed based upon the latest technology and industrial experience. The most modern design aids are used. Operation and maintenance manuals are individually prepared for each project.

Fabrication

Components are fabricated by selected subsuppliers, whereas rotary atomizers are manufactured in Niro's own workshop.

Plant delivery, erection, and commissioning

Punctuality of delivery is essential to today's business, and Niro is known for plant delivery on time. Responsibility for total plant erection is accepted, and site erection supervision can be supplied. The company's own engineers are present during the commissioning phase.

A round-the-clock spare parts service is maintained.