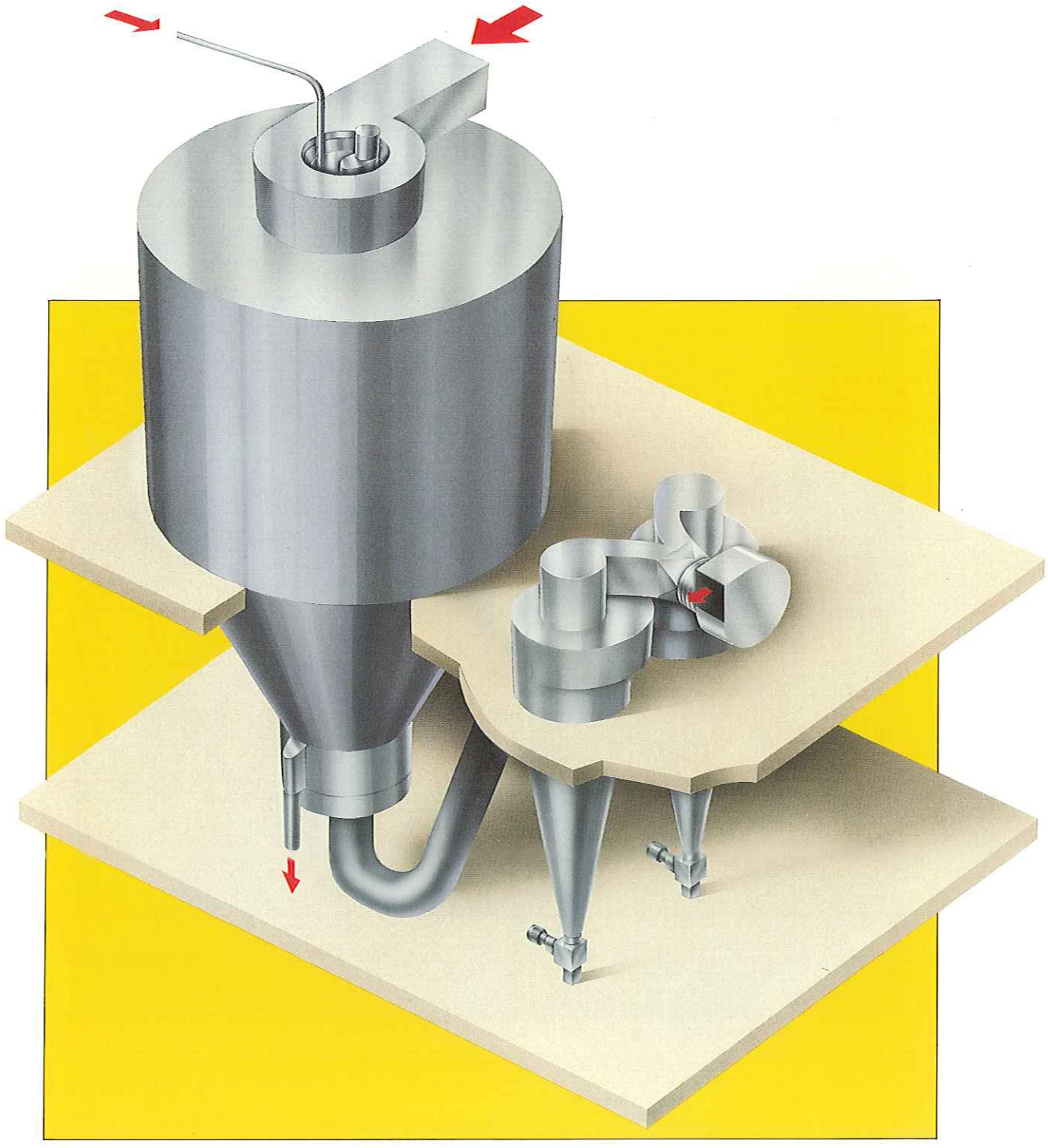
APV

Spray Drying

The continuous way to make powders from solutions, emulsions and slurries



The many uses of spray drying technology

Spray drying is recognized as one of the best methods of drying solutions, emulsions, and slurries. The spray drying process is a continuous operation in which almost any pumpable liquid can be converted into a free-flowing powder in a few seconds.

Heat-sensitive products

Because of the very short residence time, the spray drying method is applicable to heat-sensitive products which have to meet very high powder quality demands.
Most dairy and food products require special heat conditions in order to retain valuable nutrients and flavours. Also the chemical industries use spray dryers for a great variety of heat-sensitive products, for example organic chemicals and pharmaceutical products.

Low-cost production

The spray dryer is also chosen for the processing of bulk chemicals, where the main reason for choosing this drying system is the high quality obtained at favourable production costs.

Environment protection

Spray drying is widely used in today's demanding environment protection. Many waste products which were previously causing damage to the environment are now being spray dried and profitably used for various purposes. Examples are whey from the dairy industry and sulphite lye from the pulp and paper industry.
Closed-circuit plants featuring very low emission levels are applied in the drying of materials containing organic solvents or materials of toxic nature.

Dry flue gas desulfurization

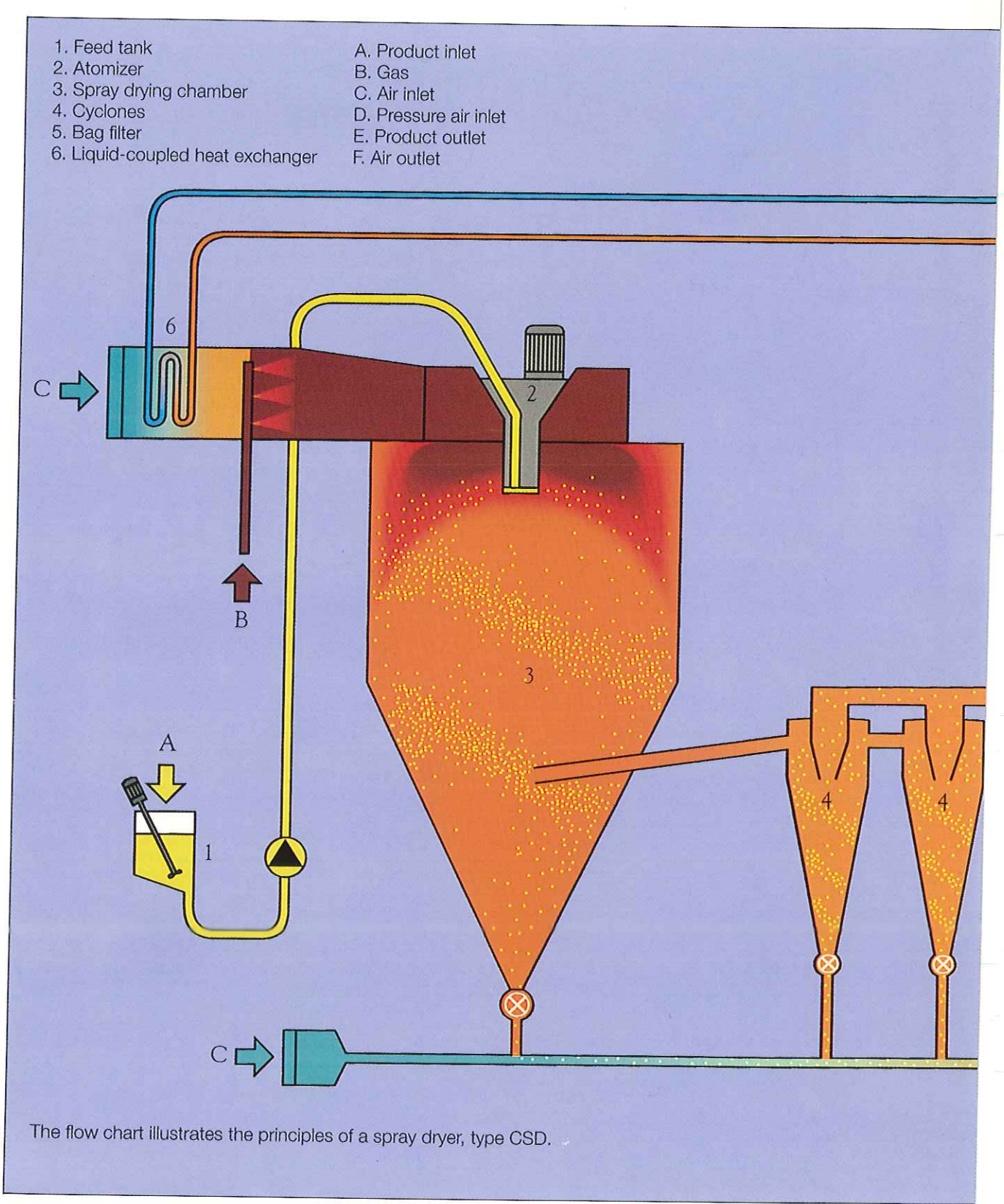
In the case of removal of gaseous pollutants (SO_2) in flue gases exhausted from coal-fired power plants, the spray drying technology is applied in an absorption process.
In this case the spray dryer offers optimum conditions for a chemical reaction, converting the gaseous pollutants to a dry material.

Powder characteristics

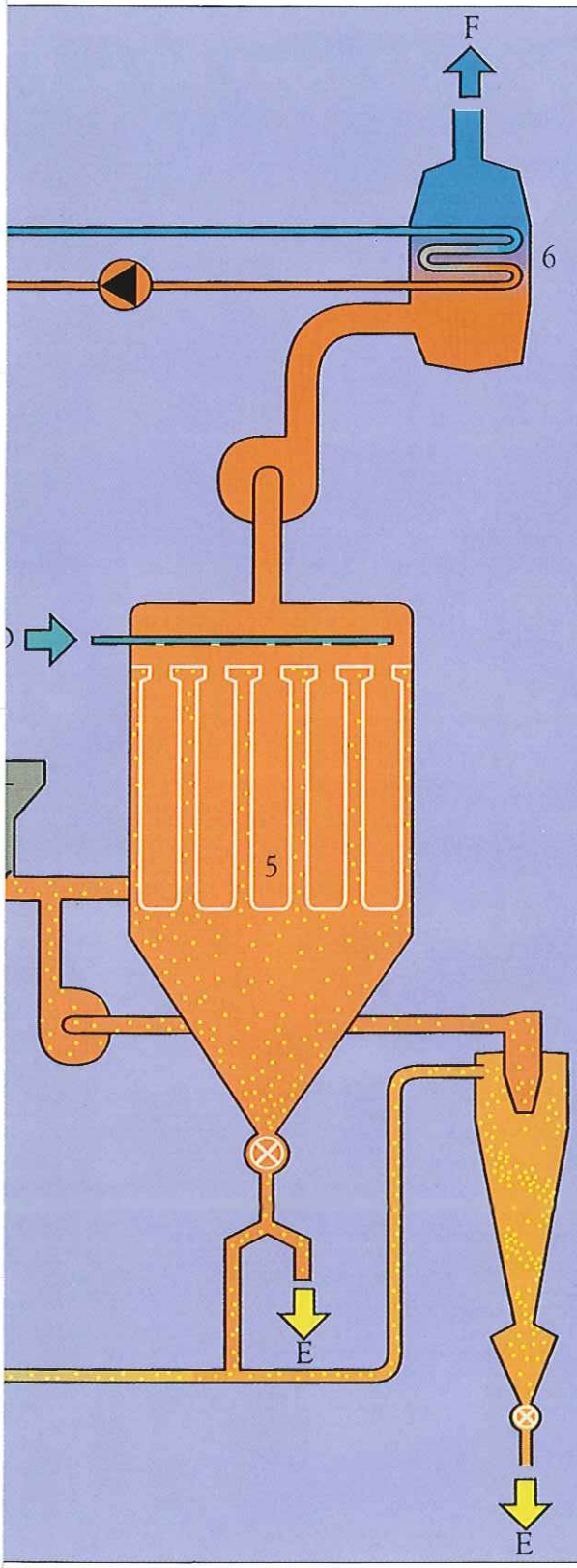
The dryer configuration has great influence on the structure of the powder, and special characteristics can be obtained by means of special design features. Furthermore, the drying temperature is a decisive factor being adjusted to suit the product in question. A spray drying plant is designed on the basis of product requirements, pilot plant test work, and many years of experience.
The standardization of components by means of computer-aided design has made it possible to supply special plants, providing our client with an optimized process both in regard to capital investment, operating costs, and powder quality.

Flexible drying plants

Today it is possible to use a spray drying plant for many different products. The selection of plant configuration as well as the adjustment of various operating parameters on any particular drying operation, such as atomizer type, temperature range, residence time, etc, ensure flexibility to optimize the drying process in each individual case.
One of the latest results of our attempts to design flexible spray dryers for high-quality powder production is the development of the spray dryer with internal fluid bed type 2CSD. As shown on the opposite page, it consists of a spray dryer with a static fluid bed integrated in the conical bottom of the drying chamber.
This spray dryer type is used for the processing of a great variety of products, and it has proved very successful for the production of agglomerated powders.
The addition of an integrated fluid bed in the spray drying process will not mean extra space requirements. An existing spray dryer can be modified and made suitable for today's needs quite easily; and the result is a more flexible plant with lower energy consumption.



The flow chart illustrates the principles of a spray dryer, type CSD.



The principle behind the process

Drying is achieved by spraying the feed product into the hot drying air in the drying chamber. The hot air provides the necessary heat for evaporation, which takes place almost instantaneously due to the very large liquid surface created by the atomization.

Prior to the drying process, the feed can be preheated, resulting in better drying economy. After preheating, the feed is led to a disc or nozzle atomizer and dispersed into the drying chamber as a fine mist. Here the droplets are brought into contact with the drying air in a co-current or mixed air flow. The resulting powder is taken out at the bottom of the chamber and conveyed for further handling, storage and packing.

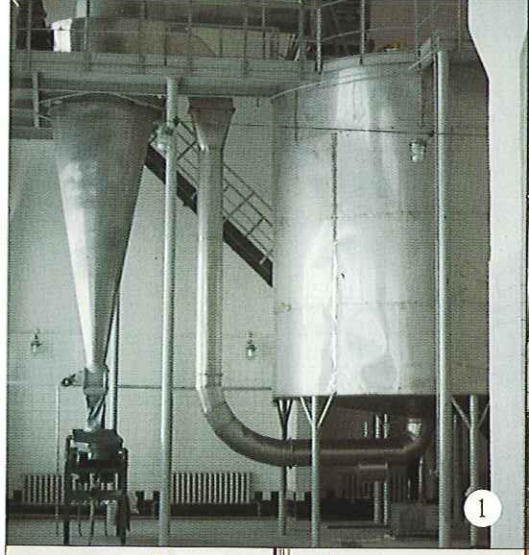
The spent drying air containing powder is cleaned in highly efficient cyclones. In many cases the air is further cleaned in a bag filter or a wet scrubber.

The energy contained in the spent drying air can be used for preheating the incoming air, the feed to the spray dryer, or for other heating purposes.

In cases where the main powder is discharged directly from the chamber bottom, the fines contained in the drying air are discharged from the cyclones and can be mixed with the main powder, discharged separately, or they can be returned to the drying process, in which case they will agglomerate with the particles being dried.

After the drying process, the powder can be cooled, for instance in an external, vibrating fluid bed or in a pneumatic cooling/conveying system. The cooled powder is ready for packing or it can be stored in silos.

The entire process is automatically controlled for example by microprocessors, monitoring all the important operational parameters.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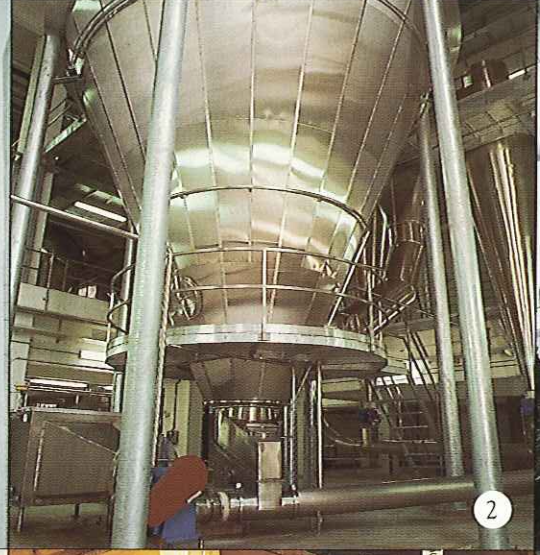
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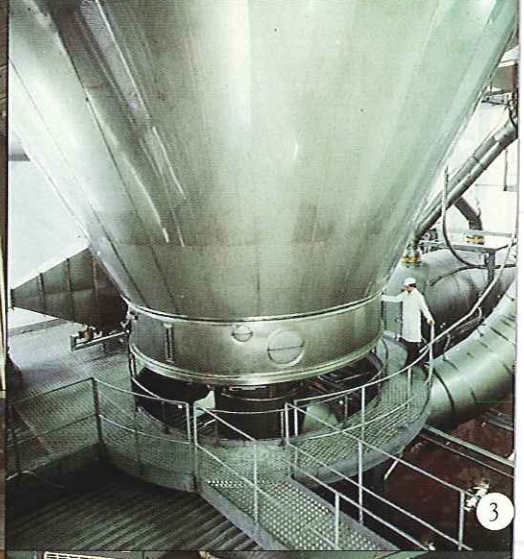
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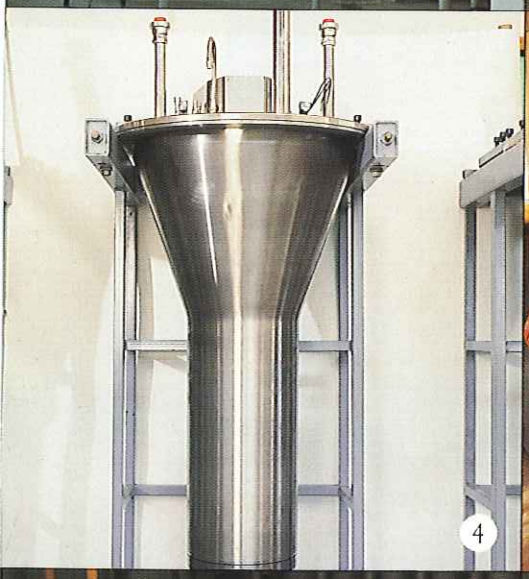
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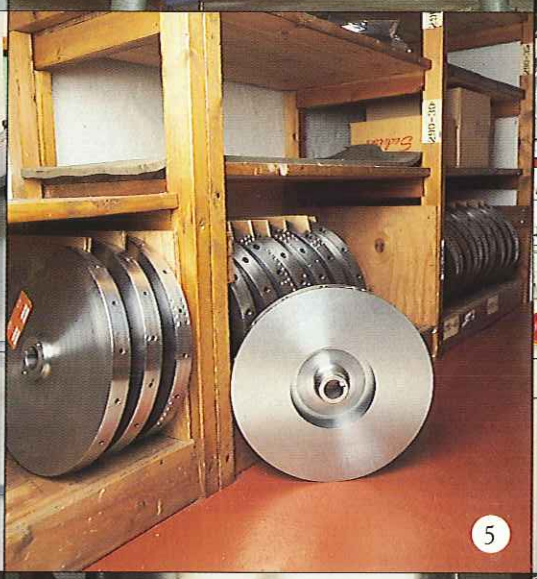
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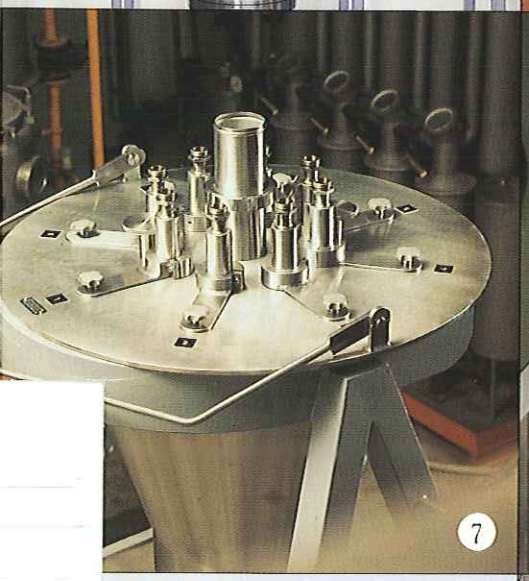
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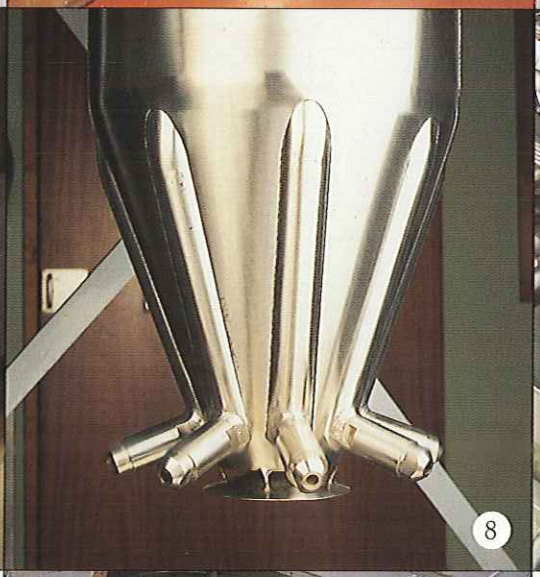
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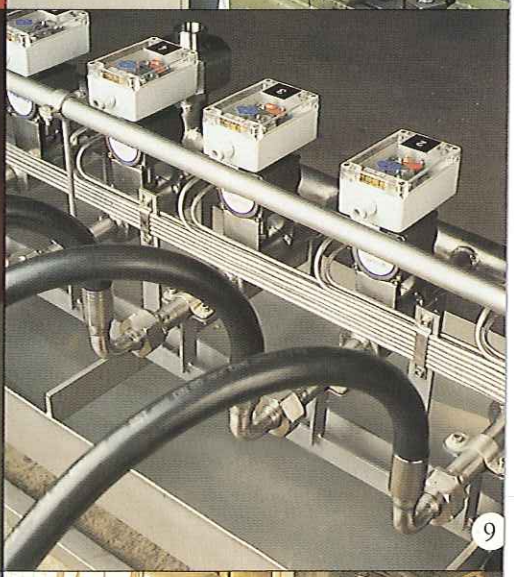
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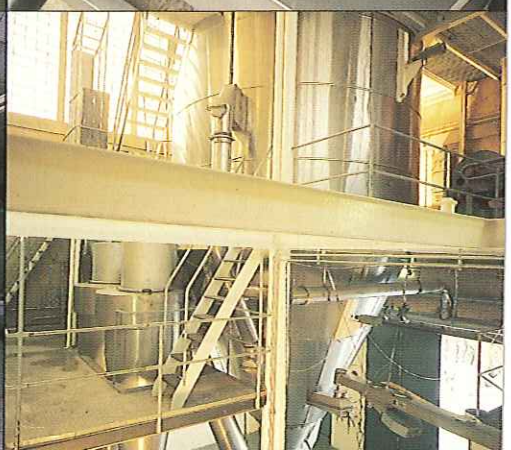


Design characteristics

Drying chamber (1-3)

The drying chamber is designed with a flat bottom and a pneumatic powder collector (1) type FBSD or with a conical bottom (2) type CSD. The conical bottom can be equipped with an internal fluid bed dryer (3) type 3CSD.
The flat-bottom design allows low building height, facilitates cleaning, and the pneumatic powder removal ensures short and defined residence time in the chamber.
In spray dryers type CSD the powder leaves the chamber under gravity. The conical bottom is often connected to a secondary dryer, for example an internal fluid bed or an external fluid bed. This means that both after-drying and cooling can take place without any intermediate handling of the powder.
An air distributor is placed at the top of the drying chamber ensuring ideal air distribution for co-current or mixed air-flow drying. The air distribution has a very important function, and it has been optimized during the experience of many years.
The drying chamber can be equipped with wall-sweeping devices preventing powder deposits on the walls.

Atomizer (4-9)

Correct atomization is the key to the spray drying process, and the atomizer design has great influence on the final powder structure.
Often, spray dryers are equipped with high-speed, centrifugal atomizers of various sizes (4). For some duties single or two-fluid nozzle atomizers (7-8-9) will be recommended.
Today's atomizers are characterized by long service life, very steady operation and easy access to replaceable parts, which means that adjustment and maintenance of the atomizer can take place at a minimum of time. Centrifugal atomizers also feature automatic bearing supervision and lubrication.
All parts of an atomizer are carefully tested before assembly, using electronic test equipment. For example the balancing of the atomizer wheel (5) is a critical operation which takes place both statically and dynamically (6).

Air heater (10)

For heating the drying air, spray dryers are equipped with steam heaters, thermal oil heaters, electric heaters, indirect oil or gas-fired air heaters, or direct oil or gas-fired air heaters.
Exhaust gas from indirect fired air heaters can be utilized for preheating.
The air heater in fig. 10 is an indirect gas-fired heater with a capacity of 1,200 kW/h.

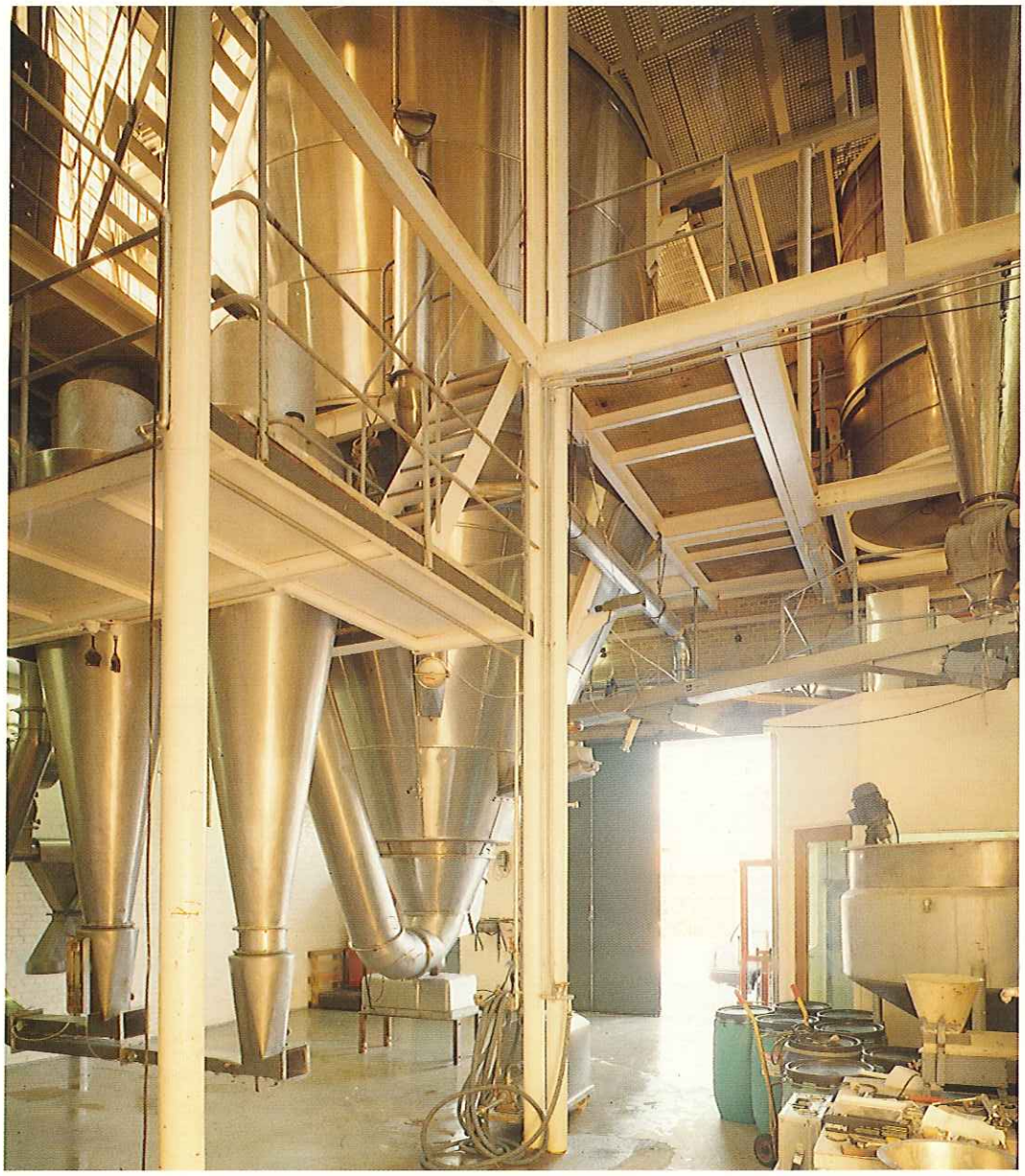
Protection against dust explosions (11)

Various equipment and special plants are available for prevention or control of fire and dust explosions in connection with drying of combustible products.
The low-ox drying system in fig. 11 is characterized by being self-supplying with inert drying medium consisting of exhaust gas from a direct gas-fired air heater.
Closed-circuit plants are characterized by being almost totally enclosed. The drying medium is an inert gas, and such plants are used for drying of materials dissolved in organic solvents.
The drying chamber can be provided with fire extinguishing nozzles and pressure relief vents*) or explosion suppression equipment.

Test facilities (12)

In order to optimize the spray drying process for each individual project, the dryer configuration is based on extensive test and research work at our test facilities in Copenhagen. A full range of drying and evaporation equipment is available. Tests can be conducted on small laboratory plants or full-scale production plants.
We have the world's largest test spray dryer with water evaporation capacities ranging from 400 to 1000 kg/h (12). The flexibility of this plant, for example, means that it is possible to build in an internal fluid bed at the chamber bottom.

*)Tested and approved by Ciba Geigy, Switzerland.



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