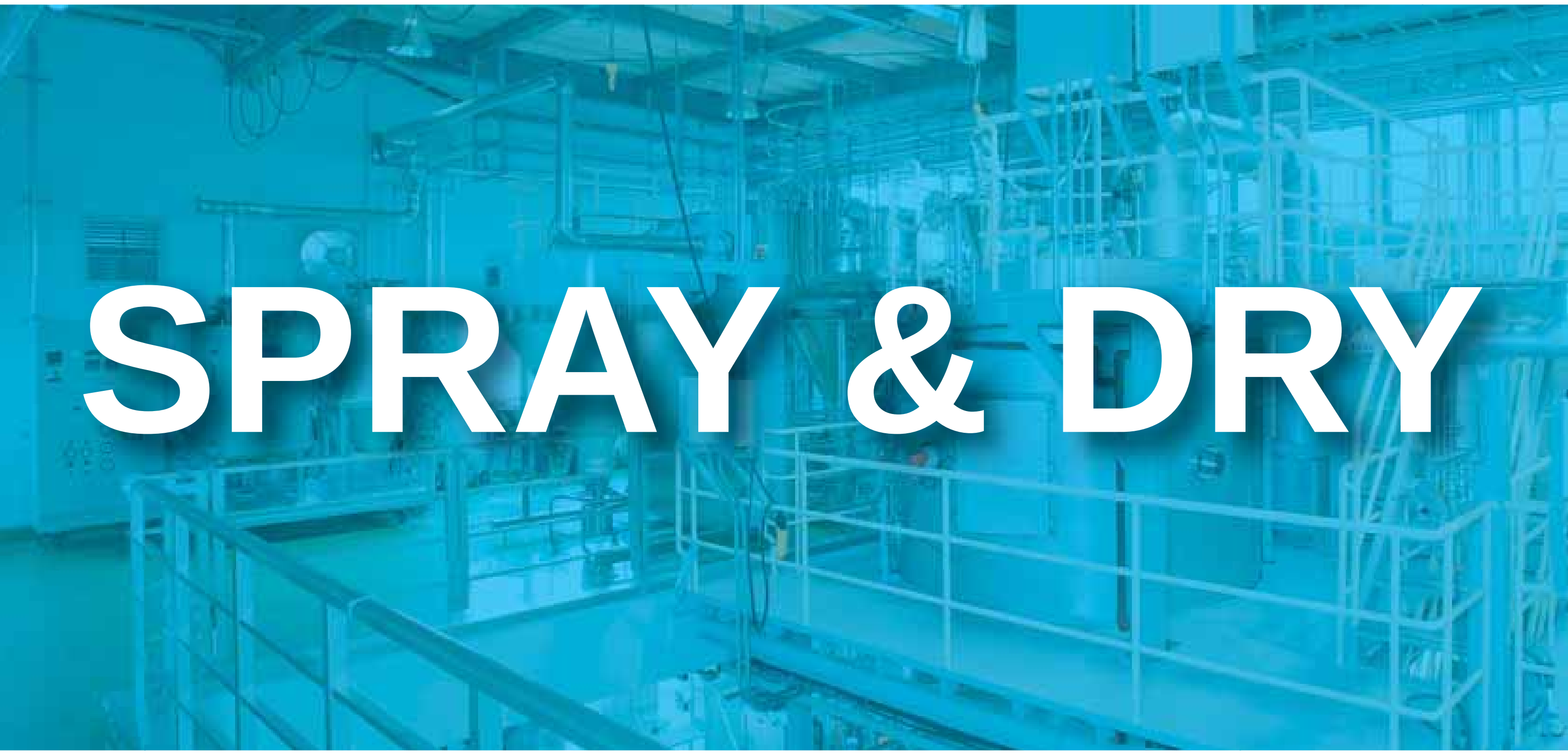
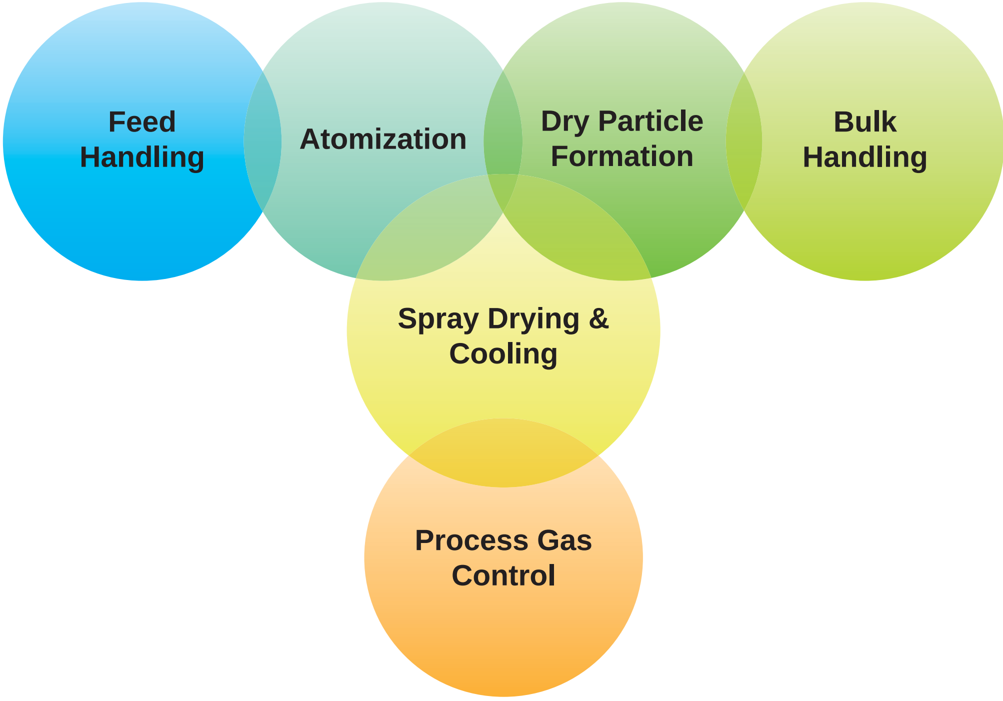


Ohkawara Kakohki Co., Ltd.
Spray Drying Systems
Yokohama Japan

Ohkawara Kakohki Engineering

Ohkawara Kakohki is specialist for *Spray Drying* and *Spray Cooling*, *Fluidized Bed Granulation* and *Exhaust Gas Treatment* in any scale.

The production of tailor-made bulk materials from various liquid feeds is an integral part of miscellaneous processes and industries. On this account, as leading industry supplier and service provider, we always demand ourselves to maintain and continuously expand our know-how in all the related fields of engineering:



Background

In 1980, Okawara MFG Co., Ltd. - a leading manufacturer of industrial drying equipment - founded Ohkawara Kakohki Co., Ltd. (Ohkawara Process Design and Equipment Corporation) as an independent subsidiary.

Initially meant for engineering a wide variety of drying machinery, Ohkawara Kakohki soon focused on spray drying, as this technology turned out to be outstandingly suitable for direct powder property control.

Development Booth & Headquarters

On this account, in 1983, a fully equipped spray drying laboratory was set up, which quickly developed to be the key facility for spray dryer and powder development in Greater Asia and beyond.

M. Ohkawara, CEO

To date, Ohkawara Kakohki has evolved to a world-wide operating company, located in Yokohama, the lively international heart of Japan's main island. We are specialized in development and production of innovative spray dryer plants in both, laboratory-scale and small to large industrial-scale.

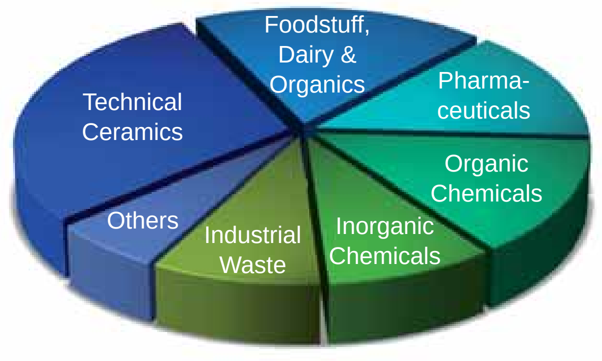
For supplying suitable equipment for any application and any type of feed, we can benefit from our big wealth of experience, covering more than 1800 completed spray drying setups all around the world.

Two subsidiaries in the People's Republic of China were founded in the years 1996 - Shanghai Ohkawara Spray Dryers Co., Ltd. and in 2002 - Ohkawara Powdertech (Suzhou) Co., Ltd.

In 2008 Ohkawara Kakohki's laboratory was relocated and relaunched as the Spray & Dry Factory SDF, a full-sized service facility for test drying, powder property validation, up-scaling and short-term production.

In 2009 Ohkawara subsequently moved into new headquarters, built at the location of the former laboratories.

Customer Market Portfolio



Head Office Key Data

- Established in 1980 in Yokohama city
- Subsidiary of Okawara Manufacturing (general drying equipment manufacturer)
- 80 employees at the Japanese head-quartes, ca. 355 employees in total
- 88 million Japanese Yen capital, joint-stock company

ISO-Certification

Concerning the development, design, production and installation work management Ohkawara Kakohki provides in-house documentation, implementation, maintenance and continual improvement of effectiveness, conforming to the ISO 9001 quality management system requirements.

We are also well aware of the global environmental impact of all activities related to spray dryers and spray coolers. Therefore also the ISO 14001 environmental management sys-tem was introduced in the year 2004.

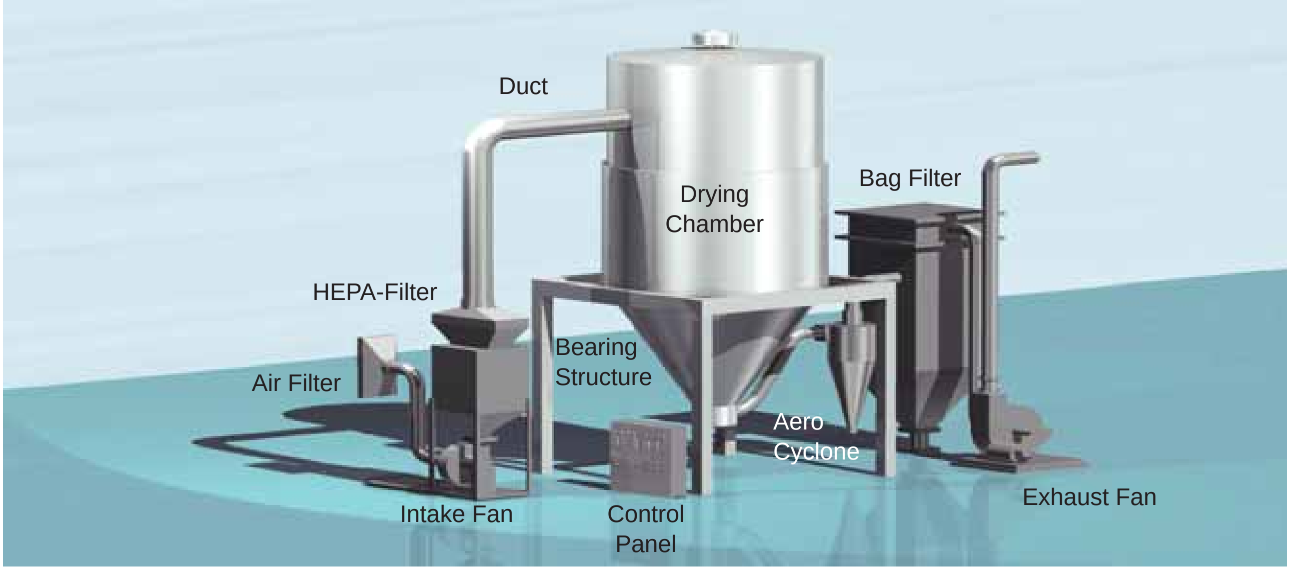
NOTE:Exporting spray dryers may require an export permit from the Minister of Economy, Trade and Industry of Japan.

Spray Drying - Mode of Operation

In terms of particle size control and consistency, spray drying is the most dependable process for producing dry powders from any type of liquid solution or slurry feed.

In a basic spray dryer, the feed is dispersed into a mist of fine droplets either by means of a rotary disc atomizer or a spray nozzle. This spray mist is distributed into a cylindrical drying chamber along with a stream of hot gas and typically blown dry within a split second.

After remaining in the chamber for a certain residence time - for further reduction of the residual moisture, the generated dry powders are separated from the gas flow either directly at the base point of the chamber or via downstream aero cyclones and bag filters.



Versatile Atomizers

Spray dryers can feature various atomizers for any type of feed or desired powder properties:

rotary discs of different shapes and materials, single fluid pressure nozzles, two-fluid nozzles, in-line intermixing nozzles, ultrasonic nebuli-zers and many more.

Consistency

In general, the particle size distribution of the acquired powders is sharp and consistent, due to easy control and reproducibility of the drying properties.

Spray dried powders exhibit high flowability, high solubility and dispersibility, allowing for facile transport, storage and subsequent processing.

No Heat Deterioration

On account of the comparably high drying speed and the short residence times, even heat-sensitive materials such as pharmaceuti-cals or foodstuff and dairy may be dried without difficulty using spray dryers.

If a rather slow rise in temperature of the spray mist droplets is required, also counter-current flow systems are feasible.

High Purity & Easy Cleaning

Cleaning of all spray dryer components is stra-ightforward and can be completed in just a short amount of time. Impurities and cross-con-taminations can be avoided reliably.

Automated WIP, CIP and SIP systems can be applied to spray dryers without difficulty.

Inflammable Solvents

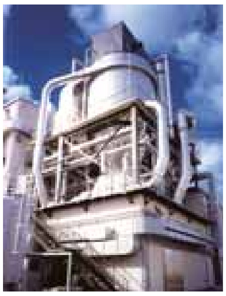
For water-based feeds the drying media is filtered air in an open system. For inflammable or in any other way hazardous feeds, nitrogen in a closed loop dryer is used. This way, also all solvent is reco-vered and may be reused.

Products - Predesigned Dryers & Custom-Made Setups

All our hardware products are available either as economically priced predesigned models or as custom-engineered plants. For both, a wide range of options and modifications is on offer.

Clean Room
Cosed System

Laboratory Scale
Pilot Dryer



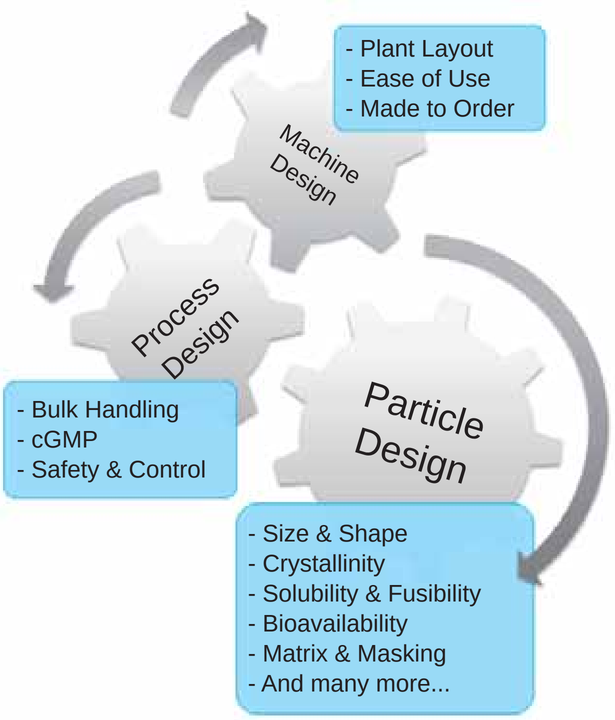
Open System
Drying Plant

Fluidized Bed
Powder Cooler

Spray Cooling
Tower

We offer...

Spray drying related engineering and its akin processes are not limited to mere solvent evaporation. Whenever talking about bulk products, it is essential to keep all aspects of the entire production process in mind. Approaching from bottom up the desired powder properties lead the way to our services:



...Development

Furthermore, you are welcome to make use of our facilities in order to perform feasibility studies, develop the required powder properties or carry out upscaling tests.

...Customer Advisory Service

Our international sales department staff will be happy to answer all your questions.

Whether you need a basic quotation or some advice on which machine would fit best to your requirements profile - please do not hesitate to contact us.

...Testing and...

The most suitable drying conditions such as the choice of the right atomizing method, the in- and outlet temperatures of the gas, the residual product moisture, confirmation of all mass flows and the resulting particle size distribution can be determined for you in our own laboratory any time.

...Project Planning & Manufacturing

From the early stages of quotation until start of operation and beyond, it will be our pleasure to provide you with all information required for your project planning team. Independent from the project scale, detail design, manufacturing and delivery can be carried out with regard to your needs and schedule.

...Commissioning & After Service

After accomplishing the final quality controls, test runs and operational training, the setup is handed over. Of course, we will always be available for your questions and maintenance issues thereafter.

Spray & Dry Factory

The newly established Ohkawara Spray & Dry Factory submontane of the world famous Mount Fuji provides our entire range of atomizing, spray drying & cooling, agglomeration and other particle design technology. With its dedicated foodstuff area, it also meets all purity requirements for powders meant for consumption.

Being an open laboratory and short-term production facility in one, the SDF welcomes you to optimize your product's particle properties, confirm the specifications of the projected machinery, verify an entire manufacturing process or have complete batches of your feed material processed.

Laboratory

The lab facilities contain all types of our ready-to-use machinery for assays and small-scale processing.

The SDF is capable of handling, dairies, technical ceramics, all kinds of chemicals and pharmaceuticals in aqueous, chlorous and organic solvents.

Foodstuff Area

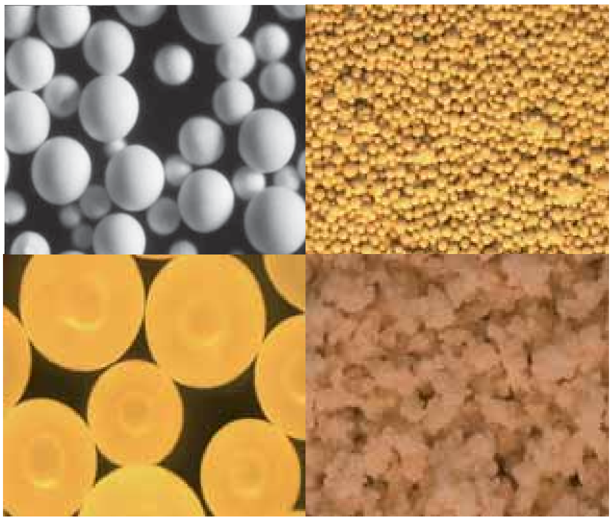
This isolated area for any type of groceries contains another two production-scale dryers with a water evaporation capacity of up to 50 kg/h each.

Machine Hall

For up-scaling tests and industrial batch-drying the machine hall features several medium sized multi-atomizer dryers with water evaporation capacities up to 120 kg per hour.

Powder Analysis

Besides making use of all common methods for characterizing the produced powders, analysis is additionally performed with state-of-the art analysis like laser diffraction and computer- and electron-microscopy.



Waste Treatment

All waste materials and effluents are collected in a central tank, spray dried and forwarded to specialized handling facilities as powders.

Atomization

The atomizer of a spray dryer distributes the feed liquid to a mist of fine droplets with a high surface to volume ratio - essential for fast, accurate and gentle drying. Its design strongly influences the final product properties in terms of particle size & size distribution, shape, porosity, flowability and many more.

The Ohkawara rotary disc and spray nozzle atomizers can easily cover all types of feeds at flow rates from less than one kilogram up to several tons per hour and allow for dependable reproducibility and easy up-scaling. Feasible droplet sizes range from one single up to hundreds of microns in diameter.

Rotary Discs

This type of atomizer uses a vaned, serrated or perforated disc rotating at high speeds. The centrifugal energy provided by means of an electric motor or an air turbine drive translates into formation of a fine horizontal droplet spray.

With rotary disc atomizers also highly viscous and abrasive feeds or feeds with very high solid content may be processed while always maintaining easy control and a homogenoeus spray. At present Ohkawara rotary disc atomizers are available in capacities up to 12 t/h.

Rotary Atomizer Units

M-Disc (patent)

Kessner Disc

Nozzle Vane Disc

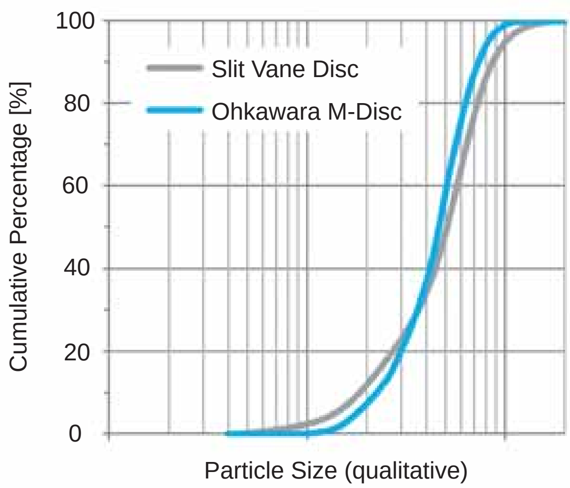
Slit Vane Disc

M-Disc

The curved teeth of the unique M-disc cause the feed liquid film to form a layer of uniform thickness over the entire height of the disc.

This results in an remarkably sharp droplet size and therefore sharp particle size distribution, compared to other disc types.

Narrow distribution of the atomized droplets will not only result in perfect flowability of the acquired powders, but also increase your overall yield.



Spray Nozzles

By comparison, nozzles convert pressure energy provided by the feed pump into kinetic energy resulting in single droplets. With exchangeable orifices nozzles can be adjusted to various operational conditions. Nozzles permit multiple atomizers in one single chamber and can therefore also cover largest capacities.


Standard Pressure Nozzle


Two-fluid Nozzle


Air-Assisted Pressure Nozzle (patent)

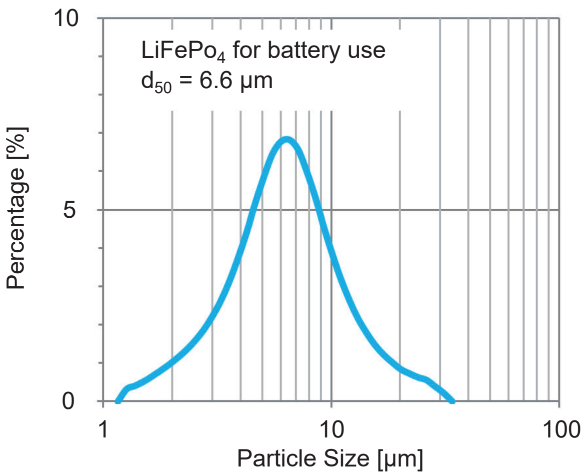

TwinJet Nozzle RJ (patent)


TwinJet Nozzle TJ (patent)

TwinJet Nozzles

The newly developed RJ- and TJ-series TwinJet spray Nozzles cover the operating range of ultra-fine particles (single micrometer range) at both - low (RJ from 1 to 25 kg/h) and high (TJ from 25 kg/h to 1 t/h) feed rates in a single nozzle setup.

Their patented two-step atomizing technology, using pressurized air to break the surface tension of the liquid, extends the working range to particle diameters unrivaled by conventional spray nozzles or rotary disc atomizers.



Operating Ranges

	Rotary Atomizer	Standard Nozzle	2-Fluid Nozzle	Pressurized 2-Fluid Nozzle	TwinJet Nozzle
Control via	Motor speed	Feed pressure	Air pressure	Feed and air pressure	Air pressure
Particle Size Range (ca.)	30 - 150 µm	70 - 500 µm	10 - 80 µm	50 - 500 µm	1 - 20 µm
Feed Capacity (per unit)	1 kg/h - 12 t/h	50 kg/h - 1 t/h	1 - 100 kg/h	50 kg/h - 1 t/h	1 kg/h - 1 t/h
Flow	Co-current	Co-current Counter-current Mixed-flow	Co-current Counter-current Mixed-flow	Co-current Counter-current Mixed-flow	Co-current

Custom-Tailored Systems

Laboratory use, medium-scale production and large industrial open and closed spray dryers, open and closed spray coolers, fluidized bed systems, exhaust gas coolers and treatment equipment, modifications of all Ohkawara basic model series on customer request. Please do not hesitate to contact us for your special inquiry.

Typical Temperatures	Spray Dryers: inlet 150 up to 450 °C, outlet 80 to 100 °C Spray Coolers: inlet 0 to 20 °C, outlet 50 to 80 °C Exhaust Gas Coolers, Special Applications: inlet up to 1000 °C
Solvent Evaporation Capacities	1 kg/h to several tons per hour
Chamber Diameters	300 mm to 10 m
Heater Types	Electric, steam, gas or oil fired (direct and indirect), combined
Standard Atomizer	Various rotary atomizers, 2-fluid nozzles, pressure nozzles, TwinJet nozzle, Pulse Jet atomizers
Powder Collection	Blow-down, take-up, aero cyclones, bag filters, wet scrubbers
Options	Any

L/OC Series

Basic open dryer systems for water-based foodstuff, non-hazar dous chemicals, pharmaceuticals and many other feeds. Featuring a HEPA-filter downstream the heater by default, high product purity is always assured.

Typical Temperatures	Inlet 150 to 250 °C, outlet 80 to 100 °C
Solvent Evaporation Capacities	1 kg/h to 42kg per hour
Chamber Diameters	300 mm to 2 m
Heater Types	Electric
Standard Atomizer	Rotary disc
Powder Collection	Blow-down, take-up, aero cyclones, bag filters, wet scrubbers
Options	Air sweeper, bag filter, wet scrubber, CIP, SIP, pneumatic powder conveyor/cooler, air dehumidifier, etc.

BDP-Series Spray Bag Dryer

Developed in close cooperation with TDK's ceramics division, this unique system features an easily removable and washable cloth-made filter chamber as the drying vessel.
Impurities due to abrasion and cross-contamination cannot occur.

The single point collection results in high bulk densities, perfect for technical ceramics meant for sintering. HEPA filter included by default.

Typical Temperatures	Inlet 150 to 200 °C, outlet 80 to 100 °C
Solvent Evaporation Capacities	3 to 80 kg/h (pure water base)
Chamber Diameters	500 to 3700 mm
Heater Types	Electric, gas (direct)
Standard Atomizer	Rotary disc
Powder Collection	Bag root point
Options	Sifter

FOC-Series

Designed for the granulation of fine technical ceramics, the FOC dryers feature a HEPA filter, the patented Ohkawara Low Cap (optimizing the yield at the chamber bottom outlet), an aero cyclone and a bag filter by default.

Typical Temperatures	Inlet 150 to 250 °C, outlet 100 °C
Solvent Evaporation Capacities	10 to 60 kg/h (pure water base)
Chamber Diameters	1200 to 2500 mm
Heater Types	Electric, gas (direct)
Standard Atomizer	Rotary disc
Powder Collection	Low-Cap, aero cyclone, bag filter
Options	Sifter

FGA-Series

Compact combined spray dryer and fluidized bed dryer in one unit. For effective granulation to obtain non-dusting products, quick-dissolving powders, coated particles, to achieve intense powder cooling and for other special applications.

Typical Temperatures	Inlet 150 to 250 °C, outlet 80 to 100 °C
Solvent Evaporation Capacities	5 to 50 kg/h (pure water base)
Chamber Diameters	800 to 2000 mm
Heater Types	Electric, gas (direct)
Standard Atomizer	2-fluid nozzle, air-assisted pressure nozzle
Powder Collection	Blow-down, fine fraction recycled via aero cyclone

Closed Cycle Dryers

Closed systems use nitrogen as the drying gas and therefore safe drying of inflammable or hazardous feeds is feasible. Furthermore, all solvent is receovered and may be reused.

Alternatively open mode operation is possible making these machines avery versatile drying device.

Typical Temperatures	Inlet 100 to 200 °C, outlet 70 °C
Solvent Evaporation Capacities	4 to 28 kg/h (Ethanol base, other solvents feasible)
Chamber Diameters	800 to 2500 mm
Heater Types	Electric, gas (direct and indirect via oil loop)
Standard Atomizer	Rotary disc
Powder Collection	Blow-down, take-up, aero cyclone, bag filter
Options	CIP, SIP, split valves for self-contained powder handling

TWIN JETTER

Lab scale dryers especially designed for use of our patented TwinJet nozzle series.
For making finest powders below 20 micrometers in diameter.

Well-suited for research and processing of e.g. battery materials, catalysts, pharmaceuticals and others.

Typical Temperatures	Inlet up to 250 °C, outlet 70 to 100 °C
Solvent Evaporation Capacities	1 to 1000 kg/h (pure water base)
Chamber Diameters	300 to 5000 mm
Heater Types	Electric, gas (direct)
Standard Atomizer	TwinJet nozzle
Powder Collection	Blow-down, aero cyclone, bag filter
Options	Nitrogen one-pass mode (1 kg/h model), filter cloth chamber (3 kg/h model), inline mixing nozzle

PL-2/CPL-2

This downsized mini spray dryer is small enough to operate on the desk in your laboratory.
Powder contact parts, from drying chamber to powder collecting pot, are made of stainless steel, so there is no risk of breaking them.

Drying unit is usable alone(PL-2), so the solvent recovery unit can be add later.(CPL-2)

Models	PL-2/CPL-2
Typical Temperatures	Inlet up to 140 °C to 200°C, outlet 70 °C to 75°C
Solvent Evaporation Capacities	0.2 to 0.6 kg/h (pure water base), 0.3 to 1.5kg/h(Ethanol base)
Chamber Diameters	200mm
Heater / Atomizer	Electric and 2-fluid nozzle system
Powder Collection	aero cyclone,bag filter
Options	Intel hot HEPA filter,Enclosure,Table for Spray drying UNIT

Spray Heat Reactor

Nozzle atomizer spray dryers with chamber panel heating, reaching temperatures up to 1000 °C. This allows for spray drying and thermal treatment such as activation, calcination or pyrolysis in one single step.

Applicable to catalysts, superconductors, battery, magnetic and various compound materials.

Typical Temperatures	Inlet up to 1000 °C, outlet 80 to 100 °C
Solvent Evaporation Capacities	0.6 to 6 kg/h (pure water base)
Chamber Diameters	200 to 300 mm
Heater Types	Electric
Standard Atomizer	2-fluid nozzle
Powder Collection	Blow-down, bag filter
Options	Combined Hypulcon and 2-fluid nozzle system

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