



## **Spray Drying & Encapsulation Solutions** Particle formation for lab scale

BUCHI's proven, reliable and versatile solutions for Spray Drying and Microencapsulation cover a broad range of applications. Discover the time- and cost-saving solutions for R&D particle formation.



## Core messages to our customers

BUCHI creates added value with “Quality in your hands”

“Quality in your hands” is the guiding principle that shapes our philosophy and our actions. It challenges us to provide outstanding services that are precisely tailored to your needs. This means that we must stay in close contact with our customers. That is why we keep in touch and continue to work very hard to understand you and your business even better.

We help you by providing high-quality products, systems, solutions, applications and services that offer you added value. This allows you to focus entirely on your processes and your work.



### Easy

You handle complex processes, do challenging work and want to focus on what is essential. We support you by providing carefully designed solutions as well as instruments and systems that are easy to operate.



### Competent

You need products, systems, solutions, applications and services that are precisely tailored to your needs. We have the technological expertise and decades of experience needed to provide competent support and work with you to continually improve our market services.



### Reliable

You want to be able to rely completely on your partner for products, systems, solutions, applications and services. We guarantee the quality and functionality of our equipment and will continue to help you quickly and efficiently whenever something does not operate to your satisfaction.



### **Cost-effective**

You want to achieve the best possible results using efficient solutions. We help you to handle your jobs and processes economically. We strive to create a high level of economic benefit and maximum added value for you.



### **Safe**

You are working in an environment in which safety is a high priority. By collaborating closely with you, we do everything in our power to make our products, systems, solutions, applications and services as safe as possible for people and the environment.



### **Global**

You value personalized service and short communication channels. As an international family-owned business with our own subsidiaries and qualified distributors, we have a presence wherever our customers are located. Our local staff and the large number of satisfied customers around the world give you the assurance that you are working with the right partner.



### **Sustainable**

You prefer a partner who acts responsibly when it comes to current environmental challenges. We support environmentally friendly processes and manufacture products that have a long service life. We utilize advanced technologies in order to conserve energy and water and leave the smallest environmental footprint possible.



## We offer solutions for Spray Drying and Microencapsulation

Many different options for a wide range of industries

For more than 30 years BUCHI has been developing market leading solutions for laboratory spray drying and encapsulation. It is our utmost ambition to understand and meet your personal demands in particle formation technologies for the lab. Our reliable and tailored solutions for various industries include ingenious products, innovative systems and a highly professional application support.

### Pharma



Active pharmaceutical ingredients, drug delivery, vaccines, inhalable drugs, taste masking

### Food/Beverage



Encapsulation of additives, controlled release, nutraceuticals, functional foods, flavors, vitamins, proteins, probiotic bacteria, juice concentrate, milk powder

### Feed



Encapsulation of additives, flavors, vitamins, proteins, probiotic bacteria, controlled release

### Academia



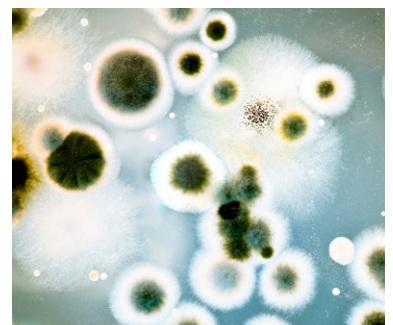
For a wide range of applications in academic education:  
· Full range of spray drying applications

### Chemicals/Materials



Nanotechnology, catalysts, fuel cells, batteries, accumulators, ceramics, UV absorbers, pigments and coatings

### Others



Cell, bacteria and protein encapsulation, cell transplantation, biotransformation, cosmetics, fragrances, environmental applications

## Range of technologies

BUCHI offers solutions to create dry particles, microcapsules, wet beads and core shell capsules from various materials. If you want to simply dry a homogeneous sample or if you want to protect your target material for controlled or target release, we have the solution that covers all your needs, even for heat sensitive materials.

### Spray Drying



### Prilling by vibration



#### Particles type

Dry homogenous or matrix particles

Liquid core beads or capsules (wet)  
(possible to dry afterwards)

#### Excipients (= shell material)

Sugars, starch, cellulose, gum, polymers, wax,  
proteins (or no excipients)

Polymers, alginate, gelatin, wax,  
gum, proteins, cellulose, whey

#### Advantages

- Continuous process
- Short process time
- Low cost at industrial scale
- Protection of core material

- Particle hardening in cooling or polymerization bath
- Short process time
- Suitable for sterile application

#### Process conditions

Mild drying conditions

Extremely gentle conditions

#### Particle size distribution

Broad

Narrow

#### Particles size

Controllable particle size and morphology  
(0.2 – 60 µm)

Selectable particle size  
(100 – 2000 µm)

#### Solutions by BUCHI

«Spray Drying  
Small» p. 6  
200 nm – 5 µm

«Spray Drying  
Medium» p. 8  
2 – 25 µm

«Spray Drying  
Large» p. 10  
2 – 60 µm

«Prilling by Vibration  
Dry» p. 12  
100 – 1000 µm

«Prilling by Vibration  
Wet» p. 14  
150 – 2000 µm

Find detailed information at:  
[www.buchi.com/spray-drying/solutions](http://www.buchi.com/spray-drying/solutions)





## Solution «Spray Drying Small» (200 nm – 5 µm) Laboratory Spray Drying for small samples and particles

You deal with expensive sample materials or want to obtain the smallest particles. We provide a solution with three patented technologies to support you in your research work and offer you new possibilities.

Dehumidifier B-296  
Nano



Nano Spray Dryer  
B-90 HP



Inert Loop B-295



Aspirator

## Your most important benefits

### Efficient

- 2<sup>nd</sup> generation spray head for optimized productivity
- Process very small volumes of sample in quick trials (<2 mL)
- Low product loss due to efficient particle recovery (up to 90 % yield)

### Versatile

- Controlled production of smallest particles by solvent evaporation (0.2 to 5 µm)
- Safe handling of water- and organic-based solvent samples
- Preservation of molecular activity due to gentle process conditions

### Convenient

- Comfortable handling and simple cleaning
- Auto-Stop mode avoids the machine to run empty
- Easily accessible application database and support

## Your solution «Spray Drying Small» (200 nm – 5 µm)



- Spray dryer: Nano Spray Dryer B-90 HP
- Gas circulator: Aspirator
- Drying gas source: Aspirator & inlet filter
- Organic solvent trap: Inert Loop B-295
- Water trap: Dehumidifier B-296 Nano & Upgrade Set
- Air conditioner: Dehumidifier B-296 Nano & Upgrade Set



- Free online application database
- Qualified application support
- Useful tools for application development
- Workshops training
- Preventive maintenance
- Minimize downtime thanks to our service hotline

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*“The Spray Dryer can easily be completely taken apart and cleaned. What I also like about the Spray Dryer is that small sample amounts such as 10 m are enough to obtain good results. [...] the machine is trouble-free, robust and very easy to use. I would certainly recommend it.”* Harald Pudritz and Anke Sass, Friedrich-Alexander-Universität Erlangen, Germany

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## Solution «Spray Drying Medium» (2 - 25 µm) Laboratory Spray Drying at high throughput with maximum possibilities

You want to benefit from an ingenious technology of spray drying for your demanding product development process. We offer the market leading solution with many possibilities in applications to reduce development time

Inert Loop B-295



Mini Spray Dryer B-290



Dehumidifier B-296



High performance cyclone



Three-fluid nozzle



## Your most important benefits

### Versatile

- Spray drying, spray chilling and microencapsulation with one product.
- Processing of organic solvent based samples possible in combination with the Inert Loop B-295
- Processing of organic solvents and water based samples in combination possible using a combination of both the Inert Loop B-295 and the Dehumidifier B-296

### Straightforward

- Free access to more than 400 reproducible applications on our database
- Small sample amounts facilitate the formulation and the parameter optimization
- Quick and easy operation
- Scale-up your process to high product volumes

### Safe

- Explosion-free handling of organic solvents thanks to the safety equipment
- User protection with the lamella safety curtain
- Safe handling of alkaline or acidic samples

## Your solution «Spray Drying Medium» (2 – 25 µm)



- Organic, acidic or aqueous samples: Mini Spray Dryer B-290
- Organic solvent trap: Inert Loop B-295
- Water trap: Dehumidifier B-296
- Air conditioner: Dehumidifier B-296
- Higher yields: High performance cyclone
- Congealing: Spray Chilling
- Immiscible samples: Three-fluid nozzle



- Free online application database
- Customized application support
- Authorized IQ/OQ documentation
- Useful tools for application development
- Training workshops
- Preventive maintenance
- Minimize downtime thanks to our service hotline

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*“The Spray Dryer is easy to use for the powder production from natural plant extracts and the production can be scaled-up without great efforts.”* Jin-Beom Kim, Scientist, Lifetree Biotech Co. Ltd, Korea

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## Solution «Spray Drying Large» (10 – 60 µm) Laboratory Spray Drying with maximized particle size

You need a laboratory Spray Dryer which is able to produce very large particles and achieve a free flowing powder. We offer the market leading solution with the established Mini Spray Dryer B-290 and the new Ultrasonic nozzle.

Ultrasonic package



Inert Loop B-295



Mini Spray Dryer B-290



Dehumidifier B-296



## Your most important benefits

### Performing

- Achieve large particles in lab scale
- Improved flow ability of the produced powder
- Uniform particle shape and narrow size distribution
- Work with low flow rates and small sample volumes

### Versatile

- One instrument for different application technologies (spray drying and encapsulation)
- Ability to work with an ultrasonic nozzle
- Free access to application database with more than 400 studies

### Easy to use

- Easy control and manipulation
- Reduced process time and fast cleaning
- Process control due to glass assembly
- Excellent transfer of results making scale up achievable

## Your solution «Spray Drying Large» (10 – 60 $\mu\text{m}$ )



- Spray Dryer: Mini Spray Dryer B-290 Advanced
- Larger Particles: Ultrasonic package
- Organic solvent trap: Inert Loop B-295
- Air conditioner: Dehumidifier B-296



- Free online application database
- Customized application support
- Authorized IQ/OQ documentation
- Useful tools for application development
- Training workshops
- Preventive maintenance
- Minimize downtime thanks to our service hotline

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*“The BUCHI Mini Spray Dryer B-290 is easy to operate and can be used with a small quantity of materials. It is convenient for investigating many operation conditions.”* Dr. Kohsaku Kawakami, Senior Researcher, National Institute for Materials Science, Japan

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## Solution «Prilling by Vibration Dry» (100 – 1000 µm) Formation of beads and capsules with further drying process

You wish to encapsulate various materials into a dry polymeric or wax matrix. We offer the ideal solution with the combination of the Encapsulator B-390 or Encapsulator B-395 Pro and the Rotavapor® system R-300.



## Your most important benefits

### Efficient

- Formation of size controlled beads and capsules
- Drying particles straight after the formation process
- Short cleaning and setup times due to ergonomic design
- Ability of easy scale-up to pilot or industrial scale multi-nozzle system

### Flexible

- Many applications in controlled delivery and release
- Can be used for a wide range of polymer and wax shell materials thanks to temperature control
- Production of microbeads and core-shell microcapsules in a single step process

### User friendly

- Fast and intuitive manipulation of the different process parameters
- Real-time visualization of the bead/capsule production process with built-in stroboscopic lamp
- Minimal downtime and maintenance thanks to robustness and durability

## Your solution «Prilling by Vibration Dry» (100 – 1000 µm)



- Bead and capsule production: Encapsulator B-390
- Particle drying: Rotavapor® system R-300
- Options: Capsule formation: Concentric nozzle, Additional sample feed: External syringe pump, Large amounts: Multi nozzle system, Bead production: Single nozzle, Small beads: Flow vibration nozzle



- Customized application support
- Tools for particle formation
- Application database
- Workshops training
- Minimize downtimes thanks to our service hotline
- Preventive maintenance IQ/OQ

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*“Thanks to the introduction of the new BUCHI Encapsulator various micro-beads can be produced quickly, and the production of beads under sterile conditions is easy.”* Dr. Eunhye Lee, Utah-Inha DDS & Advanced Therapeutics Research Center, Korea

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## Solution «Prilling by Vibration Wet» (150 – 2000 µm) Formation of beads and capsules of various materials

You wish to encapsulate various materials into a polymeric matrix. We offer a creative solution using vibrating technology (prilling) to form beads and capsules using the Encapsulators B-390 or B-395 Pro even with extremely sensitive and expensive materials.

Single nozzle system



Concentric nozzle system



Encapsulator B-395 Pro



Reaction vessel

## Your most important benefits

### Safe

- Gentle conditions allows sensitive materials to be used (e.g. animal cells and microorganism)
- Sterile applications with the reactions vessel of the Encapsulator B-395 Pro
- Documentation available for GMP

### Controllable

- Real-time visualization of the bead/capsule production process with built-in stroboscopic lamp
- Formation of size controlled beads and capsules
- Wide range of polymer shell materials

### Easy operation

- Intuitive manipulation of the different process parameters
- Short cleaning and setup times due to ergonomic design
- Minimal downtime and maintenance thanks to the robustness and durability

## Your solution «Prilling by Vibration Wet» (150 – 2000 µm)



- Bead and capsule production: Encapsulator B-395 Pro
- Options: Capsule formation: Concentric nozzle, Sterile work: Reaction vessel, Additional sample feed: External syringe pump, Small beads: Flow vibration nozzle



- Customized application support
- Tools for particle formation
- Application database
- Workshop training
- Documentation for GMP
- Minimize downtimes thanks to our service hotline
- Preventive maintenance IQ/OQ

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*“The BUCHI Encapsulator B-395 Pro is the instrument of choice on the market for the sterile encapsulation of cells into polymeric beads and capsules, and is integratable into a GMP process.”* Prof. Bice Conti, University of Pavia, Lab. Pharmaceutical Technology and Law (PT&L), Dept. Drug Sciences, Italy

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## The best solution for your need

Comparison by customer needs, application and characteristics



Mini Spray Dryer  
B-290



Nano Spray Dryer  
B-90

Needs/Solutions	Page	Mini Spray Dryer B-290				Nano Spray Dryer B-90	
		Basic	Advanced	Acid proof	Large	Basic	Advanced
«Spray Drying Small»	6					●	●
«Spray Drying Medium»	8	●	●	●			
«Spray Drying Large»	10				●		
«Prilling by Vibration Dry»	12						
«Prilling by Vibration Wet»	14						
<b>Methods</b>							
Classical Spray Drying		●	●	●	●	●	●
Encapsulation Spray Drying		●	●	●	●	●	●
Spray Chilling		●	●				
Capsules wet							
Capsules dry							
Beads wet							
Beads dry							
<b>Spray Drying sample solvents</b>							
aqueous (> 90 % H <sub>2</sub> O)		●	●		●	●	●
mixtures (20 – 90 % H <sub>2</sub> O)			●		●		●
organic (< 80 % H <sub>2</sub> O)			●		●		●
Acidic or alkaline				●			
<b>Characteristics</b>							
Maximum sample throughput		1 L/h		-	200 mL/h		
Minimal sample		5 g/10 mL		-	200 mg/2 mL		
Particle size distribution		broad <sup>2</sup>		narrow <sup>3</sup>	narrow <sup>3</sup>		
Yield		up to 70 %		-	up to 90 %		
Viscosity of the sample		up to 300 cps		-	up to 5 cps		





Encapsulator		Inert Loop	Dehumidifier	Rotavapor®
B-390	B-395 Pro	B-295	B-296	R-300 system

**Particle size**

200 nm – 5 µm

2 – 25 µm

10 – 60 µm

100 – 1000 µm

150 – 2000 µm

**Particle nature**

Micronization, agglomeration

Matrix encapsulation

Matrix encapsulation from melts

Liquid core capsule

Liquid core capsule dry

Liquid core capsule beads

Liquid core capsule beads dry

600 mL/h

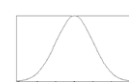
5 mL

uniform<sup>4</sup>

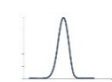
up to 100 %

up to 300 cps

<sup>1</sup> please include upgrade kit



<sup>2</sup> broad



<sup>3</sup> narrow



<sup>4</sup> uniform

## Spray Dryer

Do we have the possibility to spray with organic solvents?

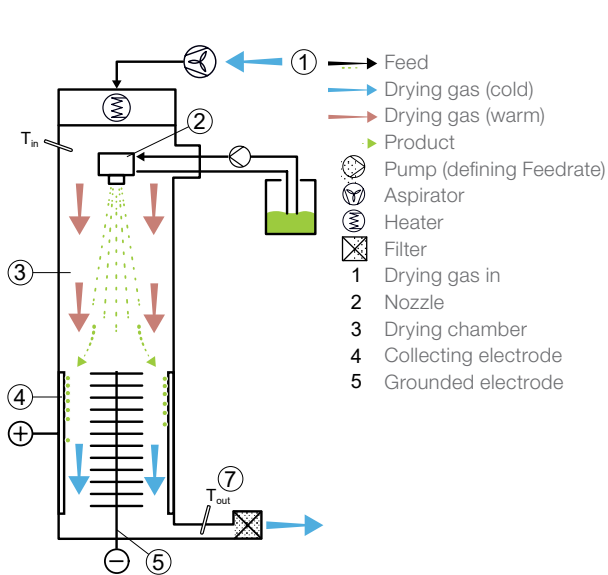
With the Mini Spray Dryer B-290 or with the Nano Spray Dryer B-90 with the Inert Loop B-295 it is possible to spray with organic solvents without risk of explosion, because the system works under inert conditions.

How can I control the outlet temperature?

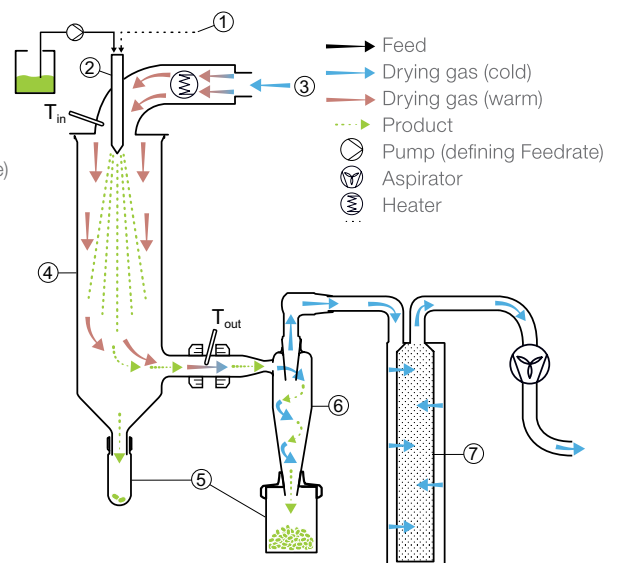
The outlet temperature is depending on the parameters inlet temperature, sample feed rate, sample concentration and aspirator rate. A change in one of those parameters will either cause the outlet temperature increase or decrease.

What is the functional principle of the laboratory spray dryer ?

- Step 1 Heating: Heat the inlet air to the desired temperature (max. 220 °C)
- Step 2 Droplet formation: Two-fluid nozzle for the B-290 and ultrasonic spray head for the B-90
- Step 3 Drying chamber: Conductive heat exchange between drying gas and sample droplets
- Step 4 Particle collection: Cyclone technology for the B-290 and electrostatic particle collector for the B-90
- Step 5 Outlet filter: Collection of finest particles to protect the user and the environment
- Step 6 Drying gas: Delivered by aspirator for the B-290 and by aspirator or compressed air for the B-90
- Step 7 Filtering of the drying gas



Nano Spray Dryer B-90



Mini Spray Dryer B-290

Find detailed information at:  
[www.buchi.com/spray-dryer](http://www.buchi.com/spray-dryer)



## Encapsulator

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What is the difference(s) between a matrix microcapsule (referred to as a bead) and a core-shell microcapsule (referred to as a capsule)?

A bead is a spherical structure which has a (encapsulated) material distributed throughout the structure (matrix) – no distinctive core and shell part.

A capsule is made up of a defined and distinctive core (consisting of the encapsulated material) and shell part which are separated from each other.

What types of polymers can be used to produce the bead structure and how is a polymer selected?

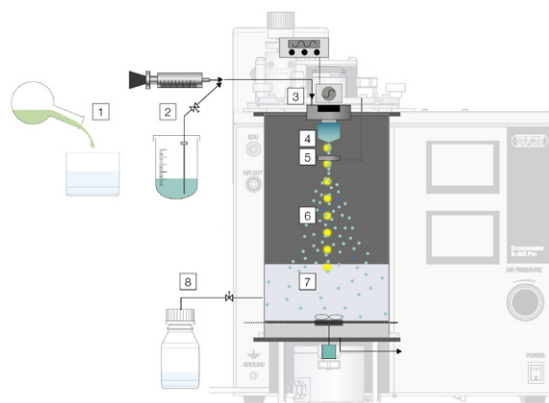
Natural polymers: Na-alginate, gelatin, lambda-carragennan, agar, agrose, chitosan, cellulose, whey protein, collagen, pectin

Synthetic polymers: Polyacrylamide, Polyvinyl Alcohol (PVA), poly(lactic-co-glycolic acid) (PLGA), cellulose sulfate, polyDADMAC, poly-L-lysine, Polyethylene Glycol (PEG)

In additional range of waxes can also be used to produce the capsules

What is the functional principle of the Encapsulator?

- Step 1 Mixing: Mixing of active ingredient and polymer
- Step 2 Pumping: Pumping of mixture with syringe pump or air pressure
- Step 3 Vibration: Superimposition of vibration
- Step 4 Prilling: Droplet formation
- Step 5 Electrode: Electrostatic charge of the droplets and dispersion of droplets
- Step 6 Process control: Online process control of droplet formation in the light of the stroboscope
- Step 7 Hardening bath: Bead formation in polymerization solution or by gelation
- Step 8 Collection: Collection of beads



Encapsulator B-395 Pro

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Find detailed information at:  
[www.buchi.com/encapsulator](http://www.buchi.com/encapsulator)



## Dehumidifier



The Dehumidifier B-296 is an efficient way to obtain constant parameters by conditioning the inlet air allowing you to work with organic solvents and water mixtures in combination with the Inert Loop B-295.

## Inert Loop



The Inert Loop B-295 is used to work in closed mode, under nitrogen atmosphere with the BUCHI Spray Dryers. Furthermore it condenses the organic solvents and recirculates the nitrogen.

## Spray Chilling



The unique Spray Chilling system allows you to work with melted samples of wax or polymers with a melting point up to 70 °C.

## Concentric nozzle



The Concentric nozzle enables the production of core-shell particles.

## Reaction vessel



The reaction vessel for the Encapsulator B-395 Pro is fully autoclaveable enabling sterile encapsulation of samples.

## Flow vibration nozzle



The flow vibration nozzle enables small beads < 80 µm and production of beads with high viscous solutions.

### High performance cyclone



The high performance cyclone is a specially optimized to collect small particles in high yields from the Mini Spray Dryer B-290.

### Ultrasonic package



The Ultrasonic package allows the Mini Spray Dryer B-290 to produce particle in the size range from 10 – 60  $\mu\text{m}$ . It is combinable with all Mini Spray Dryer B-290 models.

### Three-fluid nozzle



The three-fluid nozzle allows to spray dry immiscible substances with the Mini Spray Dryer B-290. It also allows capsules to be produced on the instrument.

### Aspirator



The aspirator can be used as a drying gas source for the Nano Spray Dryer B-90. The aspirator is needed to provide the gas velocity when working with the Nano Spray Dryer B-90 in closed mode.

### GMP Documentation



The material certificates of reaction vessel parts deliver all information for GMP validation of the product.

### Laboratory rotary evaporation



The Rotavapor® R-300 is a comprehensive evaporation solution which allows drying of particles under vacuum previously produced by the Encapsulator.



## Support and customer service

From feasibility to preventive maintenance

You value an efficient and personalized service. Our network of professional application specialists and service technicians as well as a large number of satisfied customers around the world give you the assurance that you are working with the right partner.



### Application Laboratories

A team of highly qualified specialists offers you support and the different application laboratories all around the world. If you need support for your application or if you want to do a feasibility test with your substance please contact us.

Get our application request form:  
[www.buchi.com/applications](http://www.buchi.com/applications)



### Spray Dryer Application Database

Over 30 years of experience using official and customized applications are summarized in a database. The Spray Dryer Database provides starting parameters as well as literature references for over 400 applications.

Discover the free online application database at:  
[www.buchi.com/spray-dryer/database](http://www.buchi.com/spray-dryer/database)



### Profit from workshops, trainings and seminars

We regularly offer practical seminars and workshops, often in cooperation with other partners in the field of sample preparation and analysis. Customer contributions thereby underline how our solutions facilitate the daily routine. We also attend many local and international scientific and industrial congresses.

Find an overview of our activities:  
[www.buchi.com/events](http://www.buchi.com/events)



## Use your product most effectively

We help you to set your product properly into operation. We provide thorough Installation/Operation Qualification (IQ/OQ) services to ensure compliance with FDA, GLP/GMP standards or GAMP guidelines. Whether it is because of an initial installation, requalification or relocation, we provide professional compliance verification.

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Find out more about our services:  
[www.buchi.com/service-support](http://www.buchi.com/service-support)



## Minimize downtimes

Avoid products' downtimes with preventative maintenance and tailored service packages. We offer a product warranty of one year and guarantee ten years of spare parts availability.

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Get in touch with us:  
[www.buchi.com/warranty](http://www.buchi.com/warranty)



## Global Network

Our subsidiaries and qualified distribution partners ensure proximity where ever you are. Since we are familiar with your requirements, we use our experience and knowledge to provide first-rate solutions.

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