# IKA

designed to work perfectly

EN


## MASS PRODUCTION OF BATTERY CELLS

### MANUFACTURE OF ELECTRODE MATERIALS AND COATINGS

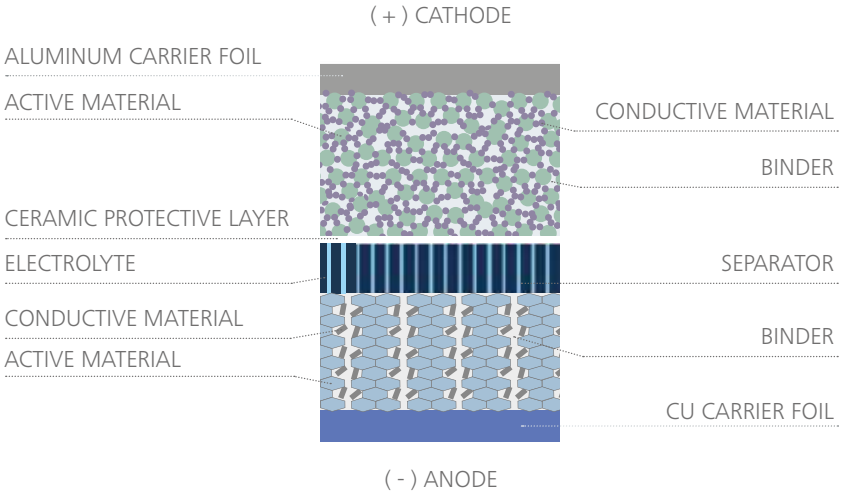
# Dispersing technology for lithium-ion battery (LIB) production

/// Fit for the future, with efficient mixing processes

**The need for electrical storage systems is increasing exponentially in many fields. This technology is without doubt an important element with regard to adherence to climate objectives over the coming decades. Whether for the storage of electrical energy generated on-site, as an intermediate buffer for fuel cells, for supplying power to mobile electrical devices, or in the automotive sector, lithium-ion battery cells represent the state of the art, wherever you look.**

To manufacture coating slurries, liquid solvents are mixed with solids in powdered form. In order that the battery cells can produce maximum power, a coating medium with no agglomerates is required. All the particles need to be evenly distributed. Different requirements apply for every ingredient. The applied mixing energy should be well controlled in order to produce the desired product characteristics. Care must be taken that particles are not destroyed or polymer chains damaged, otherwise this would result in performance and viscosity deviations.

One goal in the modern manufacturing of battery cells is to reduce costs per kWh of storage capacity as much as possible. With this in mind, IKA has developed special mixing solutions, which are perfectly suited for production on an industrial scale. Essential requirements here are in-line mixing and dispersing machines with a concentrated energy input, which guarantee maximum efficiency and consistent product and dispersion quality.




Typical structure and components of a battery cell

# Conventional process

/// Mixing in batch mode: Standard, yet obsolete?

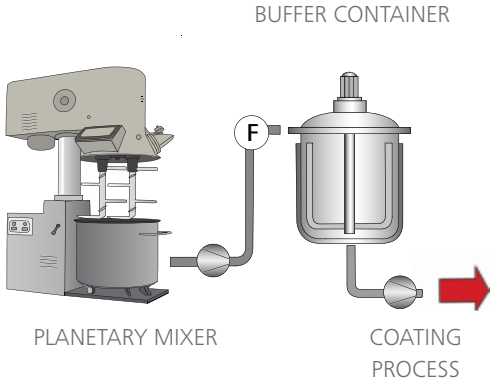
**In the conventional process, the battery slurry is mixed using batch mixing machines. Generally fitted with anchor agitators and dissolvers, they are used to produce binder solutions or C-pastes, for example. In addition to this, planetary mixers are used to add to active material within a dry-wet process. Something these systems have in common is a very limited, specific energy input. In order to achieve the desired mixing result, it is also essential that the entire batch volume remains continually in motion. With the majority of highly viscose materials having a high solid content and high density, this results in huge drive systems with a high power requirement.**

For breaking up agglomerates, it is essential that the particles reach the mixing tool. With the conventional procedure, this is ultimately only possible with very long mixing times. In spite of this, some agglomerates are still retained, representing a quality issue for the end product. They must then be removed via a filter, which incurs material losses.

Cleaning conventional batch mixing machines reveals another major problem - manual intervention and the use of huge quantities of solvents are generally required.

**CHARACTERISTIC FEATURES**

> Long mixing times
> Deposits on the lid, vessel wall, and agitator
> Inflexible production quantities
> Very frequent filter maintenance required
> Low and non-adjustable energy input
> Difficult manual cleaning
> Low output
> Expensive heavy-duty machinery
> Expensive maintenance



# Advantages and cost reduction with IKA

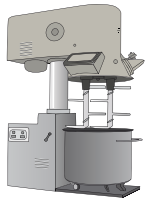
/// Advanced in-line mixing technology

**The increasing demand for production capacity and high-quality battery materials requires advanced, efficient mixing and dispersing technology.**

The solution to this problem is machines based on in-line technology. Here, all of the material is conveyed through a mixing chamber containing dispersing tools. The energy input during mixing occurs with maximum efficiency, using a low-volume mixing chamber, combined with a high-speed rotating tool. The energy input during the mixing process can be easily controlled by means of the selected tool design and the operating settings.

Because the contents are completely integrated and utilized, the quantity of raw materials can be kept to a minimum. Even in multipass batch processes, the batch quantity is flexible, as the in-line mixing machine is positioned beneath the mixing container. Cleaning is simple and can be performed completely automatically, as all machines are designed for Cleaning in Place (CIP). In a regular process flow, the cleaning medium can be used as a liquid solvent sample for the next batch.

Maximum efficiency is the main advantage of the fully continuous one-pass process. This works because all process steps run in parallel to one another. The system has a continuous output and there are no interruptions to the feeding of additives, or for cleaning purposes. The closed system can produce product without limitation, either for just a short period of time, or in 24/7 continuous operation. The runtime merely depends on the required production quantity.



**Planetary mixer**

- 15 kW motor output
- 400 l capacity
- Batch process






**MHD 2000/05 in-line mixer**

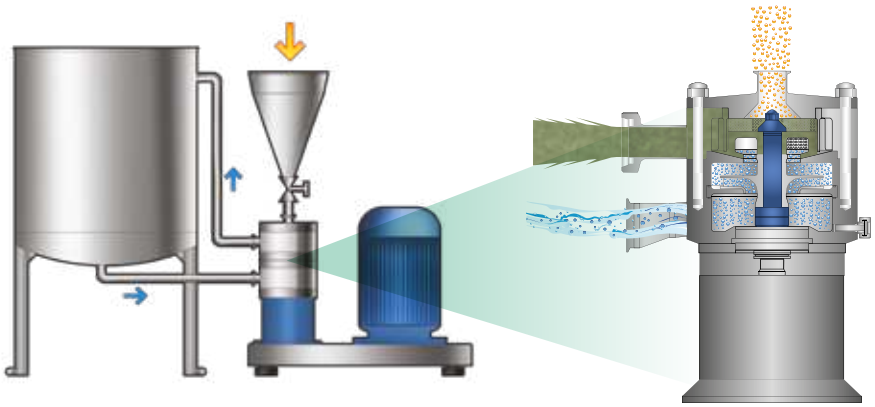
- 5.5 kW motor output
- 400 l/h throughput
- In-line process

# Mixing & dispersing within the Batch in-line process

/// CMX powder disperser for custom plant design

**The CMX is a mixing machine that integrates powder and liquid additives into liquids and disperses the mixture reliably and evenly. This takes place in an in-line batch operation. Here the main liquid is in the container, and the powder and other liquids are added to it. The circulation of the liquid produces a high negative pressure, which sucks in the solids. This means there is no need for an additional pump, adding ingredients couldn't be simpler! Even powders that are difficult to wet can be added during the liquid phase without any clumps, and viscosities of up to 10,000 mPas can be processed. Particularly efficient processing of binder and conductivity materials is therefore possible with the CMX.**

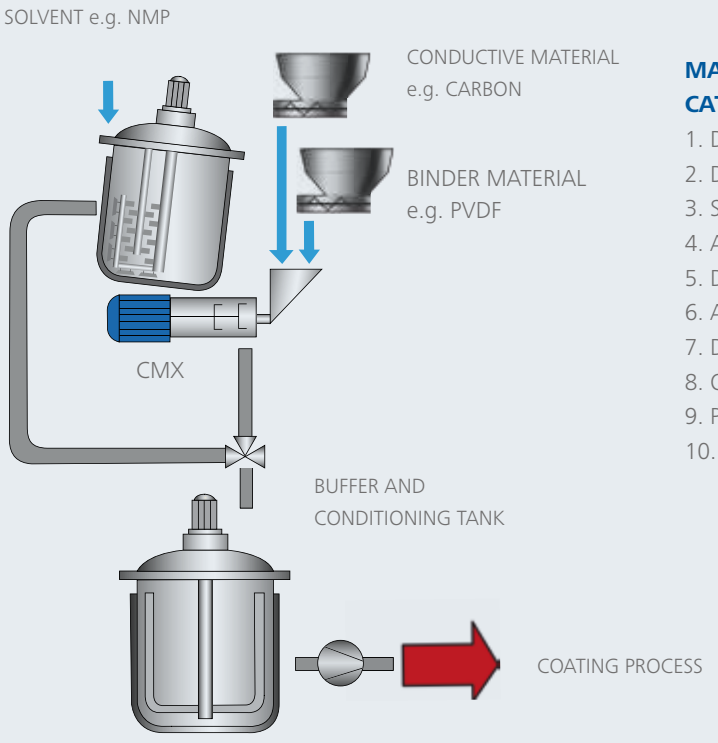
The CMX powder disperser can be perfectly and simply integrated into existing or new, customer-specific plant systems. Suitable for either horizontal or vertical installation, it requires only a low installation height and can be fitted with specific tools with a view to meeting production-site requirements.



SCHEMATIC FUNCTION SEQUENCE

**CHARACTERISTIC FEATURES**

> Cleaning in Place (CIP)-compatible
> Dry run possible without product
> Manual or fully automatic operation


## MANUFACTURE OF A C-PASTE FOR CATHODE PRODUCTION

1. Dose solvent into the mixing container
2. Dose binder material into the hopper
3. Start recirculation of the solvent
4. Add and dissolve the binder material
5. Dose the conductivity material into the hopper
6. Add and disperse the conductivity material
7. De-gassing and temperature control
8. Quality check (dispersion, solid content, viscosity)
9. Product transfer into the buffer container
10. Re-fill for the next batch or CIP

# Coating media within the batch in-line process

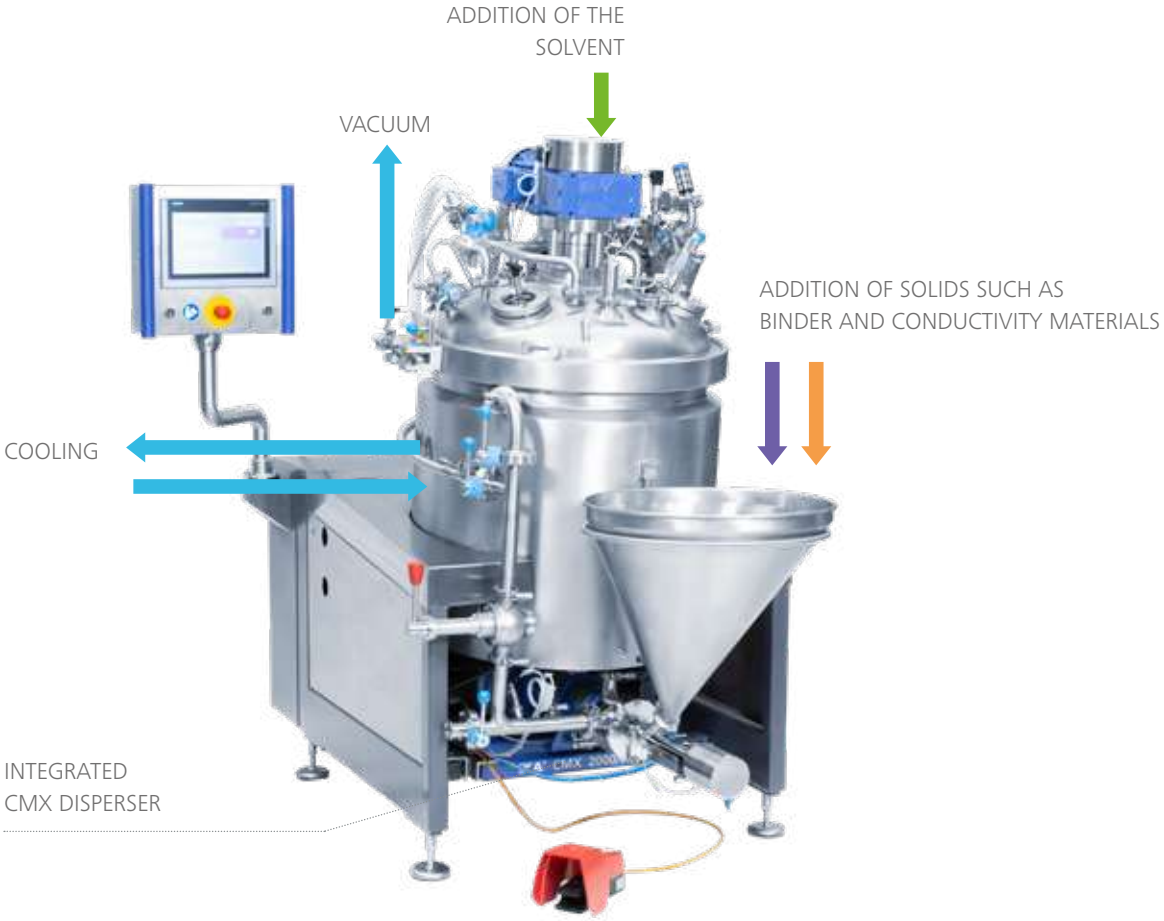
/// XPP – Integrated system for all process steps

**The XPP is a versatile, tried and tested, complete system for battery production, which is extremely efficient, including under negative pressure. The XPP was especially developed for the manufacture of highly viscose products, in particular those with a very high solid content and short batch times. With the permanently integrated CMX powder disperser, which is positioned directly beneath the container, its exceptional functionality can be combined with the ability to achieve the maximum possible production output, within an extremely limited space.**

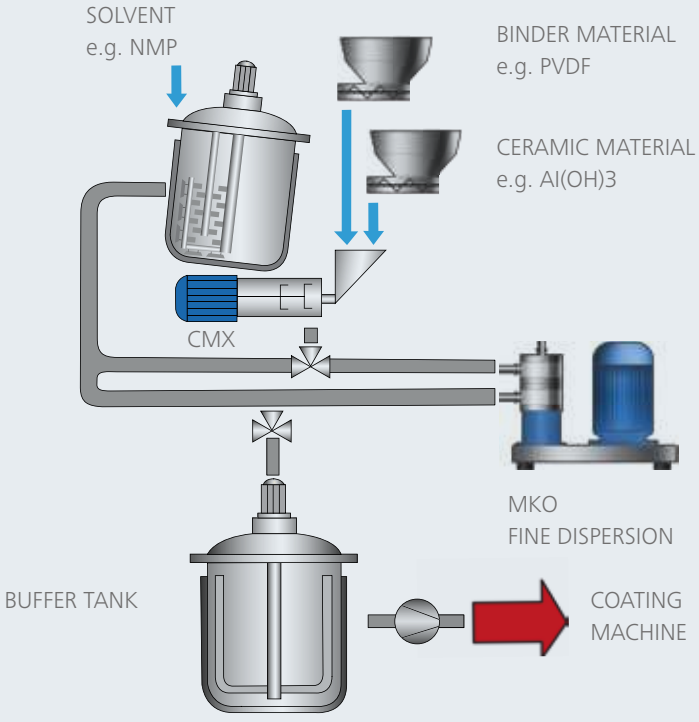
The XPP is a self-contained, complete system. As such, it also offers the option of operation as a stand-alone system. Ingredients can be fed in manually or automatically, e.g. via a hopper or dosing system. With capacities ranging from 25 to 4,000 liters, the most varied of uses and applications are possible, such as the manufacture of binder solutions, C-pastes, and ceramic coatings.


**CHARACTERISTIC FEATURES**

> No solid residues on the agitator, the container wall, or the lid
> High flexibility when changing mixtures
> Mixing, de-gassing, & temperature control possible
> During discharge, the CMX serves as a pump, meaning that no other devices are necessary




## XPP | MIXING + PRE-DISPERSING



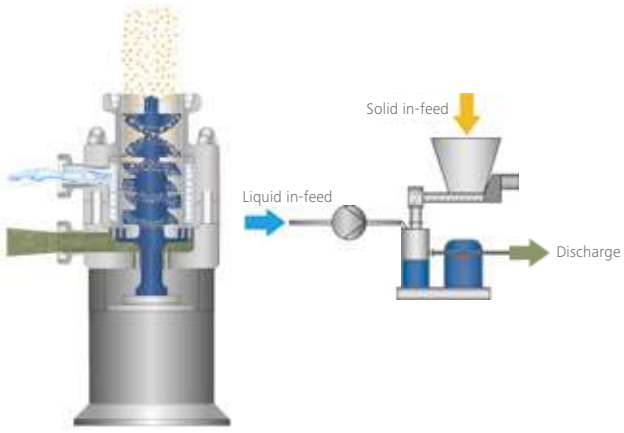

### PREPARATION OF A CERAMIC COATING

1. Dose the solvent into the XPP container
2. Dose, add and dissolve the binder material
3. Dose, add and disperse the ceramic material
4. Recirculate and homogenize the pre-mix
5. De-gassing and temperature control
6. Use of the CMX as a pump for coating the MKO cone mill
7. Fine dispersion during recirculation
8. Output in the downstream process

# Continuous in-line process for mass production

/// Suspensions & coatings with MHD/MKO

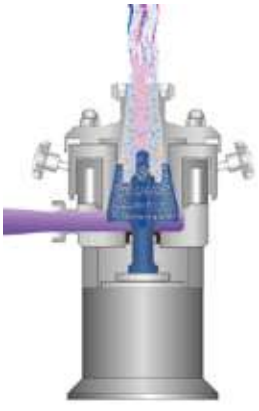
**Continuous manufacturing process of suspensions using the MHD in-line powder mixer and the downstream MKO cone mill takes place in one run. This produces the best conditions for the optimally efficient, resource-saving manufacture of electrode pastes.**




**THE PATENTED MULTI-STAGE MHD IN-LINE DISPERSER** homogenizes and disperses solids within liquids, in one step. The feeding in of a liquid phase (e.g. C-paste) with a pump, and a solid (e.g. active material) using a solid doser is carried out in proportion to the volume. The design of the mixing tools, the retention time, and the rotational speed are variable process parameters to achieve the desired mixing result.

**CHARACTERISTIC PROPERTIES OF THE MHD IN-LINE DISPERSER**

> Mixtures with up to 80 % solid content and viscosities of up to 50 Pas can be processed
> Equipped with rotor-stator tool
> Optional ceramic version



**THE MKO CONE MILL** is especially suited for the gentle fine dispersion of pre-mixed electrode pastes. This takes place with an increased retention time, in a long shearing gap, without destroying particles. The energy input can be precisely controlled via the circumferential speed of the tool and the flexible adjustment of the shearing gap.

**CHARACTERISTIC PROPERTIES OF THE MKO CONE MILL**

> Conical rotor-stator
> Processing of viscosities of up to 100 Pas
> Circumferential speed 10 - 50 m/s
> Optional ceramic version

**PREPARATION & COATING**

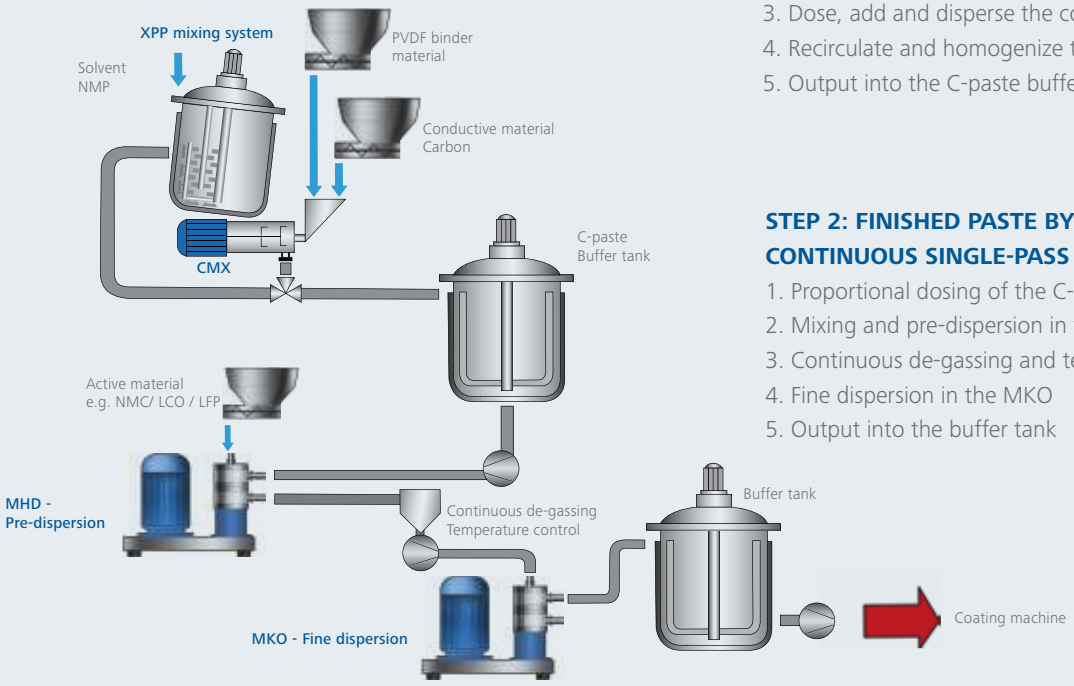
## MHD PLANT SYSTEM

In additional to the version designed as an individual machine, the MHD in-line disperser can also be produced as a complete unit with a dosing system. Within one cycle, maximum process efficiency is achieved with a minimal increase in temperature. The MHD system is designed for 24/7 operation. Thanks to its flexibility, a huge range of raw materials and formulations can be processed using the system. Furthermore, the construction of the MHD system is very compact.

## ADVANTAGES OF THE CONTINUOUS IKA PROCESS COMPARED TO THE PROCEDURE WITH ONE CONTINUOUS EXTRUDER

> Starting with a liquid, the IKA technology is better suited for the homogeneous dispersion of binding agents and conductive materials. As a result of the finer dispersion, the quality of the end product is improved and raw materials are saved
> The IKA technology can be more easily adjusted to changes in the formulation and to the raw materials
> The IKA technology is based on technically simple, low-maintenance machines
> The IKA technology is suitable for closed CIP cleaning

## CONTINUOUS MANUFACTURE OF A CATHODE COATING MEDIUM




### STEP 1: C-PASTE – BATCH IN-LINE

1. Dose solid into the XPP container
2. Dose, add and dissolve the binder material
3. Dose, add and disperse the conductive materials
4. Recirculate and homogenize the pre-mix
5. Output into the C-paste buffer tank

### STEP 2: FINISHED PASTE BY MEANS OF CONTINUOUS SINGLE-PASS OPERATION

1. Proportional dosing of the C-paste and the active material
2. Mixing and pre-dispersion in the MHD
3. Continuous de-gassing and temperature control
4. Fine dispersion in the MKO
5. Output into the buffer tank

# Manufacture of electrode materials

/// CD/CM dryer series for intermediate and end products in powder form

**The gentle mixing and drying of active materials and their intermediate products is a component of electrode material manufacture. The IKA CM/CD solid mixer and dryer series is intended exclusively for mixing, lowering the material temperature, or the effective separation of solvents under negative pressure.**

## CM CONICAL MIXER: POWDER MIXER AND COOLER

The CM conical mixer enables efficient mixing of bulk goods in a manner that is gentle on the product. Equipped with a special spiral agitator and full-length double-jacketed vessel, the materials for manufacturing electrodes can be processed incredibly effectively. Complete product discharge is guaranteed. The CM conical mixer is available as a complete plant system, including temperature control.


## VACUUM CONTACT DRYING WITH THE CD CONICAL DRYER

Due to the directly heated spiral agitator, the CD conical dryer ensures even moisture and temperature distribution across the entire batch volume. Generated vapors are extracted via an integrated metal filter, while dusts are reliably held back. The conical dryer features a compact design and is ready for instant use.

# Pilot plants and systems

/// Tailored systems for R&D and process simulation

### IT'S MAGIC!

Development of new formulations with the same processing method as used in production is already possible on a laboratory scale. And with as little material consumption as possible: this is vital for reliable, simple scale-up. Ultra-modern simulation of the production process helps, for example, with the assessment of the changing of raw materials, or the adjustment of process parameters, initially on a small scale.

Whether batch in-line, continuous in-line, or powder mixing & drying - with its modular construction, the IKA magic series is the leading system on the market for R&D work.

### MAGIC PLANT AND MAGIC LAB LABORATORY EQUIPMENT

> Modular systems
> R&D work on the smallest scale, up to an effective volume of 2l
> Complete process simulation
> Maximum flexibility during testing

### PILOT PLANTS

The next step in the simulation of the production or manufacture of small series are pilot plants for slightly larger production quantities. As is the case when working on a laboratory scale, a driver for various processing modules can be used with full modularity. Complete flexibility in relation to peripheral devices, as well as explosion protection/ATEX, enable adaptation to tomorrow's requirements.

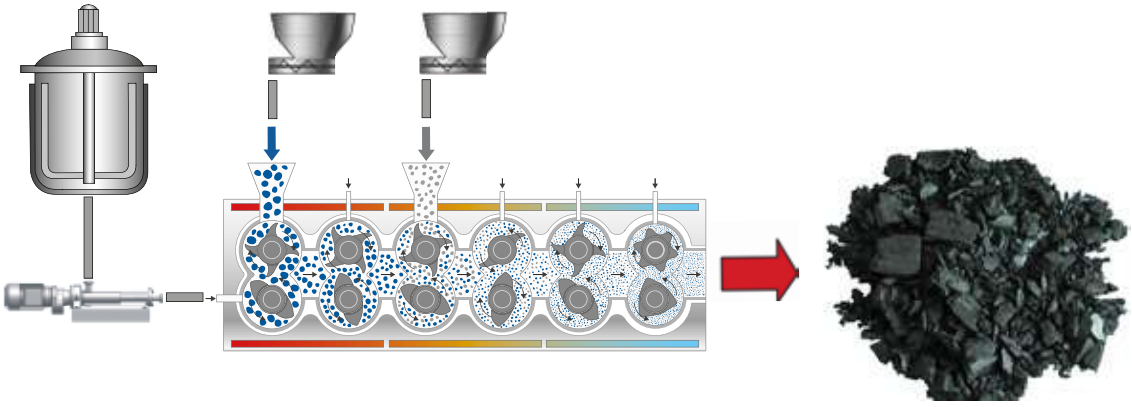
# New processes & systems

/// Ready for future requirements

### READY FOR THE FUTURE: USE US DRY!

A significant cost factor in the manufacture of battery cells is the need for solvents. These are required as a medium by which to disperse the solid components, and to apply them to the carrier foils of the anode and cathode, with a relatively low viscosity. These solvents must then be removed again by means of an intensive drying process, which requires high system and energy expenditure. The objective is to develop new electrode designs, which require no coating, or are based on entirely different coating methods.

IKA already offers the industrial solution to this problem. Either in batch or continuous operation, product components are mixed with no binding agents whatsoever, or with just a relatively small quantity.




### KNEADING MACHINES FROM IKA – MIXING AND DISPERSION OF EXTREMELY HIGH VISCOSITIES

> In-line addition of the powder
> Fully continuous process
> Minimal solvent requirement
> Suitable for 24/7 operation

# Technical Data

/// Overview of the most important machines & systems

## BATCH IN-LINE PROCESS

/// CMX

| Sizes | Circulation rate [l/h] | Max. solid input rate [kg/h] | Motor power [kW] |
|---|---|---|---|
| CMX 2000/04 | 5,000 | 1,300 | 4 |
| CMX 2000/05 | 14,000 | 4,700 | 15 |
| CMX 2000/10 | 32,000 | 8,900 | 30 |
| CMX 2000/20 | 70,000 | 16,200 | 55 |
| CMX 2000/30 | 110,000 | 25,500 | 110 |
| CMX 2000/50 | 200,000 | 46,000 | 200 |

/// XPP

| Sizes | Useful volume [l] | Connected load [kW] |
|---|---|---|
| XPP 25 | 25 | 6 |
| XPP 50 | 50 | 7.5 |
| XPP 100 | 100 | 14 |
| XPP 200 | 200 | 19 |
| XPP 500 | 500 | 35 |
| XPP 1000 | 1,000 | 62 |
| XPP 2000 | 2,000 | 120 |
| XPP 4000 | 4,000 | 210 |

## CONTINUOUS IN-LINE PROCESS

/// MHD

| Sizes | Overall throughput [l/h] | Max. solid input rate [kg/h] | Motor power [kW] |
|---|---|---|---|
| MHD 2000/04 | 30 – 150 | 100 | 2.2 |
| MHD 2000/05 | 100 – 500 | 500 | 5.5 |
| MHD 2000/10 | 400 – 2,000 | 1,300 | 11 |
| MHD 2000/20 | 1,000 – 5,000 | 2,800 | 22 |
| MHD 2000/30 | 3,000 – 15,000 | 8,500 | 37 |
| MHD 2000/50 | 6,000 – 30,000 | 18,000 | 75 |

/// MKO

| Sizes | Overall throughput [l/h] | Motor power [kW] |
|---|---|---|
| MKO 2000/04 | 20 – 80 | 4 |
| MKO 2000/05 | 50 – 300 | 7.5 |
| MKO 2000/10 | 150 – 500 | 15 |
| MKO 2000/20 | 300 – 1,200 | 37 |
| MKO 2000/30 | 800 – 3,000 | 90 |
| MKO 2000/50 | 1,500 – 6,000 | 160 |

## MIXING AND DRYING OF SOLIDS

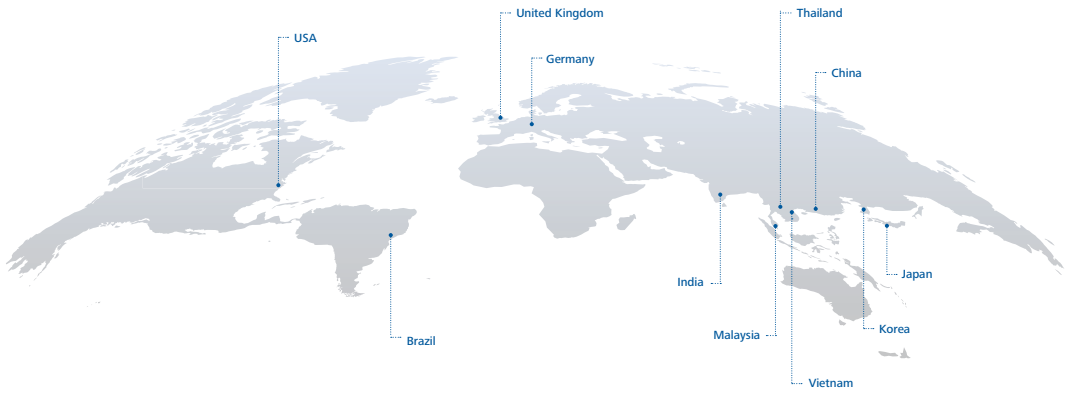
/// CM / CD

| Sizes | Useful volume [l] | Motor output [kW] |
|---|---|---|
| CM/CD 10 | 3 – 10 | 0.37 |
| CM/CD 25 | 8 – 25 | 0.75 |
| CM/CD 50 | 16 – 50 | 1.5 |
| CM/CD 100 | 30 – 100 | 3 |
| CM/CD 250 | 75 – 250 | 5.5 |
| CM/CD 500 | 150 – 500 | 11 |

| Sizes | Useful volume [l] | Motor output [kW] |
|---|---|---|
| CM/CD 1000 | 300 – 1,000 | 18.5 |
| CM/CD 2000 | 600 – 2,000 | 30 |
| CM/CD 4000 | 1,200 – 4,000 | 37 |
| CM/CD 7000 | 2,100 – 7,000 | 45 |
| CM/CD 10000 | 3,000 – 10,000 | 90 |

# IKA

designed to work perfectly




EN

**IKA-Werke GmbH & Co. KG**
Janke & Kunkel-Straße 10, 79219 Staufen, Germany
Phone: +49 (0) 7633 831-0
Email: process@ika.de

## /// WORLDWIDE

**USA**
IKA Works, Inc.
Phone: +1 910 452-7059
Email: process@ikausa.com

**UNITED KINGDOM**
IKA England Ltd.
Phone: +44 1865 986 162
Email: sales.england@ika.com

**INDIA**
IKA India Private Limited
Phone: +91 80 26253 900
Email: process@ika.in

**VIETNAM**
IKA Vietnam Company Limited
Phone: +84 28 38202142
Email: sales.proc-vietnam@ika.com

**BRAZIL**
IKA Brazil
Phone: +55 19 3772-9600
Email: sales@ika.net.br

**MALAYSIA**
IKA Works (Asia) Sdn Bhd
Phone: +60 3 6099-5666
Email: sales.process@ika.my

**CHINA**
IKA Works Guangzhou
Phone: +86 20 8222 1771
Email: Sales-Proc@ika.cn

**THAILAND**
IKA Works (Thailand) Co., Ltd
Phone: +66 85 0999274
Email: sales.proc-Thailand@ika.com

**KOREA**
IKA Korea Ltd.
Phone: +82 2 2136 6800
Email: info@ika.kr

**JAPAN**
IKA Japan K.K.
Phone: +81 6 6730 6781
Email: info@ika.ne.jp

202203_Mass production of battery cells_EN_ 94000233