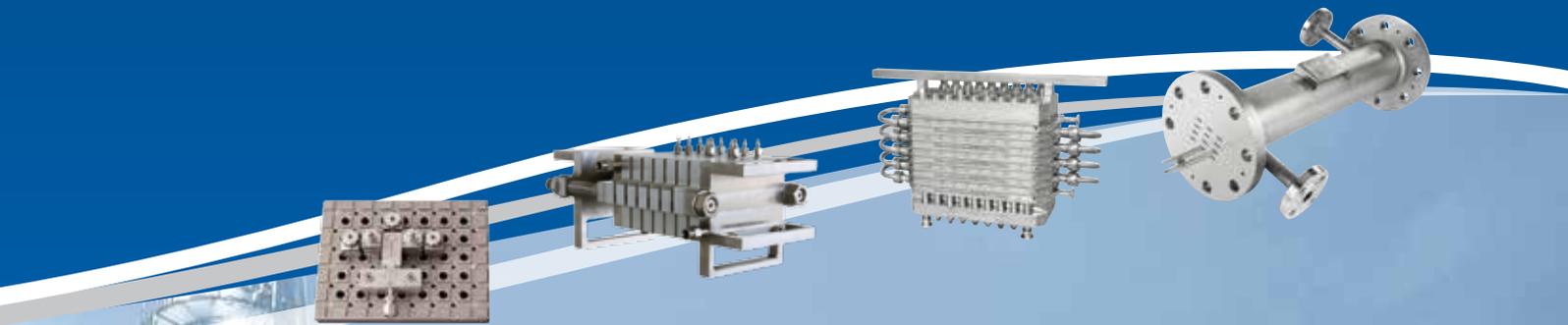


Flexible. Faster. Efficient.

Innovative technology for smart production.



EHRFELD
Mikrotechnik BTS



Microreaction technology → 04

One company, four product groupings, which adds up to:
ingeniously numberless options. → 08

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Microreaction technology

Because your process deserves the best.

The high-performance technology that renders laboratory equipment more compact and at the same time more effective has long since been adopted by labs in universities and research institutions. But it is far more than just an innovative R&D tool. This is because the equipment featuring micro/milli-technology unveils its true potential in practical use: it has been proven to ensure that production processes (in comparison to their batch equivalents) run faster, more efficiently and more reliably. Almost one in two chemical reactions will benefit from the advantages of micro-reaction technology: excellent prospects – not least for your process as well.

HIGHLY COMPETITIVE

As a company operating in the chemical or pharmaceutical industry, in a business environment of fierce global competition, your chosen market poses an abundance of challenges: Increased pressure on pricing, fast time-to-market, and a never-ending stream of ever new products necessitate intelligent solutions. Our technology platform supports you here by means of fast scale-up from the laboratory to actual production – high performance in a minimised space, coupled with maximised cost-efficiency – or to put briefly: the smart solution.

UNCOMPROMISINGLY GOOD

Micro-reaction equipment is high-performance technology in a minimised space, since the micro/milli-structured components are significantly more effective than established equipment in the field of process technology.

- excellent heat transfer
- high mixing speed
- simple, dependable scale-up
- defined residence times
- enhanced operational safety
- ultra-flexible, conveniently mobile
- simple automation
- major potential for process intensification
- quick and easy product change
- higher yield and selectivity



EXCEPTIONALLY VERSATILE

Given these advantages, it is hardly surprising that currently laboratory systems featuring micro-structured components are increasingly en vogue and are being adopted in progressively more new application categories. They are in routine use at leading companies in the chemical industry, plus of course in the pharmaceutical sector, and this trend is steadily gaining momentum in the consumer goods, food and beverage industries as well. We've provided an overview of this sheer diversity on page 6.

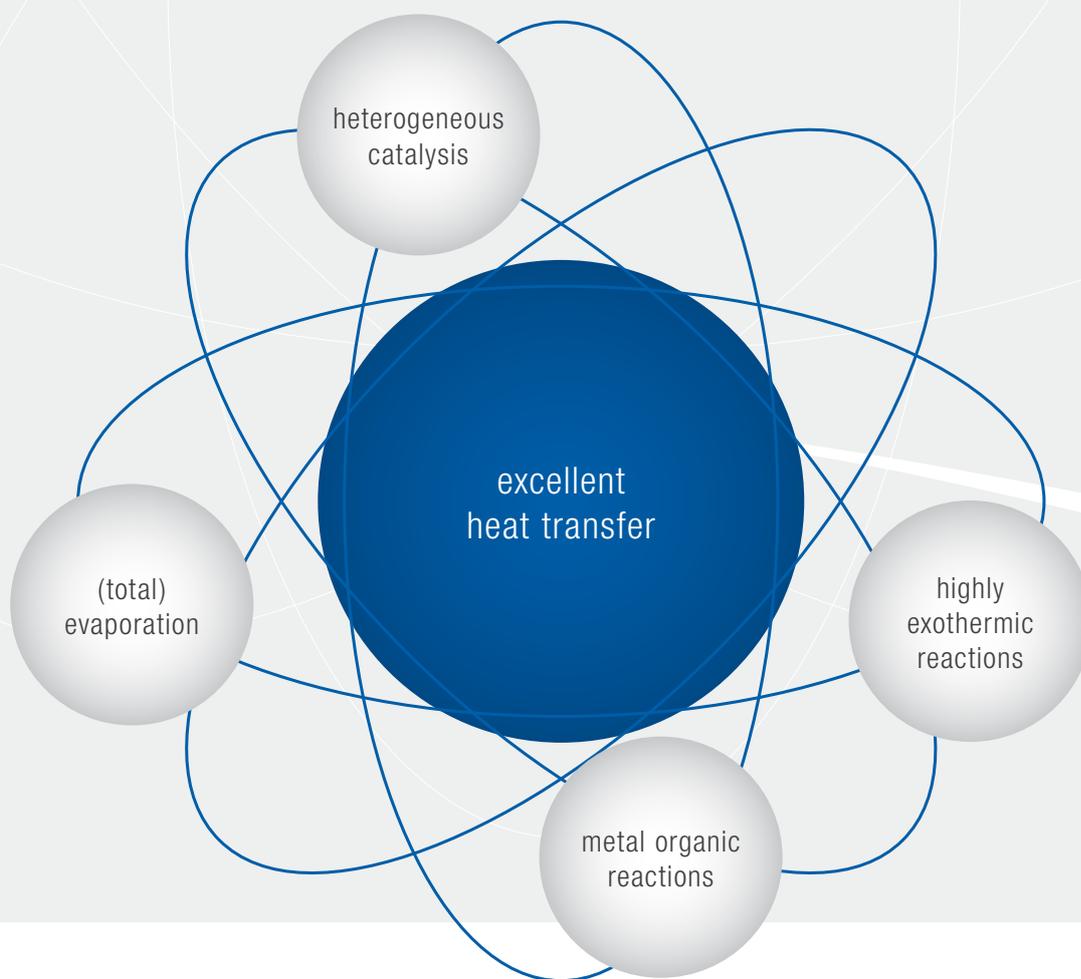
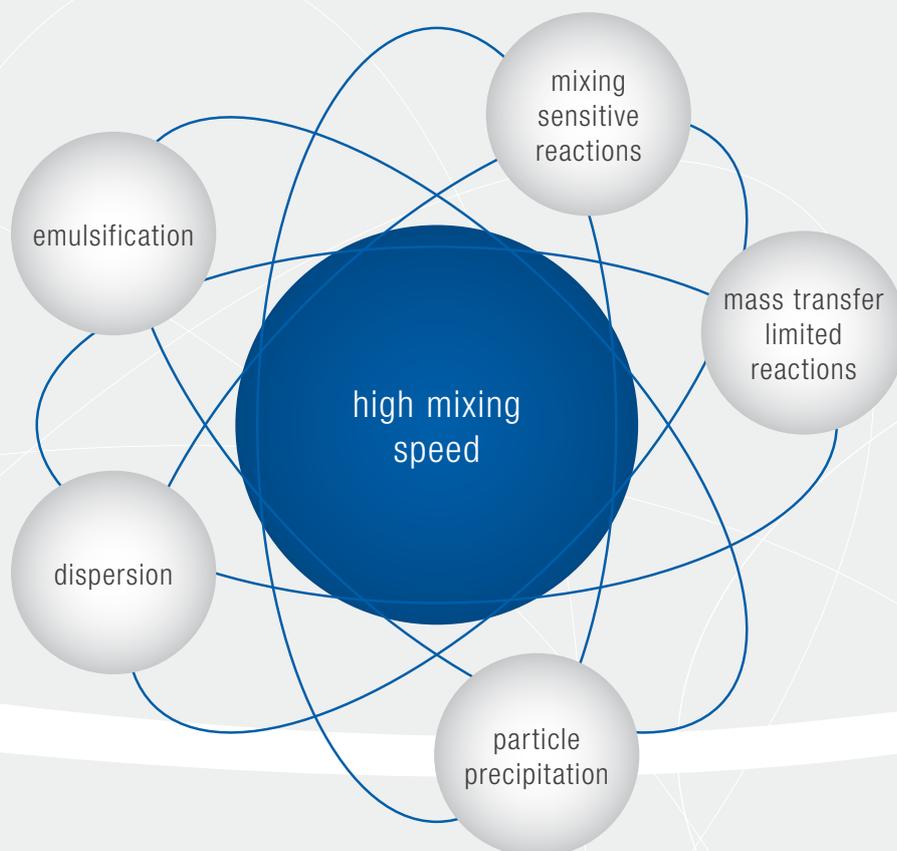
FUTURE-RESPONSIVE

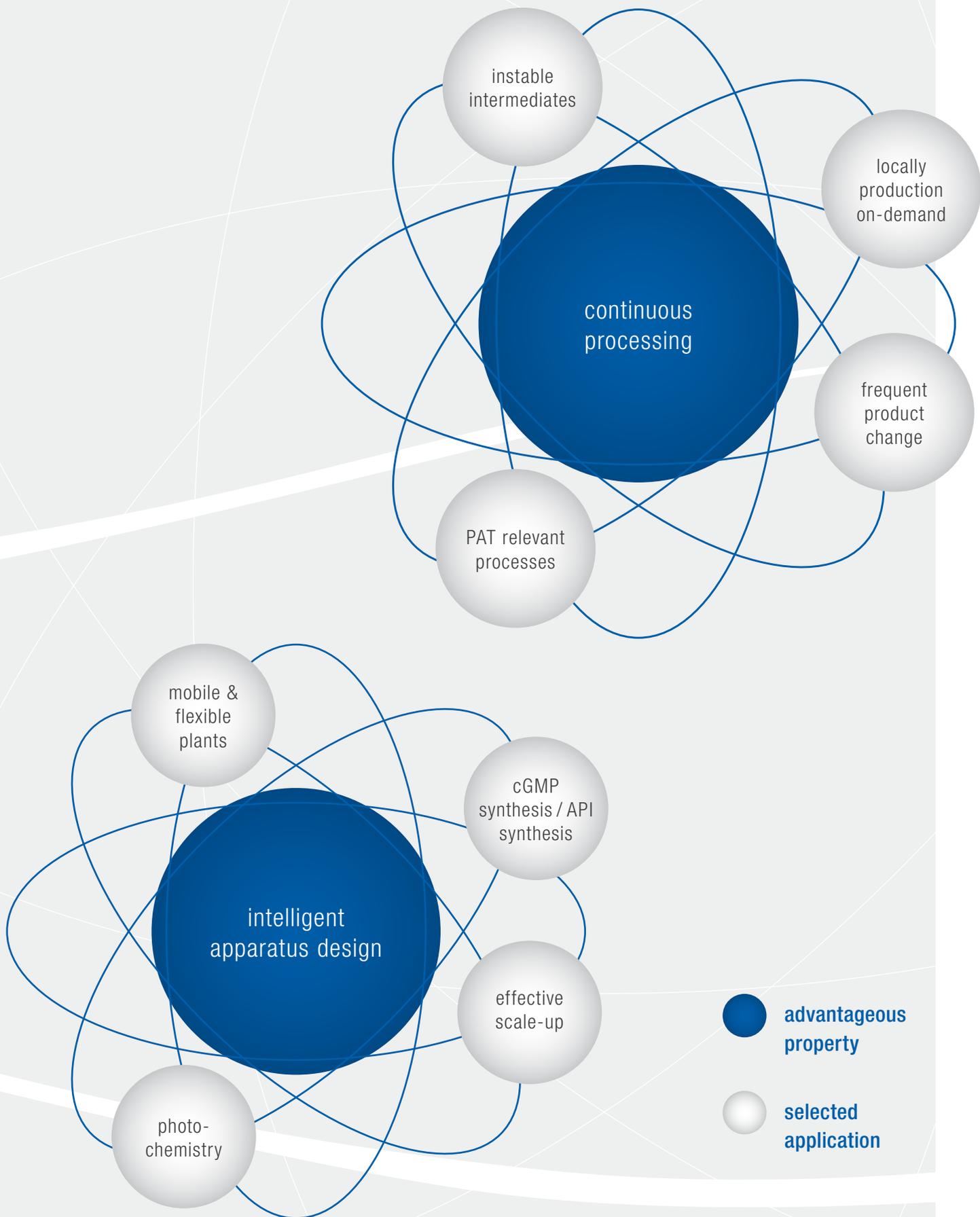
Successful products nowadays have to be cost-efficient, flexible and sustainable – and this will be even truer in the future. Micro-reaction equipment is a key technology for innovative, commercially competitive production processes. And Ehrfeld Mikrotechnik BTS offers you everything you need for this purpose: a superlative portfolio of equipment combined with specialised expert knowledge, from the laboratory all the way through to actual production. We have summarised in this catalogue the entire spectrum of our products and services.

Welcome to the fascinating world of microreaction technology. And when are you going to get on board?

Microreaction technology

Up and running almost everywhere.





One company, four product groupings, which adds up to: ingeniously numberless options.

Ehrfeld Mikrotechnik BTS is a technology leader in the field of micro-reaction equipment. Our technology platform comprises four product groupings:

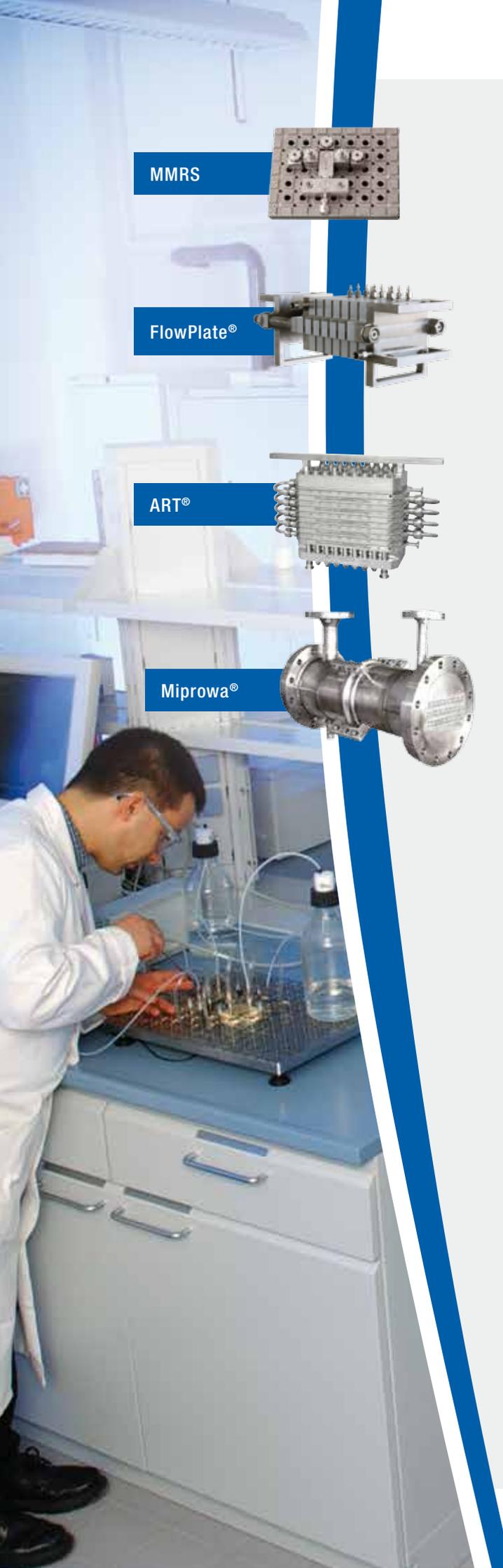
- the Modular MicroReaction System, MMRS for short
- FlowPlate® MicroReactors
- ART® plate reactors and
- Miprowa® high-performance devices

For our customers, this opens up an infinite number of options for applicational versatility. More – as a subsidiary of Bayer Technology Services, we offer you an attractive combination: the flexible rapid-response capabilities of an innovative technology specialist plus the comprehensively competent background of a prestigious globally operating corporation.

Customers choose us as their vendor because we

- develop up-to-the-future and at the same time cost-efficient solutions for a multitude of specific applications for microreaction technology
- offer leading-edge quality in terms of technology, service support and consultancy
- employ flexible and highly qualified experts
- are committed to a stringent standard of quality in creating and design-enhancing our modules and processes
- possess maximally fit-for-purpose infrastructure with laboratories and workshops
- rigorously pursue customer focus in our after-sales service operations
- provide professional management of your international projects as well as working closely together with competent partners
- belong to a networked alliance of partners in the industrial sector and at research institutions
- are able to offer you holistically conceived solutions along a system's entire life-cycle

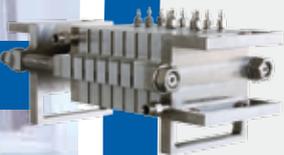




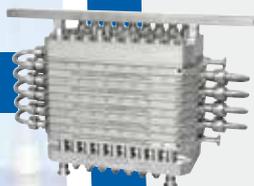
MMRS



FlowPlate®



ART®



Miprowa®



The following symbols will guide you through the world of our innovative products:



MMRS



Mixers



Reactors



Heat exchangers



Sensors & actuators



Links & connections



Clamping components



FlowPlate®



ART®



Miprowa®



Scalability



The Modular MicroReaction System:

A toolkit for innovative versatility.

There's nothing in the world to equal our Modular MicroReaction System, or MMRS for short: laboratory equipment in modularised design. It speeds up the development of new processes, and simplifies process intensification while also maximising flexibility. With the MMRS, we offer companies optimum preconditions for pole position in the international competitive environment.

FLEXIBLE

The salient feature of our system is its modularised construction. More than 60 different microreaction modules can be quickly and easily combined with each other, so as to create a customised system meeting the particular job profile involved. The operating parameters, conversely, have been standardised:

- temperature range: - 20 – 200 °C, - 100 – 600 °C
for special applications
- operating pressure: up to 100 bar, higher figures on demand
- flow rate: 0.01 – 30 L/h, depending on the module concerned
- materials: stainless steel, Hastelloy® and others on request

The MMRS is mounted on a base plate available in the following sizes: A5, A4 and A3. It is divided up into a square raster with a length of 25 x 25 millimetres per cell, enabling all our micro-components, like mixers, reactors and heat exchangers to be conveniently mounted and re-arranged at will, for maximised flexibility. If you think it resembles a plug-in system, you are quite right: the Modular MicroReaction System is just as simple – and its construction, too. Moreover, our components are very sturdy and can be easily dismantled, so that even minuscule channels can be cleaned without any problems. You'd like some more extras? No problem. The MMRS is available in special sizes, and can if required be fitted with a base plate heater. On a long-term view as well, the built-in flexibility comes up trumps: because every new supplementary module can be easily integrated, and even years later can be adapted on the platform. Since often only one module is needed for pilot trials, we offer for this purpose an equally flexible solution: many MMRS modules can be used as stand-alone units with a standard connection and without a base plate.



SAFE

Our micro-mixers, micro-reactors and micro-heat-exchangers have proved their worth wherever processes with sophisticated reactions are being run: in the case of severely exothermic reactions, for instance, or where substance transport limits the reaction speed, but also when using toxic and potentially explosive substances, they are an excellent choice. With these components, reactions can be performed under precise conditions and simply monitored, while the potential hazards are reduced, because the reaction volume is smaller, thus providing optimum preconditions for safe and dependable operation of your system.

EFFICIENT

The Modular MicroReaction System scores highly in comparison to conventional designs, not only in terms of its surface-to-volume ratio. Its finely structured modules and its continuous operating mode open up an abundance of further potential as well: as a user, you benefit from significantly accelerated development of new processes and products, in addition to optimised use of energy and starting materials. And all this on a footprint that's no larger than a sheet of notepaper – for miniaturised all-round efficacy.

AUTOMATED

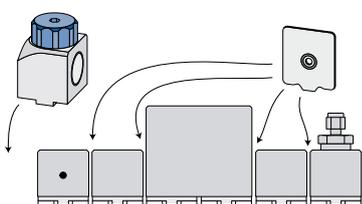
We adopt new approaches to laboratory automation: instead of individual components, the LabManager® integrates numerous automation functions in a single compact device – for unlimited options in your laboratory. External devices for instrumentation and control, plus the conventional control cubicle, are thus rendered superfluous. LabManager® is flexible, effective in operation, and very user-friendly, since the integrated module library ensures simple and intuitive use (page 35).

SCALABLE

In the shape of the MMRS, we provide you with an intelligent set of laboratory equipment with which you can develop and optimise new products and processes. Our capabilities also cover all the further phases: transfer to pilot operations, and later to production scale. For this purpose, we offer the following specialised product groupings: FlowPlate® (page 34) and Miprowa® (page 38), but numerous MMRS modules can also be upscaled for larger flow rates, such as the LH 1000 (page 42) or the Valve Mixer 300 (page 42).

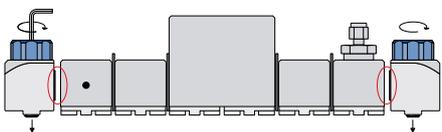
These scalable MMRS modules are designated in the catalogue by the symbol .

The construction of the Modular MicroReaction System could hardly be simpler



a

→ The modules are mounted on the base plate. The modules' own bottom plates are fitted with guide elements, which engage in the grooves of the base plate raster so as to align the modules involved. In addition, the bottom plates are made of PEEK in order to thermally decouple the modules from the base plate. This is shown in diagram a, as exemplified by a random row of five modules. For reasons of clarity, the base plate is not shown in the diagrams.

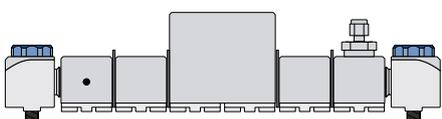


b

→ At both ends of the module row, clamping modules are screwed into the base plate by manually turning the wheel at the top (diagram a).

→ A sealing plate is inserted at every gap between two modules (diagram a).

→ Beginning with the longest module row, all rows are clamped. For this purpose, the wheels of the clamping modules are turned further by means of a hexagon socket key (diagram b).



c

→ This causes a ram to move out of the clamping module towards the modules in the row, thus pressing together the row of modules and the sealing plates (diagram c).

→ The connections of the inlet modules are linked up to dosing pumps and the connections of the outlet modules to product vessels by pipes or hoses. The inlets and outlets of the heat exchangers are connected to thermostats or cryostats.

→ Finally, electric heaters, valves, sensors and other actuators are linked up to the instrumentation and control unit by cables.



Mixers

When you need the right type.

Mixing ranks among the most important basic operations in the process industry. Depending on the task involved, you require the appropriate type of mixer. And we are sure to have precisely the one you need. No matter which of our micromixers you opt for – all of them excel in terms of persuasive product advantages:

- reassuringly sturdy construction
- field-proven and dependable in operation
- configuration flexibly matched to the specific mixing job involved
- uncomplicated cleaning, since our micromixers can be completely dismantled
- small passive volume

Our high-quality mixers are available in stainless steel or Hastelloy®, or in other materials on request.

Mixer	Cascade Mixer 06, 10, 15	Slit-Plate Mixer LH 2, LH 25	Comb-Type Mixer	Valve Mixer 30
Art.-No.	0216	0113, 0109	0101	0111
Volume flows	06: from 0.1 L/h, 10: from 0.3 L/h, 15: from 0.9 L/h	0.1 – 6 L/h, 3 – 120 L/h	from 0.3 L/h	3 – 30 L/h
Scalable	Development stage	LH 1,000 up to 3,000 L/h	see Slit-Plate Mixer	Valve Mixer 300 up to 300 L/h
Mixing of liquids	✓	✓	✓	✓
Emulsification/Dispersion	✓	✓	✓	✓
Mixing of liquids and gases	–	✓	✓	–
Particle precipitation	–	–	–	✓
Suspensions	✓	–	–	–

The applicational recommendations specified above are guideline values, and may differ in individual cases. For recommendations relating to a particular application, please get in touch with our technical service department.

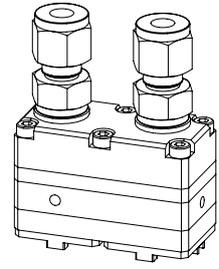


Cascade Mixer 06, 10, 15

A4, HC

Mixing principle: Split and recombine

→ Art.-No. 0216-3



Application

- for mixing jobs with wide flow-rate and viscosity ranges, such as mixing melts and suspensions, but also liquid-liquid mixtures and emulsions
- fluid flows are split several times and brought together again in an offset configuration
- volume flows:
 - › model 06: from 0.1 L/h, model 10: from 0.3 L/h, model 15: from 0.9 L/h

Characteristic

- large channel dimensions – available in the following channel widths: 0.6 mm, 1.0 mm and 1.5 mm
- sturdily resistant to blockages
- fluidically temperature-controlled



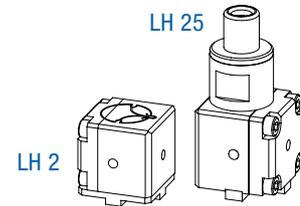
Slit-Plate Mixer LH 2, LH 25

A4, HC

Mixing principle: Multi-lamination

→ model LH 2: Art.-No. 0113-4

→ model LH 25: Art.-No. 0109-4



Application

- for liquid-liquid and gas-liquid mixing, such as emulsions
- model LH 2 for laboratory applications: volume flows from 0.1 – 6 L/h
- model LH 25 dimensioned for the pilot scale, and also optimally suited for production operations – specialty chemicals and pharmaceuticals: volume flows from 3 – 120 L/h
- for volume flows of up to 3,000 L/h, we offer the LH 1000 model (page 42)

Characteristic

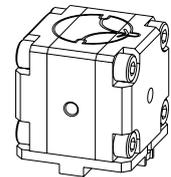
- mixing and aperture plate are replaceable
- mixing slits available in the following nominal diameters: 25/25 µm, 50/50 µm, 85/25 µm, 100/25 µm, 150/25 µm, 150/50 µm, 300/100 µm, 300/300 µm
- aperture slits available in the following nominal diameters: 25 µm, 50 µm, 100 µm, 300 µm
- model LH 25 available with integrated Pt100

Comb-Type Mixer

A4, HC

Mixing principle: Multi-lamination

→ Art.-No. 0101-3



Application

- for liquid-liquid and gas-liquid mixtures, e. g. for emulsions
- volume flows: from 0.3 L/h

Characteristic

- with three different replaceable aperture plates (nominal diameters: 50, 100 and 200 µm) included in the delivery package

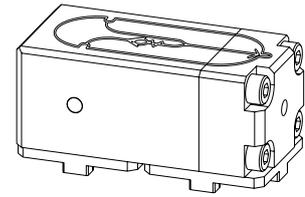


Valve Mixer 30

A4, HC

Mixing principle: Multi-lamination, impact jet

→ Art.-No. 0111-2



- innovative mixer type with one special feature: the non-return valve can almost totally prevent any back-flow of the mixture
 - micro-structures remain free from particle deposits, which in other types of micromixer lead to blockages
 - suitable for continuous precipitation reactions, e. g. for producing nano-particles, catalyst particles or colour pigments in suspension
 - for volume flows of up to 30 L/h
 - for volume flows of up to 300 L/h, we offer the valve mixer 300 (page 42)
- mixing plates with different nominal slit diameters between 105 and 400 µm available

Did you know that the mixer types LH2, LH25 and Valve Mixer are based on a special mixing principle?

We can explain to you how this principle, known as “multi-lamination”, works, as exemplified by the LH 1000. Interested? Then simply take a look at this video: www.youtube.com/watch?v=AOSP4RcTLmo



You will find further information on the LH 1000 on Page 48. We will also be pleased to answer your questions in person. We're looking forward to hearing from you:
Tel. +49 (0)6734 919 300





Reactors

For continuous quality.

Microreactors are operated in continuous mode. The reaction mixture flows steadily through the reaction volume – producing significant benefits compared to a classical batch mode: these include higher product quality, better process monitoring and enhanced reliability. This all adds up to more cost-efficiency and reduced environmental impact, thanks to optimised use of energy, raw materials and solvents.

Reactor	Cryo Reactor	Capillary Reactor	Meander Reactor 2, 11	Sandwich Reactor	Miprowa® Lab	Reactor 100
Residence reactors						
Art.-No.	0202	0214	0211	0213	0224	0219
Process volume	2.4 mL (total), 1.7 mL (cooled)	2/4/8 mL	2 mL, 11 mL	30 mL	(8/15/23 mL)* 30 mL (depending on inserts)	110 mL
Max. pressure at 25 °C	100 bar	100 bar	20 bar	20 bar	30 bar	100 bar
Temperature range	-80 – 100 °C	-20 – 200 °C	-20 – 200 °C	-20 – 200 °C	-20 – 200 °C	-10 – 200 °C
Type of temperature control	fluidic	fluidic	fluidic	fluidic	fluidic	fluidic
Dismantable	partial	partial	✓	✓	✓	✓
Continuous mixing	limited**	limited**	limited**	✓	✓	✓
Scale-up concept	–	–	✓	Miprowa®	Miprowa®	Reactor 450 on request
Applications	low-temperature reactions, single-phase liquid reactions	single- and multi-phase liquid-liquid as well as gas-liquid reactions	single-phase liquid reactions, reactions with suspensions	single- and multi-phase liquid-liquid as well as gas-liquid reactions	single- and multi-phase liquid-liquid as well as gas-liquid reactions	single- and multi-phase liquid (-liquid) reactions, reactions with suspensions

* with volume reduction flange ** via dynamic effects



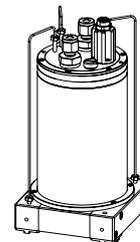
Reactor	FlowPlate® Lab	Photo Reactor	Cartridge Reactor F200	Cartridge Reactor 240	HT Reactor Unit	Fixed-Bed Meander Reactor
	Multifunctional reactor	Photochemistry	Heterogeneous catalysis			
Art.-No.	1701	0226	0203	0221	0227	0222
Process volume	depending on process plate	0.04 – 0.16 mL (depending on variable layer thickness)	2 mL	5 mL	up to 5 mL	25 mL
Max. pressure at 25 °C	35 bar	2.8 bar	100 bar	100 bar	100 bar	35 bar
Temperature range	-20 – 200 °C (-55 – 200 °C)	+15 – 50 °C	-20 – 200 °C	up to 240 °C	up to 600 °C	-20 – 200 °C
Type of temperature control	fluidic	fluidic	fluidic	electrical	electrical, fluidic after-cooling	fluidic
Dismantable	✓	✓	✓	partial	partial	✓
Continuous mixing	variable	–	–	–	–	–
Scale-up concept	FlowPlate® A6 and A5	Photo Reactor XL	–	–	–	–
Applications	single- and multi-phase liquid-liquid as well as gas-liquid reactions	Photochemistry with fluid media	Heterogeneous catalysis in a fixed bed			

The applicational recommendations specified above are guideline values, and may differ in individual cases. For recommendations relating to a particular application, please get in touch with our technical service department.

Cryo Reactor

A4, HC

→ Art.-No. 0202-4



Residence reactor

Application

- for masterly handling of low-temperature reactions
- with built-in, cooled LH 2 or cascade mixer to create a multi-functional integrated system

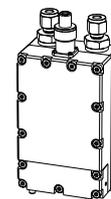
Characteristic

- process temperature: -80 – 100 °C, operated with a cooling circuit featuring external cryostats
- pressure up to 100 bar (at 25 °C)
- process volume: 2.4 mL (total) and 1.7 mL (cooled)
- can be partially dismantled

Capillary Reactor F248

A4, HC

→ Art.-No. 0214-1



Residence reactor

Application

- fluidically temperature-controlled residence reactor for small and medium volume flows

Characteristic

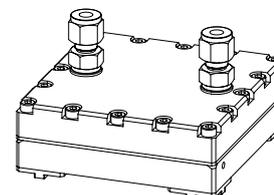
- variable retention volume by changing of the connection body
- capillary elements can be exchanged separately
- temperature control also for highly exothermic reactions thanks to a fluidic temperature control with defined fluid flow
- Pt100 temperature sensor at the service side provides close-to-process temperature measurement
- process temperature: max. 200 °C
- pressure up to 100 bar



Meander Reactors 2, 11

A4, HC

→ Art.-No. 0211-2



Residence reactor

Application

- fluidically temperature-controlled residence reactor with 2-mm-wide meander-shaped reaction channel
- suitable for reactions in the liquid phase and of suspensions

Characteristic

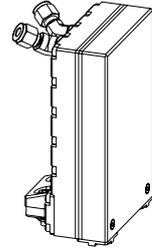
- process temperature: -20 – 200 °C
- pressure up to 20 bar (at 25 °C)
- process volume: 2 mL or 11 mL
- can be completely dismantled



Sandwich Reactor

A4, HC

→ Art.-No. 0213-1



Residence reactor

- fluidically temperature-controlled residence reactor with integrated static mixing function
- particularly suitable for single- and multi-phase liquid-liquid and gas-liquid reactions

- flow inserts with slit widths in 2 mm and 0.8 mm (others on request)
- intensive, continuous cross-mixing of the process medium in the channel
- process temperature: -20 – 200 °C
- pressure up to 20 bar (at 25 °C)
- process volume: 30 mL (depending on the flow inserts)
- can be completely dismantled



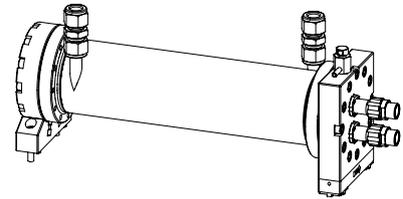
Miprowa® Lab

A4, HC

→ Art.-No. 0224-2



Residence reactor



- rectangular channels with flow inserts lead to excellent heat transfer and continuous mixing
- for process development and optimisation, and for product development
- particularly well suited for single and multi-phase liquid-liquid and gas-liquid reactions
- combines the Miprowa® technology with the MMRS
- the Miprowa® product grouping specialises in upscaling to flow rates of up to 10,000 L/h (page 44)

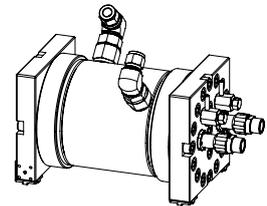
- the geometry of the flow inserts can be used to adjust pressure losses, mixing quality and heat transfer to suit the particular process involved
- process temperature: -20 to 200 °C, with 2 integrated Pt100 T-sensors; pressure up to 30 bar (at 25 °C)
- fluidic temperature control
- replaceable flow inserts mean simple cleaning or also coating with a catalyst
- process volume: 30 mL with flow inserts; can (in dependence on the inserts) be reduced by the user to 22.5/15/7.5 mL



Reactor 100

A4, HC

→ Art.-No. 0219-1



Residence reactor

- milli-structured, compact residence reactor with a large internal volume and static mixing systems for lengthy residence times
- for even larger process volumes in the MMRS, we offer the Reactor 450 on request

- process temperature: -10 – 200 °C
- pressure up to 100 bar (at 25 °C)
- process volume: 110 mL
- fluidic temperature control
- continuous mixing

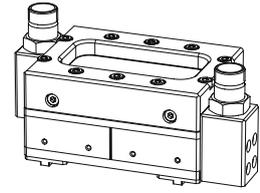




FlowPlate® Lab

HC

→ Art.-No. 1701-3



Multifunctional reactor

Anwendungen

- suitable for feasibility studies in the laboratory, for process optimisation and for preclinical research
- combines the FlowPlate® technology with the MMRS
- for pilot and production-scale operations, we offer the FlowPlate® A6 and A5 (page 39)
- various plates for:
 - › homogeneous reactions with excellent mixing
 - › for gas-liquid and liquid-liquid systems
 - › added functionality (i. e. multi-injections)
 - › scale-up studies

Eigenschaften

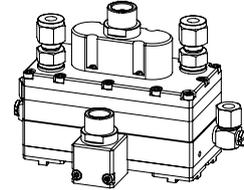
- enhanced flexibility thanks to replaceable micro-structured process plates with up to ten inlets and outlets along the process section (page 38)
- integrated and fluidically temperature-controlled mixing and residence sections
- visual monitoring of the flow processes along the entire channel through a sight glass
- process temperature: -20 – 200 °C (-55 °C on request)
- pressure up to 35 bar (at 25 °C)
- can be completely dismantled



Photo Reactor

A4, HC

→ Art.-No. 0226-2



Photochemistry

Anwendungen

- liquid media are converted by irradiation in the ultraviolet and visible parts of the spectrum, e. g. halogenations and rearrangements
- for higher flow rates, we offer our Photo Reactor XL (page 49)
- multifarious application options in the pharmaceutical industry, in the biotech sector, and also in industrial and academic research and development

Eigenschaften

- good energetic efficiency and high spectral selectivity
- homogeneous irradiation
- layer thickness of the process channel can be adjusted between 25 µm and 100 µm by simple modification measures (other dimensions on request)
- high-performance LEDs as a radiation source, which are available in wavelengths with spectral widths of approximately 20 nm
- for out-of-the-ordinary requirements, we offer a special UV lamp with a spectral filter or also LED arrays
- simple and convenient handling, since different radiation sources from different vendors can be used
- process temperature: 15 – 50 °C (others on request)
- pressure up to 2.8 bar (at 25 °C)
- irradiated process volume: 40 µl (25 µm layer thickness) to 160 µl (100 µm layer thickness)
- fluidic temperature control
- can be completely dismantled (except the radiation source)



MMRS



FlowPlate®

ART®

Miprowa®

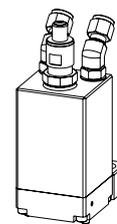
SAFEAIR®
BAYER
www.miprowa.com
+49 187 433 6380
FES-12345678
Bayer Material Science



Cartridge Reactor F200

HC

→ Art.-No. 0203-1



Heterogeneous catalysis

Application

- for heterogeneously catalysed reactions in a fixed bed
- well suited for single and multi-phase liquid-liquid / gas-liquid systems
- a filling aid (Art.-No. 0203-2001-F) is available for the defined filling of the catalyst material

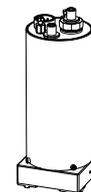
Characteristic

- cylindrical cartridge can be easily removed and replaced while the module is still installed
- temperature control also for highly exothermic reactions thanks to a fluidic temperature control
- process temperature: max. 200 °C
- pressure up to 100 bar
- flow through the cartridge (bottom-up/top-down) is free of choice for the use of liquid or gas-liquid process media
- Pt100 temperature sensor measures the reaction temperature at the upper end of the cartridge
- cartridge volume: 2.0 mL

Cartridge Reactor 240

A4, HC

→ Art.-No. 0221-3



Heterogeneous catalysis

Application

- for heterogeneously catalysed reactions in a fixed bed
- well suited for single and multi-phase liquid-liquid / gas-liquid systems
- a filling aid (Art.-No. 0221-4001-V) is available for the defined filling of the catalyst material

Characteristic

- cylindrical cartridge can be easily removed and replaced while the module is still installed
- electric heating cartridges warm up the process fluid to process temperature with 200 W before it enters the cartridge
- process temperature: max. 240 °C
- two Pt100 temperature sensors provide simultaneous measurement of the temperature in the heating block and in the process fluid directly at the outlet from the bulk material cartridge
- pressure up to 100 bar (at 25 °C)
- cartridge volume: 5 mL (others on request)

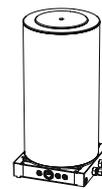
HT Reactor Unit

Alloy 600

→ Art.-No. 0227-1

Heterogeneous catalysis

As a prototype, the HT reactor unit is currently in the test phase. Its application category is heterogeneous catalysis in a fixed bed at high temperatures – so it is particularly well suited for gas phase reactions. Just get in touch with us – we'll be pleased to tell you all about the test results.



- integrated reaction unit with preheating section, mixer, fixed-bed reactor and fluidic cooling downstream
- process temperature: max. 600 °C
- pressure up to 100 bar (at 25 °C)

- cartridge volume: up to 5 mL
- electrically heated
- 3 temperature sensors allow the temperature measurement at the inlet of the packed bed, in the heating cartridge and at the outlet of the cooling zone

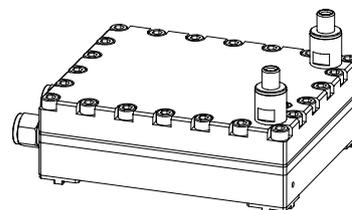
Fixed-Bed Meander Reactor

A4, HC

→ Art.-No. 0222-2

Heterogeneous catalysis

→ particularly well suited for heterogeneously catalysed reactions with large catalyst quantities in a fixed bed



- fluidic temperature control even for reactions with marked exothermy and at temperatures below room temperature
- process temperature: - 20 to 200 °C
- pressure up to 35 bar (at 25 °C)

- two Pt100 temperature sensors at the reactor's inlet and outlet provide close-to-process temperature measurement
- process volume: 25 mL in the empty channel
- can be completely dismantled



Heat exchangers

For consistently getting the temperature right.

This will probably no longer come as a surprise for you: our heat exchangers, too, are excellent. We have developed them specifically for the Modular MicroReaction System. The temperature control modules ensure very fast heat-up or cool-down – responsively and wherever this function is needed.

Heat exchanger	Plate Heat Exchanger	Coax Heat Exchanger	Heater Module	Base Plate Heater*
Art.-No.	0306	0309	0351	0830
Type of temperature control	fluidic	fluidic	electric	electric
Dismantable	–	✓	–	not necessary
Heat transfer area	74 cm ²	71 cm ²	17 cm ²	1,5 cm ² per raster unit
Remark	module with highest heat transfer area	low susceptibility to blockages	short response times, high pressure resistance	consistent temperature for entire set-up

* See at page 33 (clamping components).

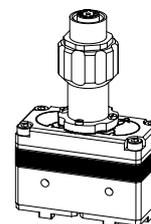


Plate Heat Exchanger

A4

Type of temperature control: fluidic

→ Art.-No. 0306-2

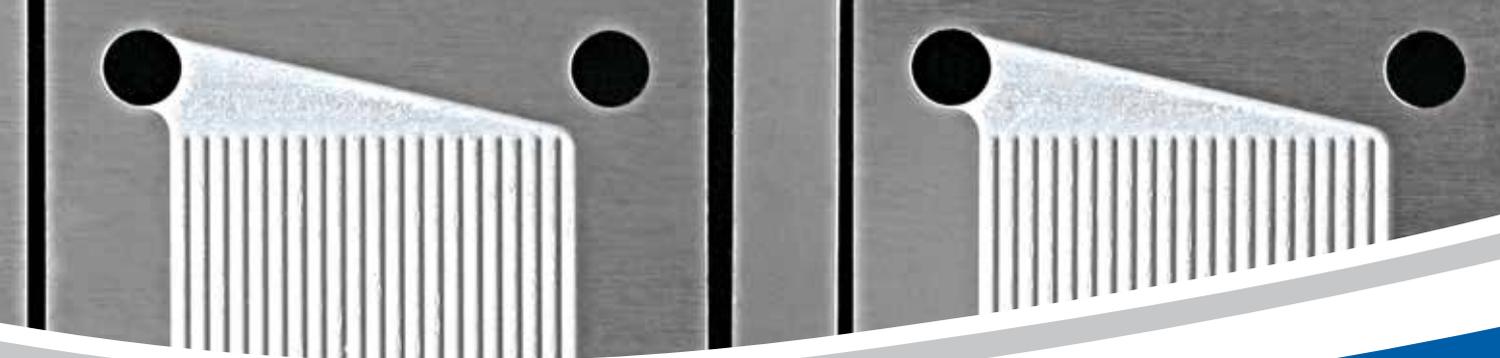


Application

- with fluids that need to be fluidically temperature-controlled particularly fast or in a particularly small space
- if only small differences are permissible between the target temperature and the temperature of the heat transfer medium
- small channel dimensions are eminently suitable for particle-free fluids with a low viscosity

Characteristic

- the core element is a diffusion-bonded stack of micro-structured stainless steel foils
- efficient heat transfer between the fluids
- low residence volume
- heat transfer coefficients (kA/V) of some 10 MW/m³
- heat transfer area: 74 cm²
- two Pt100 temperature sensors, at the inlet and outlet channel respectively, provide close-to-process measurement of the fluid temperature
- pressure up to 30 bar (at 25 °C)

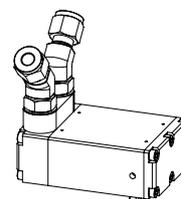


Coax Heat Exchanger

A4, HC

Type of temperature control: fluidic

→ Art.-No. 0309-4



Application

- for temperature control of process fluids – including those of higher viscosity or with particle loadings

Characteristic

- low susceptibility to blockages
- heat transfer area: 71 cm²
- pressure up to 100 bar (at 25 °C)
- can be completely dismantled
- low pressure drop

Heater Module

A4, HC

Type of temperature control: electrical

→ Art.-No. 0351-3



- pre-heater upstream of a mixer or reactor, if there is a need to avoid handling temperature control liquids
- for defined electrical heating of a process fluid

- compact construction: capillary helix soldered onto an electrically heated block of copper
- heat transfer area: 17 cm²
- pressure up to 100 bar (at 25 °C)
- two Pt100 temperature sensors – for the temperature of the heating block and the temperature of the process fluid at the module outlet



Sensors & actuators

More than instrumentation and control.

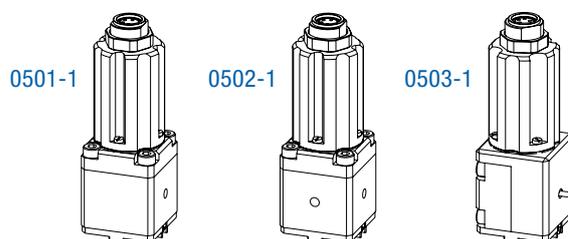
For smooth operation of the Modular MicroReaction System, other components are important too: sensors that measure pressure, temperature or flow rate, and transmit the information they acquire.

With the aid of actuators, the system then ensures that all process parameters can be optimally harmonised and regulated. And for you this means all systems go. Thanks not least to the intelligent automation solution: LabManager® (page 35), developed for the specific requirements encountered in a laboratory. You already have an automation system? No problem. The MMRS is uncomplicated in this regard as well.

Temperature Sensors

A4, HC

→ Art.-No. 0501-2, 0502-2, 0503-1

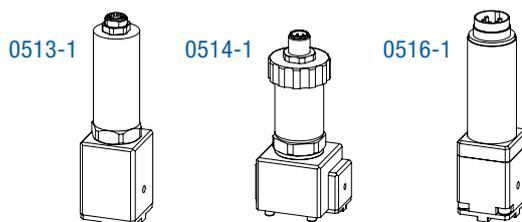


- for temperature measurement in the fluid channel with a Pt100 sensor
- enable additional measuring points to be provided at any desired positions in the system set-up
- connection directions of 90° and 180° available
- can be used at pressures of up to 100 bar

Pressure Sensors

A4, HC

→ Art.-No. 0513-2, 0514-1, 0516-1



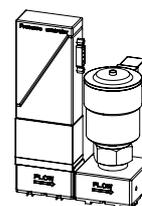
- for measuring the pressure in the fluid channel
- for the following pressure ranges: 25 bar, 100 bar (others on request)
- can be used at temperatures of up to 80 or 150 °C, depending on the model involved



Pressure Controller, electronic

A4

→ Art.-No. 0515-1

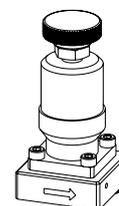


- for automated pressure control in the MMRS
- compact module with pressure sensor and pressure controller in stainless steel construction
- pressure differential up to 40 bar
- can be used at temperatures of up to 70 °C
- as forward or back pressure controller available

Back Pressure Regulator, mechanical

A4, HC

→ Art.-No. 0609-1

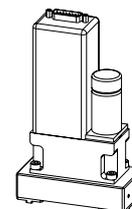


- for manual pressure regulation in the MMRS
- pressure adjustment using a setting wheel
- pressure ranges: various models, max. 25 bar
- can be used at temperatures of up to 80 or 200 °C, depending on the model involved
- materials coming into contact with the fluid are stainless steel and FFKM or PEEK (others on request)
- for pressure regulation at the outlet of the system

Mass Flow Controller, thermal, for gases

A4

→ Art.-No. 0542-1

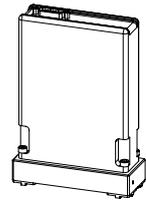


- for dosing gas flows
- integrated temperature compensation for volume flows of up to 30, 50 or 100 NL/h (others on request)
- temperatures up to 65 °C
- can be used at pressures of up to 40 or 60 bar, depending on the model involved

Coriolis Mass Flow Meter

A4

→ Art.-No. 0545-1

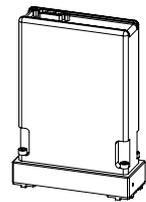


- mass flow meter serves to monitor the substance flows being used
- can be used for both gases and liquids
- enables the flow rate to be measured independently of other physical characteristics
- volume flow between 0.01 and 14 kg/h (water), depending on the model involved
- option for measuring the density of the substance flow
- temperatures up to 65 °C
- pressure: up to 30 or 100 bar, depending on the model involved

Coriolis Mass Flow Controller

A4

→ Art.-No. 0546-1

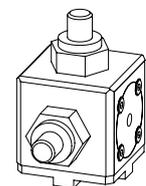


- mass flow controllers are used to regulate the substance flow to ensure a desired setpoint value, for this purpose, a coriolis mass flow meter and a control valve are installed in a single module
- volume flow is adjustable between 0.01 and 18.6 kg/h (water), depending on the model involved
- temperatures up to 65 °C
- pressure: up to 60 bar

Optical Flow-Through Cell

A4, HC

→ Art.-No. 0551-2

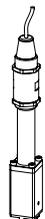


- for measuring
 - › absorption and transmission in 180° geometry
 - › fluorescence and scattered light in 90° geometry
- contains a cuvette made of quartz glass and three standard-SMA connections for linking up optical fibre cables
- the Spectrobay® NIR process spectrometer from Bayer Technology Services, for example, is well suited for connection
- temperatures up to 200 °C
- pressure up to 20 bar (at 25 °C)

pH Sensor or Conductivity Sensor

A4, HC

→ Art.-No. 0563-2

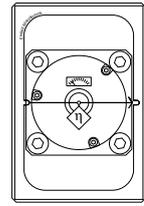


- for precise measurement of the pH value and conductivity in aqueous solutions
- simple installation and removal of the standard electrodes
- good wetting and long lifetime of the electrodes
- can be used at temperatures of up to 80 °C
- pressure up to 4 bar (conductivity sensor) or 5 bar (pH sensor)

Viscosity and Density Sensor

A4

→ Art.-No. 0581-1



- for measuring the viscosity and density of Newtonian liquids
- viscosity measuring range: 0.3 – 100 mPas
- density measuring range: 0 – 2,000 kg/m³
- temperature range: -20 – 110 °C, integrated temperature measurement
- pressure up to 100 bar (at 25 °C)

2-, 3- and 4-Way Ball Valve

A4, HC

- Art.-No. 0605-3
- Art.-No. 0606-3
- Art.-No. 0607-3

0606-3
0607-3



0605-3



- for cut off of fluid branches inside the MMRS
- manually operated
- can be used at temperatures of up to 180 °C
- pressure up to 100 bar

Relief Valve

A4, HC

→ Art.-No. 0608-1



- limits the maximum operating pressure
- for protecting pressure-sensitive parts of the system
- enables pressure to be relieved in a piping or collecting system
- can be responsively adjusted to suit the pressure conditions specified between 3.4 and 100 bar
- can be used at temperatures of up to 93 °C



Links and connections

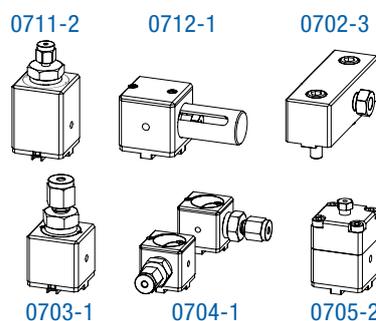
Fitting it all together.

An innovative technology will be successful only if everything is harmonised and fit for purpose down to the tiniest of details. The Modular MicroReaction System meets these requirements in full. To make sure that one module fits neatly into another we offer you a multitude of connection components that link pumps and thermostats snugly to the MMRS. And there's a beneficial side-effect: the sealing plates avoid passive volumes between the microreaction modules almost entirely.

Inlet / Outlet, Inlet with Injector, Direct Outlet, T-Inlet / Outlet Module, Inlet / Outlet 90°, Filter Inlet

A4, HC

→ Art.-No. 0711-2, 0712-1, 0702-3, 0703-1, 0704-1, 0705-2

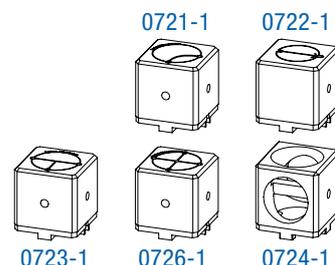


- for supplying and removing the reactants in the MMRS
- the direct outlet is particularly well suited for precipitation reactions, and can be installed downstream of the Valve Mixer 30 (page 15)
- inlet modules with a replaceable filter prevent contamination or blockage of the microreaction setup due to entrained particles
- the following connection types are available: 1/16", 1/8" or 1/4" with Swagelok® or Valco® screw union
- special connections

Connection 90° and 180°, Connection T-Shape, Connection X-Shape, Insulation Module

A4, HC

→ Art.-No. 0721-1, 0722-1, 0723-1, 0726-1, 0724-1



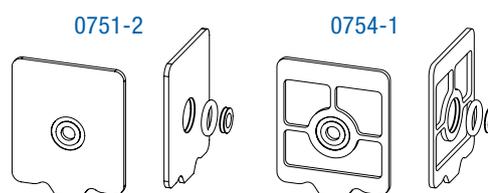
- connection modules create a 90° or 180° link between two microreaction modules
- the insulation module is used when two modules have to be operated at different temperatures and the heat flow between the two of them is to be minimised
- connection in T-Shape with three connections and X-Shape with four connections for simple branching
- 90° and 180° connection modules for additional geometrical degrees of freedom on the base plate



Sealing Plate, Insulation Sealing Plate

A4, HC

→ Art.-No. 0751-2, 0754-1



→ Sealing Plate

- › consists of an outer plate, the O-ring and an inner support ring
- › is installed between two modules with opposing fluid openings
- › can be positioned precisely on the base plate

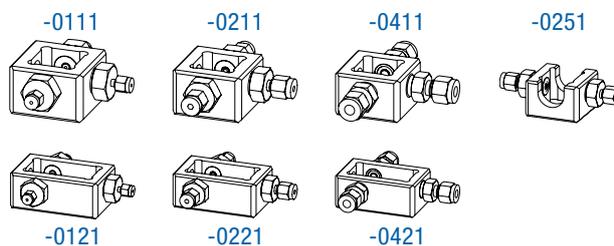
→ Insulation Sealing Plate

- › consists of PEEK reinforced with carbon fibres, and possesses only a very small contact surface with the adjoining modules
- › reduces thermal conductivity between two adjoining modules

Stand-alone Adapter

A4, HC

→ Art.-No. 0840-2



→ for the use of a standard MMRS module as a stand-alone module

→ acts as an interface to peripherals, like pumps or collecting vessels

→ Types:

- › Art.-No. -0111-F/-0114-F, -0211-F/-0214-F, -0411-F/-0414-F for insertion of an 1 x 1 module (e. g. Slit-Plate Mixer LH2)
- › Art.-No. -0121-F/-0124-F, -0221-F/-0224-F, -0421-F/-0424-F for the insertion of an 2 x 1 module (e. g. Cascade Mixer) or for 1 x 1 modules (e. g. two sensor modules) with a mixing plate in between
- › Art.-No. -0251-F/-0254-F for the insertion of the Optical Flow-Through Cell (only 1/8" connection)

→ the adapter connections are available as compression fittings (Swagelok® or Fitok® in the sizes 1/16", 1/8" or 1/4")



Clamping components

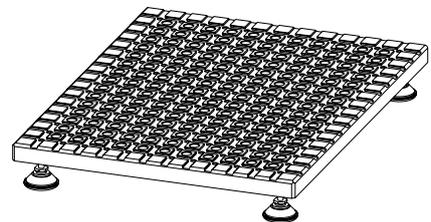
All that's needed is a single socket key.

To synergise the individual modules of our system into a perfectly functioning whole, you need clamping elements to assemble it. Our clamping modules render this step totally uncomplicated. All that's needed is a hexagon socket key for pressure-tight clamping of the modules – it could hardly be simpler.

Base Plates

Größen: A5, A4, A3

→ [Art.-No. 0811-1](#)

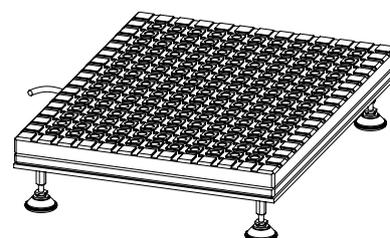


- serves as a carrier and positioning aid, on which all components of the Modular MicroReaction System can be flexibly mounted
- divided into a square raster with individual cells measuring 25 x 25 mm
- available in the following sizes: A5, A4 and A3, modelled on DIN 476 for paper formats
- made of aluminium
- sturdy and easy to clean



Base Plate Heater

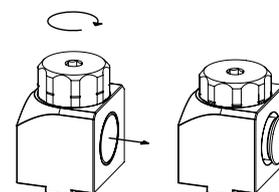
→ Art.-No. 0830-2



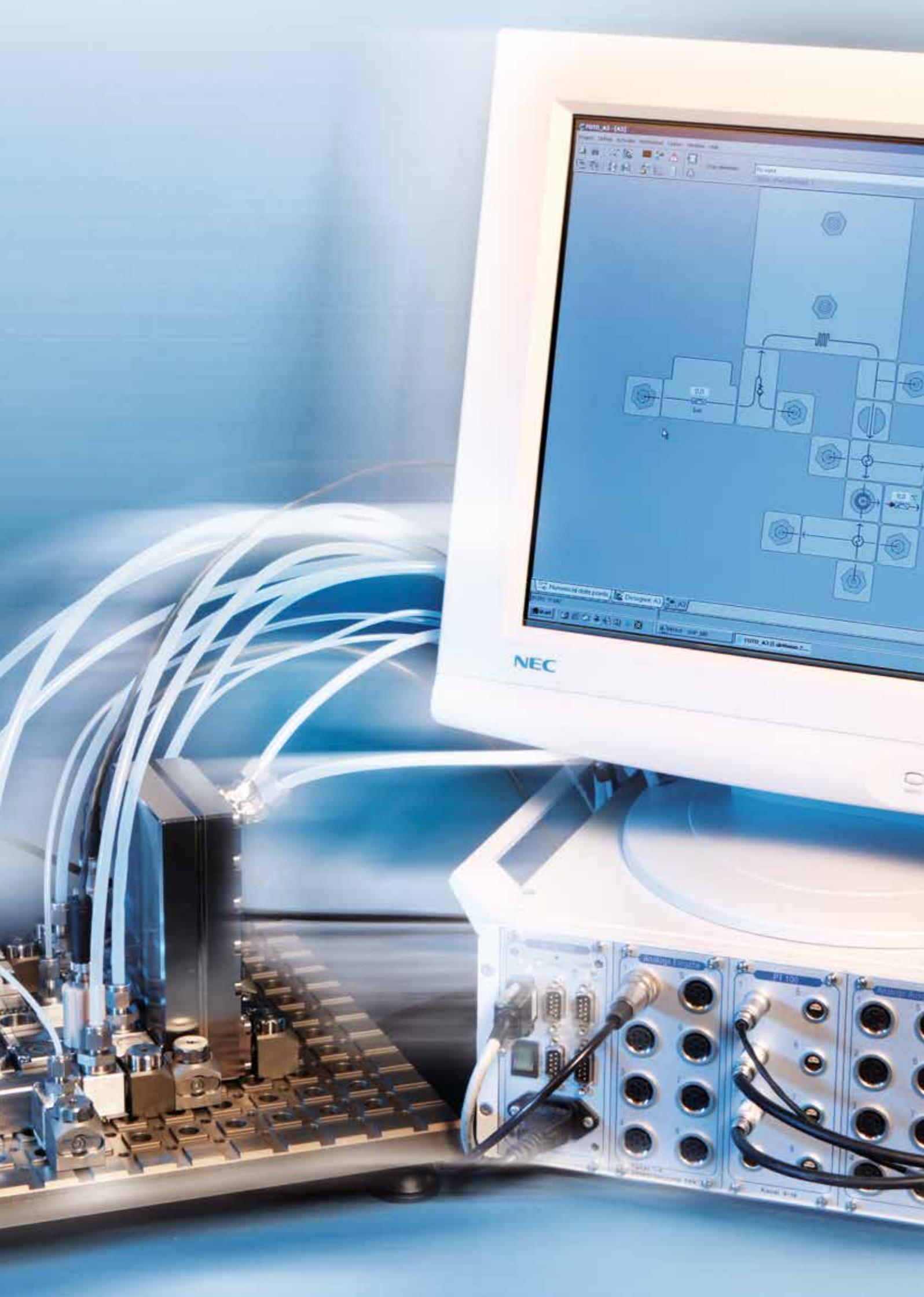
- electrical heating plates, which can be screwed in place under the base plates of the MMRS
- for even temperature control of the entire set-up
- expands the application options of a system
- ensures controlled electric heating of the base plate up to 200 °C
- heat transfer area: 1.5 cm² per raster unit
- available for all standard base plates in the following sizes
 - › A5: 8 × 6, A4: 12 × 8 and A3: 16 × 12 raster dimension
- good thermal coupling of the modules to the base plate, since aluminium is used for the modules' own bottom plates, while the standard delivery package includes insulating bottom plates made of PEEK

Clamping Module

→ Art.-No. 0821-3



- for clamping the modules in place on the base plate, at each end of a module row (page 12)
- pressure-proof and simple clamping by turning a knob
- the housings of the clamping modules are made of aluminium
- springs inside the clamping elements ensure a tight seal even in the event of thermal expansion





Automation system

Smart with LabManager®.

For the Modular MicroReaction System, we offer a responsively fit-for purpose automation solution in conjunction with Hitec Zang: a process automation system called LabManager®, which integrates all the requisite functions in a compactly dimensioned device – with well-nigh unlimited options. External individual components and the customary control cubicle are thus history.

LabManager® scores highly in terms of flexibility, performative excellence and exceptional user-friendliness. Because with the aid of the module library, developed exclusively for the MMRS, users enjoy the benefits of intuitive access: each module is depicted as a symbol on the software's user interface – even the data point links have been preconfigured. LabManager® consists of a control unit and the associated visualisation and automation software package, called LabVision®. The modules of the Modular MicroReaction System can be connected to the interfaces of the control unit using special cables, responsively altered and supplemented at will, in this way, you can read out and control up to 1000 data points. This is what smart instrumentation and control looks like nowadays.

Salient data:

- suitable for the Windows® 7 and higher
- meets the recommendations of the User Association for Automation Technology in the Process Industry (NAMUR)
- designed for processes with frequent changes to the configuration

FlowPlate® MicroReactors

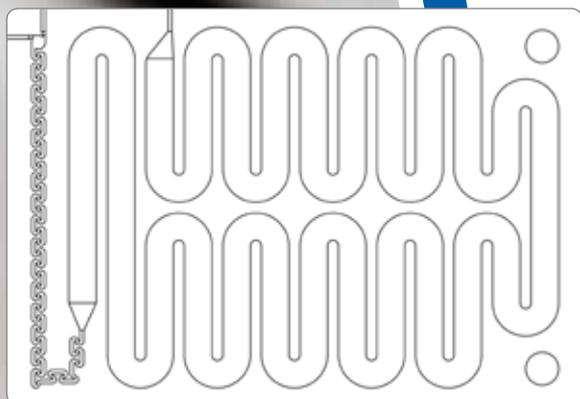
Award-winning technology.

The FlowPlate® MicroReactor concept is acknowledged as one of the world's leading designs. It was developed by the internationally operating life science company Lonza, and has won some rather prestigious prizes. Ehrfeld Mikrotechnik BTS is the exclusive distributor for FlowPlate® MicroReactors worldwide. As the cooperation partner, we work together on marketing and design-enhancing this innovative microreactor concept: an easily scalable process technology for continuous production of fine chemicals and pharmaceuticals – which explains the accolades. We thus offer our customers in the pharmaceutical industry a fit-for-purpose toolkit for putting in place tomorrow's systems today.

Mixing structure SZ:
for homogeneous
reactions at plug-flow
modus

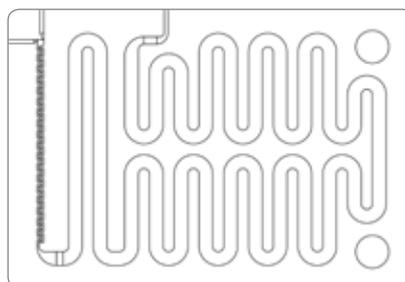
FROM LABORATORY TO PRODUCTION

A concept that covers all the phases of a product's life-cycle, from the tiniest laboratory scale in preclinical/clinical research, to pilot lines, and all the way through to commercial production, has been translated into engineered reality with the FlowPlate® MicroReactors. They ensure quick and easy scale-up for developing active pharmaceutical ingredients (APIs) and production under cGMP conditions. Production measured in tons can be up and running within a few short weeks.

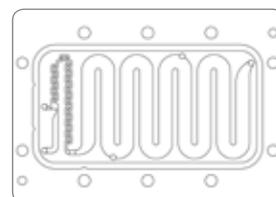


FlowPlate® A5

Material of the process plates: **Hastelloy®**



FlowPlate® A6



FlowPlate® Lab



FlowPlate® A5 for
volume flows up to
20 Liter per hour

ONE CHANNEL – LOTS OF ADVANTAGES

What's innovative about the FlowPlate® MicroReactors is their enclosed single-channel design – with significant advantages for your process:

- volume flows from a laboratory scale of a few mL/min up to production rates of up to 20 L/h and more
- quick and easy scale-up by channel upsizing under well-nigh constant process conditions
- very high heat transfer capacity
- simple process control
- flexible adaptation for different reactions:
 - › homogeneous: SZ or TG structure
 - › liquid-liquid / gas-liquid: LL structure by fast replacement of process plates
- safe handling of hazardous reagents
- can be used up to a pressure of 100 bar
- the concept eliminates passive volume, thus avoiding any residues inside the channel (CIP = Cleaning in Place)
- easy cleaning and maintenance, ready for cGMP

To sum up: the compact and versatile design of the FlowPlate® MicroReactors opens the way to innovative production concepts. And these in their turn lead to production lines for active ingredients and specialty chemicals, which can be very simply expanded and adapted using modularised components. This means that demand-responsive production and completely monitorable high-speed lines are no longer a vision for the future – they are reality. Here and now.



Mixing structure TG:
for homogeneous
reactions
with backmixing

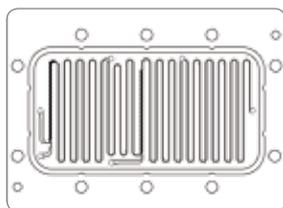
FLOWPLATE® LAB MICROREACTOR

This one is the smallest in the range, but is superbly equipped: the FlowPlate® Lab is optimally suited for feasibility studies in the laboratory, for process development jobs and for preclinical research. The micro-structured process plate contains up to ten inlets and outlets along the process section, for concomitantly enhanced flexibility. A sight glass enables the flow processes involved to be visually monitored along the entire channel. To find the best version for your own particular process, these reactors can be run with different process plates, which can be easily replaced and manufactured to match your requirements precisely. We offer you the FlowPlate® Lab MicroReactor in two different variants: as a stand-alone device or as a module for the MMRS (page 20). The dimensions are identical, just the connections are different.

Standard type 1: Process plate Multiinjection SZ

Channel: 0.6 x 0.5 mm²
Mixer nominal width: 0.2 mm
Volume: 0.4 mL
Flow range: 1.5 – 15 mL/min
Connection points: 6

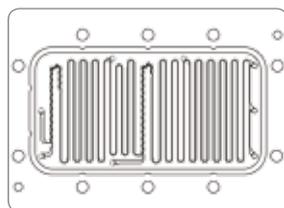
→ Art.-No. 1701-1642



Standard type 2: Process plate Multiinjection TG

Channel: 0.6 x 0.5 mm²
Mixer nominal width: 0.2 mm
Volume: 0.4 mL
Flow range: 1.5 – 15 mL/min
Connection points: 8

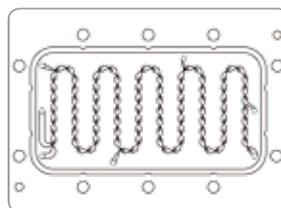
→ Art.-No. 1701-2643



Standard type 3: Process plate LL

Channel width (max.): 2 mm
Mixer nominal width: 0.2 mm
Volume: 0.4 mL
Flow range: 1.5 – 15 mL/min
Connection points: 8

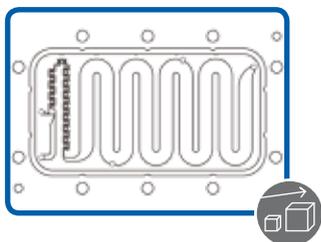
→ Art.-No. 1701-4682



Process plate SZ (large)

Channel: 5.0 x 0.5 mm²
Mixer nominal width: 0.5 mm
Volume: 1.0 mL
Flow range: 15 – 150 mL/min
Connection points: 5

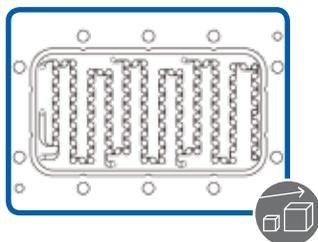
→ Art.-No. 1701-1301



Process plate TG (large)

Channel width (max.): 2.5 mm
Mixer nominal width: 0.5 mm
Volume: 1.2 mL
Flow range: 15 – 150 mL/min
Connection points: 10

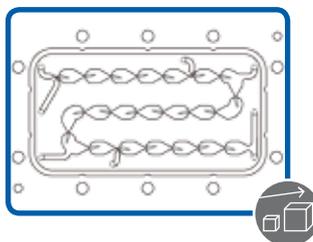
→ Art.-No. 1701-2380



Process plate LL (large)

Channel width (max.): 5 mm
Mixer nominal width: 0.5 mm
Volume: 1.2 mL
Flow range: 15 – 150 mL/min
Connection points: 8

→ Art.-No. 1701-4382



Mixing structure LL:
for heterogeneous
liquid-liquid or
gas-liquid reactions

MMRS

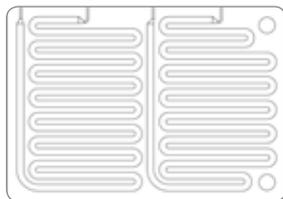
FLOWPLATE® A6 AND A5 MICROREACTORS

The range continues smoothly with the FlowPlate® MicroReactors in the A6 and A5 sizes: they're just as suitable for process development and research as for production under cGMP conditions on a pilot scale or for a product's market launch. The design resembles that of the laboratory version: the process plates feature channel structures for mixing and residence volumes, which can be easily replaced to suit the ongoing requirements involved.

Process plate pre-heating

Channel: 5.0 x 0.5 mm²
Volume: 6.8 mL
Connection points: 2 + 2

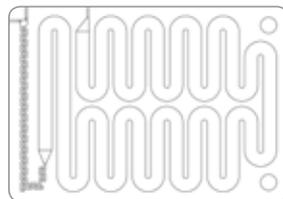
→ Art.-No. 1705-0201



Process plate SZ or TG

Channel: 10.0 x 0.5 mm²
Mixer nominal width: 0.7 mm
Volume: 16,4 / 16,5 mL
Connection points: 3

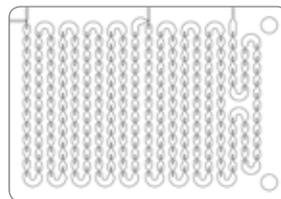
→ Art.-No. 1705-1111
→ Art.-No. 1705-2111



Process plate LL

Channel width (max.): 5 mm
Mixer nominal width: 0.5 mm
Volume: 11.0 mL
Connection points: 4

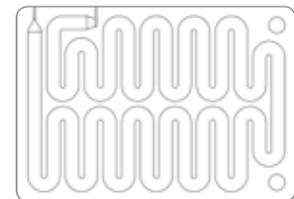
→ Art.-No. 1705-4381



Process plate residence volume

Channel: 10.0 x 0.5 / 10.0 x
1.0 / 10.0 x 2.0 mm²
Volume: 8.4 / 16.7 / 33.2 mL
Connection points: 2

→ Art.-No. 1705-0101,
1705-0111, 1705-0121



These and many other process plates (e. g. with venturi nozzles for particularly fast mixing of gas and liquid, or customised designs for your application) are available for all FlowPlate® models. Just ask us!

FLOWPLATE® A4 MICROREACTOR

This model is currently still in the planning stage. Once it has reached maturity, the A4 MicroReactor will open up a whole new dimension for its users: because with this reactor, whose footprint is no larger than a sheet of notepaper, you can start on commercial manufacture of your product: under cGMP conditions and with flow rates of up to 40 kg/h. With its flexible adaptability to a multitude of different processes, its sturdy construction, plus simple cleaning and maintenance, the FlowPlate® A4 constitutes a totally dependable, high-performance microreactor.

FlowPlate®



ART®

Miprowa®

ART[®] plate reactors:

Modular & versatile –
from development to production.

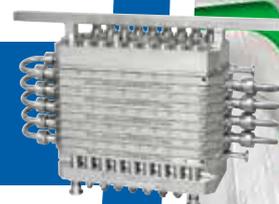
Modular, versatile, flexible, scalable, robust, economical, safe – the ART[®] plate reactors boast a long list of beneficial product characteristics. And this is only just the beginning. Because the exceptionally promising flow chemistry technology is the solution of the future for a broad spectrum of chemical processes.

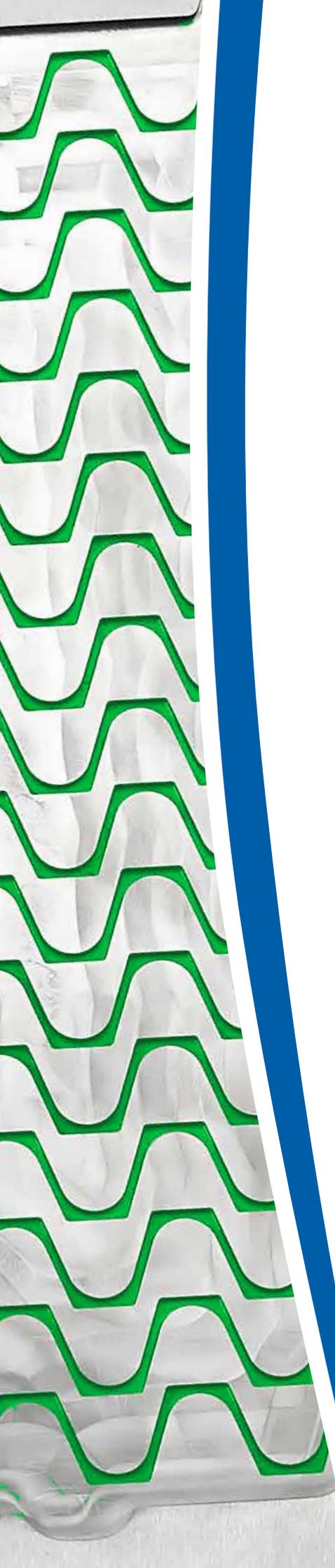
HIGH YIELDS – OPTIMUM ENERGY-EFFICIENCY

ART[®] reactors are milli-structured plate reactors, innovative and industrially proven. They combine the performative capabilities of a heat exchanger with intelligently configured reactor plates to create a modularised reactor unit. Their strengths include excellent heat transfer, tight distribution of the residence time, and fast mixing in comparison to conventional designs. This results in a significantly intensified process – the yield rises, the costs fall, thanks to the superlative efficiency, and all this combined with maximised dependability.

ART[®] reactors can be completely disassembled, which makes them easy to clean. Because of their robust industrial design and the metallic material, the compact equipment is ideally suited for a broad spectrum of reaction categories – from development to production applications. Moreover, they provide enhanced options for monitoring, since Process Analytical Technology (PAT) can also be very effectively integrated. This benefits not only producers of fine and specialty chemicals, but also companies in the biotech and pharmaceutical industries.

Flexibility for process
optimization and pilot scale:
ART[®] plate reactor 37





THE ART[®] PRODUCT LINE FEATURES:

- ART[®] LabPlate[™] / ART[®] plate reactor 37 – for laboratory and pilot scale applications
- ART[®] plate reactor 49 – for production scale

Regardless of the scale of your application, whether process development or production – you will benefit from an abundance of advantages:

- outstanding heat transfer characteristics, rapid mixing and narrow residence time distributions
- increased safety due to relatively small reaction volumes in continuous operation
- easy to clean as reactors can be completely disassembled
- reactors are made from metal and therefore robust (SS 316L / Hastelloy[®] C22)
- modular construction adapts to a broad range of reaction conditions, also suitable for suspensions
- different temperature zones within the same apparatus
- serial and parallel operation
- additional ports allow multiple injection, multi-step reactions, and sampling in mid-process
- efficient process control as process analytics (PAT) are easily integrated
- application in multi-purpose plants leads to flexible product change-over
- robust production technology

ART[®] technology: Your process will benefit too – for sure.



ART® PLATE REACTOR LABPLATE™/PR37

The PR37 Plate Reactor can be fitted with up to ten horizontally arranged plates featuring different channel dimensions. The constructionally identical model LabPlate™ can accommodate up to two plates. The four plate sizes available possess the following process volumes:

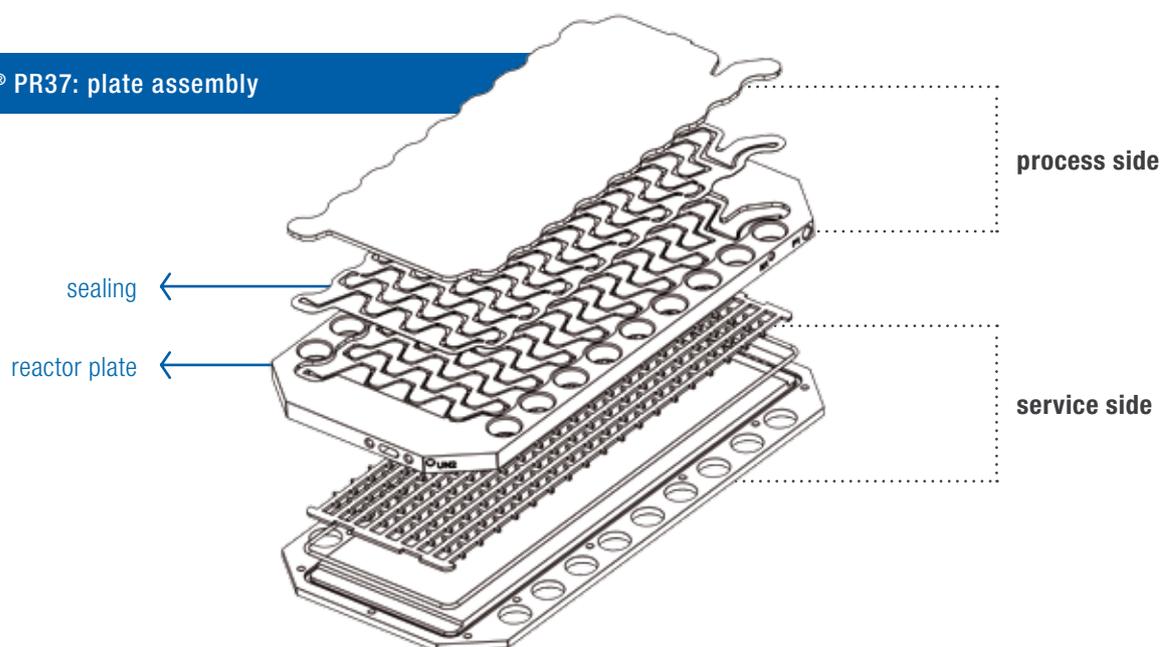
- 3.5 mL
- 13.6 mL
- 24.9 mL
- 47.7 mL

Since all plate channels contain deflections, continuous mixing is assured throughout the process. Upscaling is then effected by increasing the channel's width/height from one plate to the next larger one.

The plates can also be individually heated up or cooled down fluidically. This enables different temperature zones to be implemented in a single unit. Each plate features up to ten inlets. Depending on the application concerned, these can be fitted with injection nozzles for multi-injection, for multi-stage syntheses, or with thermocouples for temperature measurement.

The plates of the PR37 are constructed in such a way that the reactor plate is temperature-regulated from one side. In the plate stack, the levels of the process and service media alternate evenly. The individual plate elements are each fitted with seals; this means that every plate can be completely dismantled, and can be easily cleaned at need. There is also an option for a CIP (= Cleaning in Place) procedure, i. e. without having to open the reactor.

ART® PR37: plate assembly





ART® PLATE REACTOR PR49

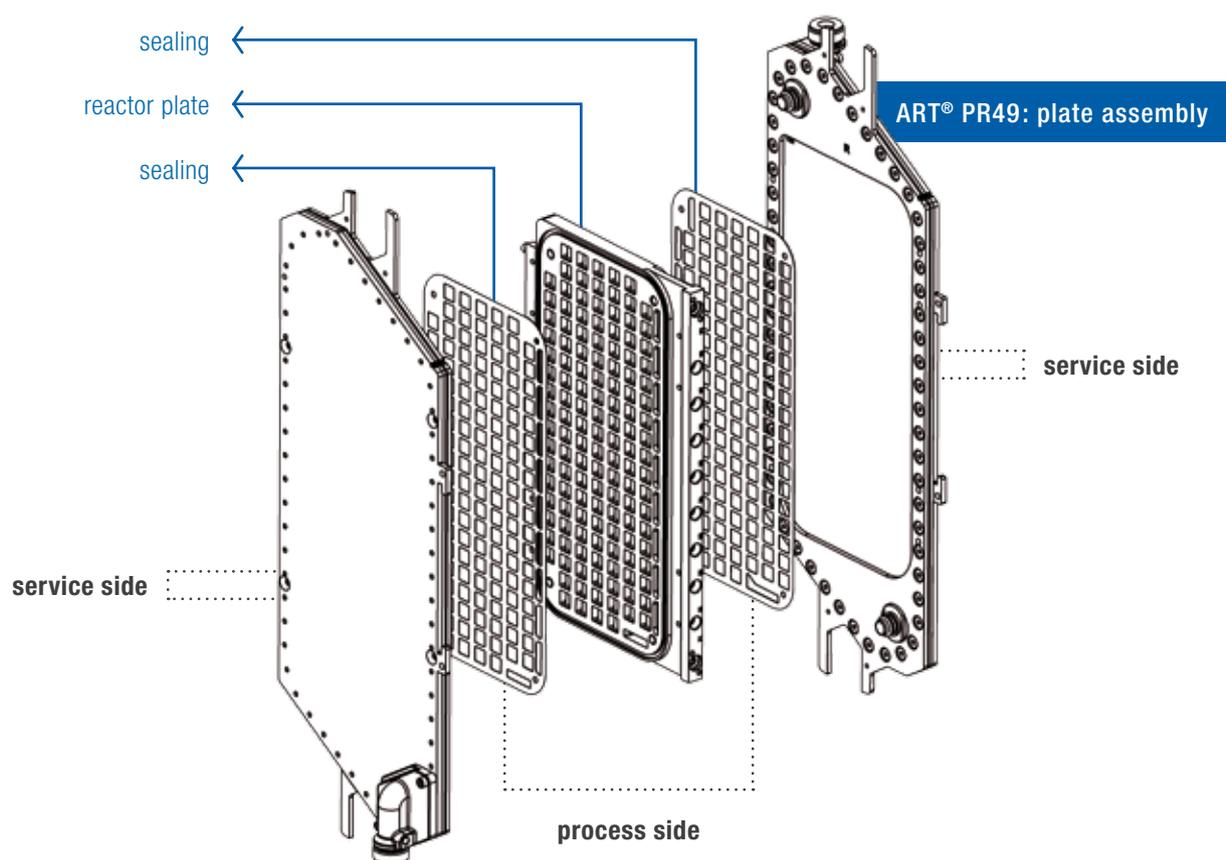
In the shape of the PR49 Plate Reactor, we offer an extension of the family in a higher volume flow range of up to 1,000 l/h. This plate reactor is in terms of its functions and elements comparable to the PR37. The unit can be fitted with up to ten vertically arranged plates featuring different channel dimensions. The three plate sizes available possess the following process volumes:

- 450 mL
- 810 mL
- 1,450 mL

It should be noted that the plates of the PR49 are constructed in such a way that their users can heat up or cool down the reactor plate fluidically from two sides. The delivery package also includes the accessories, such as a lifting device for replacing plates or a filling aid for the service fluid. These parts can be simply ordered additionally if required.

For all ART® Plate Reactors described here, the following data apply:

- temperature range up to 200 °C
- pressure range up to 20 bar



Miprowa[®] high-performance reactors and heat exchangers

Rectangular does the trick.

Fast upscaling from ultra-small to production level under the same process conditions – with the innovative Miprowa[®] technology, this is engineered reality. These path-breaking, highly efficient reactors and heat exchangers are true masters when it comes to sophisticated temperature control jobs, since in comparison to conventional units they excel in terms of significantly higher heat transfer, thanks to their considerably larger surface-to-volume ratio. Another advantage of the Miprowa[®] technology is its continuous and intensive cross-mixing capability. Even scale transfers from one litre to high volume flows of up to 10,000 litres per hour pose no problems at all for these compactly dimensioned units.

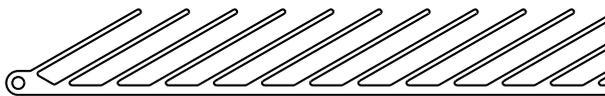
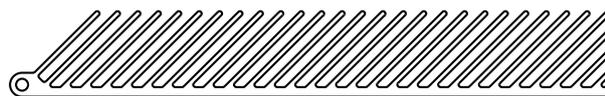
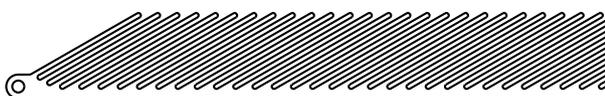
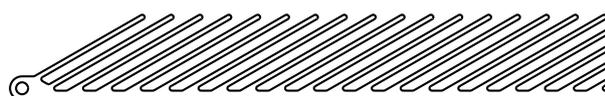
FLEXIBLE LAYERS

The secret of Miprowa[®] is its channels: they are not round, but rectangular in shape, relatively wide but not very high. Inside them are structured inserts that can be placed one on top of another in several layers to form a fine flat grid. Depending on the product requirement involved, the user can replace the easily withdrawn grids so as to influence heat transfer, pressure drops and mixing intensity.

Miprowa[®] channel with mixing inserts, view on the cross-section



Miprowa[®] for volume flows up to 2,000 Liter per hour



Inclination	Strut width	Spacing
Standard type: Single-comb insert NK 2241		
30 °	1.0 mm	2.0 mm
Single-comb insert NK 2221		
30 °	1.0 mm	1.0 mm
Single-comb insert NK 3241		
45 °	1.0 mm	2.0 mm
Single-comb insert NK 2281		
30 °	1.0 mm	4.0 mm

SMALL DIMENSIONS, GREAT PERFORMANCE

Miprowa® channels and units score highly in terms of performative excellence: a milli-reactor or milli-heat exchanger is dimensionally smaller than a conventional shell-and-tube design. The Miprowa® Lab Reactor (page 19), with a channel cross-sectional area of 12 x 1.5 mm², is optimally equipped for lab-scale operations. It is suitable for developing and optimising processes and equally appropriate for product development jobs. The larger Miprowa® units, designed for use in a pilot plant or a production line, have a cross-sectional area of 18 x 3.2 mm², which ensures sturdy durability and easy cleaning whenever necessary. High flow rates can be achieved by connecting up to 1,000 channels in parallel instead of resorting to elaborate upscaling – as with a shell-and-tube design. We offer you the Miprowa® Lab in two variants: as a stand-alone device or as a module for the MMRS (page 19). The package also includes an integrated Pt100 temperature sensor for effective process monitoring in the channels.



EFFICACIOUS TECHNOLOGY

With our Miprowa[®] reactors, you optimise not only your engineered processes, but also your costs for equipment and energy consumption – while at the same time they are gentle on any sensitive materials, thanks to short residence times and low wall temperatures.

The Miprowa[®] technology

- we offer this as synergised units for use as continuously operated reactors or heat exchangers
- technically designed to handle an operating pressure of up to 16 bar and operating temperatures of up to 200 °C (higher pressures and temperatures are possible on request)
- uses standardised materials like stainless steel and Hastelloy[®] (others on request)
- is optimally suited for exothermic and endothermic reactions, like nitration, hydrogenation or oxidation
- can also be used for fast heating, cooling, condensing, evaporating
- is already being used on an industrial scale, and is an attractive option for companies in the following industries: fine and specialty chemicals, petrochemicals, polymer chemistry, and the food, beverage and cosmetics industries

The Miprowa[®] variants

- Miprowa[®] Lab – high flexibility for the MMRS (page 19)
- Miprowa[®] Matrix – our standard for laboratories and pilot plants
- Miprowa[®] Production – customised for your own production process

MODULAR AND SMART

Miprowa[®] apparatus are your key to smart production, because they can repeatedly be revamped to suit different requirements. We will most definitely have the right one for you. A special mixer, for instance, can be integrated for mixing gas-liquid flows with superb efficacy even before they enter the rectangular channel. An abundance of flange variants changes the basic unit to suit your particular process conditions. Sensors, too, can be easily integrated if precise monitoring of the temperature is required. We also offer our customers a maximised choice when it comes to coating any mixing inserts. For each reaction, we find the particular material you need, so that you can yourself coat the mixing inserts with a catalyst.

With the Miprowa® Matrix, we offer you a choice of standardised, quickly available units:

Miprowa® Matrix with 12 x 1.5 mm²

with standard type inserts (NK 2241)

Number of channels	(1)	3
Channel length	Process volume*	
300 mm	5 mL	14 mL
600 mm	8 mL	24 mL

Miprowa® Matrix with 18 x 3.2 mm²

with standard type inserts (NK 2241)

Number of channels	(1)	3
Channel length	Process volume*	
600 mm	19 mL	71 mL
1,200 mm	46 mL	136 mL

* Matrix apparatuses will be delivered with 3 channels; volume reduction and thus reducing of the channel number (to only 1 channel) is done by turning the end flange.

* Process volume will vary depending on the geometry of the flow inserts.



Special models

Function superbly alone as well.

You need tailormade equipment like a mixer, a reactor or a heat exchanger for a special application? Here, too, we have the right solutions. Like our easy-to-dismantle Gas Phase Reactor for catalyst coatings. Or our Photo-Reactor XL for light-induced reactions on a pilot scale.

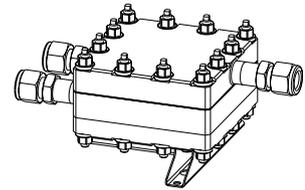
Your requirements are even more specialised?

No problem – we can make you customised equipment as well.

Slit Plate Mixer LH 1000

A4, HC

→ [Art.-No. 0110-2](#)



Application

- so far the largest model in the LH series of Slit Plate Mixers
- suitable for production and large pilot-scale operations
- for fast mixing of low-viscosity liquids with flow rates of a few 100 L/h up to a few 1,000 L/h with pressure drops of just a few bar

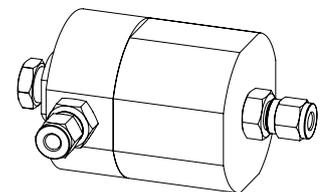
Characteristic

- compact, sturdy construction using only a few components
- easy to dismantle
- quick and easy maintenance
- different slit widths in the mixing and aperture plates for different mixing intensities

Valve Mixer 300

A4, HC

→ [Art.-No. 0121-1](#)



Application

- innovative mixer type with one special feature: the non-return valve is able to largely prevent any backflow of the mixture
- microstructures remain free of particle deposits, which in conventional types of mixer lead to blockages
- suitable for continuous precipitation reactions, e. g. for producing catalyst particles or colour pigments

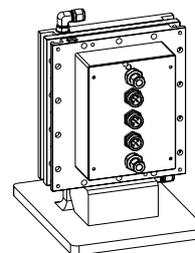
Characteristic

- volume flow up to 300 L/h
- mixing plates available with different nominal slit diameters 130, 250 und 480 µm

Photo Reactor XL

A4, HC

→ Art.-No. 0206-1



Application

- liquid media are converted by irradiation in the ultraviolet and visible ranges of the spectrum
- multifarious options for use in industrial and academic research and development, e. g. in the pharmaceutical industry and in the biotech sector
- for photocatalysis as well

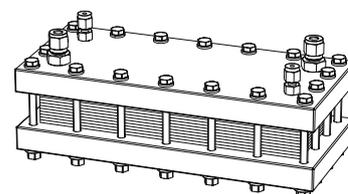
Characteristic

- good energetic efficiency and high spectral selectivity
- homogeneous irradiation
- layer thickness can be adjusted between 25 μm and about 100 μm by simple modifications (larger layer thicknesses on request)
- high-performance LEDs as a radiation source, available in wavelengths with spectral widths of approximately 20 nm
- convenient and versatile in use, since radiation sources from different vendors can be employed
- fluidic temperature control

Gas Phase Reactor

A4

→ Art.-No. 0254-1



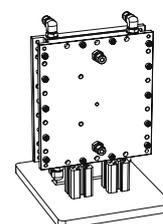
- gas phase reactions
- heterogeneously catalysed reactions at a wall catalyst

- features micro-structured stacks of plates, which can be coated with a catalyst
- the number of plates can be varied to suit the particular reaction involved
- process temperature: -20 – 200 $^{\circ}\text{C}$ (others on request)
- pressure up to 20 bar (at 25 $^{\circ}\text{C}$)
- temperature-controlled process volume per layer: 2.4 mL
- can be completely dismantled
- fluidic temperature control

Falling Film Micro Reactor

A4, HC

→ Art.-No. 0218-1



The Falling Film Micro Reactor serves to bring a flow of liquid into contact with a flow of gas under defined temperature conditions without mixing the two process media involved.

- process temperature: -20 – 120 $^{\circ}\text{C}$
- pressure up to 10 bar (at 25 $^{\circ}\text{C}$)
- empty volume: 36 mL
- recommended volume flow for the liquid: 1 – 15 mL/min
- can be completely dismantled
- fluidic temperature control

Equipment & applications

Our technology platform in overview.

EQUIPMENT FOR F&E



MMRS

(Modular MicroReaction System)

- Development of molecules and synthesis routes
- Process development / optimisation / intensification
- Small-scale production

EQUIPMENT FOR PRODUCTION

of active (pharmaceutical) ingredients

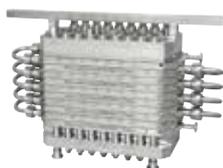
- easy to scale and to operate
- for pre-clinical and clinical phases as well for production campaigns

of Fine and Specialty Chemicals

- simple Scale-up with high scale-up factor at once
- for chemical production & multi-purpose applications



FlowPlate®
Microreactors



ART®
Plate reactors



Miprowa®
High-performance reactors

ANALOGY:

Plate-type heat exchanger

Tube-bundle heat exchanger

OUR KNOW-HOW FOR YOUR PROJECT

- Feasibility studies
- Installation support and application training
- Maintenance & after-sales support
- Strategic partnerships and equipment-referenced consultancy

More about this can be found on page 52.



And this is how your scale-up will succeed as well

Our equipment concepts score highly in terms of already exploiting potentials for further upscaling in the early phase of process development. That's the strength of our technology platform: in every phase, you possess precisely the right equipment in a synergetically harmonised configuration.

1 Research and development / Laboratory

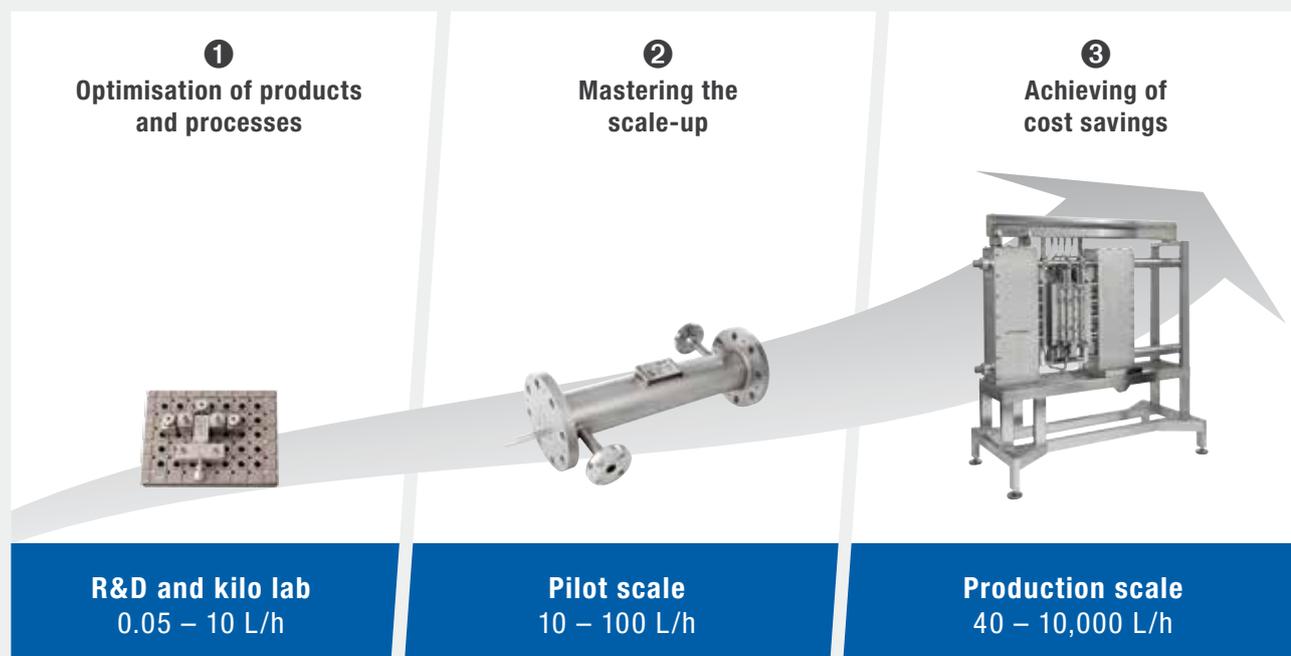
You start with MMRS – for optimum flexibility. The intelligent range of lab equipment is ideally suited for developing new products or optimising processes. Our interface modules enable you to move simply, quickly and safely into the next phases.

2 Piloting

With the FlowPlate® Microreactor A6, the ART® Plate Reactor PR37 and the Miprowa® Matrix Reactors, you have the right equipment for the pilot plant and for trialling your process and your line concept. This means you are optimally prepared for the crucial step involved, the transition into actual production.

3 Production

Our technology platform enables you to master the transition to full-scale production just as perfectly. Because this is where our high-performance devices come into play: FlowPlate® Microreactor A5, ART® Plate Reactor PR49 or a Miprowa® Production Reactor unveil their entire potential: not only do you get faster, more dependable production and enhanced efficiency, you also achieve significant cost savings.



Services & support

We are here to help you.

With the micro/milli-technology platform, you are opting for something radically new: you are transforming your process from a discontinuous to a continuous one. And because this change-over requires a readiness to innovate and in-depth expertise in process technology, we assist you in the implementation phase – and beyond.

As the technology leader, Ehrfeld Mikrotechnik BTS offers you everything you need for successfully using this innovative high-performance equipment:

- Our team: experienced, highly qualified and motivated engineers, scientists and technical sales experts.
- Our specialised in-depth knowledge of all mixer and reactor types – responsively matched to your own particular reaction.
- Our practical experience, gained in a multiplicity of international customer projects, whether in Europe, in the USA or in China.

We find solutions to your questions regarding

- the deployment and utilisation of microreaction technology in your company
- the right choice of modules and configurations from our Modular MicroReaction System, plus the selection of the system peripherals, e. g. for process and product development or process optimisation
- the planning of your line and the development of specialised components
- the composition of the system peripherals
- scale-up to milli-structured production equipment





We are experts when it comes to R&D, and support you in our laboratory

- with proof-of-principle studies for your investment decisions
- with trials that map out optimisation potentials for you

We synergise our corporate competences in our “Strategic Partnership Principle”, a new, comprehensive consultancy concept. With this convenience package, we support users who have opted to introduce this technology platform in their companies, so as to accelerate their thrust for success.

Joining forces for faster success.

As your partner, we assist you through all the phases of your project:

- We advise you on site, and ensure fast, effective process development.
- We support you in choosing the right equipment from the MMRS portfolio, in tests, during installation and implementation in your process.
- We coach you during scale-up, so that you can fully exploit all the technology's potentials. This means scale-up from the laboratory to production is completed quickly and cost-efficiently; your line operates profitably at an earlier juncture.
- We offer you special conditions for procuring the hardware, for spares and for service support.
- We train your staff.

With our Partnership Principle, we reduce your learning curve, and thus your time expenditure and your costs. Thus you generate added value, and achieve sustained success for your business.

Let's get acquainted – we're looking forward to hearing from you.

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residence time	→ 04		
scalability	→ 11, 13, 16f, 51		

The specifications given relate in all cases to the product version detailed in the catalogue and current at the time of printing (status June 2015), and may differ in the case of future versions. We reserve the right to changes and errors. Illustrations and drawings are only approximately determinant.



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