Modular Microreaction System -
a Powerful Tool for Process Development and Production

Olaf Stange, Matthias Kroschel, Frank Scheal, Frank Herbstritt

Ehrfeld Mikrotechnik BTS GmbH, Mikroforum Ring 1, 55234 Wendelsheim, Germany - www.ehrfeld.com

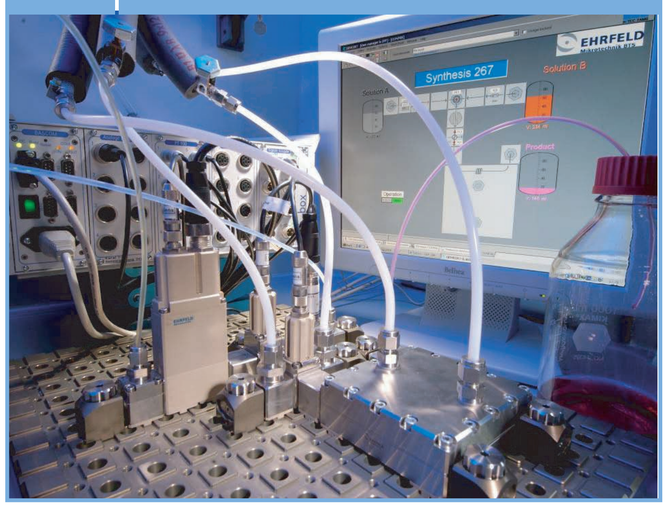
Introduction

Microreaction technology has received considerable attention during the past decade. The outstanding benefits of microreaction systems include ultra-fast mixing, highly effective heat transfer, quick system response and high safety due to low material hold-up. A particularly favoured technical solution for a microreaction system allowing laboratory scale as well as production of fine chemicals is based on a modular concept to allow flexible design and easy rearrangements of microreaction devices

In this contribution a modular microreaction system for process development and chemical production is displayed. It comprises modules for unit operations, such as various reactors, mixers, and sensors and a computer aided process control system.

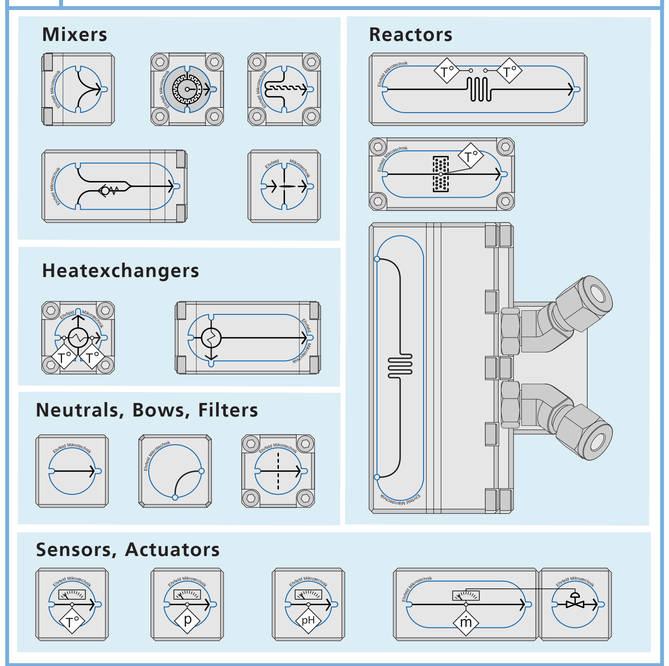
All devices have the common feature of simple cleaning and some are even applicable for precipitation reactions involving fluids with a high load of solid particles. Various type series cover throughput capabilities ranging from about 0.1 to 10 L/h, 10 to some 100 L/h and about 100 to some 1000 L/h when aqueous substances are applied. Depending on the design and materials of the modules, operating pressures of up to 100 bar and operating temperatures ranging from -100 °C to 250 °C are applicable. Standard materials in contact with process fluids are stainless steels like AISI 316Ti or Hastelloy C-276 while sealing gaskets are made from perfluorinated elastomers and polymers, respectively, as well as metals for high-temperature applications.

MMRS with LabBox

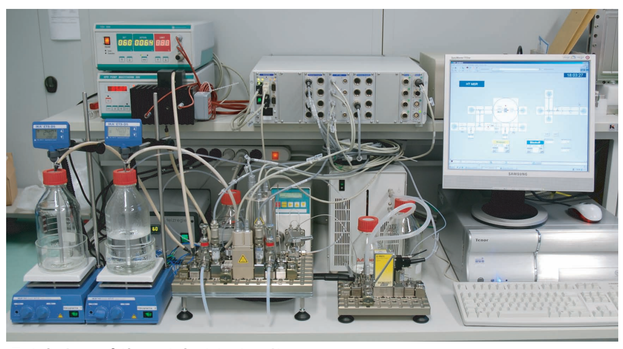


Microreactors and application examples

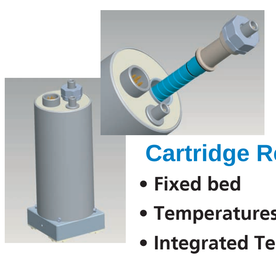
Modular Microreaction Toolbox



Catalyst Test Unit (Heated System)



Total view of the catalyst test unit



Comprising
- A heated base plate
- A heated pump
- A Lab-Box system
- A cartridge reactor XL

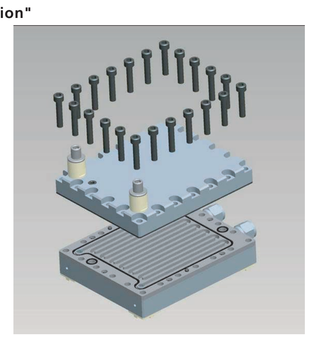
Cartridge Reactor XL
- Fixed bed
- Temperatures up to 250 °C
- Integrated Temperature sensors

Hydrogenation Test Unit

First base plate with "fluid handling section"

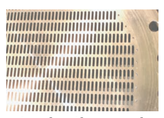
Comprising
- A heated base plate
- Coriolis mass-flow-controler
- Relief valves
- 2-Way valves
- A total of 3 base plates

Fixed Bed Meander Reactor
- Fixed bed
- Temperature range -20 ... 250 °C
- Pressure range up to 30 bar
- Volume of empty reactor: 24.5 mL
- Integrated temperature sensors



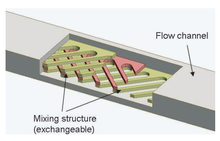
High Performance Reactors and Heat Exchangers

MIPROWA® design for industrial applications:
- Compact design
- Intensified mixing @ low flow rates
- Small „hold-up“ - low risk potential
- Large heat exchange area
- Short and defined retention time
- High corrosion resistance



Production scale 5-50 m³/h

Lab scale 3-10 L/h



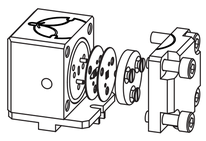
Areas of applications:
- Fast and effective heat transfer
- Careful heating of sensitive fluids
- Evaporation
- Residence time reactor with internal mixing and accurate temperature control

Scale-up

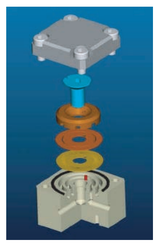
Slit Plate Mixers

Scale-up →

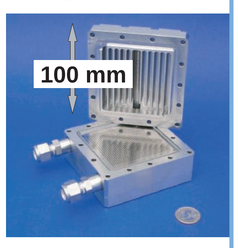
LH 2
20 slits, width 50 µm: throughput ~ 2 L/h



LH 25
300 slits, width 50 µm: throughput ~ 25L/h



LH 1000
20 000 slits, width 50 µm: throughput ~ 1000 L/h

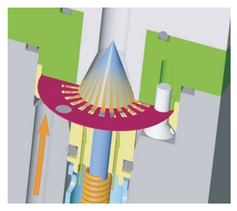


Valve-Assisted Mixers

Mixer for precipitation reactions

(i.e. synthesis of catalysts for CNT production)

Lab module (MMRS): throughput ~ 30 L/h



Development of up-scaled mixer promoted by funding through Bundesministerium für Bildung und Forschung (Project CarboScale)

Pilot module: throughput ~ 300 L/h

10 x

Conclusions: A versatile development platform

- The modular microreaction systems has been proven to be a versatile tool for process development as well as for chemical production.
- A wide variety of process lines dedicated to individual reaction classes can easily be constructed from a manageable set of modules.
- The modular microreaction system allows investigation of chemical processes in a broader parameter range and with reduced labor time consumption when compared to conventional equipment.
- Precipitation reactions can be carried out to produce particles in micrometer size range.
- Production scale micromixers enable development of processes involving mixing procedures with less scale-up difficulties.
- A computer-aided process control system is available for automated operation.

Contact

EHRFELD Mikrotechnik BTS

Ehrfeld Mikrotechnik BTS GmbH
Mikroforum Ring 1
55234 Wendelsheim
Germany
Phone: +49 (0) 6734 919300
Fax: +49 (0) 6734 919305
Email: info@ehrfeld.com
Web: www@ehrfeld.com

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