FALLING FILM MICRO REACTOR

FFMR

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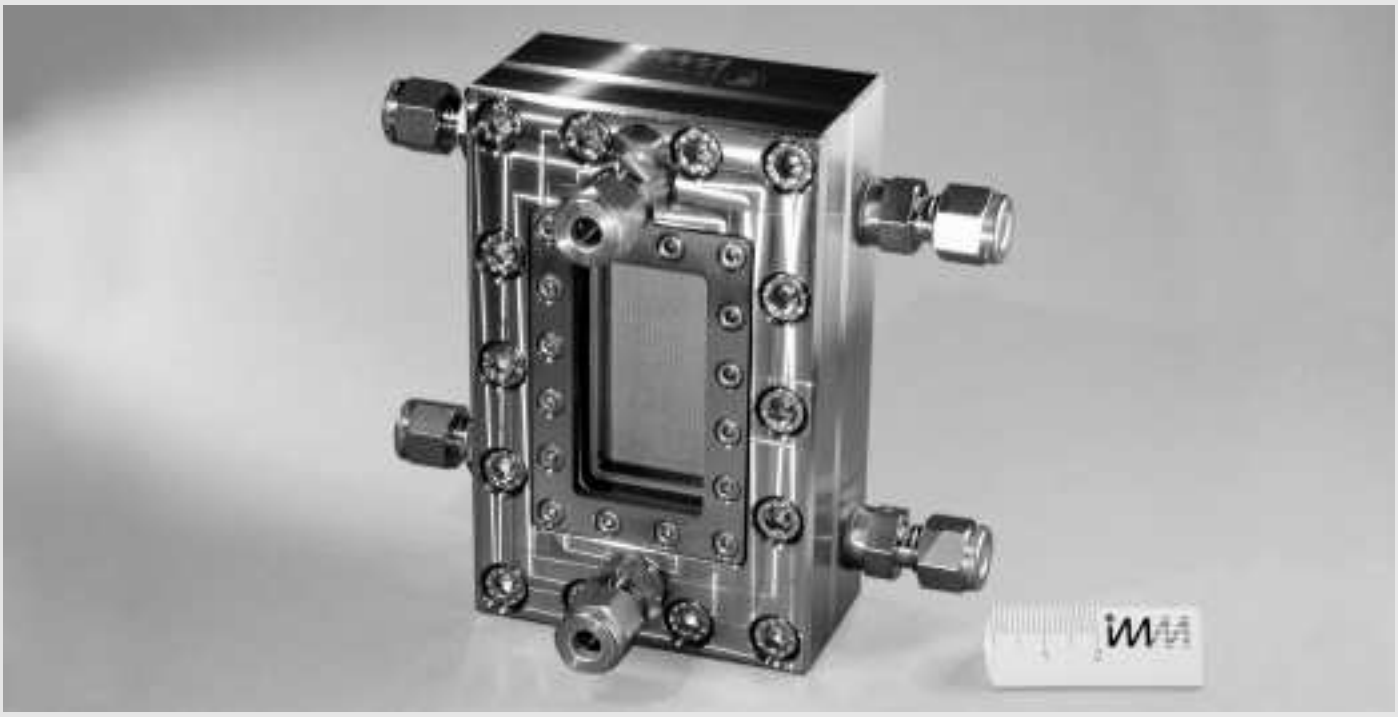


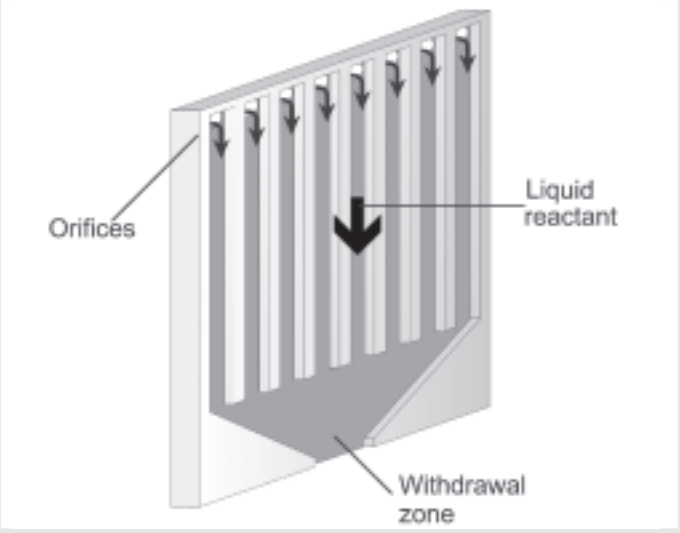
Falling Film Micro Reactor

Principle

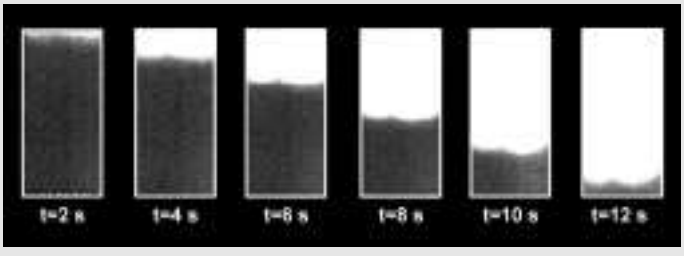
The Falling Film Micro Reactor utilizes a multitude of thin falling films that move by gravity force for typical residence times of seconds up to about one minute. Its unique properties are the specific interface of 20,000 m^2/m^3 and the good temperature control by an integrated heat exchanger. Such high mass and heat transfer were achieved performing direct fluorination of toluene with elemental fluorine in this device. This so far uncontrollable and highly explosive reaction could be managed under safe conditions and with control over the reaction mechanism. Via an electrophilic pathway, a yield of 20% of o- and p-mono-fluorinated isomers was achieved.

Fundamental studies on mass transport were carried out using the carbon dioxide conversion in alkaline media. It turned out that higher space-time yields are achievable than in conventional packed columns. Heat characteristics were monitored on-line and at real time by IR thermography with sub-micro channel spatial resolution. By CFD simulation, the parabolic flow pattern evolution was characterized. The good flow equidistribution by a pressure barrier was confirmed by analytical calculations and experimental flow visualization.

Meanwhile, the Falling Film Micro Reactor was successfully used by many customers for such important gas/liquid processes as oxidations and hydrogenations. By means of wash coating, catalyst and carrier can be deposited in the reaction channels so that gas/liquid/solid processes are amenable. For hydrogenation of nitro benzene at Pt/alumina contact almost complete conversion was achieved within a few seconds.



Falling film principle in a multi-channel architecture



Thermographic monitoring: Initial wetting flow

Disassembled FFMR

Reaction plates for FFMR

FFMR made of Hastelloy C276

Technical Data

Name	Falling Film Micro Reactor
Order number	FFMR
Size (L x B x H)	120 x 76 x 40
Connectors (Inlet/Outlet)	1/4″ / 1/4″
Material	1.4571 for housing and reaction plate Copper for cooling plate Borofloat glass for inspection glass
Standard mixing channels (µm)	300 x 300 (64 channels) 600 x 600 (32 channels) 1200 x 1200 (16 channels)
Standard cooling channels (mm)	Width: 1.5 Depth: 0.5
Options	Other materials like Hastelloy, Monell or Titan on request

Operating Conditions

Temperature (°C)	180
Pressure stability (bar)	10 (without Borofloat glass: 20 bar)
Flowrate (l/h)	0.05 for channel geometry 300 µm 0.6 for channel geometry 600 µm 1.5 for channel geometry 1200 µm
Residence time (s)	0.8 – 20
Liquid film thickness (µm)	25 – 100
Leakage Class	$L_{0.01}$
Interfacial area (m^2/m^3)	20000
volume of gas chamber (mm^3)	13336
Total inner volume (mm^3)	1800
Active inner volume (mm^3)	110