

Microstructured Production Mixer



*Modern Technology for
Today's Chemistry*

Drivers and Applications

StarLam platelets



Disassembled StarLam300



The grouped-design series of the StarLaminator allows mixing and reaction on an industrial production scale at liquid throughputs from 10 l/h to about 30.000 l/h.

Business Drivers

- Improved process performance (e.g. better selectivity) by improved mixing
- Fast process development by simplified scale-out
- High compactness and low capital cost
- Low energy consumption and other operating expense
- Reduction of maintenance by negligible wear and no moving parts
- Closed-system operation by lack of penetrating shafts and seals
- High process safety due to small internal volumes

Chemical Processing Drivers

- Short mixing time and well-defined mixing behaviour
- Small droplet generation for emulsions
- Small and well-defined particle generation
- Narrow residence-time distribution
- Performance only weakly dependent on pressure and temperature
- Simplified scale-out concepts by grouped device design and equalling up of flow elements

Application Fields

- Mixing/blending
- Fast reactions
- Emulsions or liquid dispersing
- Producing foams
- Particle and pigment synthesis
- Gas absorption

In particular:

- Enabling technology for niche mixing where conventional mixers fail
- Enabling technology for mixing under laminar-flow conditions in small spaces
- Fast mixing for even faster reactions in chemical synthesis
- Mixing at small partial internal volumes and, on demand with integrated cooling, to ensure safety for hazardous reactants and exothermic reactions



Specifications of the Grouped-design Devices

StarLam3000 with Swagelok connectors

StarLam Family

The group-design family of the StarLaminator allows mixing and reaction on an industrial production scale at liquid throughputs from 10 l/h to about 30.000 l/h. At present, the StarLam family consists of four members: StarLam30, StarLam300, StarLam3000 and StarLam30000, whereas the number in their brand name refers to the average productivity.



StarLam30



StarLam300



StarLam3000



StarLam30000

Technical Data

	StarLam30	StarLam300	StarLam3000	StarLam30000
Size (L x B x H)	40 x 40 x 64 mm	40 x 40 x 64 mm	95 x 95 x 150 mm	220 x 220 x 420 mm
Connectors (Inlet/Outlet)	8 mm/10 mm	8 mm/10 mm	DN 15/DN 25	DN 50/DN 80
Standard mixing channels (µm)	25/50/100	50/100	100/200	200
Standard material	Body: 1.4571 Foil: 1.4401	Body: 1.4571 Foil: 1.4401	Body: 1.4571 Foil: 1.4401	Body: 1.4571 Foil: 1.4401
Options	Other materials like Hastelloy, Monell or Titanium on request	Other materials like Hastelloy, Monell or Titanium on request	Other materials like Hastelloy, Monell or Titanium on request	Other materials like Hastelloy, Monell or Titanium on request

Operating Conditions

Temperature (°C)	-40 - 220	-40 - 220	-40 - 220	-40 - 220
Pressure stability (bar)	100	100	100	100
Flowrate (l/h)	12 - 150	80 - 1,000	600 - 8,000	5,000 - 30,000
Residence time (ms)	24 - 840	1.7 - 220	72 - 960	80 - 500
Inner volume (ml)	2.8	5	160	700

Mixing Principle

StarLam platelets in alternating order



Design and Mixing Principles

The StarLaminator comprises numerous platelets, up to several hundred. These platelets have a star-type feed shape which gives rise to the brand name of the StarLam series. The flow is guided from six ports to the centre position. The centre hole of the star is the region where mixing sets in.

The good mixing property of the StarLam mixers comes from the thinness of the plates which is 250, 100, or 50 μm (other dimensions on demand). This relates to the thinness of the liquid layers initially created and thus to the large interfacial area created for mixing.

The high productivity of the StarLam mixers is due to the large number of platelets. Up to several hundred platelets can be arranged in this way. These platelets are stacked on guiding pins. This allows easy cleaning of the device by reassembling the whole stack and to replace some of the platelets for maintenance and repair tasks.

When the platelets are all arranged on the guiding pins, they are compressed to yield a tight system. Now, all the centre holes form a mixing tubing with numerous feed inlets. To compensate for the increasing number of single flows, there is a pyramide-type inner structure in the mixing tubing. The platelets are fed from distribution lines.

StarLam devices have the best mixing efficiency at highest flow rates. Due to this finding and the corresponding flow regimes which are turbulent, mixing is achieved by fragmentation of eddies.

Stacking of the platelets on guiding pins for StarLam3000



Documented and Peer-reviewed Expertise

The Chemical Process Technology (CPT) department at IMM is a leading institution in the field of chemical micro processing engineering, i.e. the design and application of microstructured devices towards the needs of industrial chemical processing. General information on applications of microstructured reactors and similar components can be found in the following essays, given by IMM authors.

- [1] Kolb, G., Hessel, V.: "Micro-structured reactors for gas phase reactions: a review", *Chem. Eng. J.* **98**, 1-2 (2004) 1-38.
- [2] Hessel, V., Löwe, H., Müller, A., Kolb, G.: Chapter 2 "Microstructured Devices for Fuel Processing" in "Chemical Micro Process Engineering - Processing and Plants", Wiley-VCH, Weinheim (2005).
- [3] Jähnisch, K., Hessel, V., Löwe, H., Baerns, M.: "Chemistry in Microstructured Reactors", *Angew. Chem. Int. Ed.* **43**, 4 (2004) 406-446.
- [4] Hessel, V., Hardt, S., Löwe, H.: *Chemical Micro Process Engineering - Fundamentals, Modelling and Reactions*", Wiley-VCH, Weinheim (2004).

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