

Technical Documentation No. 11.108 Rev. 1

## Fluitemc FSB-Reactors for Laboratories, Pilot plants and Industry

Fluitemc Small Bubbles Reactors (FSBR) are used for the high performance in-line gasification of liquids of low viscosities. The generation of unique micro-bubbles at lowest energy consumption together with the continuous surface renewal rate became legendary. Scale-up is easily possible, since the bubble-size is not influenced by the reactors dimension. In contrast to static mixing elements FSB-Reactors are able to cope with gas fractions of more than 20%.

### Working principle

FSB-Reactors consist of a double-shell which is mounted around a cylindrical, porous tube. The liquid flows in axial direction through this porous tube, which is equipped with static mixing elements. The gas to be dissolved is pushed through the porous material, thus generating gas bubbles at the inner wall. The drag forces caused by the streaming liquid and the static mixing elements shear off the growing bubbles at a very early stage. In this way it is possible to generate much smaller gas bubbles than by breaking-down bigger bubbles by energy demanding turbulences in the liquid. The so called micro-bubbles are of rigid constitution and strongly inhibited in coalescence (merging of bubbles).

Once generated, the static mixing elements renew the saturated, stationary liquid film around the gas bubbles continuously. In contrast to stirred tank reactors, energy is only dissipated where it is needed. Even in contrast to conventional static mixing elements, the FSB-Reactors show up to 5 time higher gas-transfer rates. This is of especial importance if expensive, reactive or toxic gases need to be dissolved.

### Laboratory and Pilot-scale FSB-Reactors

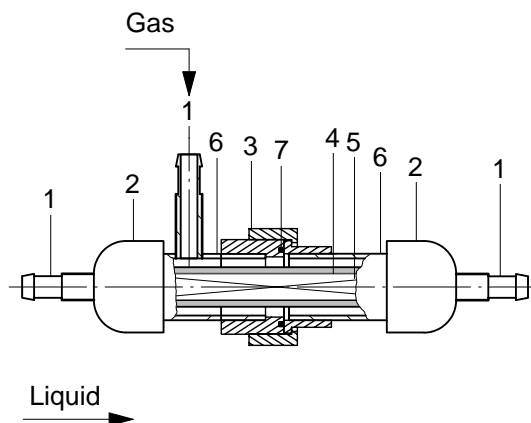
Small FSB-Reactors are especially developed for investigations at small scale. DN12 is the smallest size available at a wide range of materials, thus allowing experiments at high temperature, pressure or with corrosive media.

Combination of materials:

- polyethylene PE, sealings Kalrez or NBR
- stainless steel V4A, sealings Kalrez or Viton
- Hastelloy, sealings Kalrez or Viton
- PVDF/PTFE, sealings Kalrez or FPM
- PTFE-lined steel.



Fig. 1 FSB-Reactors DN12 out of PP



### Items

- |                    |                          |
|--------------------|--------------------------|
| 1 hose connector   | 5 static mixing elements |
| 2 cap              | 6 double shell           |
| 3 screw connection | 7 sealings               |
| 4 sintered tube    |                          |

### Fields of application FSBR DN12

- Liquid flow rate: 100 to 500 l h<sup>-1</sup>
- Gas flow rate: < 2000 NI h<sup>-1</sup>
- Max. operating pressure: 10 bar at 20°C
- Max. operating temp.: depending on material.

The operating pressure must be considered. A gas fraction of more than 40 to 60% is of no advantage. The maximum gas fraction is also dependent on the solubility of the gas.

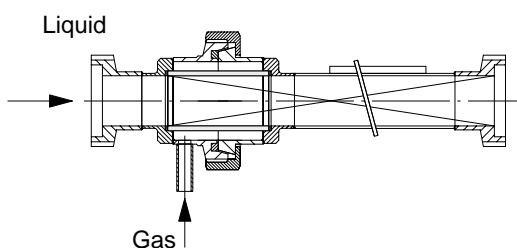
### FSB-Reactors out of stainless steel

FSB-Reactors out of stainless steel are used in the chemical industry, in biotechnology and in food and pharma. The very efficient gas transfer is significantly supported by the static mixing elements type CSE-X/4G. At lowest energy consumption, bubble sizes of smaller than 1 mm are easily achieved. The bubble size and the tendency to coalescence, however, are strongly influenced by the liquids property. Information about pH, electrolytes (salt, proteins, etc.), surface active agents (tensides) and viscosity are of high importance. FSB-Reactors equipped with standard EPDM-sealings can be sterilized with steam. The surface is electro polished or pickled on the customers request. Sterile connections or DIN-flanges are possible fittings.



Fig. 3 FSB-Reactor for biotechnology

The most used dimensions of FSB-Reactors are shown in Fig. 4. Other dimensions are specified in the Technical Documentations No. 13.017 and 13.041. Dimensions of > DN 100 are available on request.



| Size       | Di (mm)   | Definition          |
|------------|-----------|---------------------|
| FSBR DN 10 | 12 - 12.6 | DIN 11851 / DIN2633 |
| FSBR DN 15 | 15 - 15.8 | DIN 11851 / DIN2633 |
| FSBR DN 20 | 20 - 22.3 | DIN 11851 / DIN2633 |
| FSBR DN 25 | 26 - 27.2 | DIN 11851 / DIN2633 |
| FSBR DN 32 | 32        | DIN 11851           |
| FSBR DN 40 | 40        | DIN 11851 / DIN2633 |
| FSBR DN 50 | 51 - 53   | DIN 11851 / DIN2633 |

Fig. 4 Dimensions of FSB-Reactors

Materials such as Hastelloy, PTFE and other sealings are available on request.

### FSB-Reactors in industrial scale

FSB-Reactors can basically be produced in any dimension. By scaling-up, however, a minimum flow rate of 200 to 500 l h<sup>-1</sup> should be met in the laboratory in order to allow a most secure calculation.



Fig. 5 FSB-Reactors DN 200, Material 316L

### FSB-Reactors with PTFE-lining

PTFE coated devices are extremely resistant to corrosion. A maximum operating temperature of 200°C is possible. Standard dimensions of PTFE coated are listed in the Technical Data Sheet No. 13.041 reactors. Larger sizes are available on request.



Fig. 6 FSB-Reactor, DN 100, PTFE lined

### Fields of application

FSB-Reactors are basically used in the following fields of application:

- gasification and mixing of tanks applying the air-lift principle
- gasification of existing tanks using an additional external loop
- gasification of kinetically inhibited systems with a complete gas transfer (GD-reactor)
- in-line gasification at lowest energy demand

The FSB-Reactors are developed in collaboration with the University of Teesside, UK, and the University of Applied Sciences Zurich, Winterthur.