

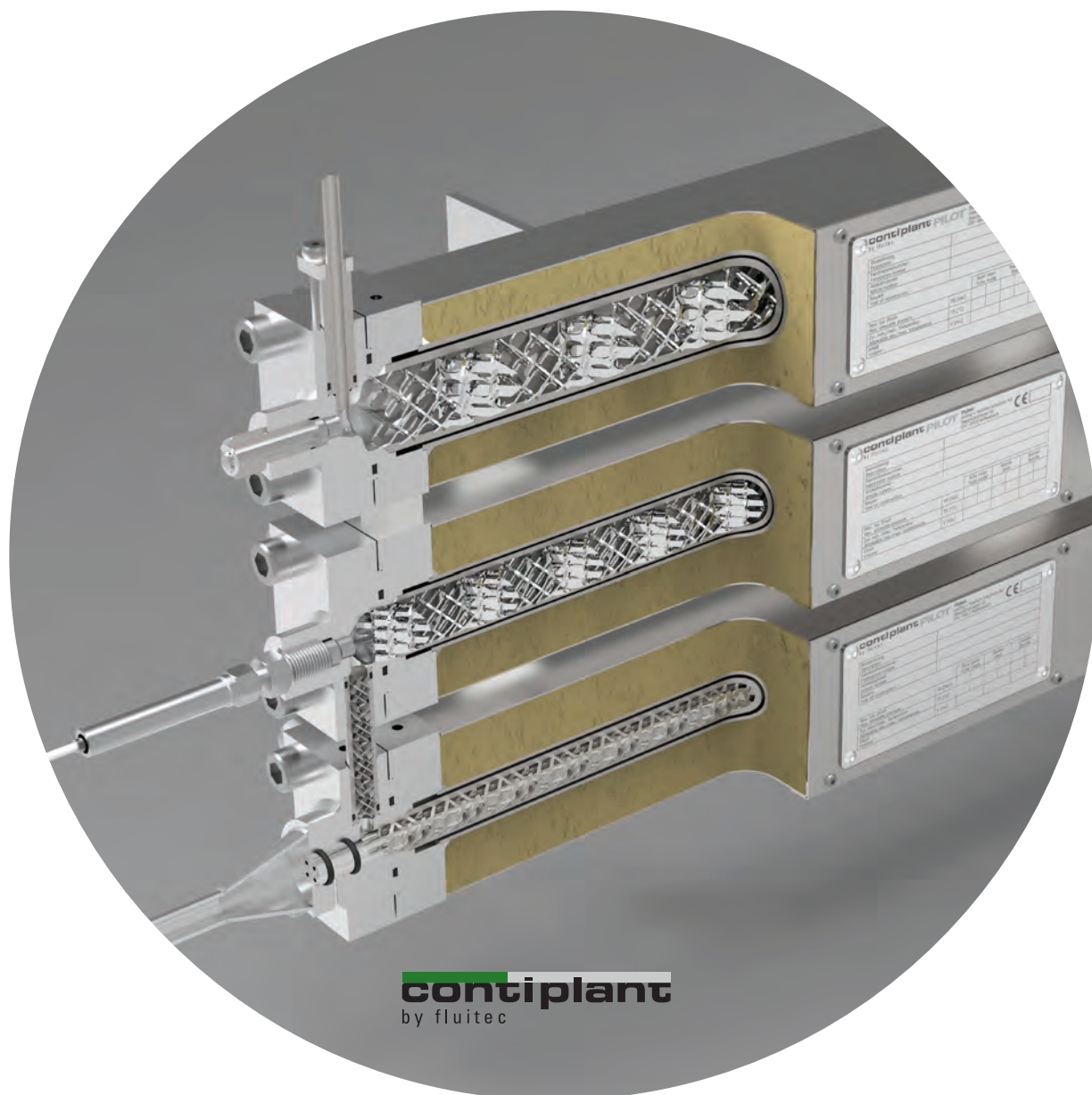
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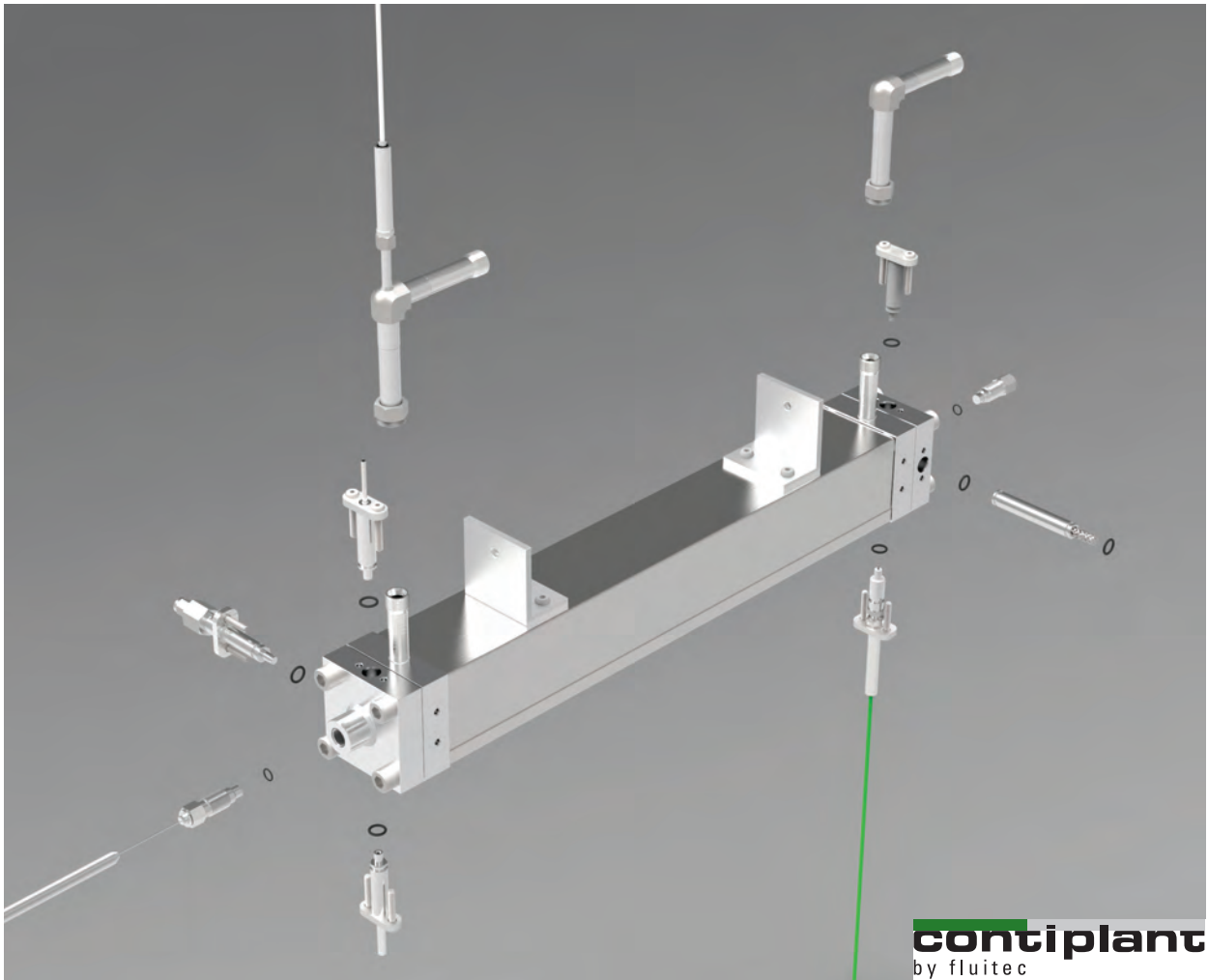
## Flow Chemistry:

# Fluitec Contiplant Flow Reactors

Fluitec offers a wide range of flow reactors for process development and scale-up of flow chemistry. In addition to standardized reactors, Fluitec is also happy to manufacture customer-specific special designs. The application area of Contiplant reactors ranges from strongly exothermic synthesis reactions to highly viscous polymerization reactions and gas-liquid-solid mass transfer processes.

The reactors presented here can be scaled up to production scale using Fluitec mixer-heat exchangers. Fluitec's unique scale-up principle allows for consistent mixing and heat transfer performance. Fluitec also offers small-scale systems with customized control systems.





### Fluitec Contiplant Reactors

The Fluitec Contiplant tubular reactors are modular in design. Up to 4 connections or sensors can be mounted on each of the two square head flanges. If these ports are not needed, they are to be closed with blind plugs. The connection plugs are sealed with O-ring seals, which need to be selected according to chemical resistance requirements of the process. Fluitec offers FFPM (Kalrez) or FPM (Viton) seals as standard.

The Contiplant reactors can be connected to each other in order to extend the reaction section or to connect a subsequent reaction (see picture on the right hand side). Thus, additional dosing or analysis is possible after each reactor unit. For example, with the 10-point axial temperature sensor, temperature profiles are recorded which are used further in reaction calorimetry.

The Contiplant plug flow reactor can be connected directly to the half-shell reactor or the dynamic Contiplant reactor via the uniform connection concept. Peripheral components like the helical coil reactor or loop reactor will be combined using appropriate connection lines. The reactors are usually mounted on a multipurpose aluminum rack.





### Helical coil reactor

The Fluitec helical coil reactor consists of a spiral tube surrounded by a closed outer jacket. It can be used both as a preheater and as a flow reactor. The mixing and heat exchange behavior is defined by the tube diameter, number of turns (N) and pitch.

- Standard sizes (tube diameter, OD):
  - 1/8": 0.3 / 1.7 ml N12
  - 6 mm: 10 ml N8, 21 ml N16, 8 / 31 ml N24
  - 1/4": 31 ml N16
  - 3/8": 125 ml N12, 250 ml N24
- Material: 1.4404 / 1.4571 or alloy C-22 / C-276
- Specification: 11-32112

The maximum permissible process temperatures are given by the stainless steel selected and the maximum permissible pressures by the tube diameters.



### Contiplant plug flow reactor

The Fluitec Contiplant plug flow reactors are tube-in-tube reactors filled with static mixers. Thus, an ideal plug flow behavior is achieved with high heat transfer at the same time. The reactor can be equipped with an axial 10-point temperature sensor or can optionally be modified to be used as a fixed-bed reactor.

- Standard sizes: 24 / 50 / 140 / 300 ml (> 3 ml/min)
- Dimensions (Di x L): 7.8 / 12.3 / 21 / 36 mm x 500 mm
- Temperature range: -15 °C ... 250 °C
- max. permissible system pressure: 60 bar (PN100)
- Material: 1.4404 / 1.4571 / FFPM
- Optional: alloy C-22 / C-276
- Specification 87-40022

The Contiplant reactors can be connected in series in a modular fashion to increase residence time or perform consecutive reactions.



### Half-shell reactor

The Fluitec half-shell reactor consists of several plates stacked on top of each other with an identical reaction section as in the Contiplant tubular reactor. It is mainly used for process development of fouling-prone reactions. This is because the reaction section can be easily opened and fouling localized.

- Standard sizes: 16 / 44 ml (1 - 150 ml/min)
- Dimensions (Di x L): 7.8 / 12.3 mm x 500 mm
- Temperature range: -15 °C ... 250 °C
- max. permissible system pressure: 60 bar (PN100)
- Material: 1.4404 / 1.4571 / FFPM
- Optional: coating
- Specification 87-40050 / 51

Anti-corrosive or antiadhesive coatings can be applied to the half-shell reactor inner walls as well as the static mixers.

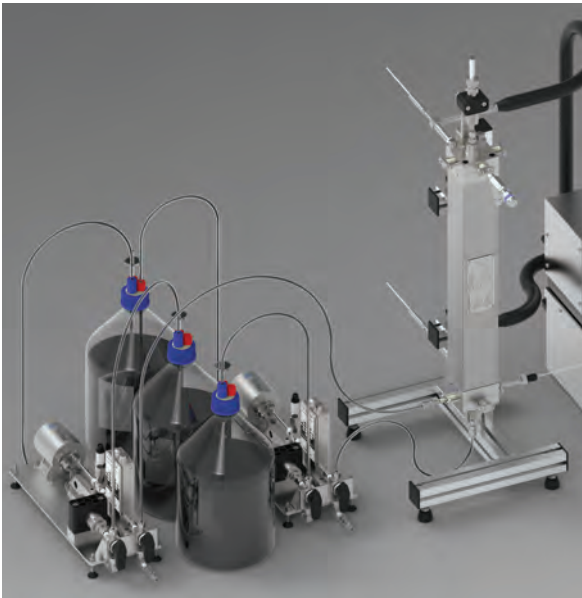


### Loop reactor (CSTR)

The Fluitec loop reactor is a recycling reactor which achieves CSTR behavior at high recirculation rates. The high heat exchange efficiency combined with strong recirculation leads to almost isothermal conditions, which makes the loop reactor suitable for kinetic studies of liquid-liquid reactions (<https://onlinelibrary.wiley.com/doi/abs/10.1002/cite.202100005>).

- Standard size: 19 ml, 7.8 mm, 0.2 - 30 ml/min
- Temperature range: -15 °C ... 250 °C
- max. permissible system pressure: 60 bar (PN100)
- Material: 1.4404 / 1.4571 / FFPM
- Optional: alloy C-22 / C-276
- Specification: 87-40020 / 21

The Loop Reactor can also be used as a disperser or as a pre-mixer in combination with Contiplant tubular reactors.



### Flow Calorimeter

The Fluitec flow calorimeter consists of a Contiplant tubular reactor with an axial 10-point temperature sensor as well as suitable dosing systems and flow meters. We distinguish between the fully automatic system and the manually operated basic design. The corresponding software displays the axial temperature profile and calculates the heat of reaction and other thermodynamic parameters relevant to safety, such as the adiabatic temperature rise.

- Standard sizes: 17 / 44 ml (1-40 / 3-200 ml/min)
- Dimensions (Di x L): 7.8 / 12.3 mm x 500 mm
- Specification: 87-42004 / 5

The reaction calorimeter is suitable for both fast and slower reactions, as described as follows:

<https://doi.org/10.1007/s41981-021-00204-y>  
<https://doi.org/10.1007/s41981-022-00237-x>



### Dynamic Contiplant reactor (CSTR cascade)

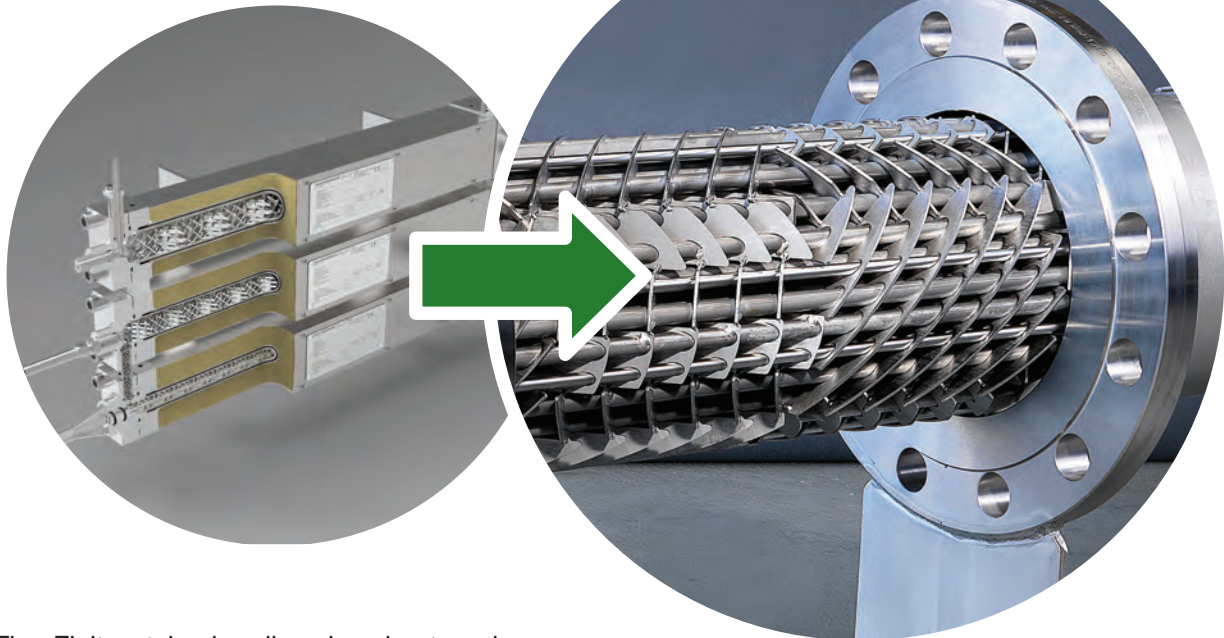
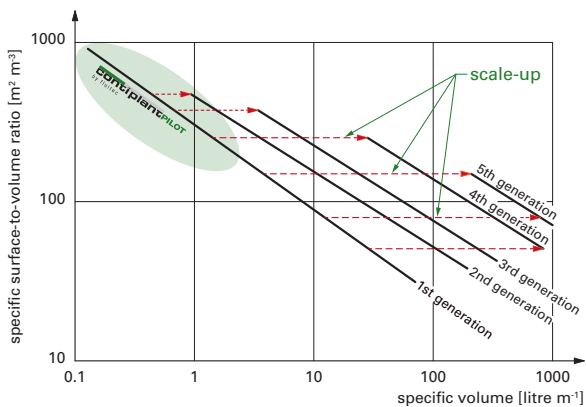
The dynamic Contiplant reactor (DCR) is equipped with an axial stirrer which actively mixes 12 CSTR cascades. It is particularly suitable for multiphase systems (gas, liquid or solid) and can therefore be used for dispersing tasks, mass transfer and catalytic processes.

- Standard size: 420 ml (1 - 200 ml/min)
- Dimensions (Di x L): 36 mm x 500 mm
- Temperature range: -15 °C ... 250 °C
- max. permissible system pressure: 25 bar (PN40)
- Material: 1.4404 / 1.4571 / FFPM / Buramex
- Optional: glass housing
- Specification 87-40057

Multiple DCRs can be connected in series to achieve a narrow residence time distribution and long residence times (> 1 h).

## Safe Scale-up

Fluitec's scale-up principle is based on a constant surface-to-volume ratio. Thus, flow processes developed in the Contiplant tubular reactor can be safely scaled up into the Fluitec mixer-heat exchanger.



The Fluitec tube bundle mixer heat exchanger (CSE-XR) is operated as a «single flow» reactor, in which the reaction mixture flows outside the small tube bundle tubes. This prevents maldistribution and, thanks to the static mixer baffles, leads to uniform mixing and constant heat exchange. The distance between the heat transfer medium tubes is minimal, so that in the event of a malfunction (standstill or cooling failure) the heat generated can be absorbed by the stainless steel. This allows not only strongly exothermic reactions to be operated in a temperature-controlled manner, but also allows slow reactions to be activated uniformly. In polymerizations in particular, this usually leads to narrow molecular weight distributions, i.e. to high product qualities. The Fluitec mixer heat exchanger is suitable for both low and high viscosity process media (up to 20'000 Pas). In addition to reaction technology, the mixer heat exchanger is used in the food and plastics industries, because of the uniform fluid distribution.

## Plant Engineering / Control Systems

In addition to standard systems, Fluitec is also happy to manufacture customized products. Thanks to the in-house design and manufacturing department, Fluitec is very agile. As an optimal completion, Fluitec offers its own Siemens S7 control systems. Thus, dosing systems, which are also manufactured by Fluitec, can be controlled and the desired data can be recorded and visualized. For the process development of safety-related demanding reactions, Fluitec offers small plants in strongly ventilated hoods or ATEX components. In the end, the goal is a scale-up to pilot or production scale - Fluitec's core competence!



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