Meet The Flow Chemist – Alain George

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Name	Alain Georg
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Education	Dipl. Ing. HTL in Mechanical Engineering
Position	Chairman of the board, founder of the company
Awards	1995 Winner of the National Heuberger Young Entrepreneur Award (Switzerland)

1) When did you start with flow chemistry? Describe the first paper or the first experiments.

I started in 1993 with the company Fluitec in a 1-room apartment and on the garage forecourt. In 1995 I won a national young entrepreneur award, which enabled us to open our own manufacturing facility. Surprisingly, it was the largest German chemical companies that supported us. With the development of the scalable Fluitec mixer-heat exchanger came the big breakthrough in mixing and reaction technology. The paper "Chemical Reactions in Tubular Reactors and Static Mixers" presented the novel Fluitec mixer heat exchanger CSE-XR for the first time (DOI: 10.1002/cite.200407095). Today, the Fluitec mixer-heat exchanger is used for numerous applications with mass flow rates from 1 kg/h to 10'000 kg/h.

2) What are the main benefits of flow that convinced you to use and implement this technology in your research?

The Fluitec mixer-heat exchanger can be scaled with a constant specific surface to volume ratio and that in one channel. This eliminates the need for numbering-up and it allows unlimited scale-up from a milli reactor.

3) What do you think the future holds for flow chemistry?

In recent years, we have worked on sophisticated safety concepts and extensive standardization, which today allow to run strongly exothermic reactions in milli reactors continuously and safely. In addition, the reduction of solvents to dilute the reaction is more and more in the focus of the companies. This means that today even smaller companies can implement continuous processes in the shortest possible time. Today, time to market is the decisive criterion for the economic realization of a continuous process.

4) Do you have any relevant tips for newcomers in the field?

Recently, Novartis developed a continuous milli reaction calorimeter (DOI: <https://doi.org/10.1021/acs.oprd.0c00117>). This novel equipment is a milestone for continuous

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reaction calorimetry. Thanks to this device, continuous reactions can be visualized along the reaction path. In addition to the safety data, the continuous reaction calorimeter provides an improved image of the reaction processes in terms of conversion, selectivity and yield. The device will soon assume the status of an RC1 batch calorimeter. I am convinced that this continuous reaction calorimeter will be essential for the development of continuous processes in the future.

My three top papers in the field of Flow Chemistry:

- 1) **Kinetic Data for Continuous Processes from Liquid-Liquid Loop Reactor Experiments** (D. P. Rütli, M. Moser, A. G. Georg, E. S. Spier, D. M. Meier, *Chem. Ing. Tech.* **2021**, 93 (8). DOI: <https://doi.org/10.1002/cite.202100005>)

This work describes how kinetic data are determined in a continuous loop reactor and how the parameters can be transferred to ideal reactor models such as PFR or CSTR. For this purpose, the basic hydrolysis of ethyl acetate was used as a model reaction.

- 2) **Safety concept for inherently safe continuous flow reactors** (M. Moser, E. Rosasco, N. Merkel, A. Georg), *CFRT Symposium in Glasgow*, **2019**, Oral Presentation.

In this presentation, a safety concept for inherently safe continuous tubular reactors was presented. Based on an example project with the Fluotec mixer heat exchanger CSE-XR, event preventing and damage limiting safety devices were shown.

- 3) **Chemische Reaktionen in Rohrreaktoren und statischen Mischern – Homogenität, Verweilzeitverhalten, Wärmeabfuhr, Auslegung, Anwendungsbeispiele** (A. Georg, M. B. Däscher, *Chem. Ing. Tech.* **2005**, 77 (6), 681–693. DOI: <https://doi.org/10.1002/cite.200407095>)

This paper highlights the advantages of the Fluotec mixer heat exchanger CSE-XR in reaction engineering, especially for highly exothermic reactions.

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