Making chemistry fit for flow and transforming it to intensified end-to-end process design

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Micro Process Technology has given strong push to continuous chemical manufacture via facilitating heat and mass transfer; named transport intensification The next big step was to develop a tailored process chemistry in flow under highly intensified conditions – which is one essence among the developing field of Flow Chemistry. This has been coined Novel Process Windows [1-3] and has two research pillars, – the exploration of unusual and typically harsh process conditions (chemical intensification) and, in a more holistic picture, a completely new and often simpler process design (process-design intensification). A survey based on several own-developed flow chemistries will underpin the above given. This will demonstrate how to boost reactivity via high-T, high-p, high-c (solvent-free; alternative solvent) concepts.

Starting from such new reaction designs, there is now the big chance to develop new process designs in flow. In the past flow plants were mainly made by retrofit. The exchange of a batch reactor versus the new intensified flow reactor was used “just” to enable the Green and Flow Chemistry benefits. Yet, there is also an own intensification momentum in Green Engineering apart from providing the mentioned service. This will be exemplified by a superficial direct adipic acid process at large-scale (400 kt/a); a change in bulk chemistry with major consequences on CAPEX/OPEX costs sustainability, and energy consumption (heat integration, pinch analysis). Process-design examples from the pharma world are an asymmetric flow hydrogenation process from Sanofi (POLYCAT project) and a multi-step flow synthesis to Rufinamide developed for OmniChem Company. On top of that, the embedment of flow processing into compact, mobile and modular chemical production platforms (‘Future Factories’; container) such as Evonik’s Evotrainer is discussed. A recent cash-flow analysis gives evidence on net-present value and financial risk-assessment for the pharma, fine-chemical and bulk-chemical markets. Distributed production and future factories are topics of relevance as well for energy/biofuel generation. The EU-Large-Scale project BIOGO (www.biogo.eu) researches and develops advanced nanocatalysts, which are allied with advanced reactor concepts to realise a modular, highly efficient, integrated process for the production of fuels from renewable bio-oils and biogas.