Review

Chemical reaction engineering, process design and scale-up issues at the frontier of synthesis: flow chemistry

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PII: S1385-8947(16)30345-X
DOI: http://dx.doi.org/10.1016/j.cej.2016.02.119
Reference: CEJ 14944

To appear in: *Chemical Engineering Journal*

Received Date: 12 November 2015
Revised Date: 28 January 2016
Accepted Date: 19 February 2016

Please cite this article as: I. Rossetti, M. Compagnoni, Chemical reaction engineering, process design and scale-up issues at the frontier of synthesis: flow chemistry, *Chemical Engineering Journal* (2016), doi: http://dx.doi.org/10.1016/j.cej.2016.02.119

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Abstract: Flow chemistry has been proposed in modern organic chemistry as a mean for process intensification, to improve the control over reaction performance and to achieve higher yield. However, many open issues can be evidenced regarding the true possibility of scale-up, as well as currently lacking information for process design and economical evaluation. This review proposes some recent examples of flow synthesis deepening in particular the scale-up and engineering issues. Required information is evidenced, as well as some transport and kinetic data required for the practical implementation of the results.

Keywords: Flow chemistry; Chemical reaction engineering; Microreactors; Process design; Reactor scale-up.

1. Introduction

Flow chemistry and microreactors technology are emerging and fascinating topics, which put in contact Chemical Engineering, Organic Synthesis and Green Chemistry. Therefore, in itself flow chemistry is a consistently interdisciplinary topic, needing a fine tuning between fluid-dynamics, heat and mass transfer, chemical reactivity and reactors design [1].

Batch processes are commonly used in fine, specialty and pharmaceutical chemistry due to their versatility, flexible production planning and scheduling. They may also be preferable due to regulatory problems, where traceability imposes to easily recall specific batches of products. On the other hand, they are often difficult to scale-up because of heat and mass transfer problems. In addition, they require significant intermediate storage capacity between process stages, resulting in large inventories of feedstock organic chemicals and sensitive intermediates. Continuous systems typically require smaller equipment volumes than batch ones and have a lower need for human intervention. Particularly referring to pharma industry, the time-to-market of a successful recipe is even more important than for base chemicals, due to the volatility of the products life. Pharma product development is regulatory driven and result of clinical phases determines market access. Thus, the possibility to access sufficient