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Editorial

Catalytic Methods in Flow Chemistry

Christophe Len [1,*] and Renzo Luisi [2,*]

[1] PSL Research University, CNRS Chimie ParisTech, 11 rue Pierre et Marie Curie, F-75005 Paris, France
[2] Department of Pharmacy—Drug Sciences, University of Bari "A. Moro" via E. Orabona 4, 70125 Bari, Italy
* Correspondence: christophe.len@chimieparistech.psl.eu (C.L.); renzo.luisi@uniba.it (R.L.)

Received: 14 June 2019; Accepted: 21 June 2019; Published: 2 August 2019

Continuous flow chemistry is radically changing the way of performing chemical synthesis, and several chemical and pharmaceutical companies are now investing in this enabling technology [1]. From this perspective, the development of catalytic methods in continuous flow has provided a real breakthrough in modern organic synthesis. In this Special Issue of Catalysts, recent results and novel trends are reported in the area of catalytic reactions (homogeneous, heterogeneous, and enzymatic, as well as their combinations) under continuous flow conditions. Contributions to this Special Issue include original research articles, as well as a review from experts in the field of catalysis and flow chemistry.

Two new technologies were developed, and compared, for the preparation of dialkyl succinates [2]. In particular, with the aid of homogenous acid catalysis, the trans-esterification of dimethyl succinate was achieved by using a microwave-assisted flow reactor. The use of enzymatic catalysis (with lipase Cal B) under flow conditions allowed for the preparation of dialkyl succinates by trans-esterification of dimethyl succinate. The advantages of flow reactors compared to traditional batch settings were demonstrated in this esterification process.

An innovative continuous flow process for the production of valuable 5-hydroxymethylfurfural (HMF) from glucose was developed [3]. The process proceeds via enzymatic isomerization of glucose, selective arylboronic acid-mediated fructose complexation/transportation, and a chemical dehydration to HMF. Interestingly, the new reactor was based on two aqueous phases dynamically connected via an organic liquid membrane, which enabled substantial enhancement of glucose conversion while avoiding intermediate separation steps. The use of an immobilized glucose isomerase and an acidic resin facilitated catalyst recycling.

Zirconium-based mesoporous materials were prepared and used as suitable catalysts for the continuous flow hydrogenation of methyl levulinate [4]. The catalysts were accurately characterized in order to ascertain the structure, texture, and acidic properties. All the prepared materials were successfully employed, under flow conditions, for the hydrogenation of methyl levulinate using 2-propanol as the hydrogen donor. Better performance was observed with catalysts possessing higher dispersion of ZrO_2 particles.

Monolithic flow microreactors were employed for studying the kinetics of the Meerwein–Ponndorf–Verley reduction of carbonyl compounds [5]. Zirconium-functionalized silica monoliths constituted the core of the reactor and performed well in promoting the reduction of cyclohexanone and other ketones and aldehydes using 2-butanol as the hydrogen donor. Important kinetic parameters and data on the reaction rates were the main output of this study.

In the context of the treatment of wastewater containing chlorinated organic pollutants, a continuous flow process for hydrodechlorination of chlorophenols was reported [6]. The process relies on the use of a Pd/carbon nanotube (CNT)-Ni foam microreactor system and formic acid as the hydrogen source. The catalytic system performed well in dechlorination reactions, and the catalyst could be regenerated by removing the absorbed phenol from the Pd catalyst surface.

An oxidative process conducted under continuous flow conditions, the Mg-catalyzed Oppenauer reaction was reported [7]. By using pivaldehyde or bromaldehyde as oxidants, and inexpensive magnesium tert-butoxide as the catalyst, several primary and secondary alcohols underwent oxidation reactions. A multigram continuous flow synthesis of the pheromone stemming from *Rhynchophorus ferrugineus* was realized using this oxidation method.

An approach for improving the productivity of multiphase catalytic reactions conducted in flow conditions was proposed [8]. A tube-in-tube membrane contactor (sparger) integrated in-line with the flow reactor was used in the aerobic oxidation of benzyl alcohol to benzaldehyde with a packed bed palladium catalyst. This technology was benchmarked in order to improve productivity, selectivity, and safety.

In the field of computational fluid dynamics, a predictive model has been presented for the simulation of the in situ Gasification Chemical Looping Combustion (iG-CLC) process in a circulating fluidized bed (CFB) riser fuel reactor [9]. Interestingly, CLC was demonstrated as a promising technology to implement CO_2 capture.

Another prediction method for estimating the erosion evolution is also described in this Special Issue [10]. The phenomenon of particle erosion is of great importance in industrial settings. The dynamic mesh technology was used to demonstrate the surface profile of erosion, and mathematical models were set up in order to consider gas motion, particle motion, particle-wall collision, and erosion.

A review dealt with catalytic methods for the production of biodiesel from renewable sources [11]. Titanium dioxide was targeted as the catalyst for the conversion, under batch and flow conditions, of triglycerides into fatty acid methyl esters (FAME), the main components of biodiesel.

We believe that the reported contributions in this Special Issue will inspire all those involved in the field of catalysis in flow conditions, providing useful hints for newcomers in this exciting and progressing field of science.

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