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Editorial

The Industrial Catalysis Section: A Place to Publish Applied Catalysis Research

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Chemical technologies provide processes for the large-scale production of materials (i.e., polymers, metals, semiconductors, ceramics, etc.) and molecules essential for a range of other technologies (e.g., information and telecommunication technologies, renewable energy production technologies) and disciplines (e.g., medicine), as well as for our daily lives (e.g., pharmaceuticals, cosmetics, detergents, etc.). This is generally implemented through steps, during which raw materials (air, minerals, natural gas, oil, biomass) are separated and/or converted to primary intermediates that are further converted, sometimes with several other steps, into final products [1].

As first recognized by the Swedish chemist J.J. Berzelius in 1835 [2], catalysis is a phenomenon allowing a chemical reaction to occur more quickly when a non-reactant species is present. Catalysis gives rise to very relevant practical effects. In fact, the increase in the rate of a reaction can result in many practically feasible applications. The acceleration of a desirable chemical reaction frequently allows it to be actually realized, or to be realized instead of other competitive unwanted reactions. Thus, finding an appropriate catalyst to speed up the desired reaction compared to the competitive ones, as well as allowing to perform it with high efficiency, are crucial aims in developing industrial processes.

Heterogeneous catalysis has been a keystone in industrial chemistry for over a century. In fact, several relevant processes using catalysts were industrially developed a long time ago (1850–1950) [3–5], when knowledge of the phenomena occurring at the molecular level was still limited. Surface chemistry and surface science were developed more recently, thanks to the introduction of experimental techniques, which can sometimes be very sophisticated, and even more recently, with the application of high-level computational technologies, made possible by modern fast electronics and informatics. These techniques have a significant role today in improving and developing catalytic materials, as well as in deepening our understanding of catalytic phenomena [6].

In practice, a large majority of real industrial chemical processes (likely > 85%) involve catalysis. Most of the catalysts used in the primary chemical industry are solids [7], but liquid catalysts also have a relevant role, perhaps more so in the field of fine chemistry. The behavior of the catalyst(s) determines the design of the entire process, because it determines the best operating conditions, the extent of reactant conversion and the amounts of products and byproducts actually obtained. From these data, the type and size of the reactors, the possible need for or convenience of recycling and the need for different product separation and purification steps are deduced. Thus, the entire engineering process depends on the chemical properties and the chemical behavior of the catalyst.

Catalysis is also a determinant phenomenon for electrodic reactions in electrochemical devices, such as batteries, electrolysis cells and fuel cells. In fact, electrodic materials actually act as electrocatalysts [8,9]. Although electrochemical devices have been used commercially for many decades, it is clear that their relevance has dramatically increased in very recent years, and it will likely continue to do so in the following years, due to their potential in favoring the decarbonization or defossilization of energy production and management [10]. Electrocatalysis can also help in molecular manufacturing [11].

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Electrocatalytic materials are frequently closely related to typical heterogeneous catalysts, and thus the two fields are undergoing parallel development.

Due to the enormous practical relevance of catalysis, research in the field is very active both at the academic level and, obviously, also at the industrial level. This research is realized in chemistry departments (in particular in groups devoted to applied or industrial chemistry research) as well as in chemical engineering and physics departments, showing that catalysis is typically an interdisciplinary field.

However, although an enormous number of different catalyst compositions are objects of investigation in academic research, as well as in applied industrial research laboratories, industries usually converge over very few and frequently only one main catalyst's composition for each reaction, which is found to have the highest performance and stability in industrial practice. In fact, commercial catalysts offered by different producers for the same reaction frequently differ only in small amounts of promoters or slight morphological differences, as they are based on the same chemical system. In spite of this, even for already well-established catalytic processes, extensive research is still needed to clarify details of the mechanisms of these reactions and the roles of the different catalyst's components, which are still not completely known. This work is likely needed to further improve catalytic systems and might also allow us to discover more efficient materials or to design better-performing reactors.

Thus, industrial catalysis [12,13] is typically a field where chemists and chemical engineers, and sometimes also physicists, either from the industry or from academia, but with a strong awareness of the practical aspects of the industrial processes, can collaborate to develop and optimize catalytic chemical processes.

Industrial catalysis research is aimed at the development and optimization of catalytic processes. One of the main activities in the field of industrial catalysis research and development is *catalysts engineering*, which refers to a number of aspects, such as:

Optimization of catalytic activity, in terms of:

- Improving activity: conversion of reactants and productivity;
- Improving selectivity of desired product(s).

Optimizing thermal stability of solid-state phases:

- Limiting deactivation phenomena;
- Improving regeneration behavior.

These targets can be fulfilled through the optimization of

- Elemental and phase composition;
- Morphology (particle size and shape, porosity);
- A preparation procedure optimized for industrial manufacturing.

Industrial catalyst engineering also requires:

- The optimization of extrudate shapes;
- The optimization of thermal stability of extrudates;
- Consideration of the ease of charging/discharging the reactor.

As already mentioned, the development of industrial catalysts is a step in the development of industrial catalytic reactors and processes. Thus, catalytic reactor and process design and modeling are fields strictly related to catalyst engineering research.

Thus, the Industrial Catalysis section of *Catalysts* is intended for the publication of research work directly related to industrial catalytic processes, both already existing and under practical development. Experimental research work should be realized in practical industrial reaction conditions or, in any case, in relevant reference conditions, and should involve real commercial catalytic materials or catalysts under development with promising properties, acceptable costs and environmental friendliness. Studies can provide results aimed at improving catalyst performances in reasonable practical conditions, as well as improving our knowledge of reaction mechanisms. On the other hand, molecular, reactor and process modeling studies, kinetic investigations, time-on-stream stability studies and catalysts regeneration studies will also be published.

Another non-negligible field is represented by the end-of-life of industrial catalytic materials and electrochemical devices. In fact, as with any other material, catalysts also have end-of-life considerations. Within the frame of a circular economy, the fate of spent catalysts cannot result in environment contamination. Conversely, based on their characterization, the availability of spent catalysts may represent an opportunity to recover chemicals and elements to recycle them for a new life. This is a field which still needs to be developed in part.

With the Industrial Catalysis section of *Catalysts*, the hope is to offer room for researchers coming from chemical manufacturing industries, catalyst manufacturing industries, refinery and petrochemical industries and energy management enterprises, as well as biomass conversion and utilization enterprises, for publishing data and exchange ideas, as well as for reporting experiences and suggestions to the academy. On the other hand, it will also be a forum for academic researchers, approaching industrial catalysis aspects from the fields of chemistry, physics and chemical engineering to report data and ideas for the practical development of catalytic processes for chemical manufacturing, energy production and environmental protection.

Conflicts of Interest: The author declares no conflicts of interest.

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