New perspectives for sustainable resource and energy use, management and transformation: approaches from green and sustainable chemistry and engineering

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1. Introduction to this special volume

Chemicals are present in every niche of our daily lives and are ubiquitous; they are present in many products, such as electronic gadgets, for example. The economic impact of the chemical industry worldwide was 3.57 trillion US dollars sales in 2011 (York, 2013), while sales in 2014 for the top 50 chemical companies were worth 961 billion US dollars (Tullo, 2014).

It has taken many centuries to understand chemistry's complexity; consolidating the periodic table of the elements is an example of genius and ingenuity that provided order in where there seemed to exist chaos. It provided the foundations for the DNA unravelling by Watson and Crick in the mid-twentieth century, for example, a giant milestone continuing chemistry evolution toward a deeper understanding of complexity. The path from inorganic chemistry to organic chemistry to biochemistry has taken place through time with small and large advances, leading to large scale industrial transformations of chemicals. The industrial level transformation of mass-produced chemicals, with its resultant pollution and resource scarcity, has set the need for a paradigm shift. Given the potential negative impacts of chemicals to health and the environment, discussions on how to make sustainable re- sources use and transformation in the chemical industry has been taking place during several decades.

The role played by innovation in the chemical industry has, at its core, set the foundation for its evolution. The centennial anniversary of the American Institute of Chemical Engineers listed 100 market innovations related to chemicals (Chemical Engineering Progress, 2008). Such innovations have also resonated with political, social, and public policy issues (Horstmeyer, 1998; Arora et al., 1998) that have played a decisive role in the industry's development. Additionally, a number of organisations have been pushing for sustainability issues to be incorporated into the chemical industry. For example, the World Business Council for Sustainable Development (WBCSD) has been supporting a recently-created project named

“Reaching Full Potential” aimed at developing a harmonized approach to corporate greenhouse gas accounting and reporting (“WBCSD e World Business Council for Sustainable Development. Chemicals,” 2015). The European Chemical Industry Council (CEFIC) made a clear commitment towards sustainability across the value chain (CEFIC, 2015). Professional associations, such as the Institute of Chemical Engineers from United Kingdom (IChemE, 2015), the American Institute of Chemical Engineers (IfS, 2015), and the American Chemical Society (ACS, 2016) have been fostering several programmes, activities, and publications related to sustainable development. Some of the large chemical companies highlight their commitment towards sustainability, and are acting upon it, such as BASF, which established its Ecoefficiency analysis, Seebalance, and AgBalance initiatives (BASF, 2015a, 2015b, 2015c). Key chemical companies, such as Dow Chemical (Dow Chemical Company, 2015), Dupont (Dupont, 2015) (which is in the verge of a merger with Dow Chemical), and Akzo Nobel, have made similar commitments (AkzoNobel, 2015).

The challenge that remains for the chemical industry is to effectively incorporate sustainability into their operations, management, research and development, and supply chains. The latter implies viewing chemistry and chemical engineering under a different perspective, as well as undertaking structural and technological changes towards more advanced states of sustainability through profound changes in the way chemistry and engineering are perceived, designed and implemented (Freire, 2014). When facing problems in the real world, demands from our society, mega trends in industry (e.g. networked society), for example in the context of climate change and resource scarcity, there are large gaps where further advancement in scientific insights and real world practices are essential (Boehm and Thomas, 2013; Tukker, 2013; Vezzoli et al., 2015). The economic, ethical and business responsibility implications to reduce toxics dispersion and generation, as well as enhanced energy efficiency will lay the foundation for societal transitions to post fossil carbon societies, and should prove inspiring for the whole chemical industry.

In parallel, the transformation of the chemical industry has become an important challenge to educators and researchers in Higher Educational institutions to prepare the new professionals with broader, more holistically oriented challenges, skills and values. Scientific research has been on the rise, for example the use carbon dioxide (CO_2) as a raw material for producing chemicals has been published (Journal CO2 Utilization, 2016). Conferences in education, for engineers and other disciplines, have taken place for several years in the recent past (ACS, 2016; AkzoNobel, 2015; Allenby and Richards, 1994; Ayres and Ayres, 1996; BASF, 2015a; CEFIC, 2015; Dow Chemical Company, 2015; Dupont, 2015; Freire, 2014; Graedel and Allenby, 2002; IChemE, 2015; IfS, 2015; Journal CO2 Utilization, 2016; McDonough et al., 2003; WBCSD, 2015).

The principles of and approaches to Green Chemistry and Green Engineering were developed as guidelines to reduce or to prevent the use, or generation, of feed-stocks, products, by-products, sol- vents, reagents, or other hazardous chemicals that are, or might be, dangerous to human health or to the environment (Anastas and Breen, 1997). They are aimed at preventing the production of toxic wastes, whereas previously they had been produced considering the environmental impacts, or potential impacts, of raw materials, products or processes. Green chemistry is based upon twelve principles divided into five categories (waste reduction, renewable resources, eco-efficiency, degradation, and health and safety) that are aimed at designing or modifying chemical reactions to be more environmentally friendly (Anastas and Zimmerman, 2003). A paradigm shift from the present day intensive resource extraction toward recycling material flows and the concept of circular economy will foster new chemical transformations routes for a more sustainable resource use. The latter will take into account the proper use of scarce materials, such as silver and antimony. This paradigm shift will consider the already existing materials as inventory in the economy and recycle them as is already the case for copper, iron, and aluminium. The conceptual framework for the latter is discussed and presented in Industrial Ecology (Allenby and Richards, 1994; Ayres and Ayres, 1996; Graedel and Allenby, 2002). Similarly to green chemistry, green engineering provides a “green” framework that approaches sustainability from an eco-effective design (Karlsson and Luttropp, 2006; Mont and Tukker, 2006) perspective by proposing a “conceptual shift away from current industrial system designs, which generate toxic, one-way, ‘cradle-to-grave’ material flows, toward a Circular Economy, a ‘cradle-to-cradle’ system powered by renewable energy in which materials flow in safe, regenerative, closed-loop cycles” (McDonough et al., 2003), while addressing product service combinations (Boehm and Thomas, 2013; Tukker, 2013; Vezzoli et al., 2015).

Green chemistry/green engineering and sustainable chemistry/ engineering are mainly directed at improving operations and pro- duction in a company and they need to be linked to the other elements of the company system (strategy and management, organisational systems, procurement and marketing, and assess- ment and communication) (Lozano, 2012), as well as to the company's business models, strategies, and practice.

This Call for Papers considers the following general themes that support the abovementioned discussion:

a. Better management to close material flow loops, recycling, and recovery;
b. The transformation of chemistry and engineering into more holistic and sustainable, through recognising and promoting drivers to technological and non-technological change and overcoming obstacles, bottlenecks, and barriers to change;
c. New governmental, societal, and corporate policies needed to promote green/sustainable chemistry and engineering at the societal level;
d. Policy specific governmental chemical policies to be developed and implemented in the chemical industry supply chains to make them more sustainable;
e. New more sustainable business models in the chemical industry, so that increasingly bio-based chemistry and engineering are developed and implemented to truly progress towards the Post-Fossil Carbon societal paradigm and towards a more circular chemical economy;
f. The ethical, economic and legal challenges that could arise in the transitions of the chemical industry towards becoming more sustainable; and
g. In depth discussion of the roles that Higher Education Institutions in educating future professionals that will be working in the chemical industry and in doing research.

2. Extended abstract and manuscript submission

All authors are invited to submit extended abstracts of 1000e1500 words of their proposed papers to Francisco J. Lozano (fjlozano@itesm.mx). The editorial team will review all submissions and will provide prompt feedback to the authors so that they are best guided for preparation of top-quality papers.

The invitation to submit extended abstracts pertain to people who submitted to either of the conferences and to anyone else who wishes to submit a paper for this exciting and urgently needed Special Volume.

After the extended abstracts have been reviewed, all authors will be notified whether their abstracts have been accepted as submitted or amendments should be made as the authors develop their full, peer-review ready papers.

The authors invited to develop their full papers are kindly requested to access and to follow the “Instructions for authors” presented in the JCLP website (http://www.journals.elsevier.com/ journal-of-cleaner-production). Then, in order to move onto pa- per submission, authors are invited to go to http://ees.elsevier.com/ jclepro and select this SV, (SustChem-Eng) and then follow the standard submission procedures of Elsevier's Editorial System (EES).

3. Tentative schedule

Authors intending to participate to this CfPs are informed that the editorial team and Elsevier staff will do their best to adhere to the time-schedule, but that is also dependent upon authors and reviewers co-working with us on this cooperative journey. In that context, the editorial team hopes that this SV will be published in the first half of 2017.

Please be aware that all the information and deadlines related to the tentative time schedule were summarised in Table 1.

Finally, after acceptance, papers will be available online as accepted-manuscripts with the related doi numbers and so will be ready to be cited. Then, corresponding authors will be emailed and linked to the online proofing system allowing them to incorporate minor corrections in their articles before the latter are published. A short time after those minor edits have been submitted, the papers will appear on line as corrected proofs, namely published-like articles that, however, do not contain all of the bibliographic details (volume, issue and page range). The latter will be provided to the authors once the SV have been assembled and published.

Table 1 – Tentative time planning: SV-development process deadlines

SV-development phases	Deadlines
Submission of extended abstracts	February 20, 2016
Feedback of extended abstracts	March 8, 2016
Manuscript submission deadline	June 8, 2016
Peer review, paper revision and final decision notification	December 7, 2016
SV online publication	March 6, 2017

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