BMC Chemical Engineering

EDITORIAL Open Access

BMC Chemical Engineering: an open access publishing venue for the chemical engineering community

Harriet E. Manning[1*], Robert Field[2], Rafiqul Gani[3], Adam Lee[4], Hyunjoo Lee[5], Jay H. Lee[5], Gongping Liu[6] and Sang Yup Lee[5]

Abstract

This editorial accompanies the launch of *BMC Chemical Engineering*, a new addition to the BMC Series. The journal follows the BMC Series ethos of being fully open access and making editorial decisions based on scientific validity and quality rather than perceived interest or impact. The scope of the journal is broad, considering fundamental and applied research in all areas of chemical engineering with the ultimate aim of providing an inclusive, community-focussed venue to ensure that the most relevant chemical engineering research is disseminated widely for all to read and build upon.

Introduction

Chemical Engineering is a broad, multidisciplinary field that encompasses many traditional scientific and engineering principles and applies them to the development of new chemical, biological and materials processes and products.

The American Institute of Chemical Engineers (AIChE) recently held their 2018 Annual Meeting in Pittsburgh with a theme of 'Chemical Engineering: Today, Tomorrow & Leading the Future'. A number of engaging talks explored how chemical engineering has changed as a discipline over the past 10, 50, 100 years. In a time of moving away from siloed fields towards breaking down discipline barriers and encouraging multidisciplinary collaboration, questions were raised about the relevance of the field of chemical engineering. The argument was made by several highly experienced and respected academics and industrialists that chemical engineering is really a boundary-less subject. The principle elements of chemical engineering, such as thermodynamics, material and energy balances, heat and mass transfer, applied chemistry and physics, and separations are solid; they remain as relevant and important today as they were a hundred years ago, but the applications have certainly changed. New expertise in data analytics, machine learning, systems and synthetic biology and sustainability are being brought into the sphere of chemical engineering to better develop processes and products.

Chemical engineering is also playing a major role in helping to achieve the sustainable development goals set by the United Nations [1]. From bio-based sustainable production of chemicals and materials to machine learning-based design and synthesis of new materials and pharmaceuticals, chemical engineering disciplines will be essential to make them work. Biotechnology, nanotechnology, information technology, and environmental technology are all being integrated into traditional chemical engineering to solve the world's most important problems including climate change and energy-water-food security, while ensuring sustainable production and supply of the chemicals and materials we use every day.

BMC Chemical Engineering aims to follow this principle of interdisciplinarity. Whilst it is divided into 6 sections that ground the journal in chemical engineering fundamentals, *BMC Chemical Engineering* welcomes research into new applications of these concepts and their integration with emerging themes such as data science.

* Correspondence: harriet.manning@springernature.com
[1]Springer Nature, 4 Crinan Street, London N1 9XW, UK
Full list of author information is available at the end of the article

© The Author(s). 2019 **Open Access** This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.

This editorial outlines in detail the scope of each section and how the journal aims to serve the chemical engineering community.

Aims and scope

In a time of increasing momentum towards open research in many fields that have in the past been more reluctant to adopt this ethos, BMC, being a pioneer in open access within the biomedical sciences, is expanding its scope and applying its expertise in open research to the physical sciences and engineering. *BMC Chemical Engineering* is one of the first new journals in the BMC Series to publish in a field outside biology and medicine, although chemical engineering has strong connections and overlap with the biomedical sciences. The journal will make all of the articles fully open access immediately upon publication, under the Creative Commons CC-BY licence [2].

BMC Chemical Engineering considers research in all areas of chemical engineering, including fundamental and applied research in chemical, biological and materials processing across a broad range of industries. Chemical engineers have a significant part to play in tackling some of the greatest global challenges. For example, in the least developed counties in the world, 30% of people do not have access to 'improved water', being piped, spring, well, or rainwater sources [3], so chemical engineers are developing low-cost, point of use water treatment systems [4] and advanced membrane water purification technologies [5]. Chemical engineers are also integrating emerging fields and tools in order to further advance their discoveries and achieve their engineering goals. For example, additive manufacturing is being applied to the chemical industry to develop microfluidic reactors and 3D printed catalytic surfaces [6], and big data analytics has the potential to dramatically affect the way research is conducted [7]. *BMC Chemical Engineering* therefore particularly welcomes research related to finding solutions to the future global challenges identified by the Royal Academy of Engineering in 2008, which have been modified and built upon by many but which still remain very much relevant to this day [8]. It also welcomes interdisciplinary work integrating, for example, data analytics, new manufacturing processes and the principles of sustainability.

BMC Chemical Engineering will publish chiefly core research articles and reviews in each of the six journal sections, including conceptual, theoretical and computational research. We are delighted to welcome Robert Field, Rafiqul Gani, Adam Lee, Hyunjoo Lee, Jay Lee and Gongping Liu as Section Editors for the Journal [9], together with our international team of Editorial Board Members and Editorial Advisors [10]. The aims and scope of each section [11] are outlined in detail here.

Editorial sections

Process design, optimization and intensification

An increasing global population together with the earth's finite natural resources points to an urgent need for new, better and more versatile products together with their more sustainable manufacturing processes. That is, innovative engineering is needed to address the grand challenges of energy, water, food and environment. Here, chemical and biochemical engineering has a major role to play, for example, through obtaining better commercial products, developing more sustainable industrial production systems, and reducing environmental impact through better use of energy sources. Papers reporting new concepts, methods, technologies, and/or applications that promise innovative new solutions and/or significant improvements of existing processes through design, optimization and intensification of chemical and related processes are welcome. This includes

- fundamental work on process and product systems engineering
- multiphase processing
- materials processing
- particle technology
- product design
- process monitoring and optimization
- reactor miniaturization
- multifunctionality and intensification of process operation

covering the chemical, petrochemical, agricultural, food, pharmaceutical, materials and energy industries.

Reaction engineering and catalysis

BMC Chemical Engineering welcomes papers in the field of reaction engineering and catalysis. As chemical engineering has expanded beyond traditional petrochemical industry toward pharmaceutical production, biomedical devices and sustainable energy generation, new types of chemical reactors are required. Most chemical reactors use catalysts to accelerate the reaction rate, and fundamental studies and applications for homogeneous and heterogeneous catalysis are welcome. More specifically, original and novel contributions from the following fields are welcome:

- new reactor design including heat control
- preparation, characterization, deactivation and regeneration of homogeneous and heterogeneous catalysts
- electrocatalysts for fuel cell or water electrolyzers
- photocatalysts for photoelectrochemical devices or artificial photosynthesis.

Transport phenomena

Transport phenomena are as much a key to chemical engineering as is reaction engineering. Indeed some reactions are mass transfer controlled and not kinetically controlled. For example the burning of coal particles in a fluidized bed will be either reaction rate controlled or mass transfer controlled depending upon particle size and temperature. Furthermore, in the area of separation processes, the designs are typically based upon either the calculation of the number of equilibrium stages (e.g. stage-wise distillation calculation) or are rate based (e.g. the calculation of the height of transfer units). The height of transfer units depends upon the mass transfer coefficients in the liquid and gas phases. These two examples illustrated the central role of transport phenomena. More generally, aspects of energy and mass transport penetrate all areas of chemical engineering. Subject wise areas of interest include:

- fluid flow
- heat and mass transfer (single phase and multiphase flow)
- transport related aspects of separation processes
- unit operations such as absorption, adsorption and membrane processes

Given our comprehensive aim, both fundamental and applied papers are welcome.

Separation and purification processes

Separation is an essential process in the chemical industry and in our daily lives. The development of efficient separation and purification processes is critically important to promote a more sustainable and higher global standard of living. The separation and purification processes section welcomes contributions focusing on experimental and theoretical studies of phenomena associated with separation and purification as well as process development and simulation, equipment design and fabrication. Synthesis and modification of materials used in separation and/or purification processes can also be considered if the intended separation and/or purification is an essential part of the work rather than a tool for characterizing a material. Of particular interest are articles aimed at solving separation challenges encountered in emerging technologies including fields such as carbon capture, renewable energy, energy storage and conversion, and resource recovery and recycling. Broadly the section welcomes papers on:

- membrane separation
- adsorption technology
- phase separation
- extraction
- distillation
- chromatography
- continuous separations
- hybrid separation processes

Plant design, management and control

To make products in the chemical industry, process units need to be developed and connected as a flowsheet. The synthesis of reaction paths, specification of unit operations, their connections, and overall flowsheet design fall into the scope of "plant design". Plants, once designed, must be operated economically, safely, and sustainably through careful scheduling, optimization, and control.

Plant design, management, and control, which were traditionally based on intuition, experience, and heuristics, have gone through much transformation during the last few decades, with the development of systematic design frameworks and superstructure based optimal synthesis and optimal control methods. They are currently poised to go through yet another transformation with the advent of big data and artificial intelligence. Some of the relevant topics in this area include:

- Sustainable process/plant design and operation methods
- Big data based modelling and optimization
- Integration of enterprise-wide planning and supply chain with process operation under uncertainty
- Development of new modelling and optimization methods and their applications using math programming and reinforcement learning.
- Model-based optimal control by combining off- and on-line optimization
- Process trend monitoring and fault detection/diagnosis using AI tools like Deep Neural Networks.

The plant design, management and control section of *BMC Chemical Engineering* aims to be the forum to discuss the new and latest developments in design, operation, and control of chemical and biological plants in the era of artificial intelligence and the 4th industrial revolution. We believe that the key lies in how these new breeds of technologies and information become blended and incorporated into the current paradigm of first principles based modelling, simulation, and optimization. Doing so will enable us to meet outstanding challenges by addressing more relevant issues and problems, currently limited by the lack of sufficient fundamental knowledge and computational efficiency.

Sustainable chemical and biochemical processes

Sustainability is generally defined as meeting the needs of the present generation without compromising the

ability of future generations to meet their needs, and has become a watchword of modern society pervading all aspects of policy-making, notably in regard of energy, health, food, transport, and the environment. Chemical engineering and sciences will play a pivotal role in transitioning society from a fossil fuel, centralised infrastructure to a distributed, low carbon world. The Section "Sustainable chemical and biochemical processes" aims to publish promising recent research and review articles encompassing the design, synthesis, modelling, and application of environmentally benign chemical and/or biochemical processes. This section encompasses:

- alternative solvents and feedstocks
- clean catalytic technologies for atom-efficient synthesis or environmental remediation (including tandem chemo-bio routes)
- high-throughput and additive chemical manufacturing
- renewable energy technologies (including biomass valorisation)
- life-cycle and techno-economic assessments

Original contributions should highlight new aspects of chemical engineering in the design, application and/or optimisation of novel or existing academic or commercial processes, emphasising improved sustainability metrics wherever possible. Critical reviews and perspectives on topical challenges in sustainable chemical/biochemical processes are also sought.

Article collections

BMC Chemical Engineering launches with two open calls for papers for themed article collections. These are in the areas of 2D membranes and CO_2 transformation. Both of these topics were suggested by Section Editors of the journal for the interesting and relevant developments that are being made at present.

New applications for 2D materials are being discovered all the time and research into their use as membranes for gas and liquid separations has attracted a great deal of interest. Our collection '2D material membranes for gas and liquid separation' aims to gather state-of-the-art research on 2D membranes, to highlight their potential but also the importance of continued advancement in materials development, separation performance and module and process design.

The second collection focusses on the conversion of CO_2 to value-added products. The relevance of this to balancing the carbon cycle and preventing climate change are clear, but the thermodynamic challenges are also great. Our collection 'CO_2 transformation to produce value-added products' welcomes work on the development of any process or system for the transformation of CO_2.

Conclusion

BMC Chemical Engineering will provide a unique, inclusive and authoritative venue for the latest developments in the chemical engineering field. Being fully open access will allow the research to be disseminated more quickly and more widely, ultimately with the aim of advancing research development.

We hope that you will find the first published articles interesting and valuable, and we look forward to working closely with our authors, editors and reviewers to ensure this journal is a valuable resource for the chemical engineering community.

Acknowledgements
Not applicable.

Funding
Not applicable.

Availability of data and materials
Not applicable.

Authors' contributions
HM and SL wrote the introduction, aims and scope and conclusion. RF, RG, AL, HL, JL and GL and wrote the editorial sections. All authors read and approved the final version of the manuscript.

Competing interests
HM is the Editor of *BMC Chemical Engineering* and an employee of Springer Nature. RF, RG, AL, HL, JL, GL and SL are members of the Editorial Board of *BMC Chemical Engineering*.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Author details
[1]Springer Nature, 4 Crinan Street, London N1 9XW, UK. [2]Department of Engineering Science, University of Oxford, Parks Road, Oxford, UK. [3]PSE for Speed, Skyttemosen 6, DK 3450 Allerod, Denmark. [4]School of Science Cluster, RMIT University, Melbourne, Australia. [5]Department of Chemical & Biomolecular Engineering, Korea Advanced Institute of Science and Technology, Daejeon, Republic of Korea. [6]State Key Laboratory of Material-Oriented Chemical Engineering, Nanjing Tech University, Nanjing, China.

Received: 13 December 2018 Accepted: 2 January 2019
Published online: 30 January 2019

References

1. UN Sustainability Goals. Available: https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
2. Creative Commons Attribution License, Creative Commons Attribution License. [Online]. Available: http://creativecommons.org/licenses/by/4.0/.
3. UNICEF. Progress on Sanitation and Drinking Water. 2015 Update and MDG Assessment. Available https://www.unicef.org/publications/index_82419.html.
4. Pooi CK, Ng HY. Review of low-cost point-of-use water treatment systems for developing communities. Npj Clean Water. 2018;1:11.
5. Lee A, Elam JW, Darling SB. Membrane materials for water purification: design, development, and application. Environ Sci: Water Res Technol. 2016; 2:17–42.
6. Capel AJ, Rimington RP, Lewis MP, Christie SDR. 3D printing for chemical, pharmaceutical and biological applications. Nat Rev Chem. 2018;2:422–36.
7. Chiang L, Lu B, Castillo I. Big data analytics in chemical engineering. Annu Rev Chem Biomol Eng. 2017;8:63–85.

8. NAE Grand Challenges for Engineering. National Academy of Engineering; 2008. Available http://www.engineeringchallenges.org/File.aspx?id=11574&v=34765dff.
9. *BMC Chemical Engineering* Editor Profiles [Online]. Available https://bmcchemeng.biomedcentral.com/about/editorial-board/editor-profiles.
10. *BMC Chemical Engineering* Editorial Board [Online]. Available https://bmcchemeng.biomedcentral.com/about/editorial-board.
11. *BMC Chemical Engineering* Sections and Section scopes [Online]. Available https://bmcchemeng.biomedcentral.com/articles/sections1.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC