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Foreword

Process intensification and innovation process (PI)2 conference II—Cleaner, sustainable, efficient technologies for the future Christchurch, New Zealand, September 24–29, 2006

This special issue of the Chemical Engineering Journal includes a selection of papers presented at the Engineering Conferences International (ECI) conference on Process Intensification held in Christchurch, New Zealand, in September 2006. The conference was grouped into four sessions: Reaction and Separation; Novel Reactors; Bioprocessing; Materials. The papers published here are taken from each of the four sessions.

The term process intensification has many different definitions and the wide scope of process intensification is perhaps reflected in the diversity of papers which appear in this special issue of the Chemical Engineering Journal. One broad definition which perhaps best encapsulates the topics covered in this issue is as follows: "*Process Intensification is the term used to describe the means by which a stage in a process, or an entire process, can be made as small and as efficient as possible*." In order to meet this definition, changes in thinking involve not just the design of machinery and hardware, but also a consideration of the chemistry, process design and logistics. Process intensification also carries a strong implication of lower inventories and less usage of hazardous and non-renewable materials in manufacturing compared with the standard. Some would argue that process intensification represents a revolutionary approach to process and plant design, development and implementation. On the other hand it can be argued that most of the above include the design and operational goals of good process engineering and have done so for many years. So what is new? The selection of papers included in this issue perhaps help answer that question. One of the major outcomes of the conference was a clear recognition of the importance of fundamental knowledge in addressing the challenge offered through process intensification. New science and deeper understanding of engineering principles make a positive impact and contribute to the implementation of process intensification. The impacts on business risk, hazard management, environmental impact and competitive advantage are all factors which require fundamental knowledge for determination of the net benefits of process intensification. Those benefits may include some or all of the following: (a) novel or enhanced products, (b) better use of chemistry, (c) reduced material inventories, (d) enhanced safety and control systems, (e) improved processing (higher efficiency), (f) distributed manufacturing, (g) energy and environmental benefits and (h) capital cost reduction.

The selected papers speak for themselves, however, there are a number of important themes which are worth highlighting here. The importance of process intensification methods in the context of energy systems emerges in a number of papers, for example, those by Kaminski et al. and by Macleod and Harvey, both of which deal with novel intensive methods for the improved production and separation of alternative fuels from renewable sources. A related theme is "sustainable processing" involving the role of process intensification methods for achieving environmental goals. Some examples of new devices, developed for high efficiency separations and intensive reactions which can improve process economics, reduce effluent and provide opportunities for alternative products are included. A third theme which emerges is the importance of controlled fluid mechanics in achieving intensification goals. Exploitation of laminar flow, ensuring consistent fluid dynamics, improving mixing efficiency and control of particle size are areas highlighted. Papers by Tsouris on the continuous-jet hydrate reactor and by Vicevic et al. describing highly novel work on the application of a spinning disk reactor to an important polymerization reaction provide excellent examples of where an understanding of the factors which control the fluid dynamics at the macro-scale can be exploited to improve performance in multi-phase systems. The importance of fluid mechanics in fact pervades almost all the papers included in this issue. Further highlighted examples include intensification of gas absorption in bubble columns for CO_2 management in a fuel cell system (Krumdieck and Wallace) where space is at a premium; intensification of gas/liquid mass transfer in fermentation using novel porous impellers (Boodhoo et al.) and enhancement of hydrocyclone performance for gas–solid separation by optimization of the vortex finder configuration (Wang and Yue).

We also include some papers which encompass the use of novel chemistry and biological techniques as examples of intensification. Such developments, which were also discussed at the conference, include protein separation; the use of ionic liquids as reaction and separation media; combined carbon

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dioxide–hydrocarbon based solvents (CXLs); novel separations and purification; integration of reaction and separation and the use of enzymes as process catalysts. These advances represent research areas which strongly complement developments in other intensive processing technologies. Indeed there are examples where combination of new molecular techniques with novel engineering may provide great overall advantage for application. For example, a paper describing the combination of enzymatic catalysis with electrically induced intensification of liquid–liquid contacting brings together the potential environmental advantages of enzymatic catalysis with an intensive contacting technique, which ensures highly efficient physical contact and final product recovery.

The significant broad conclusions from the conference and this set of papers are as follows: (i) the development of process intensification should be targeted at real products and processes, with a focus on improvements in meeting product specification (size, composition) and enhanced process economics; (ii) there is a strong nexus between energy and process intensification and between process intensification and the move to sustainable processes; (iii) successful process intensification requires a systems approach, encompassing hardware engineering, consideration of new developments in chemistry and a deeper understanding of the fundamental fluids mechanics and associated transport phenomena involved in reaction and separation systems.

PI2 provided an excellent forum for the communication of new concepts and ideas in the area of process intensification and involved approximately 50 delegates from 14 countries around the world. The papers included in this issue were fully peer reviewed and revised in accordance with feedback from the reviewers and editors. We would like to express our appreciation to members of the scientific advisory committee and to the authors and other participants for their contributions.

Co-chair and Guest Editor
Costas Tsouris
Oak Ridge National Laboratory, USA

Co-chair and Guest Editor
Laurence Weatherley *
Department of Chemical and Petroleum Engineering,
The University of Kansas, USA

* Corresponding author.
E-mail address: lweather@ku.edu (L. Weatherley)