PROCESS INTENSIFICATION AND PROCESS SCALE-UP: GAPS AND OPPORTUNITIES

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Process intensification (PI) has gained traction in modern chemical engineering and process technology with its potential for drastic improvements in equipment size, efficiency and carbon footprint. Technologies that exert greater control of process fluid dynamics, heat and mass transfer, and reaction kinetics offer the ability to achieve step changes in performance over conventional technology. Process intensification has already found commercial success exploiting these phenomena in niche separations and reactions, prominently in the area of specialty chemicals and products.

In large-scale industrial processes such as refining and commodity chemicals, effective process scale-up is required to capture economies of scale for large production volumes. The current paradigm for rapid scale-up uses small-scale studies to decouple the relevant process physics and use models to integrate these physical effects for confident commercial design. Translating this paradigm presents challenges and opportunities for process intensification to address. The complex and closely-coupled physics in PI technologies (e.g., dynamic absorption) require deeper understanding than conventional technologies in order to scale up with confidence. This physical coupling may require larger process demonstration testing that significantly increases development time and cost relative to conventional technologies.

This paper will present an assessment of the unique challenges for scale-up of PI technologies addressing both the technical complexity of scale-up as well as the applicability for large-scale commodity processes. Where scale limitations of current PI technologies exist, it highlights tradeoffs between scale-up and “number-up” approaches to commercial design. The authors will present examples to illustrate these opportunities, including commodity processing areas where new PI solutions are still needed (e.g., solids handling, bio-processes).