Recent Developments of Microreactors for Process Intensification

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Abstract

Microreactors for process intensification transform chemical synthesis, providing precise control over reactions in compact devices and enhancing efficiency. This review article explores their application in catalytic biomass conversion, emphasizing advantages in mixing, temperature control, and heat transfer. It delves into fundamental aspects, addressing challenges in design, operation, material selection, and scaling. Fundamental microreactor design principles involve scaling strategies such as internal and external numbering up, geometric similarity, and continuous pressure drop procedures. Materials like silicon, steel, and polymers, particularly polydimethylsiloxane (PDMS), play a crucial role in microreactor construction. Fabrication techniques, including microfabrication, are essential for creating complex designs and ensuring reliability. The review addresses challenges and research gaps while showcasing the versatility of microreactors. Challenges include automation, integration, optimal configurations, process optimization, and cost analyses. Overcoming these is crucial for widespread adoption in industries like pharmaceuticals and petrochemicals. The future outlook for microreactors focuses on recent advancements, collaboration between academia and industry, and the integration of automation and sensors. This envisions microreactors as key players in revolutionizing chemical production, with potential applications in fuel cells, mini-chemical plants, and next-generation catalysts. Therefore, it is in utmost importance that addressing current challenges and advancing research related to this study solidify their role in shaping the future of chemical engineering.

Keywords: microreactors; process intensification; chemical processes; synthesis; flow reactors