Abstract: Different configurations of torus reactors were investigated, batch and continuous operating modes, square and circular cross-sectioned geometries and, a scale-up of the reactor was finally conducted (100mL, 300mL and 4L). The torus reactor was simulated using the commercial code Fluent®. In batch conditions, a linear evolution of the mean circulation velocities with respect to the impeller rotation speed was obtained using square and circular-sectioned torus reactors of 100 mL. Negligible differences were found between both types of section. Finally, the reactor volume was scaled-up from a 100 mL to 300 mL and to a 4 L reactor volume. Larger reactor allowed higher bulk velocities for same impeller rotation speed. Reynolds number and Reynolds mixing number were also calculated. The mean velocities obtained in this case were significantly higher. However, same obtained relationship between Reynolds numbers denoted an important result for scaling-up the performance of torus reactor.
Optimisation of a torus reactor geometry using CFD

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Abstract

Different configurations of torus reactors were investigated, batch and continuous operating modes, square and circular cross-sectioned geometries and, a scale-up of the reactor was finally conducted (100mL, 300mL and 4L).

The torus reactor was simulated using the commercial code Fluent®. In batch conditions, a linear evolution of the mean circulation velocities with respect to the impeller rotation speed was obtained using square and circular-sectioned torus reactors of 100 mL. Negligible differences were found between both types of section. Finally, the reactor volume was scaled-up from a 100 mL to 300 mL and to a 4 L reactor volume. Larger reactor allowed higher bulk velocities for same impeller rotation speed. Reynolds number and Reynolds mixing number were also calculated. The mean velocities obtained in this case were significantly higher. However, same obtained relationship between Reynolds numbers denoted an important result for scaling-up the performance of torus reactor.

Keywords: Optimisation; CFD; Geometry; Torus reactor

1. Introduction

Despite experimental studies have confirmed efficiency of the torus geometry, the optimal conception of torus reactors and their utilisation in industrial scale production require still theoretical research. Little information about hydrodynamic characteristics involved in torus shape reactors is known. Khalid et al. (1996) and Khalid and Legrand
On the other hand, the Reynolds and the Reynolds mixing numbers for the 4 L reactor were also calculated and are presented in figure 5. A linear relation between the Reynolds and the Reynolds mixing numbers was obtained. This relation is comparable to the one obtained for the 100 mL torus reactor (equation 5), thus, the same approximation was used. Then, there is no difference whatever the reactor volume. It is good for extrapolation.

4. Conclusions

The characterization of the flow-field in a torus reactor of 100 mL was carried out for two different configurations. It was obtained that the hydrodynamic is mainly a function of the impeller rotation speed. Negligible influence on the hydrodynamic was observed for flow inlets located perpendicular to the flow circulation. No differences were found using a circular-sectioned reactor due to the small volume and the high turbulence generated inside it. A 300 mL square-sectioned reactor seemed to be more effective than the 100 mL one because it presents higher bulk velocities similar to those predicted for a torus reactor with circular section. However, same relationship was obtained for Reynolds numbers, denoting same performance.

The CFD analysis of the 4 L torus reactor shows that better velocities are obtained for bigger volumes of reactor. However, same relationship was found between Reynolds and Reynolds mixing number for all studied configurations. The main practical interest of this work is the possibility to have the same hydrodynamic behaviour for a 0.3 L torus reactor as for several litres torus reactors. This is an important result for scaling-up the performance obtained in lab-scale torus reactor.
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