MICROMIXING IN A GAS-LIQUID VORTEX REACTOR: AN EXPERIMENTAL AND NUMERICAL STUDY

Yi Ouyang, Manuel Nuñez Manzano, Sepehr Madanikashani, Laurien A. Vandewalle, Vladimir N. Shtern, Guy B. Marin, Geraldine J. Heynderickx, Kevin M. Van Geem.

Laboratory for Chemical Technology, Ghent University, Technologiepark 125, 9052 Ghent, Belgium, Kevin.VanGeem@UGent.be

Micromixing performance of a reactor is the controlling factor for fast reactions in polymerization, pharmaceutical and crystallization applications [1,2]. To achieve process intensification in micromixing-controlled processes, a vortex-flow unit is an efficient technology that has major advantages of simple structure, low cost and easy scale-up. Ever since a gas-solid vortex reactor (GSVR) was built and operated at Laboratory for Chemical Technology (LCT, Ghent University), many successful applications have been confirmed [3,4] and patented. Our recent work showed the applicability of the vortex technology for gas-liquid flows [5], leading to the concept of a gas-liquid vortex reactor (GLVR). The micromixing efficiency of the GLVR could also be an enormous advantage for applications involving liquid-liquid mixing and fast reactions.

To investigate the micromixing process, computational fluid dynamics (CFD) is first employed as a powerful tool to reveal and understand the hydrodynamics and reactive flow in the GLVR. Figure 1 shows the velocity filed in the GLVR and the contour of the liquid (as the red colour) distribution in the reactor chamber. The gas flow (as the blue colour) generates the initial vortex flow, and the momentum transfer between the gas phase and liquid phase disperses the liquid in the reactor chamber and increases the coalescence-redispersion frequency. The gas-liquid interface is large and tiny droplets are formed, which will be validated by visualization data from high-speed camera and particle image velocimetry measurements.

The Villermaux–Dushman iodide–iodate reaction system will be used to quantify the micromixing efficiency of the GLVR [6]. Figure 2 shows the schematic diagram of the experimental setup. The acid stream and the buffer stream containing ions of iodate, iodine and borate are pumped into the GLVR and mixed. The N_2 gas flow generates the initial vortex flow, and the liquid is entrained by the gas flow. Samples are collected at the outlet and immediately analysed by an ultraviolet-visible spectrophotometer. Effects of operating conditions and different GLVR designs will be investigated and the

micromixing characteristic time in GLVR is will be compared with conventional reactors. Further, by implementing the micromixing model [7] to simulate the reaction process, the CFD results will not only help to explain the experimental results but also guide the reactor design and optimization. This work will give fundamental insights in the liquid micromixing for practical GLVR applications.

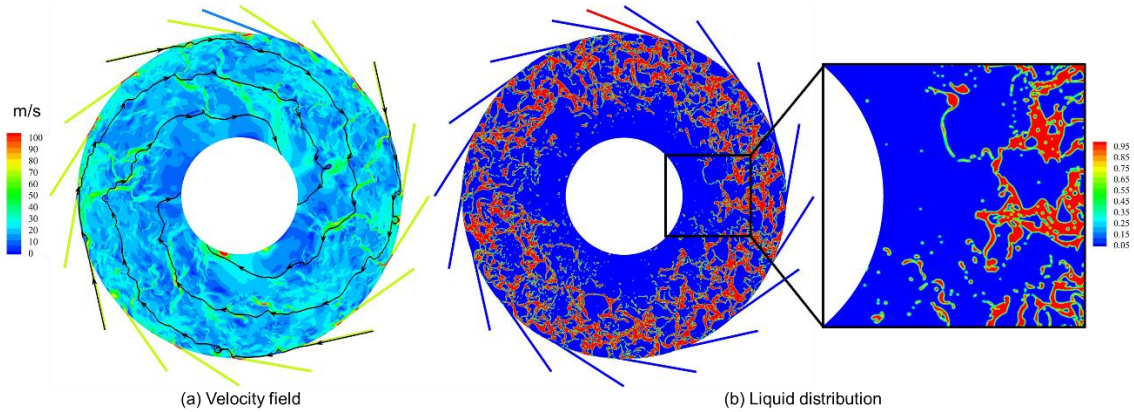

Figure 1. Contour of liquid flow distribution in the GLVU

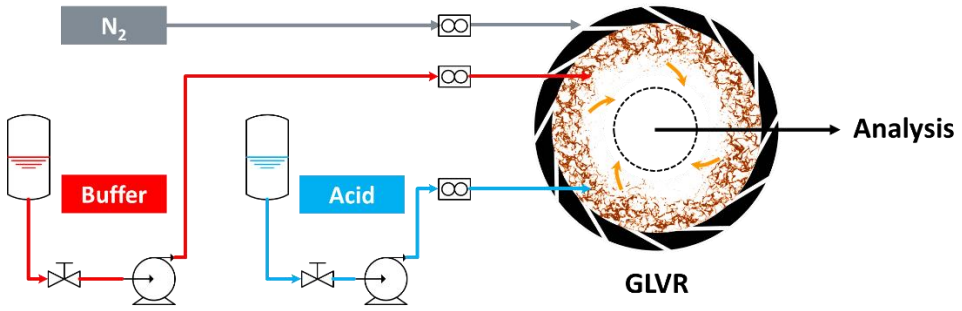

Figure 2. Schematic diagram of the experimental setup

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