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CO_2 Reduction in Wet Ionic Liquid Solution in Microscale-Based Electrochemical Reactor

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Abstract

A microscale-based electrochemical reactor was introduced for the reduction of CO_2 into CH_4, CH_3OH, H_2, HCOOH and HCHO with the presence of ionic liquid BMIM-BF_4 (1-butyl-3-methylimidazolium tetrafluoroborate). Reduction of CO_2 was studied under various experimental conditions controlled by factors such as solvent concentration, microreactor height, and mean residence time of fluids in the microreactor. A mathematical model reflecting geometry and flow conditions inside the microreactor was developed to simulate the chemical reaction process. The parameters of the mathematical model were determined using an optimization process in which the best fit between the experimental data and the model prediction was achieved. The model describes the reactions containing substrate reactants (CO_2 and H_2O) and final products (CH_4, CH_3OH, H_2, HCOOH, and HCHO), which were measured throughout CO_2 reduction process experiments.

Keywords

CO_2 reduction; Microtechnology; Ionic liquid; Electrochemical reactor

1. Introduction

Given that CO_2 emissions from combustion processes for energy production have been demonstrated to be a strong contributor to climate change [1], processes that incorporate the sequestration of the produced CO_2 have been under development [2]. As such, it is likely that significant amounts of CO_2 may be available to future generations as a chemical resource. We have therefore studying processes leading to the efficient reduction of CO_2 to useful organic molecules, such as through the use of non-aqueous solvents to lower needed overpotentials for the processes. At the time we were engaged in our study on the reduction of CO_2 in ionic