Electrochemical reduction of CO_2 to formic acid: a study of operating parameters in a microfluidic cell

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To meet the enhancement of the energy demand, the increased use of fossil fuels has resulted in a significant release of CO_2 into the atmosphere [1]. Continuous carbon dioxide emissions cause considerable environmental damage, so industries and research centres want to find a way to deal with them [2]. Nowadays, the electrochemical conversion of CO_2 is considered a relevant topic for several reasons, including the possibility to synthesize chemicals and/or fuels. The aim of the research is to find the operative conditions which allow to maintain at the same time high current density, high Faradic Efficiency, low energy consumption, long-term stability, and increase the final concentration of liquid products. These conditions were tested in a microfluidic cell. The application of continuous-flow micro-fluidic devices for the synthesis of chemicals received increasing attention in chemical engineering in the last years [3]. Especially, in this study, we have investigated the cathodic reduction of CO_2 (CO_2CR) to formic acid at tin cathodes in undivided microfluidic electrochemical cells characterized by very small inter-electrode distances: 250, 120 and 75 μm with and without supporting electrolyte [2]. The effects of numerous operating parameters such as pH, flow rate and current density were investigated.

[1] Ewisa, Dina, et al. “Electrochemical reduction of CO2 into formate/formic acid: A review of cell design and operation”. *Separation and Purification Technology* (2023): 123811.

[2] Proietto, Federica, et al. “Conversion of CO2 to formic acid in a microfluidic electrochemical cell with and without supporting electrolyte”. *Journal of Environmental Chemical Engineering* (2024): 112472.

[3] Pennemann, Helmut, et al. “Chemical microprocess technology-from laboratory-scale to production”, *Chemical Engineering Reviews* 59 (2004).