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Utilization of Micro-Mixers for Supercritical Fluid Fractionation: Influence of the Residence Time

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Abstract

The utilization of micro-mixers for Supercritical Fluid Fractionation (SFF) was investigated in this work. Two different mixing principles were tested: multi-lamination and T-type lamination. The extraction of ethanol from aqueous solutions by supercritical carbon dioxide ($scCO_2$) was chosen as the model system. The influence of the average residence time on the extraction results was studied by varying the capillary length as well as the overall flow rate. Experimental results proved that thermodynamic equilibrium is reached in the micro-mixer and therefore the extraction cannot be enhanced by increasing the capillary length. On the other hand, in the experiments with different overall flow rate but same solvent-to-feed ratio (S/F), changes in the *K-factor* were observed when having a feed of 50 wt.% ethanol: the *K-factor* decreased as the total volumetric flow rate increased. Nevertheless, for the feed concentrations of 10 wt.% and 90 wt.% of ethanol, no significant changes were observed when the total flow rate was increased.

1. Introduction

Within the last decades, different applications of micro-process technology have been developed: micro-mixers, micro heat exchangers, micro-evaporators, micro-extractors, micro-distillators or micro-membrane devices [1]. It has been highlighted that the small scale and the high surface-to-volume ratio in microfluidics offer numerous advantages for chemical processes [2]. The utilization of micro-mixers in particular has been demonstrated to be very advantageous in processes such as chemical reaction or extraction. It has been proved that liquid-liquid extraction benefits from microfluidics as the short path lengths and large interfacial area between the two liquid phases can enhance the extraction efficiency and equilibrium can be