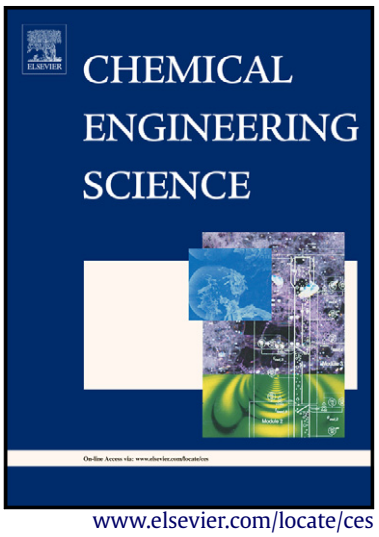

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Enhancement of mass-transfer in spacer-filled channels under laminar regime by pulsatile flow

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Abstract

Improving mass transfer in membrane modules is always desirable, but not easily achieved under laminar regime. Pulsatile flow induced by a solenoid valve was investigated as a technique to improve mass-transfer in membrane modules with spacer-filled channels. Mass-transfer coefficients were measured by the limiting current technique in open and spacer-filled narrow rectangular channels, both for steady-state flow and pulsatile flow, at Reynolds numbers ranging from 10 to 50 (based on the channel height). The test cell had a narrow rectangular channel (170mm x 15mm x 2mm) and 8 consecutive nickel electrodes (11.2 mm long and 10 mm wide) fitted in the top wall, with and without spacer inside the flow channel. The pulsatile flow followed a step function with three different frequencies (1, 10 and 50 Hz) and two different duty cycles (fraction of time during which the valve is closed in each pulse) of 25% and 50%. The results show that pulsatile flow generated with solenoid valves with frequencies between 10 Hz and 50 Hz can increase up to 50% the mass-transfer coefficient in membranes modules with spacer-filled channels, operating in laminar flow. The effect is particularly intense near the channel outlet, close to the solenoid valve, but vanishes for large distances from the channel outlet.

Keywords: Pulsatile flow, Step pulsatile flow, Mass-transfer enhancement, Mesh-type spacers, Limiting current, Spiral-wound modules

1. Introduction

Membrane modules with spacer-filled channels are widely used to concentrate aqueous solutions by reverse osmosis, nanofiltration and ultrafiltration, or to promote contact between two phases [1, 2, 3, 4, 5, 6]. In these systems, the

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