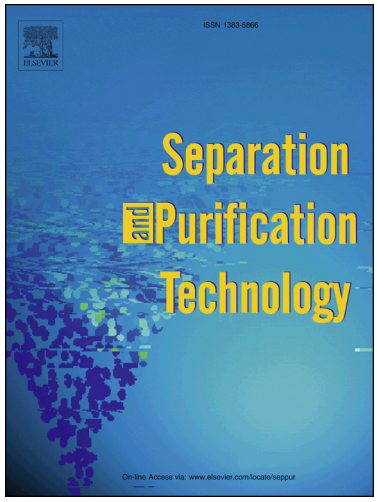

Hydrodynamics and mass transfer characteristics of circulating single drops with effect of different size nanoparticles

Javad Saien, Ronak Hasani

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Hydrodynamics and mass transfer characteristics of circulating single drops with effect of different size nanoparticles

Javad Saien*, Ronak Hasani

Department of Applied Chemistry, Bu-Ali Sina University, 65174, Hamedan, Iran

ABSTRACT

The effect of three different size silica nanoparticles, ranged within 11–14, 20–30 and 60–70 nm, on the hydrodynamic and mass transfer of circulating drops in liquid–liquid extraction was investigated. Chemical system of toluene–acetic acid–water was used; toluene in nanofluid drop phase. Six concentrations of each nanoparticle, within 0.0005 to 0.005 wt%, were examined. Mass transfer direction was from nanofluid drops to aqueous continuous phase. Viscosity of nanofluids increases slightly with the size and concentration of the nanoparticles whereas the system interfacial tension remains almost constant. Terminal velocity values were comparable with those predicted by Grace and Vignes equations. The average and maximum mass transfer enhancements of 51.8 and 78.7% were achieved, respectively, with nanofluid drops. The smallest size nanoparticle at nearly the mid concentration of 0.003 wt% provides the highest enhancement. Nanoconvection caused by Brownian motion is the main plausible cause of this behavior. It was demonstrated that enhancement factor of diffusivity coefficient can be reproduced by a quadratic equation of drops' Reynlods number, and the Newman equation based on effective diffusivity can predict the mass transfer coefficient satisfactorily.

Keywords: Liquid–liquid extraction; Circulating drops; Nanofluid; Nanoparticle size; Hydrodynamic; Mass transfer

1. Introduction

Liquid–liquid extraction is an extensively used separation method that has found an important place in engineering and industrial applications. Among different industrial extractors, columns are mostly in use because of high contact area of drops and the breakage/coalescence

*Corresponding author.
E-mail address: saien@basu.ac.ir (J. Saien).