



HAL
open science

Development of a high velocities co-flowing stratified microfluidic process to obtained kinetic constants for liquid-liquid extraction

F. Corne, A. Lelias, A. Magnaldo, C. Sorel, Nathalie Di Miceli Raimondi,
Laurent Prat

► To cite this version:

F. Corne, A. Lelias, A. Magnaldo, C. Sorel, Nathalie Di Miceli Raimondi, et al.. Development of a high velocities co-flowing stratified microfluidic process to obtained kinetic constants for liquid-liquid extraction. Continuous Flow Technology IV, SCI; RSC, May 2019, Manchester, United Kingdom. cea-02339460

HAL Id: cea-02339460

<https://cea.hal.science/cea-02339460>

Submitted on 4 Dec 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Development of a high velocities co-flowing stratified microfluidic process to obtained kinetic constants for liquid-liquid extraction

Florian Corne¹, Anne Lélías¹, Alastair Magnaldo¹, Christian Sorel¹, Nathalie Raimond², Laurent Prat²

¹CEA, Nuclear Energy Division, Research Department on Mining and Fuel Recycling Processes, Research Service for Dissolution and Separation Processes, Laboratory of Conception of Extraction Processes, F-30207 Bagnols-sur-Cèze, France

²Laboratoire de Génie Chimique, Université de Toulouse, CNRS, INPT, UPS, Toulouse, France

Kinetic constant in liquid-liquid extraction processes are generally determined using constant interfacial area method as the single drop method, Nitsch cell or Lewis cell. Those technics only reach the overall mass transfer constant that can be subdivided on chemical constant and diffusive ones. Molecular diffusive transfer is quite hard to be restrained in a non-stirred device while any phase stirring has to be avoided to determine chemical kinetics. Hence, our microfluidic process carried out high velocities stratified flow in co-flowing configuration to aim chemical kinetics constant determination, thanks to both diffusive length reduction and fine flow control of the microfluidic technology. Moreover, to avoid any Dean vortexes or other convective movements that can be presents at high velocities even at laminar flow, all extraction experiments were realized in a 1.25 cm straight and linear microchannel. Our experimental hypothesis as a centred interface have also been verified tanks to confocal experiments.

This presentation will focus on the extraction experiments of uranium(VI) in nitric acid by the tributylphosphate (TBP) diluted at 30% in TPH as shown on Figure 1.

For example, on a 50.4 g/L uranium(VI) initial aqueous concentration, aqueous and organic residence times are lying between 0.050 s and 0.009 s. Thus, we achieved to reach 12 % extraction yield at low speed and even 4 % at maximum phases velocities.

These extraction yields are quite good considering our phases contact time inside the microchip.

To calculate the kinetic constants and especially the chemical one, modelling were run with Scilab and COMSOL Multiphysics software. Neither with Scilab nor COMSOL Multiphysics the chemical kinetic were obtained, all modelling results were way below the experimental data. Hence, we suspect the presence of an acceleration factor enhancing the overall mass transfer.

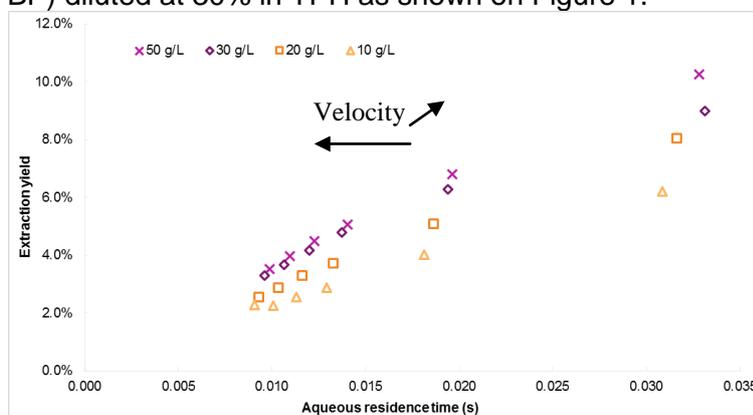


Figure 1. Uranium(VI) extraction yields versus aqueous residence, function of the initial uranium(VI) concentration.