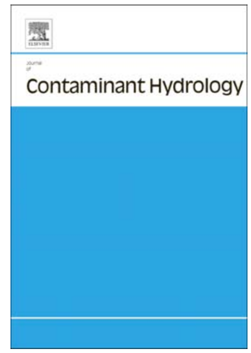
Accepted Manuscript



Comparison of theory and experiment for NAPL dissolution in porous media

T. Bahar, F. Golfier, C. Oltéan, E. Lefevre, C. Lorgeoux

PII: S0169-7722(17)30326-1
DOI: doi:10.1016/j.jconhyd.2018.03.004
Reference: CONHYD 3379

To appear in: *Journal of Contaminant Hydrology*

Received date: 20 October 2017
Revised date: 8 February 2018
Accepted date: 2 March 2018

Please cite this article as: Bahar, T., Golfier, F., Oltéan, C., Lefevre, E., Lorgeoux, C., Comparison of theory and experiment for NAPL dissolution in porous media, *Journal of Contaminant Hydrology* (2018), doi:10.1016/j.jconhyd.2018.03.004

Comparison of theory and experiment for NAPL dissolution in porous media

T. Bahar[a,*], F. Golfier[a], C. Oltéan[a], E. Lefevre[a], C. Lorgeoux[a]

[a] *Université de Lorraine, CNRS, CREGU, GeoRessources lab., Vandœuvre-lès-Nancy Cedex, F-54518, France*

Abstract

Contamination of groundwater resources by an immiscible organic phase commonly called NAPL (Non Aqueous Phase Liquid) represents a major scientific challenge considering the residence time of such a pollutant. This contamination leads to the formation of NAPL blobs trapped in the soil and impact of this residual saturation cannot be ignored for correct predictions of the contaminant fate. In this paper, we present results of micromodel experiments on the dissolution of pure hydrocarbon phase (toluene). They were conducted for two values of the Péclet number. These experiments provide data for comparison and validation of a two-phase non-equilibrium theoretical model developped by Quintard and Whitaker (1994) using the volume averaging method. The model was directly upscaled from the averaged pore-scale mass balance equations. The effective properties of the macroscopic model were calculated over periodic unit cells designed from images of the experimental flow cell. Comparison of experimental and numerical results shows that the transport model predicts correctly - with no fitting parameters - the main mechanisms of NAPL mass transfer. The study highlights the crucial need of having a fair recovery of pore-scale characteristic lengths to predict the mass transfer coefficient with accuracy.

Keywords:
Porous media, NAPL dissolution, Upscaling, Volume averaging method

List of symbols

A_{ij}	Interface between the i- phase and j- phase (i,j : ω, β, γ, k)
$\mathbf{b}'_\beta$	Dimensionless form of the closure variable $\mathbf{b}_\beta$, $(-)$
C_a	$= \frac{\|\mathbf{v}_\beta\|\mu_\beta}{\sigma_{\beta\gamma}}$, Capillary number, $(-)$
$c_{A\beta}$	Pore scale concentration of species A in the β phase, (kg m^{-3})
$\langle c_{A\beta}\rangle$	Averaged concentration of species A in the β- phase, (kg m^{-3})
$c^{eq}_{A\beta}$	Concentration of species A in the β- phase in equilibrium with ρ_γ, (kg m^{-3})
c_f	Circularity, (-)
c_0	Injected concentration in the complex 2D geometry , (kg m^{-3})

*Corresponding author
Email address: tidjani.bahar@univ-lorraine.fr (T. Bahar)