Simulation of pollutant transport investigated through an expansive clay.

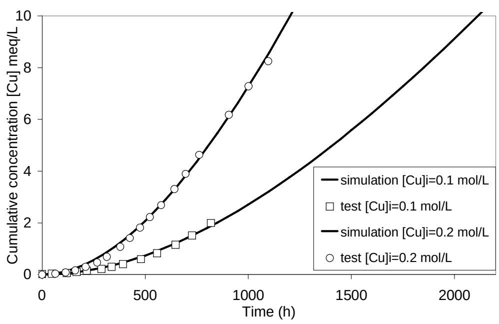
Chantal Proust, Roger Lédée, Agnès Jullien, Lydie Le Forestier

SIMULATION OF POLLUTANT TRANSPORT INVESTIGATED THROUGH AN EXPANSIVE CLAY

C. Proust [a,b], R. Ledee[b], A. Jullien[c], Le Forestier [a,b]

[a]*ISTO (UMR 6113 CNRS-Université d'Orléans), 1a rue de la Férollerie, 45071 Orléans Cedex 2, France. lydie.leforestier@univ-orleans.fr*
[b]*ISTO (UMR 6113), Polytech'Orléans, 8 rue Léonard de Vinci, 45072 Orléans Cedex 2,France.*

In the framework of domestic waste disposals, the in-situ compaction of soil is usually used to obtain engineered clay barriers with suitable confining properties. Permeability and pollutant retention are the major properties which should be investigated in this context for barrier evaluation. Considering clay barriers in contact with waste leachates, they may be saturated by solutes of various chemical compositions, including in particular toxic heavy metals. In this context, the expansive Fo-Ca clay, a natural Ca-smectite from the Paris basin of Ypersian (Sparnacian) age, was chosen because of its very low permeability and ability for pollutant retention through cationic exchanges. The smectic is associated with kaolinite (up to 20%), and minor quartz, calcite, goethite and gypsum.
An experimental work [1] was performed to analyse the Fo-Ca properties when submitted to chemo-hydro-mechanical coupled effects produced by soaking the clay with a polluted copper solution. The evolution of leachate chemical composition was carried out as a function of time in order to characterise the ability of the clay to copper retention. Then a model can be proposed to simulate 1) the pollutant concentration and 2) the exchangeable clay cation in leachate.
The clay samples can be considered as a system submitted to an external constraint (x(t)) and delivering a response (y(t)). The copper behaviour can be modelled through the equation $y(t) = \partial M/\partial t\ (t-\tau + \tau\ e^{(-t/\tau)})$, with M the molar concentration of the input copper solution (mol/L), τ the time constant (hours). It is possible to use the same approach to simulate the cation concentration evolution in leachate. The cation exchange capacity of the clay (CEC) was used to set the boundary conditions. This new system can be summarised by the equation $y(t) = CEC\ (1 - e^{(-t/\tau')})$. Simulated curves using different copper concentrations are presented on figures 1 and 2. The model allows to predict the behaviour of more diluted copper solutions representative of waste leachate through a clay barrier.



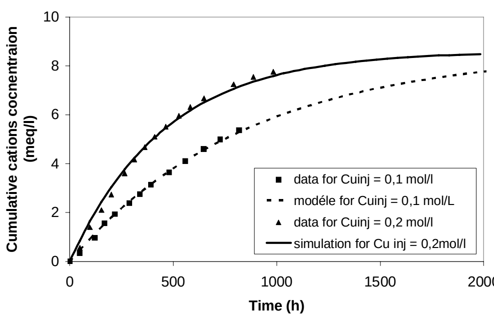


Figure 1 (left) : experimental and simulated Cu^{2+} concentration in leachate as a function of run duration, for different initial Cu^{2+} concentration in the injected solution.
Figure 2 (right) experimental and simulated exchangeable cation concentration in leachate as a function of run duration, for different initial Cu^{2+} concentration in the injected solution

[1] A. Jullien, C. Proust, L. Le Forestier, P. Baillif, Applied Clay Science, 21 (2002) 143

S6 POSTER