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Membrane behavior of bentonite-amended compacted clay towards Zn(II) and Pb(II)

Qiang Tang [*1], Takeshi Katsumi [2], Toru Inui [2] and Zhenze Li [3]

[1] *School of Urban Rail Transportation, Soochow University, China*
[2] *Graduate School of Global Environmental Studies, Kyoto University, Japan*
[3] *Department of Civil Engineering, University of Ottawa, Canada*

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Abstract. Zinc and lead pollution are public environmental issues that have attracted lots of attention for a long time. Landfill leachate contains heavy metals, such as Zn(II) and Pb(II), which are usually related to the pollution of groundwater, especially in developing countries. Bentonite has been proven to be effective in enhancing the membrane property of clay, by which landfill liners can have better barrier performance towards the migration of contaminants. In this study, 5% sodium bentonite amended with locally available Fukakusa clay was utilized to evaluate the membrane behavior towards the heavy metals zinc and lead. The chemico-osmotic efficiency coefficient, ω, was obtained through Zn(II) and Pb(II) solutions with different concentrations of 0.5, 1, 5, 10, and 50 mM. According to the results, ω continually decreased as the Zn(II) and Pb(II) concentrations increased, which is consistent with the Gouy-Chapman theory. Compared to normal inorganic ions, the membrane behavior towards heavy metal ions was lower. The migration of heavy metal ions was not observed based on experimental results, which can be attributed to the adsorption or ion exchange reaction. The mechanisms of the membrane performance change were discussed with the assistance of XRD patterns, free swelling results, XRF results, and SEM images.

Keywords: Bentonite amended compacted clay; Zn(II); Pb(II); membrane behavior; adsorption; mechanism

1. Introduction

Because of the rapid development of industrial economies, the environment is faced with severe heavy metal pollution. These metals are discharged into the environment in numerous ways, including from mine drainage, car manufacturing, painting, smelters and metal refineries, and industrial and domestic sewage (Kimbrough and Suffer 1995). Unlike organic pollutants, which are susceptible to biological degradation, heavy metals are not biodegradable and sometimes such pollution may last for two millennia (Hong *et al*. 1994). What is worse, heavy metals tend to accumulate in biological systems and can result in severe environmental problems; they can even threaten people's health.

Zinc is an essential trace nutrient that is required by most living organisms for healthy growth and enzyme function (Tang *et al*. 2012). However, it is toxic to plants and animals at elevated

*Corresponding author, Ph.D., E-mail: tangqiang@suda.edu.cn

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