Sorption Characteristics of Arsenic by Calcium-Magnesium Composite Particles Amended with Soil

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1. Introduction

Many public works have resulted in the excavation of large volumes of ground, which may contain non-anthropogenic heavy metals. Heavy metals (e.g., As, F, and Pb) in soil have adverse environmental significance because of their potential toxicity and mobility. A cost-effective approach to reduce this contamination risk is to apply a semipassive in situ treatment method that essentially consists of a horizontal permeable sorptive barrier to immobilize the potentially toxic trace elements and control the soil leaching potential. It is of importance to evaluate the sorption characteristic of the barrier material.

2. Methodologies

Both batch and up-flow column tests were conducted to evaluate the sorption characteristics of Ca/Mg composite as a function of two Ca/Mg particle sizes of under 2 mm and 2-7 mm. Herein, batch sorption tests were conducted to evaluate the equilibrium and kinetic sorption of arsenic. Whereas, up-flow column tests were conducted to evaluate the breakthrough curves for arsenic transport through saturated soil columns and to contact materials with solutions under a more practical condition. The study also intended to evaluate the sorption mechanism of arsenic (As) by soil-Ca/Mg composite.

3. Main conclusions

1) Freundlich isotherms were observed to effectively describe the sorption of As. The sorption of As by Ca/Mg composite is mainly influenced by the particle sizes of Ca/Mg composite, mix ratio, and the initial As concentration (Fig. 1).
2) The Ca/Mg composite was observed to have a strong pH buffering effect, as it was able to retain the column effluent pH between 9 and 10. In addition, the Eh of the column effluents were between 0.3 V to 0.4V, which indicates oxidizing conditions. Similar to pH, the Eh values were almost consistent until the end of the experiment. The column effluent Eh-pH characteristics indicate that As existed dominantly in the protonated anion state $HAsO_4^{2-}$, and formed complex compounds with Ca and Mg, which are stable in alkaline conditions.
3) The sorption of As by Ca/Mg composite involved the flushing-out of metal ions, particularly Ca^{2+} and Mg^{2+} (Fig. 2). It is speculated that the sorption mechanism of As involved the precipitation of As with Ca to generate calcium arsenate, and co-precipitation of As as a reaction in the surface function of Mg.

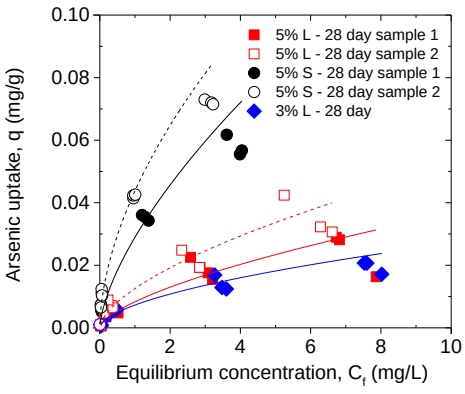

Fig 1. Freundlich sorption isotherm of As

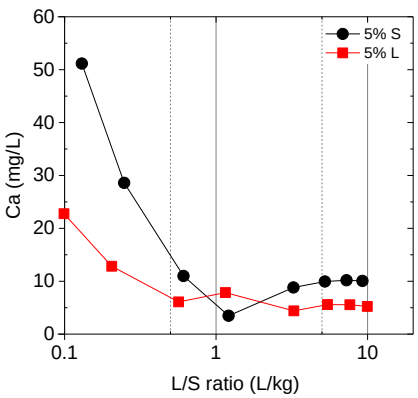

Fig 2. Release of calcium ion in up-flow column test