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Clay Minerals as a Feasible Additive to Stabilize Cadmium in Contaminated Soils

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Keywords: Clay minerals, Amendment, Contaminated soils

Abstract. The adsorption behavior of clay minerals in cadmium contaminated soils has been studied in order to remedy soils contaminated with this metal in this work. The results show that Langmuir model best describes the adsorption of Cd^{2+}, and the maximum sorption values of 8.45 mg/g for bentonite, 5.69mg/g for sepiolite and 10.57mg/g for attapulgite are obtained at pH 5-6. In addition, the effect of clay minerals amendment on a highly cadmium contaminated soil has been studied by means of pot experiments. The results indicate that the metal concentrations in shoot and root of plant decreased with addition of clay minerals to soil (1%), and the highest decrease value of metal concentrations is obtained in the soils added by attapulgite amendment.

Introduction

The intensive development of industry, without protecting the ambient environment by efficient emission controls such as industrial wastes [1,2] or mining activity [3,4], may cause the accumulation of high amounts of heavy metals in soils. Metals in soil are not biodegraded by natural process, and remain in the ecosystem. They would seep into groundwater or even channel into the food chain by crops planted on such soil. Heavy metals become extremely hazardous when they finally find their way into human or animal bodies [5]. In order to reduce the environmental risks arising from heavy metal pollution of the soils, it is necessary to develop some low cost remediation methods, which do not destroy the soil structure and fertility, and are suitable for application on the topsoils.

There are three major reclamation technologies for metal-contaminated soils: isolation, removal of the contaminant and physicochemical stabilization or solidification [6]. Adding clay mineral into the soil is one example of stabilization methods. Clay minerals that consist of crystallized silicate have received great interest in a wide array of applications because of its high specific surface area, superior capability in adsorption and cation exchange. In view of the availability and market price of clay minerals, this research is intended to capitalize on clay mineral's superior cation exchange capacity to reduce the transport of the heavy metal Cd in soils, and to stabilize and prevent Cd from being adsorbed by crops or migrating into groundwater. The effects of clay minerals on Cd stabilization in soils were investigated by batch experiments and pot experiments.

Materials and Methods

Soil and clay minerals. The uncontaminated cultivated sandy soil samples (0-20 cm depth, pH=8.6) were taken from the Haidian District, Beijing, China. The following three kinds of potential adsorbent materials were selected: Na-bentonite (pH=10.2) from Xuanhua Ca-bentonite modified by Na, sepiolite (pH=8.9) from Nanyang, attapulgite (pH=9.8) from Xuyi.

Isothermal adsorption experiment. Cadmium solutions for isothermal adsorption experiments with concentrations ranging between 50 and 600 mg/l were prepared with ultra pure water from metal standard solutions of 1000±2 mg/l, and the pH values of the solution were adjusted to pH 6.0.

Adsorption tests were carried out in centrifuge tubes by shaking a given dose of adsorbent with 20