Competitive adsorption of heavy metals by two different types of soils

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Abstract

Soil is a key element in human survival and can be described by various definitions according to its main utility. Nowadays, it is accepted that soil is a very complex heterogeneous medium which consists of solid phases containing minerals and organic matter and soil solution, defined as the fluid phase where soil reactions, transport and adsorption occurs (Alloway, 1995).

Unfortunately, in the last decades, soils have been used as a deposit of residues. Therefore, the contamination and pollution of soils, sediments, surface and groundwater are of main concern.

There are several ions and compounds of organic or inorganic nature that can contaminate soil and water. The inorganic contaminants include heavy metals like cadmium, chromium, cooper, lead and zinc, which are focused in this study. These metals are commonly present in industrial wastes (electroplating, textile and dyes, etc.), in fertilizers or in sewage sludge, but they can also contaminate soils through atmospheric deposition or runoff water (Serrano et al., 2005).

Since adsorption is well recognized as the main process affecting the mobility of heavy metals through soils (Bradl, 2004), the aim of this work is the study the non competitive adsorption of these five metals, as well as the competitive adsorption in two different typical soils of the North of Portugal

The soil samples were collected in Póvoa de Varzim, from O-horizon and A-horizon (0 cm -30 cm), one from a culture land and another from a beach land.

To evaluate the adsorption equilibrium, batch tests were performed by adding to 2 g of air dried soil, 20 mL of 0.01 M $CaCl_2$ solution, containing different initial concentrations of Pb [$Pb(NO_3)_2$], Cd [$CdN_2O_6{\cdot}4H_2O$], Cu [$Cu(NO_3)_2{\cdot}3H_2O$], Zn [$Zn(NO_3)_2{\cdot}6H_2O$] and Cr [$K_2Cr_2O_7$], isolated (non-competitive system) and coupled (competitive system).To eliminate the mass effect, the multi-metal solutions were prepared in terms of molar concentrations (Echeverría et al., 1998). To avoid precipitation the pH of initial solution was adjusted to 2. Isotherm models like Freundlich and Langmuir equations were adjusted to experimental data.

Batch tests are useful for the understanding of the adsorption process. However, advection and dispersion may occur in dynamic systems justifying the need of flow experiments (Miretzky et al., 2006). For continuous experiments, soil samples were packed in a column (25 cm × 3.2 cm) and a single – or multi – element solution of 50 mg/L was pass upwards during seven days. Then, using the CXTFIT code, the convection-dispersion equation was adjusted to the breakthrough curves in order to determine the retardation factor (*R*) and to compare the behavior of the different ions and soils.

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