Sorption of copper, lead and zinc on iron oxide samples

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Abstract: *The retention studies of Cu, Pb and Zn in materials such as iron oxide samples, in the laboratory to understanding metal adsorption between solution phase and solid phase of the suspended materials. The metals adsorption shows different adsorption responses between these materials. In the iron oxide case the most of heavy metal Cu, Pb and Zn concentration was measured in the solid phase, which consequence a high K_d value. The results show the affinity orders of heavy metals components, namely; Cu > Pb > Zn for most of the mass materials used.*

I.   Introduction

In the water, system the suspended sediment is contains of sand, clay and other silicate minerals and hydrous metal oxides, as well as organic particle such as microorganisms, diatoms and plant detritus (Hart et al, 1982). A mixture of factors such as natural efficiency, soil, flora, water cycle, and element controls the availability of metals in the fluvial system (Jain and Sharma 2001; Zhang and Huang 1993; Aurada et al.,1983; Warren et al.,1981). The most of the metals load is held and distributed by suspended particulate matter in river system environments (Covelli et al., 2007). Several earlier studies suggest that suspended particles can play an important role in carrying metals in the river system (Giesy and Briese 1977; Reuter and Perdue 1977; Hoffmann et al.,1981; Salbu et al., 1985; Tanizaki et al.,1992; Dai and Martin 1995; Ross and Sherrell 1999, Hill et al 2001).

The heavy metal transported in fluvial system in the both dissolved form, and adsorbed to the surface coating of the suspended particulate matter (Gallo et al 2006). In addition, there is some important as carrier particles for oxides coating and hydrous Fe and Mn oxides. Moreover, organic matter influences heavy metal partitioning onto suspended particle like Mineral surfaces such as clays and alumino silicates (Horowitz, et al 1991). The exchange of metal ions between water and sediment is an important process to study the metals transport in the water system (Singh, et al 2005).

Suspended materials nature can control metals absorption rate and the availability of dissolved metals. Metal is linked easily to clay materials that may be because the chemical and physical properties of the clay materials such as a high ion exchange capacity (Boenigk et al., 2005). The correlation between the concentrations of trace metal and sediment are important, which may be due to the change in total surface area of the sediment in suspension (Bradley et al., 1982). The surface area of a sediment particle controls the surface chemistry and its ability to adsorb sediment-associated contaminants (Gibbs et al., 1977, Horowitz and Elrick 1987). The fine particle size is increasing the surface area of the clay, which may be resulting increase the ability to absorption metal per unit mass (Lead et al., 1999).

Iron oxide has a variable charge which depends on the pH of the environment; the variable charge allows iron oxide to interact with metals. The surface charge of the iron oxide is positive under acidic conditions and negative under alkaline conditions. In the current study, there is no explanation of low metals associated to the solid phase. The result indicated that iron oxide suspended sediment has low metal carrying ability**.** The studies evaluate the heavy metal effect in single sorption system.

The distribution coefficient (K_d = [metal] $_{solid}$/ [metal] $_{solution}$) was determined for each system as a function of adsorbent concentration. K_d values have frequently been used to assess the relative concentration of metals in solution associated with suspended materials (Yin et al 2002). The higher the K_d value, the more metal is associated in the solid materials. Materials representative of components of suspended particles was iron oxides. This study will evaluate the ability of different components of suspended material to take up heavy metals. Experiments were carried out to measure the distribution of copper, lead and zinc between an aqueous phase and solid phase sediment material. This study tries to simulate the natural system, exploring the effects of trace metals on important materials, which are commonly found in the soil.

II.   Methods

Four representatives for each materials iron oxides sample were investigated. The samples were analysed by Atomic absorption Spectrometry a Perkin Elmer 400 B model. The experiment was performed by adding different masses (0.3 g, 0.5 g, 0.8 g and 1 g) of one of the materials iron oxide to one litre of distilled water containing trace metal at a1mg/l concentration of metal in a clean, dry glass beaker. Approximately e.g.

0.3 g of dry material was weighed in a beaker.1 ml of 1 mg/l concentration of metal was added to one litre of distilled water. The 0.3 g of the material was added to the 1 mg/l concentration solution. A stirrer bar was added and the beaker placed on a magnetic stirrer for mixing the sample. The sample was mixed for times ranging between 15 and 30 minutes. The nylon membrane filter paper with 0.2 □m pore size was weighed. The sample material was filtered through 0.2 □m pore size filters, and the filter paper was reweighed to determine the mass of material recovered. The filter paper was digested in 3:1 hydrochloric acid /nitric acid solution, an aqua regia digest.

III.   Results and discussion

The affinity order of metal K_d for iron oxide, namely in table (1), were Cu > Pb > Zn with 0.3 g and 0.5 g of masses material, which was similar to results previously reported (Covelo, et al 2007, Forbes 1976, and Grimme,et al 1968). Using 0.8 g and 1 g of iron oxide, the metal order for the K_d value was little different Cu ≈ Pb > Zn. In general, the highest K_d value was found for Cu. The difference in K_d metal order may be because of an increase in the number of binding sites on the surface of iron oxide with an increase in mass. That may be because increasing the amount of the iron oxide sediment, and keeping the metal concentration fixed makes a large number of sites available with additional masses.

Table (1) Recovery of iron oxide and distribution of Cu, Pb, and Zn metals between solid and solution phase

A Sample weight (g)	B Weight of iron oxide recovered in filter (g)	C Recovery of iron oxide (%)	D Concentration of metal in digest of recovered iron oxide (mg/l)	E Weight of metal in recovered iron oxide (mg)	F Weight of metal in 1 L of filtered water (mg)	G Total weight of metal recovered (mg)	H Total weight of metal adjusted for recovery of iron oxide (mg)	I Kd
1 mg/l Cu								
0.3	0.277	92	0.19	0.019	0.98	0.99	1.00	0.019
0.5	0.447	89	0.22	0.022	0.99	1.01	1.01	0.022
0.8	0.751	93	0.23	0.023	0.95	0.97	0.97	0.024
1	0.972	97	0.28	0.028	1.01	1.03	1.03	0.028
1 mg/l Pb								
0.3	0.286	95	0.12	0.012	0.83	0.84	0.94	0.014
0.5	0.489	98	0.19	0.019	0.92	0.94	0.94	0.020
0.8	0.782	97	0.22	0.022	0.91	0.94	0.94	0.024
1	0.977	97	0.25	0.025	0.90	0.92	1.00	0.028
1 mg/l Zn								
0.3	0.283	94	0.09	0.009	0.815	0.82	0.85	0.011
0.5	0.489	97	0.05	0.005	0.862	0.86	0.86	0.005
0.8	0.735	91	0.07	0.007	0.717	0.72	0.80	0.011
1	0.975	97	0.09	0.009	0.853	0.86	0.86	0.011

*C= (B/A)*100, **G= (E+F), ***H= (E*100/C) +F, #I= (E/F)

IV.   Conclusion

The results show most of the iron oxide was recovered in the filter paper. The majority of the metal was measured in the aqueous phase, with only a small amount measured in the solid phase. That may be due to a decrease in K_d values. The small adsorption capacities of the iron oxide can cause small changes in metal uptake (Farah, 1977). In the current study the small in metal K_d may be because of a variable-charge on clay edges with different masses of materials used, which attract the cations to the surface.

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