A study of natural iron precipitates as adsorbents for copper and nickel

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Adsorption efficiency of siderite, goethite and hematite, occurring in natural iron bog deposits in Vihanti area, Central Finland, has been studied for copper and nickel. The amount of iron precipitates in Vihanti area is exceptional compared to the other analogue areas in Finland. Siderite and goethite are iron minerals that commonly form under sedimentary conditions. Hematite used in this study is fired goethite which has thermally transformed to hematite.

The adsorption efficiency of Ni and Cu on the iron minerals was studied by using the batch technique. Reference tests were made using commercial synthetic goethite (CSG) (commercial Fe(III) hydroxide oxide (FeO(OH)). The tests were run as a function of different pH, Ni^{2}+ or Cu^{2}+ solution concentrations and the amounts of adsorbents.

The main parameters affecting the adsorption efficiency were pH of the solution, grain size and crystallinity of the adsorbents, their surface area, and the composition of the solution.

Dosage of the adsorbent clearly affects the adsorption efficiency. When the adsorbent dosage is increased to 15g/l, all of the studied adsorbents achieve high adsorption capacity for Cu. This is partly a result of the co-precipitation of Cu from the solution. For Ni the adsorption efficiency levels out under 30% for all studied adsorbents at dosage of 0.625g/l at pH= 3. At pH= 5 and pH= 7 even the smallest dosages achieve adsorption efficiencies of 70% with GOT and SID and 60% with HEM.

The adsorption capacity of the adsorbents for Cu^{2}+ at a dosage of 2.5g/l follows the order HEM < GOT < CSG < SID and for Ni^{2}+ HEM < CSG < GOT < SID.

In aiming to follow pH fluctuation and pH changes during the experiments, the initial solutions were not buffered. The correlation between adsorption capacity and changes in the pH of the solutions is strong. At low pH-conditions all studied materials tend to increase the pH of the solution and at higher pH they tend to decrease it. This is a result of proton release occurring at higher pH levels: as pH is high, the amount of H+ -ions in the solution is smaller than it is a lower pH – as the metal binds to the surface of the adsorbent it releases protons into the solution and the pH decreases.

All materials achieved their maximum adsorption efficiency in four hours.

Keywords: adsorption, goethite, siderite

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