Recovery of heavy metals by ferrite process: New results

M. JOHN* AND S. HEUSS-AßBICHLER

Ludwig-Maximilians-Universität München, Department for Earth and Environmental Sciences, Theresienstr. 41, 80333 Munich, Germany (*correspondence: melanie.john@min.uni-muenchen.de, heuss@lmu.de

Metallic elements and their compounds represent, depending on their concentration and bioavailability, a potential hazard to the health of humans, animals, plants and other living organisms. Water contaminated with heavy metals and also radioactive elements may be generated e.g. during mining processes or industrial productions. These wastewater are generally treated by precipitation of hydroxide. Another attempt proposed is the ferrite process to remove cations from low concentrated wastewater in form of ferrites. The basic principle of this method implies the addition of Fe^{2+} ions into the solution and subsequent alkalinisation of the solution under oxidizing conditions.

Our studies clearly show that the ferrite process is an effective method to decrease the concentration of heavy metals in solutions up to 10 g/L. In case of Cu^{2+}, for example, after treatment the concentration dropped down to < 0.2 mg/L. The average recovery rate is 99.98 to 99.99 % independent of the used experimental parameters.

Phase analysis exhibit that most of the precipitates are oxides. This leads to a drastic decrease of the precipitate volume compared to the other wastewater treatment methods. Accordingly, environmental impacts due to subsequent desorption processes of the coprecipitated heavy metals with hydroxides can be avoided.

The analysis of the precipitates by means of XRD, FTIR, SEM, TEM and magnetic measurements show that the constituents and composition of the precipitated nanoparticles depend on the reaction conditions and ageing procedure. However, the results reveal that the expected formation of ferrite solid solutions, like copper ferrite, can only be achieved under special conditions. The main controlling parameters are temperature, aging time and conditions as well as the initial concentration of the heavy metals in the solution.

The mechanism of the phase precipitation was studied. Green rust is decisive for the later phase formation and is effective as reduction agent. The redox state of the heavy metal oxides can be controlled depending on the initial concentration, oxidation conditions and ageing procedure. Under special reaction conditions we succeeded to obtain heavy metals in zero-valent state.