Precipitation of metals and sulphate from mining waters: separation and stability analysis of the precipitates

Kaj Jansson[1], Janne Kauppi[2], Mikko Huhtanen[3], Antti Häkkinen[3]

[1]Outotec, Rauhalanpuisto 9, 02230, Espoo, Finland
[2]Outotec, Tukkikatu 1, 53100, Lappeenranta, Finland
[3]LUT School of Engineering Science, Lappeenranta University of Technology, P.O.Box 20, FI-53851, Lappeenranta, Finland, Antti.Hakkinen@lut.fi

Extended Abstract

This paper introduces an experimental study that was carried out to demonstrate and compare the performance of different chemical precipitation methods for removal of soluble metals and sulphate from mining waters. In addition to this, the separation characteristics of the precipitates formed were determined and the environmental acceptability of the final solids was evaluated. The goal of the study was on the other hand to generate stable solids that can be easily separated from the recycled water, and on the other hand, to investigate if some suitable solid fractions could be successfully separated and utilized as secondary raw material resources. This was achieved by performing the precipitation processes in several steps and by separating the precipitates formed during different stages into individual fractions. Analysis of the products formed enabled detailed evaluation of the most suitable precipitation conditions in order to optimize the precipitation steps and to compare the alternative methods for solid residue treatment.

The experiments performed in this study were made with laboratory-scale equipment by using mining water samples obtained from an industrial process. The water used in the experiments had a relatively high concentration of sulphate (> 2500 mg/dm^3) and also significant quantities of various metals (Fe, Ni, Cu, Zn, etc.). The precipitation experiments were performed as simple batch tests where the precipitation conditions were varied in order to detect the most important process variables and to find the practical limits of the method. Solubility data existing in the literature was utilized for selecting the pH-range for each precipitation step. The composition of the water sample was investigated carefully before and during the tests and pH and redox potential of the solution were continuously monitored in order to detect the conditions were the main reactions occurred. The solids formed during the different precipitation steps were separated from the solution by performing filtration tests with a laboratory-scale pressure filter. The data collected during these tests enabled calculation of the theoretical filtration parameters that can be used for further process development. All the solid fractions were also analysed to determine their chemical compositions, particle sizes and stability according to standardized procedures. Different process configurations were suggested in order to maximize the overall performance of the treatment process and to evaluate the economics of alternative processes.

It was shown that the precipitation methods considered in this study could be used for removal of most metals from the water samples and also sulphate could be successfully removed to achieve acceptable levels in the treated water. The overall results of this study are promising and suggest that stable metal precipitates can be generated in a cost effective way and that the composition of the precipitates can be reliably controlled by careful selection of the precipitation conditions. Splitting the precipitation process into several subsequent steps opens up some new possibilities to utilize certain fractions of the precipitates as secondary raw materials. Separation of all precipitates could be successfully performed by applying pressure filtration and the results from this part of the study can be further used for selecting the most suitable separation equipment for each step of the overall process.

Key words precipitation, sulphate, metals, separation, stability