In-situ recovery of Cr and Ni from landfilled neutralisation sludge

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Significant amounts of a Cr-Ni-rich neutralisation sludge from acidic waste waters are produced by industry in Europe each year. This sludge is landfilled, as it is considered a hazardous waste due to its high heavy metal content. It is estimated that >10 Mtonnes of such sludge is present in EU landfills.

In this work, the in-situ recovery of Cr and Ni from this material by heap leaching is studied. Heap leaching is a low-cost, controlled process whereby complex or low-grade ores are stacked in low heaps and irrigated in a controlled manner with a solution to extract the optimum amount of a metal from the ore. In several cases, heap leaching could be easily applied to landfilled slag materials since material stacking, bottom lining and drainage water collection and treatment installations are already in place.

The studied sludge is very fine grained (99% <44 µm) and consists mainly of gypsum (60 wt% dm) and fluorite (20 wt%) but also calcite, magnetite and amorphous iron oxide phases are present. Both the fine particle size and presence of water soluble gypsum pose challenges for the application of heap leaching, since they compromise the permeability of the leaching solution and the integrity of the heaps, respectively. Therefore, granulation of the material and leaching by a pH buffered and $CaSO_4$ saturated leaching liquor were tested to overcome such problems.

First, the concept of heap leaching by a saturated gypsum solution was tested. Therefore, a column leaching experiment was set up to test the proposed concept. A leach solution saturated in gypsum (0.04 M $CaSO_4$), with addition of a pH buffer (0.5 M Na_2SO_4/ 0.05 M $NaHSO_4$) was percolated through a column (diameter 5 cm, filling height 20 cm) with a flow rate of approximately 7 ml/h. The gypsum sludge was mixed with 20% sand to enhance permeability. Results clearly show that Ni leaches selectively within the pH range 5-6, Cr starts to leach at pH 4 and at lower pH (±3) also Fe leaches. Based on these findings, a stepwise heap leaching process can be developed to recover selectively Ni and Cr and avoid the dissolution of interfering metals, such as Fe, for further recovery. Secondly, a granulation process was developed to shape the fine grained sludge material into larger grains in order to allow stacking in heaps with increased and uniform permeability. The granulated material was also tested by column leaching, to allow simulation of heap leaching conditions.

This work was performed in the framework of the METGROW+ project which aims to valorise low-grade resources by implementing novel methodologies, with a zero-waste approach.