LCA in the mining sector: the environmental implications of new recycling technologies for sulphidic mine residues

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Goals

The mining of non-ferrous metals such as Cu, Zn, Co, Ni, can produce a large amount of metal-containing residues, which are not fully recovered today. Sulphidic mine residues, for instance, are the leftover from the metal extraction process and they are often stored as a slurry in impounding lakes. Such storage facilities require careful maintenance, because of the risk of surface and groundwater contamination. On the other hand, the recycling of sulphidic mine residues presents various benefits, such as the recovery of valuable metals and minerals, and the avoided need for storage facilities (i.e. tailing ponds). Through the recycling of sulphidic mine residues, adverse effects related to the oxidation and acidic mine drainage of residual sulphides is also eliminated.

Therefore, innovative techniques are currently developed to exploit the reuse potential of sulphidic mine residues. The goal of this study is to provide an analysis of the environmental costs and benefits of newly developed techniques for sulphidic mine residues valorisation.

Methods

The "Horizon 2020" project NEMO stands for "Near-zero-waste recycling of low-grade sulphidic mining waste for critical-metal, mineral and construction raw-material production in a circular economy". It investigates one large mining site in the EU, aiming at developing new ways to valorise sulphidic mine residues, through the recovery of valuable metals and critical raw materials (Cu, Pb, Zn, Ni, Co, REEs/Sc, Mn, Mg). The extraction of metals from residues is based on enhanced bioleaching processes, as well as on a range of technologies to recover metals from the pregnant leach solution (i.e. different steps of chemical precipitation and solvent extraction). NEMO will also use the residual, clean mineral fraction as a raw material for the mass production of cement and concrete for construction products. Sulphates will be recovered for the production of fertilizers and detergents. Together with the technical challenges posed by the sulphidic mine residues valorisation, NEMO aims at analysing the sustainability of the developed technologies. In this context, an LCA will be developed to study the environmental hotspots and the environmental benefits of the NEMO recovery technologies. The inventory analysis for the LCA will be mainly based on the information gathered directly at the mining sites.

Results

The LCA analysis is expected to highlight the trade-off between the environmental costs and benefits of sulphidic mine residues valorisation. The recovery and reuse of valuable metals can indeed avoid the mining of new primary metals. This can be of relevance for REEs and cobalt, which are included in the list of critical raw materials by the European Commission. Moreover, the recycling of the inert fraction to produce new construction materials can have lower global warming potential (GWP) emissions compared to the traditional concrete based on Portland cement. On the other hand, it can highlight the environmental hotspots of the whole process (i.e. the energy consumption of the enhanced heap bioleaching, or the use of chemicals) providing a solid base for further optimisation of the newly developed technologies.