INNOMET

Combining bioleaching and bioelectrochemistry for innovative metal recovery from metallurgical dusts

A biotechnological approach for low-energy recovery of metals from secondary resources

The generation of dusts within the steel production, presents significant challenges; however, their recycling potential offers an opportunity for resource recovery, environmental sustainability, and cost efficiency through the extraction of valuable metals and reuse in industrial applications. Currently, great amounts of these metallurgical dusts are landfilled whilst present recycling strategies such as the Waelz process require a large energy input. Essential metals such as zinc and iron are thus lost, calling for innovative strategies to facilitate an efficient recovery and reusage of these metals. Biotechnological processes such as bioleaching to produce a metal-rich leachate and bioelectrical systems for the recovery of metals are alternative approaches to achieve these goals.

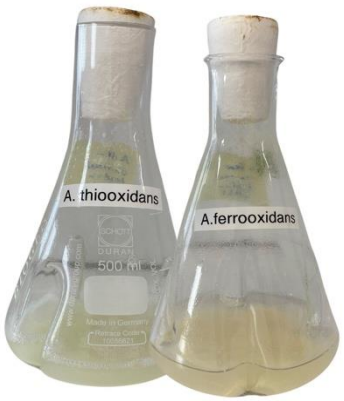

Figure 1: Pre-cultivated microbial cultures.

Bioleaching utilizes microorganisms (Fig. 1) to extract metals from ores, concentrates, and industrial wastes. This environmentally friendly method offers a sustainable alternative to traditional mining techniques by facilitating the recovery of metals through biological activity. Through microbial oxidation reactions, the microorganisms produce acids and metabolites which facilitate the extraction of the metals such as zinc and iron from the dust matrix.

A set of experiments were conducted bringing the microorganisms directly into contact with different metallurgical dusts. Through the oxidation of supplemented elemental sulfur, the fall in pH solubilized mainly zinc. Further, indirect bioleaching approaches were evaluated, separating the microbial sulfate production and the leaching process, allowing higher pulp densities whilst shortening the leaching duration.

In the next process step the recovery of zinc and iron from the bioleachate solution is investigated. First, selective precipitation of iron from a synthetic leaching solution was investigated and precipitation efficiencies of 96% iron were obtained by addition of base. In the following step a microbial electrolysis cell was used to recover elemental zinc from the remaining supernatant. The anode of this bioelectrochemical systems was colonized by electroactive microbes, which gave up electrons to the electrode, and have reduced thereby the energy demand for zinc recovery. The cathode chamber was filled with a synthetic leachate and stainless steel was the electrode material of choice. Zinc has been deposited onto the electrode (Fig. 2) and high zinc recovery efficiency of >99 % have been monitored. Currently, experiments with real bioleachates are conducted and the precipitated iron will be characterized and evaluated for its reusability. Furthermore, the purity of the deposited zinc will be analyzed.

Figure 2: Deposition of zinc onto the electrode.

Update on dissemination activities

Rebeka Frueholz presented the bioleaching results at the European Congress on Biotechnology in Rotterdam (Netherlands), 30.06. – 03.07.2024.

The results of the bioleaching experiments will be presented by Rebeka Frueholz at the Recy & DepoTech in Leoben (Austria), 13. – 15.11.2024.

Involved Partners

This project is funded by the province of Styria
(Zukunftsfonds Steiermark, funding contract PN 1507).