INNOMET

EAF dust recycling with the help of bacteria

A cost-effective and eco-friendly process using microorganisms and their metabolites to extract metals from metallurgical dusts.

In 2022, more than 1.8 billion tons of crude steel was produced worldwide, of which 28 % was produced in electric arc furnaces (EAF) (World Steel in Figures, 2023). A significant amount of dust is generated during the production of steel. Depending on the type of steel produced (carbon or alloyed steel), about 10 – 30 kg of dust per ton of liquid steel (kg/t LS) has been reported for an EAF according to 'Best Available Techniques (BAT) reference document for Iron and Steel Production (2013)'. Due to its widespread use in the corrosion protection of steel, zinc occurs in higher concentrations in EAF dusts (in the range of 2 – 43 %) and is present in the dust in the form of zinc oxide (ZnO) and zinc ferrite ($ZnFe_2O_4$).

Figure 1: EAF dusts from two different steel mills.

The currently established processes focusing on the recovery of metals from steel mill dust can be categorized as physical, hydrometallurgical and pyrometallurgical. In recent years, however, alternative processes such as microbial leaching have gained interest for the removal of heavy metals such as zinc, as they are more environmentally friendly, require less energy and economical compared to chemical leaching. The usage of microbial processes in metal extraction is generally known as bioleaching or biomining. The microorganisms commonly used for bioleaching applications are acidophilic bacteria. Depending on their metabolism, they are classified as chemolithotrophs, which oxidize inorganic compounds such as iron and sulfur to grow, and chemoorganotrophs, which oxidize reduced organic compounds. The mechanisms behind bioleaching lie within the production of inorganic or organic acids, formation of complexing ligands, and oxidation and reduction reactions.

Currently, various mesophilic and thermophilic cultures of the genera *Acidithiobacillus*, *Leptospirillum* and *Sulfobacillus* are investigated in terms of their leaching ability. Microbes in the *Acidithiobacillus* and *Leptospirillum* genera are mesophilic and prefer temperatures between 25 and 35 °C for growth, *Sulfobacillus* are moderately thermophilic (between 45 and 55°C for growth).

Within the scope of the INNOMET project, the potential of chemolithotrophic bacteria is evaluated to extract metals from EAF dusts. The first results demonstrated that mesophilic bacteria exhibited promising leaching efficiencies compared to thermophilic bacteria. The best results were achieved with *A. thiooxidans.* In shake flask experiments (Fig. 2), *A. thiooxidans* was able to leach 100 % of the zinc and 60 % of the manganese from the investigated dust, which had a zinc concentration of 39 %, within 7 days. Based on these results a stirred tank reactor was build up and started with 10 g/L EAF dust (Fig. 3).

Figure 2: Shake flask experiments

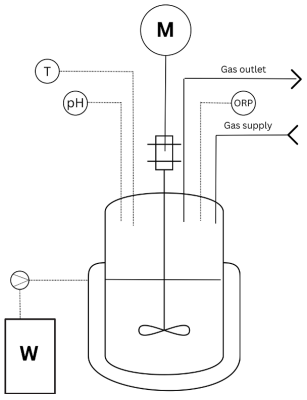

Figure 3: Schematic illustration of a stirred tank reactor. M … motor stirrer, W … water bath, T … temperature electrode, pH … pH electrode, ORP … redox electrode

Update on dissemination activities

Results of the bioleaching experiments will be presented at the Recy & DepoTech in Leoben (Austria) from 13. – 15. November 2024 by Rebeka Frueholz.

Involved Partners

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