INNOMET

Efficient separation of valuable elements by selective extraction using DES-leaching

Deep **e**utectic **s**olvents (DES) offer an innovative route to remove phosphorus from converter slag and open the way to recover metallurgical secondary raw materials

A primary objective of INNOMET is the development and optimization of an efficient process-route to recover valuable elements from industrial slags and dusts for their potential reuse in primary metallurgy. In order to selectively regain metals such as iron as well as basicity generating components or slag additives from converter-type slags, unfavorable elements such as phosphorus must be removed from the slag-materials. In the proposed process a highly selective separation of phosphorus from the starting slag material generates three phosphorus-free solid fractions (Fig. 1) by leaching with a molten salt-like solvent phase at moderate temperature conditions (50 – 70 °C) and by two subsequent precipitation steps with only pure water as an additive. Therefore, the investigated group of so called deep eutectic solvents (DES) could offer a promising way of an efficient and environmentally-friendly post-treatment of slag-materials.

Contrary to various ordinary organic solvents, DES are often biodegradable, non-hazardous and hardly flammable. They typically show considerable low melting points, in some cases near room-temperature. This property is explained by a strong interaction between the two main species, namely a quaternary ammonium cation ionically bound to a halide ion leading to a salt-like species as well as a hydrogen bond donor (HBD) which usually is present as a carboxylic acid or an alcohol.

Oxaline, used in the current investigation, is a DES based on choline chloride as the quaternary ammonium salt and oxalic acid as the HBD. It has been identified as a promising solvent to intermediately complex originally mixed-oxidic cations like iron or calcium in their oxalate state, e. g. as FeC_2O_4 or CaC_2O_4 and to conserve the leached phosphorus in a solution enriched in dissolved PO_4^{3-} -ions.

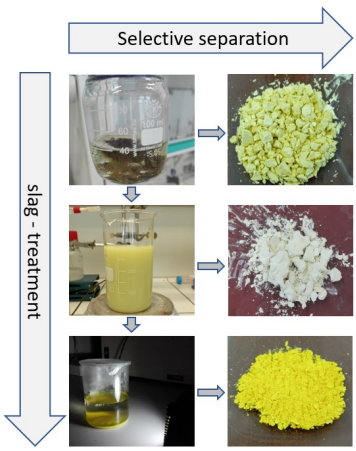

Figure 1: DES-leaching of slag and down-stream processing for the selective separation and regaining of valuable elements

Based on batch tests and prior to further optimization, the separation efficiency of one leaching step can be quantified in terms of enrichment of phosphorus in the filtrate phase. After one single leaching step performed at a solid fraction of 10 weight percent, phosphorus turns out to be enriched in the filtrate compared to iron by a factor of 25, while still staying below the detection limit in the three solid fractions.

Currently, investigations aim to further extent cost/leaching-effectiveness considering the amount and composition of the used DES. Since DESs are usually quite hydrophilic in nature, the influence of the amount of water on the leaching-properties is of special interest and will be explored. Furthermore, options for valuable phosphate products and process-internal solvent recycling will be defined.

Involved Partners

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