

## Dephosphorization routes for BOF slag offered by selective oxalic acid based solvolysis

**D**eep **e**utectic **s**olvent (DES) concept and alternatively **A**queous **o**xalic **a**cid (AOA) treatment as well show capability to fractionize BOF slag and convert the removed phosphorus into the mineral phase struvite.

Within one specific work package of INNOMET potential routes towards dephosphorization of BOF slag by innovative acid leaching concepts were explored. This investigation aims on the recycling of the steel slag's iron and basicity generating flux components back into the primary metallurgical process in largely phosphorus-free form. Oxalic acid was chosen as the central digestive reagent in favor of its strong acidity, bio-degradability and intermediary complex-forming properties which lay the basis for a less chemistry intensive downstream processing of the primary leaching products. The oxalic acid was applied in the leaching step as DES phase (cf. Newsletter #3 from Dec. 2023) or alternatively as an aqueous solution of the acid's dihydrate with a molar concentration of 3 mol/L. Subsequent product fractionation only apply pure water and ammonia as further additives.

After the separation of the leaching residue further downstream processing of the DES leaching involves the steps of hydration, photocatalytic precipitation of iron-oxalate and crystallization of the phosphate product. The leaching residue (1) as well as hydrolysis product (2) and iron-oxalate (3) are obtained in largely P-free form. Despite of these obvious advantages of the DES route its challenges considering a potential recovery of the complex solvent must not be overlooked. Therefor the AOA alternative seeked further process simplification based on aqueous acid digestion and ammonia induced fractionated precipitation, cf. the sequences of processing steps at the following page in Fig.2.



Figure 1:  
Products of slag leaching and subsequent precipitation steps; DES-route (in the left row) and AOA-route (right hand side).

Interestingly, conditions for the formation of the mineral phase struvite, a barely soluble magnesia-ammonia-phosphate ( $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$ ) could be met within the fractionated ammoniacal precipitation regime in a pH range of 9.0 to 9.5 without separate addition of pure magnesia. Thereby, it could be demonstrated that the natural content of  $\text{Mg}^{2+}$  and  $\text{PO}_4^{3-}$  -ions in the leachate after the precipitation of the iron-group hydroxides (6) is favorable for struvite crystallization.

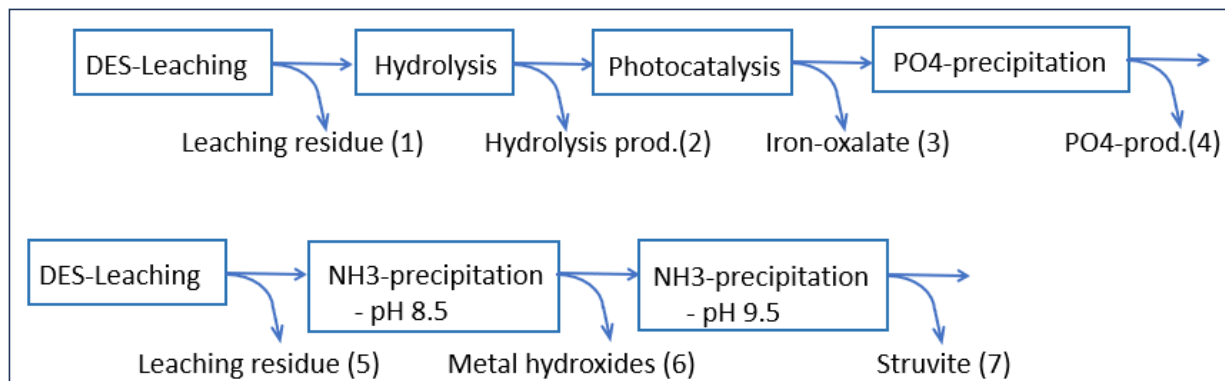


Figure 2: Sequence processing steps of the ground BOF slag and solid state products; DES-route (upper line ) and AOA-route (lower line).

Microscopically detected crystal habitus and LIPS-analysis (Laser-induced-plasma-spectroscopy) allowed to identify struvite from the final precipitation step; Fig.3. However, intergrowth with further mineral phases may occasionally occur and demand precise control of the crystallization conditions.

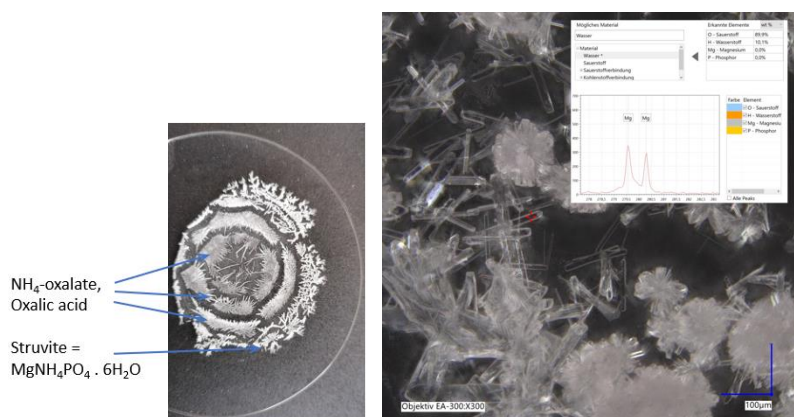


Figure 3: Microscopic detection of struvite supported by Laser induced plasma spectroscopy.

## Involved Partners



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