MSCA-ETN SULTAN

European Training Network for the Remediation and Reprocessing of Sulfidic Mining Waste Sites

Recovery of metal ions from dilute aqueous solutions by ion flotation

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Department of Chemistry KU Leuven| Leuven | Start date: 17/01/2019

Objectives and Milestones

Objectives:

- Recovery of valuable metals from dilute aqueous solutions by ion flotation (Cu)
- Detoxification of mining effluents by ion flotation (As, Cd)
- Stripping of metals from the foam and recycle the surfactants

Milestones:

- Ion flotation process for the removal of cadmium and arsenic from aqueous solutions
- Optimized flow sheet for the recovery of valuable metals from aqueous solutions by ion flotation

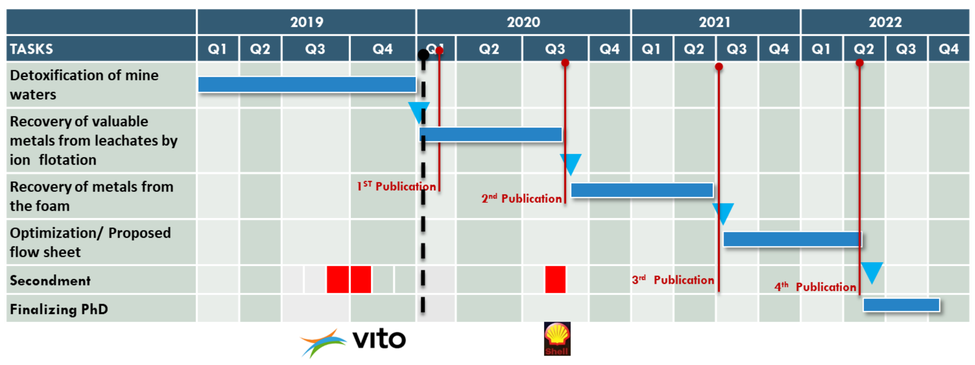


Figure 1: Gantt Chart

Abstract

The state-of-the-art method for recovery of metal ions from dilute aqueous streams is by using columns with ion-exchange resins. An interesting alternative to ion exchange is ion flotation. The difference with ion exchange is that there is a stationary solid-liquid interface in ion exchange, whereas the adsorption in ion flotation is at a mobile gas-liquid interface. In ion flotation, the ionised species is collected by a surfactant (collector) at the gas bubble interface and is concentrated in a stable foam phase. A mixture of a metal ion solution and a surfactant is introduced in a flotation column. Air is bubbled through the column from the bottom. The foam formed is collected via a lateral tube. The advantages of the technique are its simplicity, rapid operation, good recovery yields, suitable for treating large volumes of solutions with low metal concentrations, low cost and low energy requirement. A major advantage over ion exchange is that the need of an elution step is eliminated. The technique has an intrinsic simplicity because there are no other control requirements other than the feed and gas flow rates.

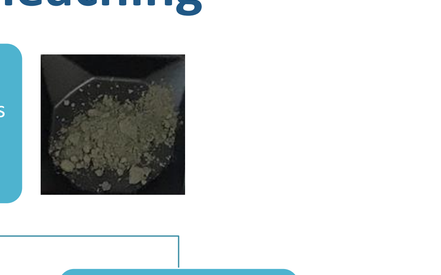
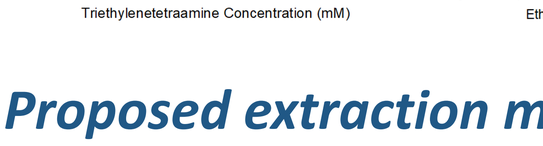


Figure 2: Typical ion flotation process (Liu and Doyle, 2009)

Removal of Cd(II), Mn(II) and Zn(II) using SDS as collector and Trien as chelating agent

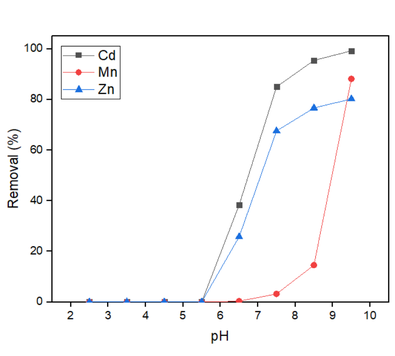
Reagents:

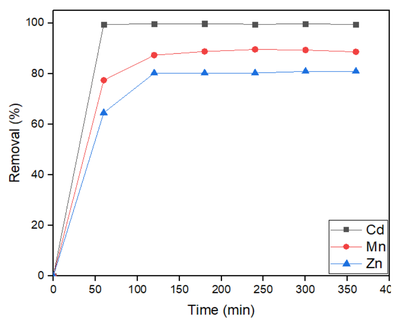


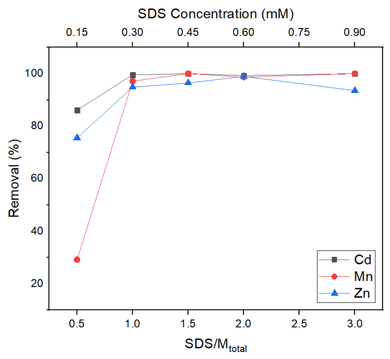
Sodium Dodecyl Sulphate (SDS)

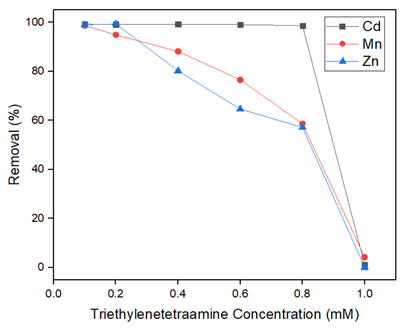
Triethylenetetraamine (Trien)

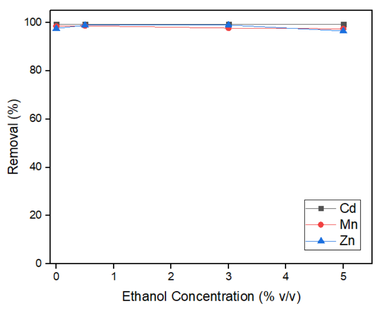
Investigated parameters:



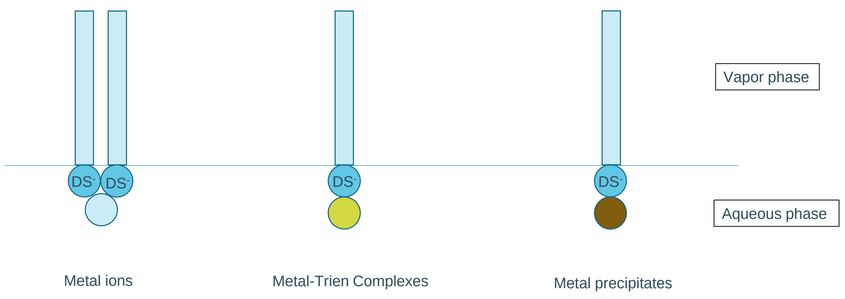








Proposed extraction mechanism:



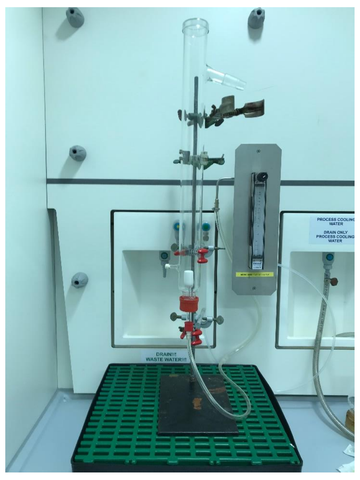
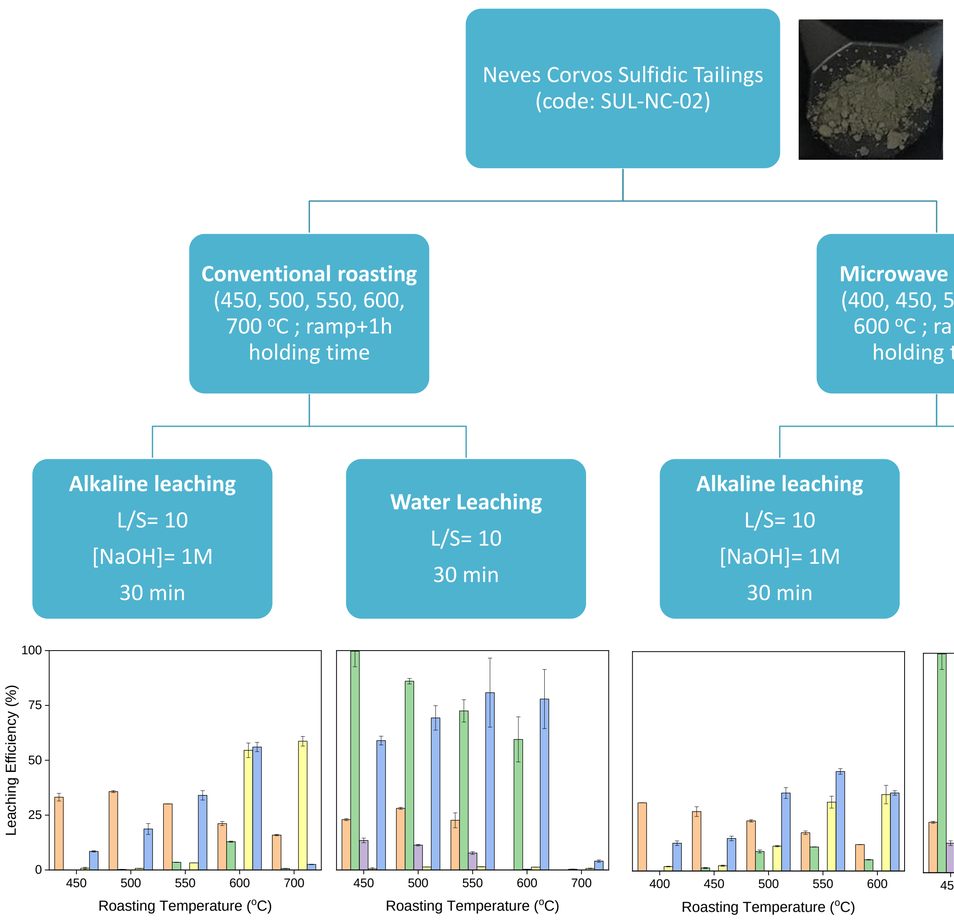
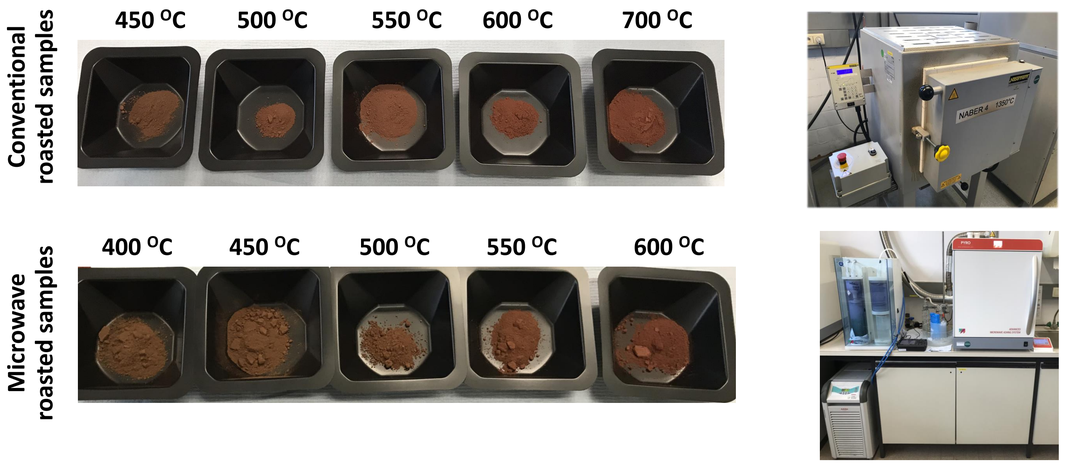


Figure 3: Lab set up used for the flotation experiments

Microwave roasting of sulfidic tailings followed by water and alkaline leaching





Secondment at VITO (Mol, Belgium): 21/10/2019- 20/12/2019 with Demian Kalebic (ESR05)

Conclusions

- Cadmium(II), manganese(II) and zinc(II) could be removed from the bulk solution to the foam phase at one step at pH around 9.5 using SDS as collector and Trien as auxiliary ligand. The metals are concentrated to the foam phase as M-Trien complexes, by interacting directly with the functional group of the collector (DS-) or as precipitates
- Copper leaches best in water (99.98%) after conventional roasting at low temperature (450 °C), although iron concentration is relatively high (4200 ppm)
- Zinc leaches best in water (80.84%) after convectional roasting at 550 °C but in alkaline conditions its leachability is more selective
- Lead and arsenic leach best in alkaline conditions (54.55% and 35.73%) after conventional roasting at 600 °C and 500 °C accordingly.

Upcoming Steps

- Determination of solid phase in the SDS-Trien-Cd-Mn-Zn system
- Investigate the recovery of copper and zinc from the leachates produced in VITO via ion flotation
- Removal of arsenic from dilute aqueous solutions using cetyltrimethylammonium bromide (CTAB) as collector and glutathione (GS) as auxiliary chelating ligand.
- Recovery of copper ions from SOMINCOR run-off water stream by ion flotation

Acknowledgements

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