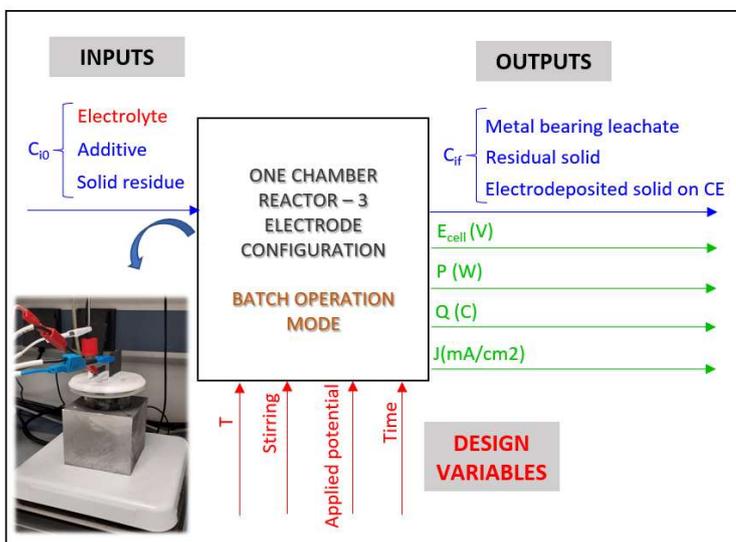


Recovery of metals from waste streams using an electroleaching process

Introduction

State of the art (SoA) technologies to recover valuable critical and precious metals from waste streams present several drawbacks such as: they require several unit operations, strong oxidative and acid media as reagents, and the generation of spent solutions. As an alternative, and under the support of two European funded projects, TECNALIA is developing an electroleaching (ELX) process, relying on electrochemistry and milder electrolytes. This technology will avoid several unit operations and will reduce considerably the use of chemicals, which will improve the economics compared to the SoA technologies and reduce GHG emissions. The ELX approach considers a combination of organic solvents, including deep eutectic solvents (DES), and mild aqueous solutions of NaCl (e.g., 0.5 M), to selectively dissolve metals from solid materials. The polarization of the electrodes will promote the production of oxidizing agents at the anode, such as hydroxyl radicals and hydrogen peroxide (hence avoiding their external addition), releasing the metals from the solid residue. The simultaneous electrodeposition of metals may take place on the cathode, depending on the physicochemical features of the solid input residues and the operational conditions employed.

Concept of the ELX technology

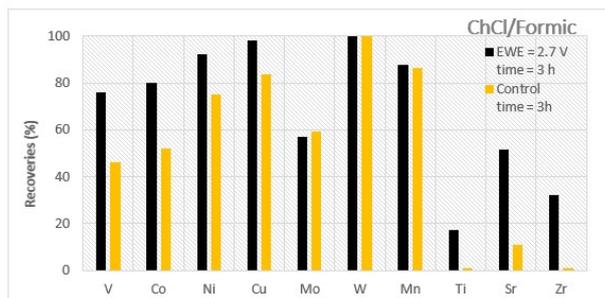


Conditions

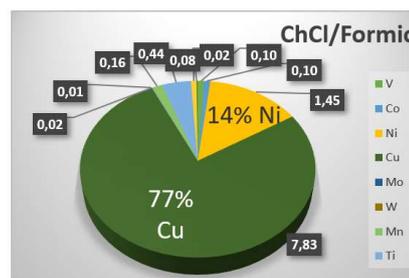
- One chamber reactor
- Electrolyte = Deep eutectic solvent (DES) (80%) + aqueous solution (0.5 M NaCl (20%)).
- Ratio Catalyst residue/electrolyte = 1/9
- HCl 2M as additive (Ratio Catalyst /HCl = 1:1)
- T = 80°C
- Time = 3 h
- Stirring = 350 rpm
- WE = Boron doped diamond (BDD)
- CE = Graphite, Ni, Cu.
- RE = Ag/AgCl
- Potential ≈ + 2.7 V or
- Current density: 45 mA/cm² applied

Variable: Effect of DES chemistries, reaction time and temperature, type of electrode materials.

ELX results

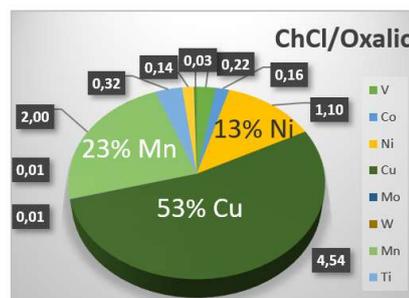
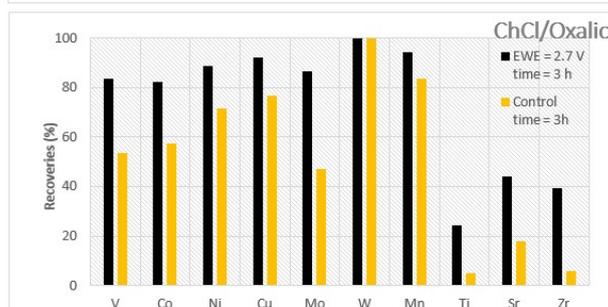


Electrodeposition on the cathode surface



• ChCl/Formic acid-based DES.

Cu (83%) and Ni (87%) recovered on the cathode from the leachate. The element composition analysis of the cathode showed a metal product of 77% Cu and 14% Ni.



• ChCl/Oxalic acid-based DES.

Cu (53%), Ni (59%) and Mn (31%) recovered on the cathode from the leachate. The element composition analysis of the cathode showed a metal product of 53% Cu, 13% Ni and 23% Mn.

- We have extracted 95% Cu, Ni, and 100% W. Regarding Co, V, and Mn, we have achieved roughly 80% leaching yield.
- ELX performed better than conventional leaching process for V, Co, Ni, and Cu. The ELX process not used H₂O₂ as additive, therefore we reduced chemical usage.