Assessment of the ultrasound assisted electrodialytic separation of cobalt from tungsten carbide scrap powder

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The tungsten carbide–cobalt (WC–Co) hard metal or cemented carbide, referred to as a composite material, is usually composed of WC particles embedded within a Co binder. In recent decades, with the rapid development of society and industry, the production of cemented carbides has increased, while the reserves of cobalt and tungsten decrease yearly (Shade, 2010). W and Co are part of the EU 2020 Critical Raw Materials List (European Commission, 2020). Therefore, it is necessary to recover cobalt and tungsten from the cemented carbides scraps. According to a U.S. Geological Survey, nearly 55% of the tungsten consumed in the United States in 2022 was utilized in cemented carbide (USGS, 2022). It is envisaged that recycling of tungsten carbide will considerably grow in the future, being necessary to find efficient and green methods for the cemented scrap recovery.

One possible alternative is the use electrodialytic (ED) processes in which the separation of ions is promoted through the application of an electric field. An ED cell can be divided in 2 or more compartments with the electrodes being placed in opposite sites. To separate the compartments anion (AEM) and/or cation (CEM) exchange membranes are used, which only allow the passage of anions or cations, respectively. Usually, the compounds of interest are removed from the matrix towards the electrode's compartments (through electro-migration and -dialysis), promoting their effective separation and potential recovery. In this study, ED was coupled to ultrasound assisted extraction (UAE) as it can provide added benefit by increasing the extraction yield at lower temperatures and thus decreasing extraction time resulting in a more efficient process.

In the work here presented, the separation of Co from WC was tested using ED treatment alone and coupled to UAE. The UAE treatment was applied using an ultrasonic probe system. Initially, the WC-Co powder was suspended in different solvents, and the UAE amplitude, pulse periods and treatment time were tested. After, ED was applied alone and coupled to UAE and the DC intensity was tested for Co separation from WC.

When ED was applied alone, between 24 to 58% of Co were solubilized, but these values were increased up to 96% through the combination with UAE (Figure 1). The best Co separation was achieved when 200 mA were applied in the ED-UAE reactor, with 88% of the total Co electromigrating to the cathode side as cation (Figure 1), leaving behind the WC residue at the anode. The combination of ED with UAE presents as an opportunity for Co separation from WC residues, with further tests being needed to optimize W recovery.

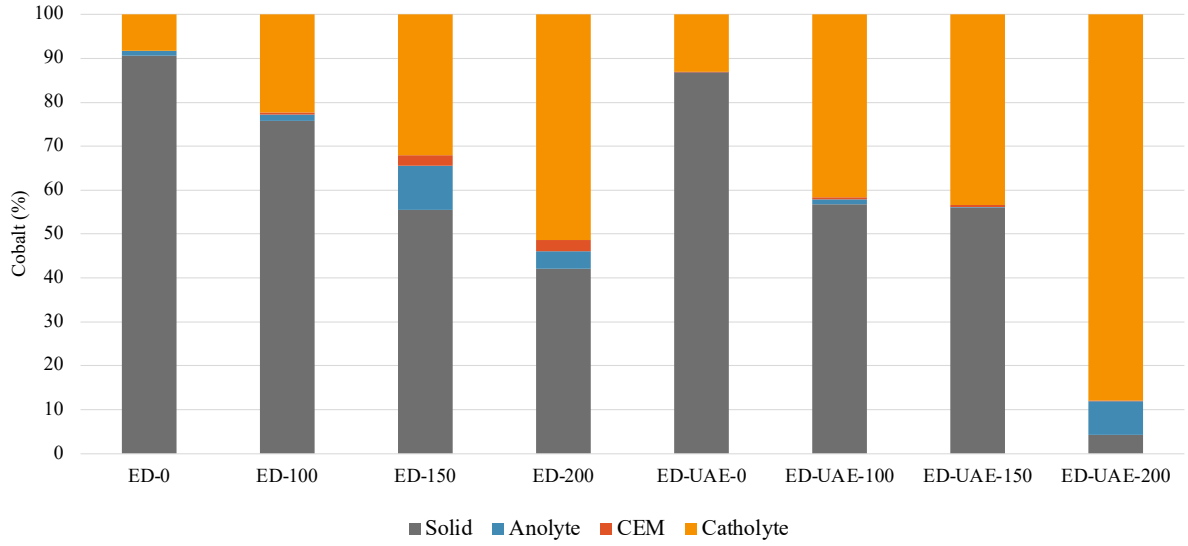

Figure 1. Percentage of cobalt in the solid, anolyte (liquid phase), cation exchange membrane (CEM) and catholyte.

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