The application of electrodialysis enhanced with complex formation for the selective copper salt concentration from industrial wastewaters

D. Babilas [(1)], P. Dydo

[(1)] Silesian University of Technology, Faculty of Chemistry, Department of Inorganic, Analytical Chemistry and Electrochemistry, B. Krzywoustego 6, 44-100 Gliwice, Poland
+ 48 32 237 24 90, dorota.babilas@polsl.pl

1. Introduction – Copper is an example of precious and valuable metal, which is often used in electroplating industry. Therefore, copper and copper salts are present in industrial wastewater. Moreover, copper is toxic and non-biodegradable, thus copper-contaminated wastewater must not be discharged to the environment. There are many methods to heavy metals recovery from industrial wastewaters. One of the interesting techniques is electrodialysis (ED). It is an electro-driven membrane process in which ions migrate across ion-exchange membranes (IEM). The most advantage of ED is that allows to salt concentration in concentrate compartment. Unfortunately, the disadvantage of ED is low selectivity. However, the selectivity of ED can be improved by the complexing agent addition to the treated solution [1-3]. Therefore, in this work, the possibility of selective copper salt recovery and concentration from wastewaters by ED enhanced with complex formation was investigated.

2. Experimental - Experiments included a series of electrodialysis (EDs) of two-component transition-metal salt solutions with addition of Na_2EDTA as chelating agents. The examined solutions contained iron and copper compounds. To investigate the effect of chelating agent addition on the rate of iron and copper ions transport, diluate samples containing 0.25M copper sulfate ($CuSO_4 \cdot 5H_2O$), from $8.9 \cdot 10^{-4}$M to $8.9 \cdot 10^{-3}$ M ferric sulfate ($Fe_2(SO_4)_3 \cdot 24H_2O$), and chelating agent were used. As a concentrate, and electrode rinse solution 0.3M sulphuric acid was applied. The ion-exchange membranes (IEMs) used in the investigations were heterogeneous: AM(H)-CM(H) (Ralex, Czech Republic). Firstly, molar fluxes of iron and copper through the anion- and cation-exchange membranes and the selectivity coefficients of copper recovery for the investigated solution were determined. Next, the desalination and concentration experiment was conducted. The desalination experiment was performed in EDR-Z/10-0.8 module (MemBrain, Czech Republic), with the effective membrane area of 64 cm^2. There was 10 pairs of IEM.

3. Results and Discussion - The objective of the experiments was to examine the applicability of the ED enhanced with complex formation for copper salt recovery from wastewater contaminated with iron species. Molar fluxes of iron and copper across the cation- and anion-exchange membranes and the selectivity coefficients of copper recovery for the investigated solution were determined. It was found that, the selectivity coefficient increased from around 5.6 for diluate containing $8.9 \cdot 10^{-4}$M $Fe_2(SO_4)_3 \cdot 24H_2O$ to around 14.7 for diluate containing $8.9 \cdot 10^{-3}$M $Fe_2(SO_4)_3 \cdot 24H_2O$ (as contamination). In addition, the results showed that, copper salt recovery exceeded 87%, and high iron retention coefficient was observed.

4. Conclusions - Electrodialysis enhanced with complexation appears to be a viable method for selective recovery and concentration of copper salt from waste industrial effluents.

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5. References

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