[92] # Integration of selectrodialysis and ion-exchange for copper and zinc recovery from metallurgical process streams containing arsenic

M. Reig*, X. Vecino*, M. Hermassi*, J. López*, C. Valderrama*, O. Gibert*,, J.L. Cortina*,****

*Chemical Engineering Department, UPC-Barcelona TECH; Barcelona Research Center for Multiscale Science and Engineering, C/ Eduard Maristany 10-14, Campus Diagonal-Besòs, 08930 Barcelona, Spain.

**CETaqua, Carretera d'Esplugues, 75, 08940 Cornellà de Llobregat, Spain.

Keywords: free-arsenic stream; metal recovery; selectrodialysis; ion-exchange resins; mining industry; circular economy.

Introduction

Water scarcity suffered nowadays entails wastewater treatment and reuse. Industries are producing loads of waste effluents, which could be valorised. One facility example is the metallurgical one, which produces acidic streams containing heavy metals and impurities. Heavy metals have an added value, which could be obtained by the wastewater treatment.

In this work, a circular economy scheme is proposed in order to be able to take advantage of an acidic effluent (containing cooper (Cu), zinc (Zn) and arsenic (As)) produced in the cooper metallurgy industry. In order to valorise the acidic stream, while separating and concentrating all its ions, two ion-exchange technologies were used: selectrodialysis (SED) and ion-exchange (IEX) resins.

SED is a novel electrodialysis-based technology that uses standard and mono-selective membranes in order to separate different charge ions when electrical current is applied (Zhang *et al.* 2012). In this work, SED was used to separate As from Cu and Zn. Then, the As-rich solution obtained could be treated properly for external disposal, due to the toxic behaviour of the arsenic. On the other hand, after the SED treatment, a Cu/Zn-rich stream was obtained. For this reason, ion-exchange resins were used to separate Cu from Zn in order to reuse both streams in the cooper and zinc metallurgical industries, respectively (Juang *et al.* 1992). In this case, two different IEX resins were used in a column design obtaining the separation of both metallic ions (Cu and Zn).

Material and Methods

An ED lab-scale set-up (ED 64-4, PCCell, Germany) was used to conduct the SED experiments. Standard anionic, standard cationic and monovalent selective cation-exchange membranes from Fujifilm Manufacturing Europe B.V (Netherlands) were placed between two electrodes. Constant voltage of 7 V was applied to treat an acidic solution containing 10.5 g Cu(II)/L, 4.75 g Zn(II)/L and 8.5 g As(V)/L and be able to separate the As from Cu and Zn. Samples collected during the experiments were analysed by inductively coupled plasma (ICP) to determine the Cu, Zn and As concentration in each stream over time. Once an As-free stream was obtained, it was

treated by IEX resins in a column design in order to separate the Cu from the Zn. These experiments were carried out by means of two different IEX resins: Purolite S960 and Lewatit OC VP 1026, in order to test which resin has the highest separation factor of both cations (Cu and Zn).

Results and Discussion

Conductivity evolution of each stream was followed during the SED process in order to stop the experiment when the feed solution reached a conductivity value near to zero. Moreover, the electrode rinse stream conductivity was checked. This one should be constant during the trials, due to there is no interaction between it and the others streams. The concentration of As increased in the As-rich compartment, while Cu and Zn concentrations increased in the Cu/Zn-rich one. After the SED process, it was possible to recover 49.1 % of As (which should be treated further before disposal) and 81.9 % of Cu/Zn. The energy consumption of the process was about 4.8 kWh/kg Cu+Zn.

Then, the Cu/Zn-rich stream was treated by IEX resins in a column design. Best results were obtained by using the Lewatit 1026 resin. First of all, adsorption of the acidic solution (pH 2.7) and elution by H_2SO_4 1 M was done recovering 68.7 % of Zn, then, the pH was incremented up to 4.7 to adsorb the Cu (elution using H_2SO_4 1 M) achieving 96.5 % of Cu recovery.

Conclusions

It can be concluded that it was possible to separate As from an initial acidic solution containing As, Cu and Zn by SED and also it was possible to separate Cu and Zn by IEX resins. Then, a circular economy scheme could be closed by using the obtained streams in the copper and zinc metallurgical industries, respectively.

References

Zhang Y., Paepen S., Pinoy L., Meesschaert B., Van der Bruggen B., *Selectrodialysis: Fractionation of divalent ions from monovalent ions in a novel electrodialysis stack*, Sep. Purif. Technol. 88 (2012) 191–201.

Juang R.S. and Su J.Y., *Separation of zinc and copper from aqueous sulfate solutions using bis(2-ethylhexyl)phosphoric acid-impregnated macroporous resin*, Ind. Eng. Chem. Res. 31 (12) (1992) 2779–2783.

Acknowledgments

This research was supported by the Waste2Product project (CTM2014-57302-R) financed by the Spanish Ministry of Economy and Competitiveness (MINECO) and the Catalan Government (Project Ref. SGR2014-50-SETRI), Spain. As well, Xanel Vecino thanks MINECO for her Juan de la Cierva contract (ref. FJCI-2014-19732) and Julio López for his pre-doctoral grant (ref. BES-2015-075051).