Electrodialysis and electrocoagulation as combined treatment for industrial wastewater containing arsenic and copper

H.K. Hansen(1), C. Gutierrez(1), A. Rojo(1), A. Lazo(1), M.E. Hansen(1), J. Leiva(1), P. Lazo(2)

(1) *Departamento de Ingeniería Química y Ambiental, Universidad Técnica Federico Santa María, Avenida España 1680, Valparaíso, Chile*
+56 322654030, henrik.hansen@usm.cl

(2) *Instituto de Química y Bioquímica, Facultad de Ciencias, Universidad de Valparaíso, Chile*

1. Introduction – Wastewater produced by mining activities often exceeds the limiting concentrations of different contaminants established by local authorities. For this reason, in Chile a treatment to lower the concentrations of the contaminants in order to fulfill the limits established by Chilean standard D.S. Nº90/00 is necessary.

Currently, the used treatment to reduce the concentration of inorganic contaminants – or the so-called heavy metals - in mining wastewater is based on the addition of chemical reagents, such as lime slurry that facilitates the precipitation of the different metals by a pH increase of the wastewater, together with possible flocculant and coagulant addition. This procedure generates high economical costs due to the reagent consumption and the large volume of generated sludge, which requires further processing. Moreover, processes for recovery of valuable metals are not implemented and the waste is only disposed.

The main objective of this research is to study a new technology combining electrodialysis (ED) and electrocoagulation (EC) to remove the inorganic contaminants arsenic and copper present in wastewater from a copper smelting process, applying electrochemical processes at a low voltage. First in this process, arsenic and copper is removed from the wastewater by ED (including copper recovery), and then the arsenic is precipitated as a low volume solid waste by EC - produced by the same current used to generate the ED. The process is evaluated in a batch setup, and the variables studied are the treatment time and the current density.

2. Experimental – A total of 7 laboratory copper smelter wastewater treatment experiments were carried out in a combined electrodialysis and electrocoagulation batch cell that consisted of 4 compartments separated by ion exchange membranes in a way that allowed the transport of cation (e.g. copper) towards the cathode an anions (e.g. arsenic) towards the anode.

3. Results and Discussion - Copper and arsenic removal was achieved and the electrocoagulation of arsenic applying mass balance was verified. With electrodialysis, the arsenic and copper removal was 67% and 99.99%, respectively, while for the electrocoagulation process the arsenic removal was 55% of total arsenic.

The optimal current density was found to be 300 A m^{-2}, due to shorter treatment times necessary to produce removal percentages, recovery percentages and energy/removed copper mass ratios, in the same ranges as the values achieved with a current density of 225 A m^{-2}.

4. Conclusions - The application of electrodialysis and electrocoagulation to treat wastewater was possible using one batch reactor, achieving the separation of copper and arsenic in addition to the coagulation of arsenic.

The study of the behavior of a real wastewater and the application of these techniques to recover heavy metals are considered in a next research, mainly due to the presence of other ions in the real wastewater.