AC current in EKR of copper mining waste

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1. Introduction – The conventional EKR with DC current has proven to be effective in removing pollutants in soils, however its application to mining waste leads to an increasing polarization over time in the remediation cell that makes the process inefficient. For this reason it seems interesting to use AC current in EKR since the variable frequency can reduce this negative effect. In this context, to verify the electro-kinetic phenomena a sinusoidal electric field must be used by applying simultaneously continuous-alternating (DC–AC) voltages. In this case, the resulting electric field is a sinusoid with an offset corresponding to the DC voltage value, and the electro-kinetic transport is the result of the positive electrical charge obtained when DC+AC voltages are applied simultaneously.
In an EKR operating with this electric field combining AC-DC voltages according to the DC voltage offset, depolarizing conditions more favorably can be obtained when the polarity of the electrodes of the EKR cell is reversed cyclically, so the electro-kinetic transport corresponds to a positive net charge obtained during this cyclic process.
The main objective of this research is to determine the removal pollutants from mining waste of the copper industry with the application of EKR using a sinusoidal electric field with the simultaneous application of DC+AC voltages. This investigation is part of the search for a remediation technique to environmentally stabilize the large amount of solid waste generated by the Chilean copper industry.

2. Experimental – The effect of EKR with an electric field obtained by mixing DC+AC voltages was analysed by remediation experiments performed over a period of 7 days. In these experiments, a synthetic mine tailings adjusted to 820 mg/kg of total copper in the tailings with 45% soluble copper were prepared. In all experiments, a sample of approximately 1.5 kg solid dry weight of the synthetic waste mentioned above was adjusted to an initial humidity of 20%, using sulfuric acid solution. The DC+AC voltage studied were 10/15 [V] (RMS 14.6 [V]) and 20/25 [V] (RMS 26.7 [V]), considering AC voltage frequencies between 50 and 1000 Hz. A conventional reference EKR with 20 [V] DC was included.

3. Results and Discussion - For the experimental conditions tested, copper removal with a sinusoidal EKR with 14.6 [V] RMS is twice as effective as the conventional EKR 20 [V] voltage DC, when the frequency of the AC voltage reaches 500 Hz. The expressed above shows the important role played by the frequency of the AC voltage for the sinusoidal EKR proposed here, because with a lower electric field intensity the copper removal of a sinusoidal EKR (RMS 14.6 [V] DC+AC) can overcome the copper removal of a conventional EKR (20 [V] DC), only increasing the frequency of the AC voltage to above 50 Hz. Also, sinusoidal EKR with an RMS of 14.6 [V] and 26.4 [V], shows a steady increase in the removal of copper (total and soluble) if the frequency of the AC voltage increases from 50 to 1000 Hz.

4. Conclusions - For the experimental conditions selected in this discussion the conclusions are:

- EKR with sinusoidal electric field obtained by applying DC and AC voltages simultaneously can achieve a copper removal from the cell better than EKR with continuous electric field.
- Especially polarity reversal of the system reduces polarization during the remediation, and by this way enhances the process mainly in terms of increasing the copper removal.
- Also the removal of copper improves and lower energy consumption results can be obtained by only increasing the AC voltage frequency.