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MASS TRANSFER ENHANCEMENT USING ELECTROKINETIC AND SOLUTION PULSING METHODS IN IN-SITU RECOVERY OF METALS

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ABSTRACT

With traditional mining methods, in situ recovery (ISR) has the potential to recover metals at a lower cost, with less waste and a significant reduction in energy consumption and environmental footprint. However, ISR in low-permeability deposits, such as hard-rock gold and copper deposits, is constrained by the restricted interaction between the leaching solution and the ore body, which results in a low metal recovery. To improve the solution–rock contact, coupled electrokinetic and solution-pulsing methods can be used in ISR to improve mass transfer and fluid flow in such deposits.

The electrokinetic method induces ion migration by applying an electric potential difference across a medium immersed in liquid. The solution-pulsing method induces fluid flow by pumping solution into a porous medium intermittently instead of continuously, which has the effect of driving the solution from less-permeable to high-permeability zones.

To ensure reproducible conditions for identifying the highest propagation of ions in a laboratory scale experimental setup, it is essential to establish a standardised method to test different conditions. In the first part of this study, we developed a standard laboratory scale setup to perform measurements of mass transfer for ISR. The setup was developed to simulate a real ISR system because a hydrostatic pressure could be applied and core samples of different permeabilities could be used. The effect of different parameters on the migration of ions using an electrokinetic method was evaluated through a series of experiments in which the propagation of lixiviant solution (iodide/triiodide) in an electrokinetic setup was monitored. Experiments were performed at different voltages, using synthetic core sample with different permeabilities. For samples of varying permeabilities, a higher core permeability resulted in a higher concentration of lixiviant ion movement to the target reservoir. The standard experimental setup for future EK-ISR testing has been chosen as Setup B, which included a hydrostatic pressure reservoir.

In the second part of this study, solution pulsing was used to enhance mass transfer in the ISR setup. Experiments were designed to evaluate the effect of different parameters, such as pump on and off time and flow rate, on the movement of lixiviant ions through synthetic core samples. When the resting period was too long, the pulsed pumping was inefficient and only a small amount of lixiviant ions moved through the synthetic core samples. A comparison of the electrokinetic and solution pulsing methods showed that the former resulted in more ions moving through the same synthetic core samples.

Keywords: Electrokinetic; Solution pulsing; In situ recovery; Mass transfer; Permeability; Voltage; On/off time.