604/E2

Optimizing conditions for the electrodeposition of chromium in very diluted aqueous solutions

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Heavy metal pollution has become one of the major problems in the world. To overcome this problem, we have to minimize the generation of metal waste, while using techniques to treat the already contaminated environment. Phytoextraction is an environmentally friendly remediation method used successfully by several developed countries to treat existing heavy metals. After phytoextraction, heavy metals have to be re-extracted into aqueous solutions to complete the removal process. According to prior studies, these solutions contain heavy metals in very low concentrations (100 – 150 μg dm^{-3}). Electrodeposition is one possible metal recovery method in aqueous solutions having higher metal concentrations. Therefore, the present study investigated the applicability of the electrodeposition technique to recover heavy metals from re-extracted aqueous solutions having relatively low concentrations of the heavy metal. Chromium extraction and the conditions for electrodeposition were also optimized.

Model chromium solutions with a concentration of around 100.0 μg dm^{-3} were used. A three electrode system consisting of platinum, carbon and Ag/AgCl electrodes were used for the electrodeposition. Deposition voltage was supplied with Model 264 V Polarographic Analyzer/ Stripping Voltammeter (Potentiostat). Concentrations were determined with GBC 9 321B Plus Atomic Absorption Spectrophotometer with flame unit. The conditions optimized were deposition voltage, deposition time, temperature, pH and ionic strength and the optimum values were -3.00 V, 20 min, 50° C, 1.0 and 0.5 mol dm^{-3} respectively. However, the reduction of water occurs at -0.83 V and it may interfere with the electrodeposition at this optimum voltage. The optimization experiments were initially carried out assuming that the conditions were independent of each other. The analysis was repeated by considering their dependency, using sequential simplex optimization method. It was carried out using two conditions, deposition voltage and time. According to the results, the optimum values which were obtained from initial independent optimization studies were proven to be correct. Under the optimum conditions electrodeposition was performed and it resulted a mean percentage weight of 10.7 (±0.4) of chromium deposited.

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