OPTIMIZATION OF SOURCE PREPARATION METHODS FOR ALPHA SPECTROSCOPY IN EMERGENCY RESPONSE SITUATIONS

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ABSTRACT

The nation's current focus on emergency response and preparedness in the event of a radiological incident has given impetus to develop novel rapid analysis methods for radionuclide identification and quantification. The goal of this research project was to examine and optimize three methods of sample preparation for alpha spectroscopy to enable the faster and more efficient analysis of actinide elements. The three techniques investigated in this project were evaporation, electrodeposition and microprecipitation. Each method was scrutinized to optimize method performance while keeping the time required for sample preparation in mind.

Evaporation was found to be the method that required the least amount of sample manipulation before deposition onto the counting media. An evaporation temperature of approximately 140 ˚C was determined as the most effective. No dependency on evaporation or temperature was seen for energy resolution or yield results. For the best yield results, it was established that the sample should be added to the planchet at the same time in the center of the planchet. Evaporation was the fastest method examined, but the samples produced were inferior in regards to yield and resolution compared to the other methods investigated.

For electrodeposition it was found that the general method as published by Kressin using planchets that had been both washed and electropolished showed the best yield results. Energy resolution was however best for planchets that had been washed but not electropolished. A study on the amount of solution deposited over time showed the fraction of activity in solution to decrease steadily up to about 100 minutes. Variation of the deposition current led to the recommendation of keeping the current set between 0.8 A and 1.2 A for the best results in yield. The best energy resolution results were seen when the current was set at 1.0 A. Overall, samples prepared by electrodeposition showed superior energy resolution and acceptable yields; however the method was discovered to be lacking in reproducibility. Use of a multiposition electrodeposition unit allowed for the preparation of up to 12 samples in approximately 4 hours.

The microprecipitation method was studied using the cerium fluoride method. Parameters varied included the amount of cerium carrier and hydrofluoric acid, the

precipitation temperature and the time that the precipitate was allowed to settle. A study of the influence of the carrier and acid concentrations on energy resolution and yield revealed that the best results were obtained if the amount of hydrofluoric acid is kept at 1 mL. The best energy resolution was achieved by addition of 0.01225 mg of Ce, while the best yield was obtained by addition of 0.0050 mg of Ce. When the precipitation time was varied, the best energy resolution was seen for samples with a precipitation time between 30 and 50 minutes. The highest yield was however achieved if the sample is allowed to settle for 30 minutes. Overall the reproducibility of the microprecipitation method was found to be far superior compared to the other methods. The use of a multiposition sampling manifold combined with a precipitation time of 30 minutes allowed for the preparation of 12 samples in less than one hour. Based on these results microprecipitation was singled out as the most promising method for source preparation for alpha spectroscopy in emergency response situations.