Development of a Radiochemical Sensor for Environmental Applications

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This research demonstrates the principal of combining a selective extractant material with a scintillator support to produce a dual-purpose radiochemical sensor. The dual-purpose (ScintEx) resin was produced by impregnating inert polystyrene, typically used in extraction chromatographic resins, with organic fluors (PPO and DM-POPOP) to produce a scintillating support which was subsequently impregnated with the extractant. The resultant actinide-selective ScintEx resin was evaluated off-line using a conventional liquid scintillation counter. These tests were conducted by packing the ScintEx resin into opaque chromatography columns. Columns were loaded with 60 Bq of ^{241}Am then trimmed to fit into a 7-ml liquid scintillation vial. The absolute detection efficiency for ^{241}Am was calculated to be 98%. Subsequently, actinide-selective and strontium-selective ScintEx resins were evaluated on-line using a flow-cell scintillation detection system. The absolute detection efficiencies for ^{233}U and ^{241}Am alpha particles sorbed to the actinide-selective ScintEx resin, and ^{90}Sr beta particles sorbed to the strontium-selective ScintEx resin were ~100% and ~30%, respectively. The capacity factor, k' for uranium (VI) in a 2.0 M HNO_3 solution was experimentally determined with the actinide-selective ScintEx resin to be ~3000. The increased retention (count-time) of the analyte in the flow-cell was determined from the k' and was used to calculate the minimum detectable concentration for uranium to be 22 Bq/m^3 (0.6 pCi/L) for the on-line measurement.