

Determination of the distribution coefficients of elements in the diacetyl/hydrochloric acid system for nuclear medicine applications

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The development of selective radiochemical separation systems is an important prerequisite for the production, purification, and quality control of radionuclides used in nuclear medicine [1]. Distribution coefficients (K_d) provide quantitative information on the affinity of elements toward a selected sorption material and therefore represent a key parameter for evaluating separation selectivity, optimizing elution conditions, and predicting impurity behavior in radiochemical processes [2]. In this work, the distribution coefficients of selected elements were determined in the diacetyl/hydrochloric acid system using two sorption materials with different functional properties: the strong-acid cation-exchange resin DOWEX 50WX8 and the chelating resin Chelex 100.

Static batch experiments were carried out in hydrochloric acid media of two concentrations, 0.1 and 0.3 M HCl, with different diacetyl contents: 0, 20, 90, and 95%. These experimental points were selected to evaluate the influence of both acid concentration and organic solvent fraction on the retention of elements. Resin samples were contacted with solutions containing known concentrations of the studied elements until equilibrium was reached. After equilibration, the liquid phase was separated, and elemental concentrations were determined by inductively coupled plasma mass spectrometry, ICP-MS. The obtained equilibrium concentrations were used to calculate K_d values and to compare the sorption behavior of elements on DOWEX 50WX8 and Chelex 100 under identical chemical conditions.

Diacetyl was selected as the organic component because it can modify the solvent environment and act as a neutral solvating medium. This property may influence metal ion speciation, solvation, and interaction with functional groups of ion-exchange or chelating resins [3]. In addition, the high volatility of diacetyl is an important practical advantage for radiochemical applications. After elution, diacetyl can be readily removed by evaporation, allowing the eluate to be concentrated and transferred into a small-volume aqueous medium without introducing persistent organic residues [4]. This feature is particularly relevant for radionuclide purification procedures, where the final solution should be compatible with subsequent radiolabelling, formulation, or analytical control.

The comparison of DOWEX 50WX8 and Chelex 100 provides insight into different retention mechanisms, including cation-exchange and chelation-based interactions. The obtained K_d values reveal changes in element retention depending on hydrochloric acid concentration, diacetyl content, and resin functionality. Particular attention was given to elements relevant to radionuclide production, target material processing, and impurity control in nuclear medicine applications.

The results provide a quantitative basis for selecting promising separation conditions in diacetyl/hydrochloric acid media and may contribute to the development of efficient purification schemes for medically relevant radionuclides.

Список источников

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