I_{12}

ION-EXCHANGE REACTIONS OF CATIONIC RADON

Lawrence Stein
Chemistry Division, Argonne National Laboratory, Argonne, IL 60439 (U.S.A.)

Solutions of cationic radon can be prepared by oxidizing elemental radon with halogen fluorides in 1,1,2-trichlorotrifluoroethane or sulfuryl chloride, solvents which are highly oxidation-resistant. These solutions provide a convenient means for studying the chemistry of radon. Recently, we have found that the cationic species can be collected by ion-exchange with a number of solid materials. When a solution of the cations in trichlorotrifluoroethane is passed through a column packed with either KPF_6, $NaSbF_6$, Na_3AlF_6, or thoroughly-dried Nafion resin (H^+ or K^+ form), for example, the radon displaces the H^+, Na^+, and K^+ ions in these materials and adheres in a narrow band at the top of the column. It can be washed repeatedly with dilute BrF_3 in the halocarbon solvent, then eluted rapidly with 1.0 M BrF_3 in sulfuryl chloride. In batch equilibration experiments, we have found that radon also displaces Cs^+, Ca^{2+}, and Ba^{2+} ions from the compounds $CsBrF_4$, $Ca(BrF_4)_2$, and $Ba(BrF_4)_2$, but to a lesser extent. By measuring the distribution coefficient, K_d, of cationic radon on Nafion resin (H^+ form) in BrF_3-trichlorotrifluoroethane solutions as a function of the concentration of BrF_3, we have been able to determine that the charge on the radon cation is +2 and that the parent molecule is RnF_2. This method makes use of the fact that BrF_3 produces the univalent cation BrF_2^+, which competes with Rn^{2+} for sites on the resin. The following equilibria occur in this system (R^- represents the anion of the resin):

$$Rn^{2+} + 2H^+R^- \rightleftarrows Rn^{2+}(R^-)_2 + 2H^+ \quad (1)$$

$$BrF_2^+ + H^+R^- \rightleftarrows BrF_2^+R^- + H^+ \quad (2)$$

$$2BrF_2^+ + Rn^{2+}(R^-)_2 \rightleftarrows 2BrF_2^+R^- + Rn^{2+} \quad (3)$$

These experiments provide new evidence that radon should be classified as a metalloid element, together with boron, silicon, germanium, arsenic, antimony, tellurium, polonium, and astatine (L. Stein, J. Chem. Soc., Chem. Commun., 1985, 1631).

Work performed under the auspices of the Office of Basic Energy Sciences, Division of Chemical Sciences, U. S. Department of Energy, under Contract W-31-109-Eng-38.