

Evaluation of behavior of Nb^V and Zr^{IV} in system H₂O₂/ HCl – AG 1x8 – UTEVA.

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Objectives: ⁹⁰Nb is a potential PET nuclide (T_{1/2} = 14.6 h and high positron branching 53%). Promising results in labeling and *in vitro* evaluation of ⁹⁰Nb-labeled monoclonal antibodies [1,2] confirm expectation about ⁹⁰Nb as an appropriate isotope for *immuno*-PET. In recent work, we evaluate behavior of Zr and Nb in system oxalic acid/HCl- AG 1x8- UTEVA to develop direct flow separation strategy to isolate ⁹⁰Nb from Zr or Mo irradiated targets.

Methods: For determination of distributions coefficients, the anion exchange resin AG 1x8, 200-400 mesh (4 g) was applied. The resin was first washed with water (10 mL), and then transferred to the Cl⁻ form via washing with 12 M HCl (20 mL). Finally, the resin was additionally washed with water (10 mL) to remove excess of Cl⁻, and kept until drying for 48 hours at room temperature.

The UTEVA resin was applied without further preconditioning.

Distribution coefficients (K_d) were determined by batch mode according to the following procedures: 50 mg of resins (AG 1x8 or UTEVA) were placed in a 2 mL tube, then 1 mL of solution of appropriate concentrations of oxalic acid/HCl and 10 μL of the radionuclides stock solution (no carrier added ⁸⁸Zr (T_{1/2} = 83.4 d) and ^{92m}Nb (T_{1/2} = 10.15 d)) were added. The mixture was vigorously stirred and allowed to stay for 24 hours at room temperature. Next, the mixtures were centrifuged and 900 μL of the solution was taken and measured by γ-ray spectroscopy. Distribution coefficient were calculated from equation, where A_{50mg(res.)} is the activity in 50 mg of the resin and A_{50μL(sol.)} is the activity in 50 μL of solution.

$$K_d = \frac{C_{phase1}^{eq.}}{C_{phase2}^{eq.}} = \frac{A_{1g(res.)}}{A_{1mL(sol.)}} = \frac{A_{50mg(res.)}}{A_{50\mu L(sol.)}}$$

Results: Values of distribution coefficients provide us with understanding of behaviour of Zr^{IV} and Nb^V on anion exchange resin and UTEVA in HCl/ H₂O₂ mixture in static system.

However, determination of K_d in HCl/H₂O₂ accompanied with some complications. Incubation time is needed to setup equilibrium between tracers, resin and media, but this equilibrium is impossible because hydrochloric acid reacts with hydrogen peroxide and with time changes its concentration. Therefore 4 hours was founded to be optimum incubation time for radionuclides equilibrium

from one hand and for the other hand not sufficient concentration change. Errors in samples with peroxide were up to 30%.

Most appropriate mixture is 9 M HCl/1% H₂O₂, were for anion exchanger K_d value is 13 and for UTEVA 4674. Other mixtures are 9 M HCl/0.75% H₂O₂ and 9 M HCl/1.18% H₂O₂ for them K_d values AG1x8/UTEVA are 16/505 and 9/728 respectively. However the last two K_d for UTEVA are relative low, that can be reason for Nb breakthrough in case of dynamic column separation.

K_d values for Zr^{IV} in mixture HCl/H₂O₂ in system AG1x8 and UTEVA are presented. Measurement behaviour of Zr in the same system can find condition for increasing separation factor for Nb purification. At 9 M HCl/1 % H₂O₂ distribution coefficients for AG1x8 is 22 and for UTEVA 1706, that is very similar to Nb.

General dependences which can be concluded from obtained distribution coefficients are i) increasing of concentration of hydrochloric acid strongly increase K_d values ii) increasing concentration of hydrogen peroxide not essentially increase K_d values iii) not significant difference between K_d for Zr and Nb which can allow additional separation was observed.

Conclusions: Systematically evaluation of behaviour Nb and Zr in system hydrogen peroxide/HCl-AG1x8-UTEVA allow us determine condition for direct flow transfer of Nb fraction from anion exchange column (AG 1x8) to UTEVA.

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References

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