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Development of new sorbent materials for the preparation of 99Mo/99mTc generators

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99mTc is one of the most often applied radioisotopes in diagnostic imaging. 99mTc is typically supplied to hospitals in the form of a 99Mo/99mTc generator in order to facilitate regular availability. The 99Mo used to produce these generators is a fission product of 235U, and therefore it can only be obtained from just a few nuclear reactors in the world. The goal of this work is to investigate sorbent materials that are efficient enough to adsorb large quantities of Molybdenum to allow the use of 99Mo produced by alternative production routes, such as neutron capture of 98Mo, i.e. 98Mo(n,γ)99Mo, which is possible in large number of nuclear reactors. We have investigated the adsorption capacity of two different aluminum based materials, namely mesoporous aluminum oxide and aluminum oxide nanopowder, and compared them to the conventionally used in generators, namely acid activated aluminum oxide. The kinetic experiments used to determine the adsorption rate showed that the nanopowder has the fastest adsorption (less than 30 s) followed by the mesoporous material and finally the acid activated aluminum oxide. Adsorption isotherms were conducted at pH 2, revealing adsorption capacity of 249 mg/g (nanopowder), 232 mg/g (mesoporous) and 28 mg/g (acid activated aluminum oxide). The capacities were calculated using the Langmuir extended isotherm model (1). The 99mTc elution was evaluated using 99Mo produced from the 98Mo(n,γ)99Mo reaction. After the adsorption process the sorbers were rinsed with HCl 0.1 M twice, and once with buffer of pH 7.4 in order to eliminate the non-adsorbed Mo and adjust the pH. Finally 0.9% NaCl solution was added to the sorbers and they were left to equilibrate. The elution experiments were performed every 24 hours in order to simulate a real generator. The total activity and the activity of the supernatant of 99Mo and 99mTc were measured in a NaI(Tl) gamma counter to estimate the amount of each radioisotope that it is eluted and respectively retained on the sorber after elution. The elution efficiency of 99mTc for the acidic activated Al2O3 was 52±16 % and 53±17 % for 100 and 200 mgMo/gsorber respectively. The mesoporous Al2O3 had a 99mTc elution efficiency of 75±8 for 100 mgMo/gsorber and a breakthrough of 0.8±0.2% 99Mo. The 99mTc initial elution efficiency was nearly 100 %, but the breakthrough was also higher, i.e. 13 % for the same material but at higher Mo concentration (200 mgMo/g). Subsequent elution showed 77±10 % 99mTc removal efficiency and the Mo breakthrough was reduced to 3±1. It is concluded that the Al2O3 nanopowder and mesoporous materials are good candidates as sorbent materials in 99Mo/99mTc generators using 99Mo having low specific activity, i.e. produced by different production routes than fission.

1. Zhang, P.; Wang, L. (2010) Extended Langmuir equation for correlating multilayer adsorption equilibrium data. Separ. Sci. Technol., 70: 367–371

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