Eksperimen Dan Pemodelan Adsorpsi Limbah Radioaktif Cair Mengandung Uranium Karbonat Dengan Resin Penukar Ion Amberlite IRA 402 Cl = Experiment and Modeling Adsorption of Liquid Radioactive Waste Containing Uranium Carbonate Using Amberlite IRA 402 Cl Ion Exchange Resin

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Abstrak

Uranium memiliki peranan penting dalam bidang energi. Ion uranil sangat larut dalam ikatan asam atau larutan karbonat-bikarbonat dan akan membentuk kompleks yang stabil dengan ion karbonat dan sulfat, sehingga pelindihan lebih banyak menggunakan asam sulfat atau natrium karbonat/bikarbonat. Tujuan penelitian ini adalah untuk mendapatkan kondisi optimum dan kapasitas adsorpsi maksimal resin Amberlite IRA 402-Cl terhadap uranium (VI) karbonat. Penelitian dilakukan secara batch dengan resin Amberlite IRA-402 Cl pada variabel waktu kontak, pH larutan terhadap masing-masing konsentrasi karbonat. Eksperimen juga dilakukan secara kontinyu di dalam kolom dengan konsentrasi karbonat 0,05 M dan 0,1 M untuk memperoleh kurva breakthrough. Pemodelan dilakukan untuk menentukan kurva breakthroughpada konsentrasi karbonat 0,05 M dan 0,1 M. Eksperimen pada variabel konsentrasi karbonat dan pH didapatkan nilai optimum pada konsentrasi karbonat 0,1 M dan pH 10. Waktu kesetimbangan eksperimen batch pada menit ke-120. Kinetika adsorpsi uranium mengikuti pseudo orde dua. Model isoterm Langmuir menghasilkan kapasitas adsorpsi uranium 81,96 mg/g. Kurva breakthrough hasil eksperimen kontinyu dipengaruhi oleh konsentrasi karbonat. Hasil karakterisasi FTIR, SEM XPS, dan XRF menunjukkan mekanisme adsorpsi uranium oleh resin Amberlite IRA 402-Cl melalui pertukaran ion. Hasil pemodelan proses kontinyu adospsi uranium konsentrasi karbonat 0,05 M dan 0,1 M divalidasi dengan hasil eksperimen menghasilkan tingkat kevalidan yang sangat baik.
......Uranium is a key element in the nuclear fuel cycle. In aqueous phase, uranyl ion forms stable complexes with ligands, such as carbonate and sulfate ions. Therefore adsorption study of these aqueous uranyl complexes is important for various purposes, from uranium mining to waste treatment. The objectives of this study were to obtain the optimum conditions and maximum adsorption capacity of Amberlite IRA 402-Cl resin for uranium (VI) in carbonate solution. The study was conducted using batch experiments to investigate the effect of contact time, pH of the solution, and carbonate concentration. Furthermore, continuous experiments were also carried out using glass column with carbonate concentrations of 0.05 and 0.1 M to obtain breakthrough curves. Additionally, modeling was carried out to determine the breakthrough curves at 0.05 and 0.1 M carbonate concentrations. The modeling was carried out with PHREEQC code using selectivity of the resin for uranyl carbonate and carbonate ion obtained from the batch experiment. The results show that the equilibrium time of adsorption of uranyl carbonate onto the resin was attained at 120 minutes. The optimum adsorption efficiency was obtained at 0.1 M carbonate concentration and pH 10. The uranium adsorption kinetics followed pseudo second order. The maximum adsorption capacity obtained from Langmuir isotherm model was 81.96 mg/g. The FTIR, SEM XPS, and XRF characterization results suggest the mechanism of uranyl carbonate adsorption onto Amberlite IRA 402-Cl resin is predominantly through ion exchange. The breakthrough curve of continuous experiment was affected by the carbonate

concentration. The results of continuous process modeling of uranium adsorption at carbonate concentrations of 0.05 and 0.1 M were validated with experimental results to produce a very good level of validity.