PENGOLAHAN LIMBAH RADIOAKTIF CAIR SEKUNDER MENGANDUNG ^{137}Cs DENGAN METODE KOPRESIPITASI MENGGUNAKAN ASAM PERKLORAT

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INTISARI

BAPETEN menemukan paparan radiasi cesium-137 (^{137}Cs) melebihi batas di Perumahan Batan Indah pada tahun 2020. Proses dekontaminasi (*clean up*) menghasilkan ratusan drum limbah tanah terkontaminasi ^{137}Cs dan memicu keterbatasan kapasitas penyimpanan di *Interim Storage* (IS). Upaya dekontaminasi dilakukan dengan *soil washing*, tetapi menghasilkan limbah cair radioaktif yang perlu diolah. Di antara berbagai metode, kopresipitasi dipilih karena dinilai paling praktis dan ekonomis dengan proses yang sederhana. Penelitian ini bertujuan mengkaji pengaruh zat pengotor (Fe, Si, dan Ca) dan efektivitas pengolahan awal terhadap nilai *recovery* ^{133}Cs pada limbah simulasi, serta menentukan kondisi optimum suhu dan konsentrasi $HClO_4$ untuk mengendapkan ^{137}Cs dan keberhasilannya dalam mencapai tingkat klierens.

Penelitian dilakukan melalui tahap eksperimen awal pada limbah simulasi tanpa dan dengan pengotor, serta kopresipitasi limbah radioaktif. Variasi perlakuan meliputi tiga suhu (25℃, 0℃, dan -11℃), tiga konsentrasi $HClO_4$ (7,5, 15, 30) wt.%, serta dua kondisi pengolahan awal untuk menguji efek eliminasi pengotor. Analisis sampel pada limbah simulasi dilakukan menggunakan *Atomic Absorption Spectroscopy* (AAS) dan limbah radioaktif menggunakan Spektrometer Gamma.

Hasil penelitian menunjukkan zat pengotor tidak berpengaruh signifikan terhadap nilai *recovery* ^{133}Cs. Sementara tahap pengolahan awal dengan presipitasi pengotor menggunakan NaOH dapat meningkatkan nilai *recovery* ^{133}Cs secara signifikan. Kondisi optimum kopresipitasi ^{137}Cs diperoleh pada suhu -11℃ dan konsentrasi $HClO_4$ 15% dengan nilai *recovery* ^{137}Cs sebesar 83,79%, serta hasil akhir aktivitas jenis sebesar 0,093 Bq/g yang telah memenuhi tingkat klierens.

Kata kunci: Asam perklorat, Cesium-137, Cesium perklorat, Kopresipitasi, Konsentrasi, *Recovery* ^{137}Cs, Suhu.

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TREATMENT OF SECONDARY LIQUID RADIOACTIVE WASTE CONTAINING ^{137}Cs USING THE CO-PRECIPITATION METHOD WITH PERCHLORIC ACID

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ABSTRACT

In 2020, BAPETEN detected radiation levels of Cesium-137 (^{137}Cs) exceeding safety limits at the Batan Indah residential area. The clean-up process generated hundreds of drums of radioactive waste, straining the capacity of the Interim Storage (IS) facility. As a follow-up, soil washing was conducted to separate ^{137}Cs from the soil. However, this process produced radioactive liquid waste that still required further treatment. Among various methods, co-precipitation was selected as it is considered the most practical and economical, with a simple process suitable for large-scale applications. This study aimed to evaluate the effect of impurities (Fe, Si, and Ca) and the effectiveness of pre-treatment on the recovery of ^{133}Cs in simulated waste, as well as to determine the optimum temperature and $HClO_4$ concentration for precipitating ^{137}Cs and achieving clearance levels.

The experiments included preliminary tests on simulated waste with and without impurities and co-precipitation on actual waste. The process was carried out with three temperatures (25℃, 0℃, -11℃), three $HClO_4$ concentrations (7,5, 15, 30) wt.%, and two pre-treatment conditions to assess impurity removal. Sample analysis of simulated waste was carried out using Atomic Absorption Spectroscopy (AAS) and radioactive waste using a Gamma Spectrometer.

The results showed that impurities had only a minor effect on precipitation efficiency, while pre-treatment using NaOH significantly improved the removal of ^{133}Cs. The optimum condition for co-precipitating ^{137}Cs was found at -11℃ with 15% $HClO_4$ concentrations, achieving ^{137}Cs recovery of 83.79% and a final activity of 0.093 Bq/g, which met the clearance level requirements.

Keywords: Perchloric acid, Cesium-137, Cesium perchlorate, Co-precipitation, Concentration, ^{137}Cs Recovery, Temperature.

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