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#6-12 Optimization of neutron shielding in radioactive waste containers using novel materials: a Monte Carlo simulation approach

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The long-term safe disposal of neutron-emitting radioactive waste necessitates advanced container designs that effectively attenuate neutron radiation and reduce dose rates. This study introduces a multi-layered shielding approach for optimizing waste containers such as boron-based materials, gadolinium-based alloys or oxides, hydrogen-rich moderators, metal-organic frameworks (MOFs), and advanced concrete with boron additives. Through Monte Carlo simulations, the neutron shielding performance is analyzed regarding neutron flux distribution and dose rate at various distances from the container, such as at the contact and 1 meter. Neutron flux maps are generated to assess the spatial distribution of neutrons inside and around the container, evaluating the shielding materials' effectiveness at reducing neutron flux. Dose rate calculations are conducted to compare with safety standards for radioactive waste storage. The study also considers the attenuation factor of the shielding materials over time, accounting for long-term disposal conditions. This approach aims to optimize neutron shielding performance while maintaining the structural integrity of waste containers for extended storage periods.

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