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Prediction Of The Effective Multiplication Factor Of The Fuji-U3 Molten Salt Reactor Using Artificial Neural Networks Based On Monte Carlo Simulations With OpenMC

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Nuclear energy is one of the most promising energy sources to meet the world's growing energy demand. This calls for the development of more efficient and safer Generation IV reactor technologies. The FUJI-U3 Molten Salt Reactor (MSR), as one of the Generation IV reactor designs, offers several advantages, including high fuel efficiency, long-term reduction of radioactive waste, and the ability to operate at low pressure. However, the neutronic design of this reactor involves high complexity due to multiple operational parameters. This study aims to develop a predictive model using Artificial Neural Network (ANN) to accelerate the calculation process of the effective multiplication factor (k_(eff)) based on Monte Carlo simulation data generated by the OpenMC computer program. By varying the Th/U ratio, operating temperature, and core geometry parameters, a dataset consisting of 400 configurations was obtained. Prior to training the ANN model, the simulation data were analyzed and normalized. The ANN model was developed using a three-hidden-layer architecture with the GELU activation function and optimized using the Adam algorithm. Model evaluation on test data yielded a Mean Absolute Error (MAE) of 0.00228, Mean Squared Error (MSE) of 0.00001, Root Mean Squared Error (RMSE) of 0.00273, and a coefficient of determination (R^2) of 0.99626, indicating a very high level of prediction accuracy. These results demonstrate that the ANN model is effective and can be used as a predictive tool in the design and optimization of the FUJI-U3 MSR.

Technical Track

Reactor Physics

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