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Study of Multi-Group Neutron Diffusion in Nuclear Fuel Pellet based on Peridynamics

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ABSTRACT

In this study, a method for solving multigroup neutron diffusion equations for nuclear fuel pellets is proposed based on the bond-based PeriDynamic (PD) theory. Firstly, adopting the idea of non-local diffusion, the PD neutron diffusion coefficient is defined and calibrated through the equality of potential with the traditional neutron diffusion coefficient. Comparing the calculation results of the neutron flux distribution of the single-group neutron diffusion by the PD method and the traditional finite element method, the feasibility of the method is verified. Secondly, apply the leakage term in single-group to multi-group and consider the scattering term between different energy groups. Therefore, the calculation of the multi-group neutron diffusion equation is further studied. Through the research on the four-group two-dimensional square plate model, the reference value of the effective multiplication coefficient (0.872297) and the neutron flux distribution results are in good agreement with those in the reference literature. Also, calculation model with different materials is considered with the parameters across the interface using 1/2 of those on two sides. Finally, heat transfer caused by neutron diffusion is considered, where the heat source is determined by neutron flux distribution. Therefore, coupling between the neutron and thermal diffusion equation can be achieved.

KEYWORDS

Peridynamic; neutron diffusion equation; nuclear fuel pellets; neutron flux

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