Progress towards scalable liquid-metal MHD solvers for fusion breeder blanket multiphysics applications

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Breeder blankets will be a core component for the generation of net power and closure of the fuel cycle in future magnetic confinement fusion power plants. Some designs rely on the flow of a liquid metal, necessitating considerations of magnetohydrodynamics (MHD) in fluid simulations due to the proximity of the blankets to strong magnetic fields. A major challenge in the design of fusion components is simulating the complex multiphysics problems involved. Constructing a capable multiphysics package for fusion applications requires a suite of highly scalable solvers, each individually proficient in simulating a specific aspect of the physics involved. This work details an investigation into potential routes for a liquid-metal MHD module. Two OpenFOAM-based MHD finite-volume solvers, mhdFoam [1] and epotFoam [2], are assessed in terms of parallel scaling and validation, providing a baseline for comparisons. Initial progress into the development of a finite-element liquid-metal MHD solver built using the MOOSE framework [3] is presented, forming the early stages of one of the building blocks for highly coupled simulations of complex fusion components.

References

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