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NekRS for fluid simulations in fusion multiphysics

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In order to accelerate development of magnetic confinement fusion from experimental tokamaks to power plants, detailed computational multiphysics approaches are being developed to enable predictive modelling and in silico design. A key step towards this goal is identifying a highly scalable computational fluid dynamics code to tackle the large, challenging fluids problems involved. NekRS is being explored for this purpose, building towards application to cases such as coolant flows in complex pipe systems and designs for components including the hypervapotron and tritium breeder pins, with the ultimate aim of connecting these systems to multiphysics simulations in MOOSE using Cardinal. In addition, a challenging problem in fusion is modelling the flows of liquid metals, which feature in some tritium breeder and divertor designs, and their strong magnetohydrodynamic coupling to the magnetic fields used to confine the plasma. Numerical modelling of liquid-metal MHD is generally less developed than conventional CFD, and NekRS is being considered as a potential route to highly scalable liquid-metal MHD simulation. This talk summarises progress with learning to use NekRS, as well as Cardinal for coupling into MOOSE, and outlines future plans for application to fusion-relevant problems, including coolant flows, liquid metal breeder blanket analysis, and multiphysics interactions.

Relevance for Nek [100 words max]

This talk covers progress and future plans for using NekRS as a scalable code for supporting fusion development, design and predictive modelling, both as a standalone CFD code as well as for coupling to other codes for multiphysics simulations. This work will involve using NekRS, as well as developing extensions to expand its applicability to key fusion problems.

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