Towards modeling of MHD effects on imploding liners in context of Magnetized Target Fusion approach.

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Magnetized Target Fusion (MTF) approach is currently pursued by General Fusion Inc. . In this approach a magnetized plasma target is compressed by the imploding liquid metal liner to thermo-nuclear conditions. Significant progress in the liner's design and the means of its implosion has been made by using a pure hydrodynamic solver; in our case the "compressibleInterFoam" solver in the OpenFOAM suit. In those simulations, compressible gas phase has been used to mimic a plasma target and to implode the liner, while compressible liquid phase has been used to mimic the liquid metal liner. Pure hydrodynamic approach has limitations, as it does not account for the effect of a magnetic field (both externally imposed and that of magnetized plasma itself) that may affect trajectory of the liner, stability of liquid metal/plasma interface etc. and, ultimately, change expected efficiency of the compression with respect to the fusion yield.

To progress towards modeling the effect of magnetic field on the liner during the compression, "compressibleInterFoam" solver has been modified to include some of MHD effects in the liquid phase.

Current modifications are limited to the axisymmetric problems for which the magnetic field can be represented in divergence-free form using poloidal flux and toroidal functions, by that reducing a general induction equation to the set of two PDEs. Main modifications to the "compressibleInterFoam" that have been implemented to date are: (i) addition of two PDEs describing diffusion of the magnetic field into the liquid metal, (ii) addition of Lorentz force contribution into momentum equation (acting only on liquid metal), (iii) addition of Ohmic heating contribution to the energy equation (in the liquid phase). Foundation version OpenFOAM 7 has been used for this development.

The code has been verified by comparison with 1D solutions for implosion of the cylindrical liners compressing magnetic fields in vacuum. Good qualitative comparison with in-house experimental data has also been achieved for the evolution of an axisymmetric liquid lithium puddle placed inside evacuated vessel and subjected to the short electrical pulses.