MHD MODELLING FOR LIQUID METAL VERTICAL BANANA-SHAPED CHANNELS FOR DUAL-COOLANT BREEDING BLANKET DESIGN FOR DEMO

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Design refinements of vertical insulating banana-shape liquid metal channels are been considering as a progress of conceptual design refinement of dual-coolant liquid metal blankets (DEMO specifications). Among them: a) optimized channels geometry both radial-toroidal cross-sections/poloidal shapes and b) design refinements on flow channel inserts.

Progress of channel conceptual design is conducted in parallel with an extension of MHD thermofluid computational capabilities of FEM/FV tools and underlying physics of MHD models in diverse aspects: (1) Hartmann layer modeling, (2) FCI variable thickness and/or roughness, (3) LM/FCI/wall electrical coupling, (4) channel-FCI-wall thermal coupling, (5) LM buoyancy effects;

in order to progress on common liquid metal flow characterization pressure drop and three-dimensional flows.

The analyses are assumed as extension of those previous carried out for the DCLL blankets [1][2] for new design refinements. Analyses are at first for pure MHD case so as to analyze the stability of the flow. Afterwards, the thermal coupling is examined and the mixed convection quantified. Special consideration is given to the buoyancy effect in the inlet duct where inverse flow can appear.

The analysis is accomplished with the 3D transient algorithm implemented in OpenFOAM CFD toolbox [3]. The MHD part of the algorithm is electric potential based making use of the inductionless hypothesis. The thermal coupling is implemented by means of the Boussinesq hypothesis.

The paper overviews the ongoing modeling studies, making model refinements explicit and anticipates some modeling results for three-dimensional flows.

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