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THERMO-FLUID DYNAMIC STUDY OF THE MHD FLOW AROUND A CYLINDER IN CASE OF BOUNDING WALLS WITH NON-UNIFORM ELECTRICAL CONDUCTIVITY

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ABSTRACT To minimize MHD pressure drops, the liquid metal in a fusion blanket can be employed just as tritium breeder, whereas a non-conductive secondary fluid is used as coolant. The coolant can be carried in the breeding zone by pipes that, being transversal to the streamwise direction, affect the flow features and heat transfer. This work studies numerically the case of the flow around an electrically insulated heating cylinder that is bounded by walls of non-uniform electrical conductivity and subjected to a transversal magnetic field, with non-null components in the toroidal and poloidal directions. The flow is investigated by simulations performed in a 3D domain over the range $20 \leq \mathrm{Re} \leq 80$ for the Reynolds number, $0 \leq \mathrm{M} \leq 50$ for the Hartmann number and $0° \leq \alpha \leq 32°$ for the magnetic field inclination on the toroidal axis. The transition to the MHD regime causes the suppression of the cylinder wake and the disappearance of the steady vortex structures. Electromagnetic coupling balances the flow rates between the top and bottom sub-channels, individuated by the obstacle. The flow pattern modifications affect the heat transfer, which is found to increase with both M and α in the range considered, albeit for the latter in a non-monotonic trend. The pressure drop in the channel exhibits a similar behaviour. Moreover, the channel pressure drop is dominated by the fully developed component due to the 2D currents, whereas the local one due to the cylinder presence decreases steadily with the intensity of the applied magnetic field. The simulations were performed with ANSYS CFX-15.