Universal solver based on Volume Averaged Navier-Stokes equations for porous flow modelling and ablation problems

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Abstract

Modelling the interactions between porous flow and pure flow at atmospheric entry conditions is a challenging task. New models and high fidelity numerical tools are required to better understand aerothermal flow through porous material and ablation phenomena. This study presents the derivation of Volume Averaged Navier-Stokes (VANS) equations for porous flow modelling. Volume Averaged Navier-Stokes equations are applied to develop a universal solver (KATS-US) that solves both porous and flow domains at the same time. The solver is tested and verified with channel flow including porous material. Moreover, a set of simulations of a permeable arc-jet test sample is carried out in order to observe the solver capability under supersonic flow conditions. A qualitative assessment of shock formation, porous flow development, pressure change across the porous sample and temperature evolution throughout the porous domain is studied.

Keywords: Atmospheric Entry, Porous Flow, Volume Averaging, Universal Solver, Ablation.

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