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Master's Thesis Abstract

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Numerical Investigation of Turbulent Flow around Obstacles and Evaporating Porous Media

In this work, the effects of turbulent flows on the evaporative transfer processes between porous media and free flow domains in obstacle bounded geometries are explored. A multi-domain model is used, where a free flow domain is separated from a porous media domain by a coupling interface, across which mass, momentum, energy, and components are transferred. In the free flow domain, a $k - \omega$ turbulence model, developed as the closure condition to the Reynolds averaged Navier-Stokes equations (RANS equations), is developed and implemented on a staggered grid. This implementation will model the turbulent effects that emerge in free flows, and which may have a considerable impact on the transfer rate between the two domains. In the porous media domain, a two-phase non-isothermal Darcy's equation implementation on a finite volume grid is used. This model will account for the two-phase phenomena that affect the transfer across the interface. First, the turbulence model is compared to experimental data and an analytical solution, and a grid convergence test is performed. Second, a single phase isothermal model coupling is developed where the free flow is compared against a benchmark validation case, the Backward Facing Step problem. Parameters in the porous media domain and on the coupling interface are then varied and the same test is performed to understand the domain coupling's effects on the free flow. Third, a non-isothermal, two-phase model coupling is developed, where the evaporation at the domain interface is evaluated given a more complex 3D free flow geometry. The results are compared against experimental data from a similar set-up.

Keywords: Turbulence, Evaporation, Multi-Phase, Multi-Domain, Non-Isothermal, Modelling