APPLICATION OF A THERMO-MECHANICAL MODEL FOR COUPLED POROUS MEDIA – CLEAR FLUID FLOWS TO THE COMBUSTION OF POROUS FUELS

P.D. Antoniadis, and M.V. Papalexandris[1]

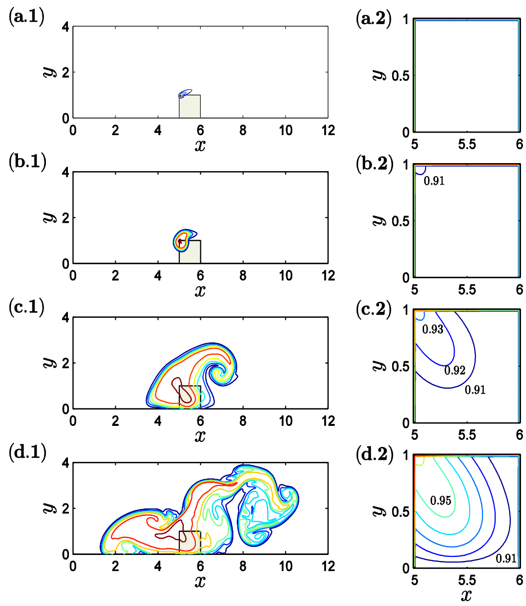
Université catholique de Louvain
Institute of Mechanics, Materials and Civil Engineering
1348 Louvain-la-Neuve, Belgium

Introduction

In the first part of this presentation we outline the derivation of a thermo-mechanical model for flows in coupled domains consisting of porous and pure-fluid regions with interphasial heat and mass exchange.

This model is based on the one-domain approach according to which the same set of equations is valid in both porous and pure-fluid regions. For its derivation we follow a mixture-theoretic formalism, so that its phase is assigned its own thermodynamic and kinematic variables. Notably, we consider that each phase is endowed with its own temperature field, thereby allowing for thermal non-equilibrium between the two phases [1] – [3].

In the second part, we present results of simulations of natural and forced convection involving porous layers; comparisons of our numerical predictions with experimental data are also included. Further, we present a numerical study involving the combustion of a porous fuel block by employing a simplified global reaction mechanism. This study serves as a proof-of-concept for the models and numerical methods that we will employ for the simulation of porous-fuel combustion with more detailed chemical kinetics mechanisms.



Combustion of a porous fuel block ignited by a hot source. The initial porosity of the fuel is 0.90. Figures (a1) - (d1) on the left depict the evolution of the temperature field. Figures (a2) - (d2) on the right depict the evolution of the fuel porosity

References

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[1] Corresponding author : miltos@uclouvain.be