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GAS FLOW AROUND HOT POROUS MEDIA

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In this work we want to present results obtained from a numerical and theoretical analysis of the flow around a particular porous media which is, namely, wooden chips. In such a study the variety of different type processes are being involved. Those processes are: evaporation, pyrolysis, gasification and combustion under low oxygen supply condition. We are focusing on heat transportation in solid and gaseous part of porous media using biomassGasificationFoam developed in an open-source C++ code OpenFOAM (Open Field Operation and Manipulation), for the comprehensive simulation of the physical and thermochemical processes of biomass gasification and pyrolysis.

BiomassGasificationFoam is a library with a variety of implemented functionalities like transient flow in porous media (with changing porosity), a flexible definition of biomass and its properties, heat and mass transfer between gases and solids, homogeneous and heterogeneous reactions, and customisable kinetic mechanisms of pyrolysis and gasification which makes it a suitable tool for complex analysis of such processes. The advantage of this particular solver is the separation in solving energy equation for gaseous and solid phase which gives more comprehensive results.

We are running several numerical tests trying to verify the solver under different initial and boundary conditions, domain mesh generation and using variety of available in OpenFOAM numerical methods in order to obtain the most accurate solutions. Studying simple test case we are trying to optimize approach to domain partition and chosen discretization methods.

We are working on case with three hot (300, 1000, 1500, 2000 K) porous spheres of 0.45 cm radius submerged in cold (300 K) gas flow in cuboid domain sized 5 x 5 x 15 cm. We are tracking mass and temperature transportation in gas especially taking into consideration the part of the domain between hot spheres. This case is interesting from few different reasons. First of all, it is not an easy numerical task to handle with such big temperature gradient in flow, particularly inside porous media. On the other hand, this case is the easiest one in which we can observe the flow inside a lode that is important in engineering applications like biogas energy installations.

We made several numerical tests to observe simple case of hot spheres in cold gas flow. We were able to develop efficient numerical procedure to avoid instability and other numerical problems. Comparison with theoretical results shows that biomassGasificationFoam gives solutions which are promising. The obtained results indicate that high temperature of submerged spheres cause an increase in the velocity and temperature area between them and consequently, the decrease in density which cause decrease in mass transportation in this zone. This conclusions means that most of important processes like evaporation or pyrolysis are being delayed in high temperature lode similarly to those which take place in industrial-scale gasifiers.

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