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Multiscales and Multiphysics Computations using the Finite-Volume Method

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Abstract

Numerical computations using the finite-volume method (FVM) have been reported for multitude of applications from nanoscale to large scale, from laminar flows to turbulent flows, from incompressible flows to compressible flows, from subsonic flows to supersonic flows, with and without reactions and etc. We present FVM for two categories of problems being developed in our research group. These are (1) an approach to model multiscales problems and (2) an approach to model multiphysics problems.

We present numerical methods for a class of multiscale problems where the transport phenomena occurs at the continuum scale but the large axial length to transverse dimension ratios make these multiscale problems. We present a simple approach to model this class of problems and demonstrates its capabilities by modeling (1) flows and asphaltene deposition on the wall of the long pipelines and (2) geothermal heating. We use our approach to simulate available experiments and real-life measured values. We also modeled coupled-ground heat exchangers for an industrial application.

We also present a fixed-grid approach to model structural mechanics problems. Here we use the displacements as the dependent variables. These governing equations are then solved using the FVM. We extend our distance-function based approach for rigid solids to model the elastic deflections/deformations in solid structures. Our solutions compare well with available published literature.