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An alternative model of multicomponent diffusion based on a combination of the Maxwell-Stefan theory and continuum mechanics

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We present a theory of multicomponent mixtures which does not employ any splitting of component fluxes into convective and diffusive parts. Instead, momentum balance is formulated individually for each component in which both 1) viscous friction within a component, and 2) momentum exchange among different components, are taken into account. While the viscous friction is described using the Newtonian stress tensor, the Maxwell-Stefan theory is used to describe the momentum exchange among different components. When the viscosity is neglected, the model of ideal mixture of ideal gases leads to a hyperbolic system of conservation laws. For the non-ideal mixtures, we obtain a first-order system in a non-conservative form. A simplified version of the model is discretized using a combination of the finite volume method and the mixed-hybrid finite element method. Numerical examples are provided to show typical behavior of the solution of the model equations.

References

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