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Modelling of radiative heat transfer in a pyrolysis pilot plant biomass: Study of the anisotropic scattering coupling Mie theory with the finite volume method

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Abstract

In the present work, the radiative heat transfer problem is investigated numerically for 3D complex geometry biomass pyrolysis reactor composed of two pyrolysis chambers and a heat recuperator. The medium is gray and absorbs, emits, and anisotropically scatters radiative energy. The radiative transfer equation is solved with the finite volume method using the step scheme, the "blocked-off-region" procedure is used to treat the complex geometry, and Mie equations for the evaluation of scattering phase function. In order to examine the anisotropic scattering effects on the distributions of the temperature and the radiative heat flux, various cases are considered:(i) the isotropic scattering, (ii) the forward and backward scattering and (iii) scattering with the solid particles of several various coals and of an ash. The results show, that the radiative heat flux increases with an increase of the albedo and the absorption coefficients for the case of the coals and the ash, unlike the case of the functions F1 and B1. Moreover, the particle size parameter has a significant effect on the radiative heat flux.

Keywords: Radiative heat transfer, Finite volume method, Blocked-off-region procedure, Heat recuperation, anisotropic scattering, Mie theory.