DIRECTIONAL RADIATIVE INTENSITY CALCULATION IN NONGRAY SCATTERING MEDIA WITH REFLECTING BOUNDARIES BY THE STATISTICAL NARROW BAND MODEL AND THE REVERSE MONTE CARLO METHOD

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Directional radiative intensity in different spectra can provide fruitful information inside gaseous media. It is very useful for reconstructing temperature and species concentration in combustion systems and infrared remote sensing of hot exhaust systems with nongray combustion products. The line by line (LBL) method obtains the most accurate spectral radiative quantities, but usually it takes very long computation time and may fail to be applied in practical applications. The statistical narrow band (SNB) model has much better time efficiency comparing with the LBL method and is proved to have good accuracy to solve radiative transfer in gaseous media [1]. It is a good alternative method to solve radiative transfer in gaseous media if the LBL method is prohibited by computation time. However, the SNB model is normally applied to non-scattering gaseous media and black boundaries, since it calculates narrow band average transmissivity and radiative transfer can only be solved in terms of these transmissivities. Menart et al. [2] combined the SNB model with the radiative transfer solution of the DOM method, and applied it to diffusely reflecting boundaries. The media considered are non-scattering in this work. Liu et al. [3] applied the SNB model to solve nongray radiative transfer in three-dimensional absorbing-emitting-scattering media. The total radiation intensity is split into the nonscattered part and the scattered part. The nonscattered part is solved accurately using the SNB model. The scattered part is solved with approximation by using the gray-band model to estimate the band correlation between the scattered intensity and the gas absorption coefficient. The introduce of the gray-band model may lead to significant error in some cases.

In a word, the SNB model still faces difficulties to be applied in scattering media and/or reflecting boundaries without introducing any approximation. In the present work, the SNB model is used to solve nongray radiative transfer in scattering media and reflecting boundaries by combining with the Reverse Monte Carlo (RMC) method without any approximation introduced. The LBL approach based on HITEMP2010 database is regarded as the benchmark solution, and the SNB model parameters are obtained from the updated EM2C database. Directional radiative intensity in one-dimensional gaseous media containing CO_2, H_2O and their mixture, as well as scattering particles, surrounded by diffusely reflecting boundaries is investigated. Results show that the SNB model combined with the RMC method can obtain directional radiative intensity in nongray gaseous media efficiently and accurately and is a good extension of the band model to scattering media and/or reflecting boundaries.

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