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Turbulent Two-Phase Flow Simulation with Heat Transfer by Stochastic Particle Collision Model

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ABSTRACT

Modeling of turbulent two-phase flows heat transfer, besides being of scientific interest, is of considerable practical importance in many industrial processes. For example, the rate of Nitrogen Oxide formation in a combustor with the same average temperature field depends on the temperature fluctuation. Dispersion of thermal pollutant in atmosphere, evaporation of spray droplets, and combustion of pulverized coal particles in boilers are examples illustrating the industrial importance of the thermal transport between the phases.

Considering gas flow calculations, Numerical models for turbulence modulation are still in development so no specific model has been adopted. There are limited published works on temperature fluctuation field in multiphase turbulent flows. The thermal interactions between the phases are not as yet well understood.

The effect of particle collision on hydrodynamic field was studied in the last decade. Berlemont, Simonin and Sommerfeld [1] described different formulations for particle-particle collisions for hydrodynamic modeling applications. Accordingly, inter-particle collisions can be computed either deterministically or stochastically. Sommerfeld [2] performed a stochastic method without coupling between phases in a horizontal channel and proved that the particle collisions have a significant effect on the particle velocity fluctuation field. Mansoori et al. [3] showed that even in dilute two-phase flows, inter-particle collisions may significantly affect the gas flow temperature. The direct simulation approach, however, is relatively time consuming.

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A thermo-mechanical turbulence model developed by Mansoori et al. [3,4] and used for predicting heat transfer phenomena in a gas-solid flow through a vertical pipe with constant wall heat flux. This thermo-mechanical turbulence model is based on solving the hydrodynamic transport equations of the turbulent kinetic energy and turbulent time scale, beside the thermal turbulent equations of temperature variance and thermal turbulence time scale. That is, the interactions between the hydrodynamics turbulence and thermal turbulence including particle collision effects are accounted for the new simulation.
The stochastic collision model of Sommerfeld [2] was extended from hydrodynamic field to thermal turbulent field by Mansoori et al. [5]. A direct collision model was used to generate the data for developing the correlation function for evaluating the fictitious particle fluctuating temperatures in the stochastic model
In the present paper four-way interaction model of two-phase flows within the framework of the Eulerian-Lagrangian approach and stochastic collision model was used in the numerical simulation to study the effect of particle collision on thermal and hydrodynamic field for higher loading ratios.

REFERENCES

1. A. Berlemont, O., Simonin, M., Sommerfeld, "Validation of Inter- Particle Collision Models Based On Large Eddy Simulation" ASME, FED, Gas – Particle Flows, Vol. 228, pp.359- 369, (1995)
2. M. Sommerfeld, "The importance of ineter-particle collisions in horizontal gas-solid channel flows" In: Stock, D.E. et al. (Eds.), Gas-Particle Flows. In: ASME Fluids Engineering Conference, FED- Vol. 228. ASME, pp.335-345, (1995)
3. Z. Mansoori, M., Saffar-Avval, H., Basirat-Tabrizi, G., Ahmadi, "Modeling of heat Transfer in gas-solid flow" *Int. Journal of Heat Mass Transfer*, Vol. 45(6), pp.1173-1184, (2002a)
4. Z. Mansoori, M., Saffar-Avval, H., Basirat-Tabrizi, G., Ahmadi, S., Lain "Thermo-mechanical modeling of turbulent heat transfer in gas- solid flows including particle collisions" *Int. Journal of Heat and Fluid Flows*, Vol. 23, 6, pp.792-806, (2002b)
5. Z. Mansoori, F. Behzad, M. Saffar-Avval, P. Ramezani, G. Ahmadi "Turbulent Thermal Field Simulation in Two Phase Flows Using Statistical Particle Collision Model" *6th International Conference on Multiphase Flow, ICMF2007*, Leipzig, Germany, (2007)