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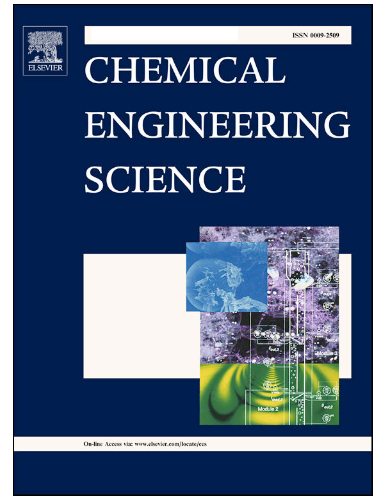

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Development of novel heat conduction interaction model for solid body thermal contact in CFD based particle flow simulations

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Abstract:

Traditional computational fluid dynamics (CFD) simulations with resolved objects progressing through the fluid using a moving and deforming mesh require a fixed mesh topology. Though such simulations may more readily capture conditions where large gradients in the flow field exist, particularly high speed, compressible flow phenomena, the ability to directly model the conduction portion of the contact between particles or between particles and other solid bodies immersed in the fluid is thus restricted. A new method was devised to allow for the maintenance of the mesh topology while simulating the contact heat conduction between a discretized particle pair and between a discretized particle and a wall for the intended purpose of implementation of the technique within a computational fluid dynamics (CFD) based coupled particle-fluid flow model. The method is tested for a range of contact resistances (0 to $1x10^{-3}$ m^2K/W) and material thermal conductivity (1.60W/mK to 162 W/mK) and specific heat (50.28 to 5028 J/kg-K) combinations with one object initially at 700K and the other at 300K. The temperature distributions across the mid-particle or mid-particle and wall line produced by the new method at a given time are compared to the results for a standard finite volume simulation of contacting bodies. The maximum difference in the local temperatures obtained is under 1%. Hence, the technique is a robust means of simulating the resolved heat conduction contact thermal energy exchange without connected computational elements, retaining the needed fluid gap space around the solid bodies. Future work will build upon this technique to include the convective and radiative modes of heat transfer before simulating moving and interacting particles in a fluid flow.

Keywords: Particle technology, heat conduction, thermal contact

Declaration of interest: None

Submission declaration: This work has not been published previously and is not under consideration for publication elsewhere.