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Energy Consumption Statistic of Gas-Solid Fluidized Beds through Computational Fluid Dynamics-Discrete Element Method Simulations

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Abstract : Two energy paths are proposed from thermodynamic viewpoints. Energy consumption means total power input to the specific system, and it can be decomposed into energy retention and energy dissipation. Energy retention is the variation of accumulated mechanical energy in the system, and energy dissipation is the energy converted to heat by irreversible processes. Based on the Computational Fluid Dynamics-Discrete Element Method (CFD-DEM) framework, different energy terms are quantified from the specific flow elements of fluid cells and particles as well as their interactions with the wall. Direct energy consumption statistics are carried out for both cold and hot flow in gas-solid fluidization systems. To clarify the statistic method, it is necessary to identify which system is studied: the particle-fluid system or the particle sub-system. For the cold flow, the total energy consumption of the particle sub-system can predict the onset of bubbling and turbulent fluidization, while the trends of local energy consumption can reflect the dynamic evolution of mesoscale structures. For the hot flow, different heat transfer mechanisms are analyzed, and the original solver is modified to reproduce the experimental results. The influence of the heat transfer mechanisms and heat source on energy consumption is also investigated. The proposed statistic method has proven to be energy-conservative and easy to conduct, and it is hopeful to be applied to other multiphase flow systems.

Keywords : energy consumption statistic, gas-solid fluidization, CFD-DEM, regime transition, heat transfer mechanism
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