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INVESTIGATION OF VARIOUS OPTIONS FOR NUMERICAL MODELING OF FLUIDIZED BEDS FOR A SOLAR THERMAL APPLICATION

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ABSTRACT Circulating fluidized bed solid particle absorption solar thermal energy system is a promising approach to solar thermal with thermal energy storage. For accurately modeling such systems, the fluidized bed numerical model should be correctly representing the behavior of the actual bed. There are several suggested partial semi-empirical models in the literature considering distinct phenomena related to fluidization and void fraction distribution in a fluidized bed. In this study, combinations of the available partial models are tested for the purpose of generating a viable fluidized bed model. For the drag model, the Syamlal-O'Brien model and the Gidaspow model are tested against the available experimental data for a fluidized bed of glass beads. While considering the effects of drag model selection, different solid phase and gas phase model options are also investigated. For the gas phase, the laminar and turbulent flow (with k-epsilon model) cases are investigated. For the solid phase, as a stress model, the Cao-Ahmadi model is considered as a modification of the k-epsilon model. Together with these modeling options, the Johnson-Jackson wall boundary condition with different specularity coefficients and particle-wall restitution coefficients and the Jenkins boundary condition are considered. The data from the resulting large number of cases are compared against the experimental time averaged axial void fraction distributions at two different sections of the investigated bed. During the transient simulations, MFIX: Multiphase Flow with Interphase eXchanges code of NETL is used with an axisymmetric 2-D model of the fluidized bed. The results are also compared with the previous numerical study of Deza [2009] for the same experimental conditions. Analyzing the data from the large array of simulations, recommendations for suitable modeling options are made for the modeling of the fluidized bed of the solar thermal energy system.