Multiphase Flow Modeling — Validation and Application CRADA MC94-019, Final Report

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For the development and validation of the multiphase flow modeling capability in Fluent, a cooperative research and development agreement (CRADA) is in effect between Morgantown Energy Technology Center (METC) and Fluent Inc. To validate the Fluent multiphase model, several simulations were conducted at METC and the results were compared with the results of MFIX, a multiphase flow code developed at METC, and with experimental data. The results of these validation studies will be presented. In addition, the application of multiphase flow modeling will be illustrated by presenting the results of simulations of a filter back-flushing and a fluidized bed coal gasifier. These simulations were conducted only with MFIX, since certain features needed in these simulations will be available only in the next release of Fluent.

Fluent and MFIX were used to simulate the injection of a solids slurry into a tank. The solids settle out and slowly fill the tank. The solids build-up in the tank predicted by Fluent and MFIX were compared and found to be in excellent agreement. A bubbling fluidized bed experiment (Rowe and Partridge 1965) was simulated and the predicted bubble rise velocity was compared with experimental data. A turbulent gas-solids jet experiment (Tsuji et al. 1988) was simulated, and the steady-state gas and solids velocity profiles were compared with experimental data.

An example application is the simulation of a filter back-flushing. In this operation a high pressure pulse is used to dislodge the cake on a ceramic filter. To determine the fate of the dislodged filter cake, three size fractions in the filter cake were described in the simulation. The simulation results show the motion of the three size fractions toward a collection hopper at the bottom of the filter vessel. Such results can be used for designing the baffles in the filter vessel to prevent the reentrainment of the particles from the filter cake.

Another example is the simulation of a fluidized bed gasifier, which produces fuel gas by reacting coal with air and steam. In this simulation the gasifier is described in terms of three phases (gas, coal, and char), eight gas species, four species in each of the solids phases, and thirteen gas phase and gas-solids reactions. The simulation results provide information on the nature of the combustion zone, the solids recirculation rate, the maximum solids temperature, and the location where coal devolatilization is completed. The results were used to identify regions of the gasifier where the particles have a proclivity to agglomerate.

Rowe, P.N., and B.A. Partridge, "X-Ray study of bubbles in fluidised beds," *Trans. Inst. Chem. Eng.*, **43**, T157-T175 (1965).

Tsuji, Y., Y. Morikawa, T. Tanaka, K. Karimine, and S. Nishida, "Measurement of an axisymmetric jet laden with coarse particles," *Int. J. Multiphase Flow*, **14**, 565-574 (1988).