Self-leveling Behavior of Mixed Solid Particles in Cylindrical Bed Using Gas-injection Method

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Abstract

In the present study, we performed self-leveling experiments in cylindrical bed using binary mixture of solid particles with different properties. An empirical model was developed to predict variations of bed mound height during the self-leveling process for various particles mixtures and gas injection velocities.

Keywords: sodium-cooled fast reactor, core disruptive accident, debris bed, self-leveling, mixed particles

1. Introduction

In sodium cooled fast reactors, during a core disruptive accident, molten core material may discharge into the lower inlet plenum of the reactor vessel and form the debris beds over debris trays. However, coolant boiling that is caused by decay heat in the fuel debris could lead to a leveling-off of the debris bed. This phenomenon, which is termed self-leveling behavior, is of essential importance for the heat-removal capability from debris beds as well as the neutronic characteristics because it depends on bed shape or bed height strongly.

2. Methodology

In this study, several experimental cases of binary-mixed particles, which include two different components of particles (same-size different-density and same-density different-size), were performed. By using the dimensional-analysis approach, an improved empirical model was formulated to predict the behavior of binary-mixed particle beds.

3. Results

Over the 62 cases with 774 experimental data points, the present empirical model can predict all data points of the transient bed mound height $H_b(t)$ within a deviation of ±10.0% compared with the experimental results. Figure 1 shows the transient self-leveling behavior of mixtures of: (a) Al_2O_3 and SS particles with the same diameter d_p = 6.00 mm and (b) SS particles with diameter d_p = 2.00 mm and 4.00 mm predicted by our empirical model (lines) in comparison with experimental data (points). The proposed empirical model can predict the experimental data reasonably well for a wide range of experimental conditions.

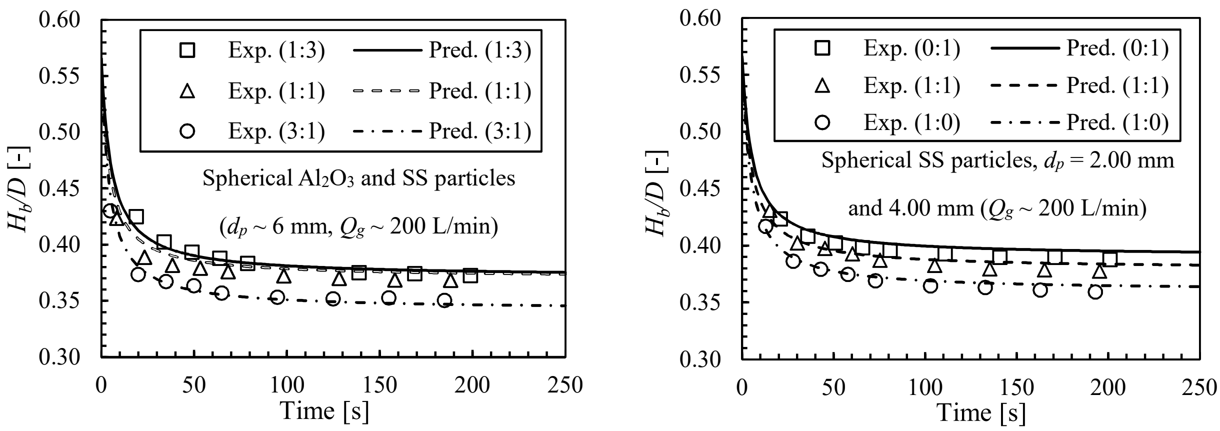

Figure 1. Transient bed mound height by prediction (Pred.) and experiment (Exp.)

References

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