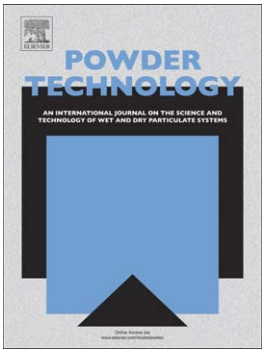

Modelling of the time-averaged gas-solid drag force in a fluidized bed based on results from transient 2D Eulerian-Eulerian simulations

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PII: S0032-5910(14)00353-2
DOI: doi: 10.1016/j.powtec.2014.04.045
Reference: PTEC 10206

To appear in: *Powder Technology*

Received date: 11 February 2014
Revised date: 4 April 2014
Accepted date: 9 April 2014

Please cite this article as: Sirpa Kallio, Juho Peltola, Timo Niemi, Modelling of the time-averaged gas-solid drag force in a fluidized bed based on results from transient 2D Eulerian-Eulerian simulations, *Powder Technology* (2014), doi: 10.1016/j.powtec.2014.04.045

Modelling of the time-averaged gas-solid drag force in a fluidized bed based on results from transient 2D Eulerian-Eulerian simulations

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Abstract

In the present paper, the possibilities to cover all fluidization states by a single drag law in steady state CFD multiphase flow modelling are evaluated. The time-averaged drag force is expressed as the product of the drag force calculated from the traditional drag laws for homogeneous conditions, and a correction function. Closure correlations for the correction function are developed by nonlinear regression modelling based on data collected from 69 transient 2D simulations of bubbling, turbulent and circulating fluidized beds. The correlations are given as functions of eight variables: the solid volume fraction, the distance from the nearest wall, the height above the air distributor, the slip velocity between the phases, the gas velocity, the particle size, the solid density and the gas viscosity. The results indicate that covering all fluidized bed conditions in a single drag correlation is feasible, although fully satisfactory results were not obtained for the surface and freeboard regions of a bubbling fluidized bed (BFB) with correlations that were acceptable in circulating fluidized bed (CFB) conditions. A correlation that covers the whole range of fluidized states is complicated and thus the modelling task could be divided into development of separate correlations for different regions that could be combined into a single correlation by means of blending functions. The validity of this approach was demonstrated by developing a separate correlation for the dilute conditions above a height of 1.5 m in CFB risers. Results show that the accuracy of the predictions significantly improved in dilute CFB conditions where a much simpler correlation with six input variables could be used. The modelling approach is a good starting point for the development of a general drag law for CFD simulations of fluidized beds.

Keywords: Drag force, Circulating fluidized bed, Time-averaging, Computational fluid dynamics, Empirical modeling

1. Introduction