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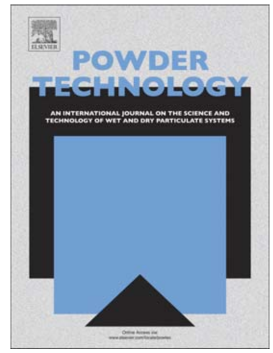

Hydrodynamics model for the dilute zone of circulating fluidized beds

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Hydrodynamics Model for the Dilute Zone of Circulating Fluidized Beds

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Abstract

In this work, a previous model for the hydrodynamics of circulating fluidized beds, which was basically centred in the dense zone, is revised in order to cover the dilute zone, from the dense zone to the riser outlet. The new pressure and void fraction gradient models for the dilute zone include a newly defined gas velocity along the freeboard. This gas velocity is derived from a transformation of classical particle mechanics (the single particle equation) through the mapping between inertial frames of reference. The model predictions of the pressure drop and axial solids holdup profiles along the freeboard are successfully validated with a limited amount of literature data.

Keywords: cfb dilute region; one-dimensional gas-solid flows; characteristic gas velocity; void fraction; pressure drop

1. Introduction

Circulating fluidized beds (CFB), with a large number of process and power applications [1-3], are gas-solids reactors containing particles that are fluidized at a high gas velocity. The weight and acceleration of solids have a significant influence on the the axial profile of the pressure drop occurring along the CFB riser. This is a major issue in the design of such reactors [1-5].

The riser axial profiles of the concentration of solids can be divided [1, 2], in general, into three zones: a dense bed at the bottom, an upper dilute or transport zone more or less near the top, and an intermediate zone between them, which some authors [1] call the 'splash' or transition zone because upwards bubbles, on reaching the bed surface, burst splashing with solids this zone above the dense bed. In this work, the dilute zone is treated as extending from the dense zone surface to the riser outlet thus comprising of the splash and the upper dilute zones.

However, the actual flow structure in CFB risers [6-14] is so complex and highly heterogeneous both in radial and axial directions that, despite decades of research and industrial application, the real time behaviour of particle flow fields in CFB's is still not well understood [15].

Recent high speed videos and high speed particle image velocimetry data [15] taken in three different risers with three different particles have revealed the extreme complexity of instantaneous particle flow fields in CFB risers, which consist of numerous high speed jets of low particle concentration. These jets were observed wandering around the riser interacting with particle clusters, many of them with undulating shape (streamers), in locations near the riser wall left by