USAGE OF EMPIRICAL MODELS FOR SIMULATION OF DUST LIFTING IN RECTANGULAR CHANNELS

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Abstract

The investigation of dust lifting processes in channels has applications in both chemical and mechanical engineering, as well as in process technology and in aspects of safety. The present paper is mainly devoted to the problem of mathematical modelling of two-phase flows, paying special attention to the creation of a dust mixture behind shock waves. In spite of much effort in the field, the mechanism is still not entirely known, leading to difficulties in conducting computer simulations of such phenomena. The obtainable results are far from reality and one could doubt if they are even quantitatively correct.

Most of mathematical models are based on using so-called two-fluid approach, where the both phases (solid and gaseous) are described in continuous manner. Such an approach is not always proper for the solid phase, and there are problems to describe the phenomena of interactions between the particles phenomenologically. Another aspect is the simple fact that the particles are of different sizes and shapes, which leads to further difficulties in choosing a model of collision between the particles and a model for the interphase force. The latter addresses other problems, such as aerodynamic forces, lift forces, and unsteady forces among others. Finding sufficient formulae for them is a problem in itself. All the drawbacks lead to one conclusion: it is extremely difficult to derive a model of two-phase flow for dust mixtures in the layer and its vicinity.

The final disadvantage is the practical limit: the size of the dust layer is extremely small in comparison with the whole channel in which the process takes place. Numerical methods usually require computational meshes and the time of computation is a strong function of the number of cells. Due to the layering dense meshes are necessary but not feasible because of the huge dimensions of the channels. Adaptive Mesh Refinement techniques, for example are possible methods, but one can still doubt if it is enough for really large geometries.

In order to overcome these problems, another approach has been suggested in present research: the conducting of numerical computation on a sparse mesh, omitting the presence of the layer by using some empirical functions. Those functions should be found through experimentation and are to be based on exact measurement of parameters such as dust concentration over layer as a function of time and velocity of gas. There is still a need to use a good model for two-phase flow, but all aspects, like the interactions and other problems with exact modelling of such phenomena, might be more easily neglected.

In the paper, such a model will be suggested. It might be used for simulation of dust lifting in large-scale geometries.