

Investigation on hydrodynamics of gas fluidized bed with bubble size distribution using Energy Minimization Multi Scale (EMMS) mixture model

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ABSTRACT

Modeling of fluidized beds with special focus on mesoscale structures has become prominent area of research in recent years. These efforts have focused on incorporating the effects of bubbles and clusters on the bed hydrodynamics. To account for the effects of these mesoscale bubbles on hydrodynamics of gas fluidized beds, appropriate sub-grid models are required. Energy Minimization Multiscale Modeling (EMMS) is one of the promising approaches available to this end. Present work focuses on development of an EMMS modeling approach where a bubble size distribution has been considered. In this work, bubble based EMMS mixture model developed earlier by same team has been modified. To consider the distribution, user defined values of minimum ($d_{b,min}$) and maximum diameter ($d_{b,max}$) are specified. As a first test case, a uniform bubble size distribution was followed. Due to the distribution, drag force was considered to comprise of contribution from each size group. The mathematical form of the objective function describing the energy for suspension and transport has not been altered. The heterogeneity index (H_d) from this new drag modification is used for simulation of turbulent fluidized beds with particles from Group A and B. It is shown in present work that this current EMMS model is capable of capturing major hydrodynamic features of fluidized beds.

Keywords: EMMS; CFD; turbulent bed; fluidization; multiphase.

INTRODUCTION

Recent years have witnessed significant growth in modeling and simulation of fluidization with specific focus on resolution of mesoscale structures [1, 2]. Depending upon the operating conditions, these mesoscale structures appear either as gas bubbles or particle clusters [3]. Gas bubbles rising through a suspension of solid particles has been a subject of intensive research. Several experimental and modeling efforts have been put to resolve these gas voids or bubbles [4-8].

Accurate modeling and CFD simulations of bubbling fluidized beds has been a challenge [8-10]. Gas–solid flows, such as in bubbling fluidized beds, show a range of spatial-temporal structures, which results in heterogeneity. Accurate modeling of these mesoscale bubbles is key to predicting accurate hydrodynamics of bubbling and turbulent fluidized beds. Energy minimization multiscale (EMMS) modeling has proved