Detached Eddy Simulation (DES) of Co-Current Spray Dryer

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***Abstract*-This paper presents Computational fluid dynamics (CFD) modelling of hydrodynamics in a co-current spray dryer. The simulations were performed using two different turbulent models, i.e. standard k-ε (SKE), and the Detached Eddy Simulation (DES). The predicted axial velocity, temperature and humidity profile inside the spray drying chamber were found to be in fair agreement to the experimental data adopted from literature for all turbulence models tested in this work. A great potential of the Detached Eddy Simulation for predicting the flow pattern in a co-current spray dryer was uncovered as its provides more accurate predictions compared to the other models tested in this work.**

Keywork - CFD, DES, Spray Dryer, Hydrodynamics.

I. INTRODUCTION

Spray dryer is a well established method for converting liquid feed materials into dry powder forms. Spray dryer is widely used to produce foods such as whey, instant drinks, milk, tea and soups, as well as healthcare and pharmaceutical products, such as vitamins, enzymes and bacteria [1] also in production of fertilizers, detergent soap, and dyestuffs.

Detail hydrodynamics of spray dryer chamber has been extensively studied experimentally and numerically by several researchers in the past such as Kieviet et al [2,3], Anandkharamakrishnan et al. [4], Southwell and Langrish [5], Langrish and Zbincinski [6], Zbicinski et al. [7], Harvie et al. [8] and Huang et al. [9]. Most of the previous work deals with a common co-current flow spray drying and reported extensive comparison between experimental measurement and CFD simulation. The turbulence modelling was realised using a standard *k-ε* (SKE) model in their work, and it seems to give a fair prediction of the multiphase flow inside the drying chamber. However, there is a still discrepancy, especially on the prediction of gas axial velocity and the humidity profile. Therefore, this work attempt to evaluate the performance of two turbulence models namely standard *k-ε* (SKE) and Detached Eddy Simulation (DES) for predicting the flow pattern in a co-current spray dryer. The DES is a relatively new development in turbulence modelling belongs to a hybrid turbulence model, which blends Large Eddy Simulation (LES) away from the boundary layer and RANS near the wall. This model was introduced by Spalart et al. [10] in an effort to reduce the overall computational effort of LES modelling by allowing a coarser grid within the boundary layers. The DES employed for the turbulence modelling in this work is based on Spalart-Allmaras model and has never been previously used for modelling of spray drying.

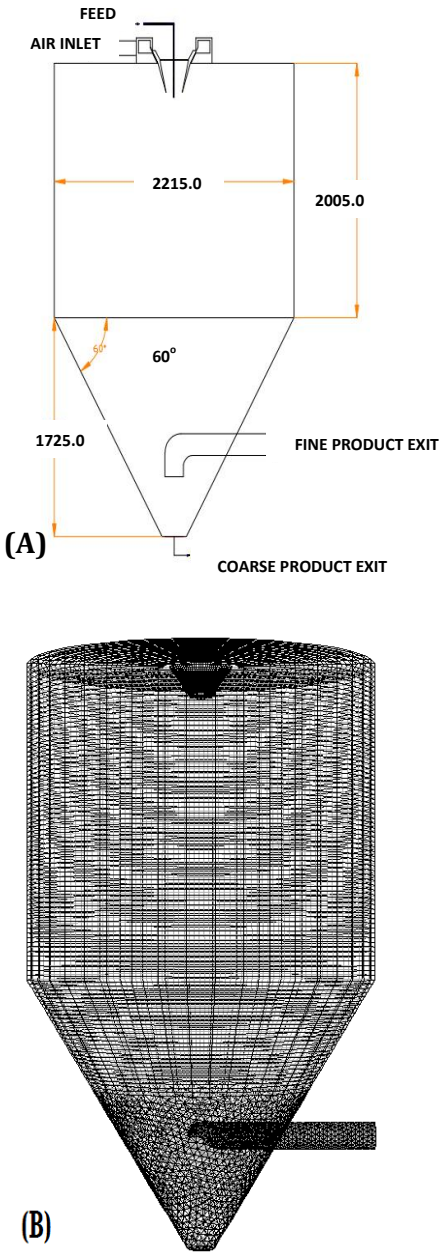

Figure 1. A) Spray-dryer geometry (all dimension in mm) Keiviet[2], B) CFD mesh