CHAPTER 7

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

A system of dilute, homogeneous, gas-solid particle turbulent flow in axisymetric vertical pipe is studied and a hydrodynamic-mathematical model is validated in order to be employed for airlift conveyor flow simulation of various pipe inlet configurations. The outcome of simulation is used to determine the most effective airlift pipe inlet configuration among the cases considered in minimizing powder deposition on the pipe wall.

The conclusions will be systematically divided into two area, namely, conclusion of the model validation and conclusion of airlift conveyor flow simulation. Suggestions for further work will be discussed in last section.

7.1 Conclusions of mathematical model validation.

The validation is performed by computing the "two-fluid" mathematical model using CFD technique and compare the computed results with measurement data of Tsuji et al. [1984]' s experimental data. At first step three turbulence models are employed in particle shear stress excluded mathematical model computations in order to validate the most appropriate turbulence model. Standard turbulence model computation yields the most favorable air and particle velocity predictions compare with the other two models. In the second step, particle shear stress term including model employing standard k-ε model is computed. Computed particle velocity profile is significantly improved qualitatively and quantitatively. Turbulence intensity prediction, which is doubtful for standard k-ε model excluding particle shear stress term computation, is now satisfied. The computed results of the standard k-ε model employed model including particle shear stress term are then compared with the computed result of other literature, namely, Louge et al. [1991]'s. Computed particle velocity profiles of this study yields better prediction performance than those of Louge [1991]'s work but yields level performance in predicting air velocities and turbulence intensities. The validated model can predict pressure drop profile in acceleration zone successfully once particle velocity at inlet boundary is accurately estimated.

In summary, standard k-ε model employed particle shear stress term including in "two-fluid" model is valid in describing the flow in the hydrodynamic range; 200 μm and 500 μm particles in 7.96 to 17.18 m/s mean air velocity.

7.2 Conclusion of flow simulation.

A scale down case of plant scale uniform inlet airlift is simulated as a reference case for actual inlet configuration. Particle shear stress term and phase mass diffusion term included in the model significantly affect volume fraction distribution in acceleration zone. Area of relative high concentration in the pipe cross section can be observed from simulation result. This area move from pipe wall (at pipe inlet) toward pipe centerline as the flow moves upward and dissappear in fully developed region.

Mixture-annulus inlet configuration (Case B) which the mixture of powder and air flows in annulus area of pipe while the clean air flows into core area. Phase mass diffusion of powders from annulus area to core area cause volume fraction of powders at the tiny computational cell attached to the wall to decrease along axial direction and become lower than the reference case at the distance z=5.5m.

Mixture-core inlet configuration (Case C and C+) yield the most favorable result in decreasing of powder volume fraction at the wall boundary. Volume fraction at the computational cell attached to the wall increase along axial direction but the net result is better than reference case. Mixture core inlet configuration yield lower rate of particle wall collision and higher lift force within the studied acceleration range.

Reduction of mixture-core area cause lower powder-wall volume fraction, lower rate of particle wall collision, but within limited starting length, approximately 2.5 m from inlet.

In summary, mixture-core inlet configuration (Case C) is proposed for airlift conveyor modification. The optimized mixture-core area cannot be specified in this study since the effect of particle-particle collision to inlet particle velocity at the feeding section is not accounted for, especially in the higher local solid loading ratio.

7.3 suggestions for further work

Particle-wall interaction is not included in the model studied. this validated model can be improve by inserting appropriate expression of particle-wall boundary condition. The improved model can be employed for gas-solid flow simulation in curved pipe and horizontal pipe.

There are the other gas-solid flow in vertical pipe application can be studied using this model within the range of validation. Also, there are still many alternative of airlift inlet configurations that is worth for study such as circumferential clean air inlet or tangential clean air inlet which is rather complex than the present work.