CHAPTER 4

CONCLUSION

In the present investigation, by using an external loop airlift fluidized bed, the hydrodynamic studies were conducted. Based on the present experimental results, it can be concluded that the vital and important hydrodynamic parameters such as minimum fluidization velocity, riser gas holdup, riser liquid holdup and liquid circulation velocity are influenced by the variables such as superficial gas velocity, liquid velocity, physical properties of the liquids, size of the particles and shape of the particles etc.

The present hydrodynamic study on the external loop airlift fluidized bed covered the following aspects.

(i) Minimum fluidization velocity
(ii) Riser gas holdup
(iii) Riser liquid holdup
(iv) Liquid circulation velocity

4.1 MINIMUM FLUIDIZATION VELOCITY

In the external loop air lift fluidized bed reactor, the minimum fluidization velocity was studied by varying the properties of liquid phases and solid phases. It was observed that the minimum fluidization velocity was decreased when the superficial gas velocity was increased and it got decreased when the diameter of the particle and the viscosity of the liquid were increased. When the flow consistency index was increased, the minimum
fluidization velocity got decreased. The minimum fluidization velocity
decreased with increase in the surface tension. By using the present
experimental data, the following correlation was developed for the prediction
of the minimum fluidization velocity based on the properties of the liquid
phases, solid phases and the fundamental variable and operating variable in a
wide range. It was found that the proposed correlation coincided with the
present experimental results and the AARD was found to be ± 6.5%. The
correlation could be used confidently for design of commercial reactors.

\[ N_{\text{Remf}} = 0.0168 \left( N_{\text{Reg}} \right)^{-0.11} \left( \frac{d_p}{d_c} \right)^{-0.31} \left( \frac{\alpha_l}{\alpha_w} \right)^{0.13} \left( \frac{\rho_s - \rho_l}{\rho_l} \right)^{-0.162} (Ar_m)^{0.5} \]  \hspace{1em} (4.1)

4.2 RISER GAS HOLDUP

The influence of the fundamental variables and operating variables
on riser gas holdup was studied in a three phase external loop air lift fluidized
bed reactor by using different liquid systems and solid particles. It was
observed that the gas holdup in the external loop airlift fluidized bed reactor
was dependent on both the superficial liquid velocity and gas velocity. The riser
gas holdup increased with the increase in the superficial velocities of the
gaseous phase and the liquid phase. The riser gas holdup decreased with an
increase in the diameter size of the particle and sphericity of the particle. It was
also observed that the riser gas holdup increased with an increase in the
viscosity and flow consistency index of Newtonian liquid and non-Newtonian
liquid respectively. The following correlation was developed for the prediction
of riser gas holdup based on the superficial gas velocity, liquid velocity, the
physical properties of the liquid systems, size of the solid particles, shape of the
solid particles and AARD which was found to be ± 9.7%.

\[ \varepsilon_g = 0.97 \left( N_{\text{Reg}} \right)^{0.365} \left( N_{\text{Relm}} \right)^{0.67} \left( \frac{d_p}{d_c} \right)^{-0.99} (\Phi_s)^{-0.02} \left( \frac{\rho_p - \rho_l}{\rho_l} \right)^{-0.99} (Mo_{\text{Im}})^{-0.131} \]  \hspace{1em} (4.2)
4.3 RISER LIQUID HOLDUP

From the experimental results, it was observed that the experimentally measured liquid holdup was dependant on both superficial liquid velocity and gas velocity. The liquid holdup was increased with the increase in the superficial liquid velocity and decrease in the superficial gas velocity. It was observed that the liquid holdup decreased with increase in the flow constancy index of the non-Newtonian liquids. The same trend was observed when the viscosity of the Newtonian fluids was increased. The increase in surface tension increases the liquid holdup. The correlation was proposed based on the physical properties of liquid, size of the liquid particles and shape of the liquid particles etc., for the determination of the riser liquid holdup and it was found to be coinciding with the experimental results (with AARD of ± 7.8%).

\[
\varepsilon_l = 0.98 \left( 1 + N_{Reg} \right)^{-0.046} \left( N_{ReIm} \right)^{0.027} \left( \frac{d_p}{d_e} \right)^{0.455} \left( \frac{\sigma_l}{\sigma_w} \right)^{-0.15} \left( \frac{\mu_s}{\mu_l} \right)^{1.01} \left( Ar_m \right)^{-0.028}
\]

(4.3)

4.4 LIQUID CIRCULATION VELOCITY

In the three-phase external loop air lift fluidized bed reactor, the liquid circulation velocity was studied for different properties of liquid phase and solid phase for the Newtonian and non-Newtonian systems. The liquid circulation velocity increased with the increase in the superficial gas velocity, but decreased with the increase in the solid density. It was observed that the velocity of the liquid circulation decreases with introducing the solids into the column. The liquid circulation velocity was decreased with increase in the flow consistency index of the non-Newtonian liquids. The following correlation was developed based on the various properties of liquid and solid phases with AARD of ± 10.4%. 
\[(N_{Re})_{\text{Cir}} = 0.97 (N_{Re g})^{0.152} (N_{R e m})^{-0.078} \left( \frac{d_p}{d_c} \right)^{1.11} (\phi_s)^{-1.03} \left( \frac{\rho_p - \rho_l}{\rho_l} \right)^{-0.57} (\text{Mo}_{\text{lm}})^{-0.274} \]  

(4.4)

### 4.5 FUTURE PLAN OF ACTION

The proposed correlations must be useful to the designers for the design of the commercial three phase external loop airlift fluidized bed, as the systems.

- The Proposed correlations such as minimum fluidization velocity, riser gas holdup, riser liquid holdup and liquid circulation velocity have to be verified using different $A_R/A_D$ ratio.
- Real industrial effluents have to be used to verify the predicting ability of proposed correlations.