# Chapter 9

## Conclusion and Recommendations for Future Work

### 9.1 Conclusion

The system model is constructed with particular attention to the calculation of carbon combustion efficiency. It incorporates the population balance of carbon feed, carbon burning in bed and elutriation, Merrick and Highley elutriation constant correlation, carbon particle shrinking rate including Tanaka spherical reaction radius, Davidson and Harrison gas interchange, Cranfield and Geldard bubble diameter correlation, Ergun equation for minimum fluidizing velocity, Kunii and Levenspiel terminal velocity. These subsystem models correspond to the physical conditions, certain specific features and assumptions.

The system model's validity is tested and the results are in good agreement with experimental data.

With fair confidence in the developed system, the model is simulated for the effects of bed temperature, superficial velocity and coal feed rate on carbon combustible losses. The simulation yields reasonable estimates. Under the conditions of high gas velocity, excess air by more than 100% and 99% by weight of large limestone particles occupying in bed, for high carbon combustion efficiency about 95 %, the optimum superficial velocity is about 5 of $U_o/U_{mf}$ and the bed temperature can be operated to 1000°c with small NO emission (lower than 500 ppm which is acceptable emission standard). For efficient combustion with significantly no carbon combustible loss in overflow, the average resident time of burning char particles in bed should not be less than 7 seconds.

The calculation of the system model is approximate in nature. The sensitivities of the system model to certain subsystem models, variables, and parameters, are simulated to simplify the model. This results in the insensitivities of the system model to subsystem models such as the Colakyan correlation, the shrinking rate based on Davidson spherical reaction radius. Under the high gas velocity of $U_o/U_{mf}$ between 3 and 10, excess air between 100 % and 300 %, and large particles fluidized bed which comprises of 99 % by weight of limestone particles, concentration of oxygen in particulate phase ($C_{Ap}$) can be assumed to be equal to the concentration of oxygen in inlet air, and the value of $X_b$ (the number of times that a bubble is flused out-by-through-flow and diffusion in passing through the bed) can be disregarded. This is convenient for designing without measuring the value of $C_{Ab}$ (concentration of oxygen in the bubble phase), and makes the system model much more simpler.

## 9.2 Recommendations for Future Work

This system model is developed for fluidized bed combustion of coal with large limestone particles as bed material. The mathematical modelling for other low grade solid fuels such as oil shale or the mixture of oil shale and other solid fuel, the effect of higher combustor Reynolds number by different bed height on carbon combustion efficiency, and how to perform the nearly complete reaction with CO emission lower than 500 PPM, should be considered for future work.