CHAPTER 5
CONCLUSIONS AND RECOMMENTATIONS

5.1 Conclusions

The investigation in this work leads to the following conclusions:

1. A packed bed external loop airlift bioreactor system (PBABR) achieved both nitrification and denitrification. The system could be operated continuously until the biofilm clogged up the aeration zone of the reactor in which case the aeration zone needed to be cleaned to remove excess biomass.
2. The appropriate operating conditions in the PBABR were pH 7-8, dissolved oxygen of riser 3-4 mg/L, dissolved oxygen of downcomer 1-2 mg/L, initial C/N = 20-40, and alkalinity of greater than 100 mg ($CaCO_3$)/L.
3. Nitrification rate achieved in PBABR was in the range of 0.06-0.87 gNH_3-N/m^2-d, and denitrification rate was 0.01-0.08 gNO_3-N/m^2-d.

5.2 Contributions

This study demonstrates the possibility of applying airlift bioreactor as an integrated system for the nitrification/denitrification. The characteristics of this airlift bioreactor is rather attractive as it requires no complicated mechanical components and the only parameter needed for the operation is the aeration rate. Despite several significant differences between the nitrification and denitrification reactions, the airlift bioreactor could still be arranged such that these two reactions occur simultaneously. Although the nitrogen removal rates achieved from this system are still not among the reported best level, this work provides a novel innovative idea for the treatment of wastewater containing nitrogen compounds which could be significant particularly for the aquaculture industry. In addition, experimental data from this work will be useful for further development of airlift bioreactor in nitrification/denitrification research area.

5.3 Recommendations

Due to the time limitation of the master course work and also due to the fact that this work required a considerably lengthy experimental time, there are still a number of research focuses that should be given full attention. These points are summarized as follows:

1. The configuration and operation of the reactor are still not optimized for both nitrification and denitrification. Not only are best nitrification and denitrification rates are the utmost objectives, but it is also required that the two rates are of the same magnitude as both ammonia and nitrate will be removed from the system at the same retention time. And only this equal-rate condition will guarantee the maximal reactor performance.
2. Although the reactor could be operated continuously for quite a long time, the excessive growth of nitrifying biofilm in the aeration zone of the reactor caused fluid shortcuts and dead zones due to the blocking of the flowpath. Also this excess biofilm prevented the oxygen from reaching the inner surface of the packing which lessened the nitrification rate. Hence, the reactor needed to be cleaned to remove this excess biomass. Further development of this system should investigate this aspect by applying fluidized bed or other similar configurations to ensure no biofilm accumulation.