Chapter 5

Conclusions and Recommendations

5.1 Summary

The investigation in this work leads to the following conclusions:

1. Hydrodynamics: Gas holdups, liquid velocity, and overall volumetric mass transfer coefficient in all filters increased with superficial velocity, showed in table 5.1

Table 5.1

Reactor type	A_d/A_r	Usg(cm/s)	ε_0	ε_r	k_La	V_L
F	1.57	1	0.02	0.035	0.02	11.71
		1.7	0.027	0.046	0.034	13.16
		2.3	0.034	0.057	0.028	14.37
	2.78	2.3	**0.055**	**0.068**	**0.063**	**21.68**
P	1.57	1	0.04	0.068	0.046	8.42
		1.7	0.083	0.143	0.047	10.12
		2.3	**0.1**	**0.172**	0.061	12.1
	2.78	2.3	0.062	0.077	**0.066**	**17.13**
S	200 bioball	1	0.126	-	0.062	-
		1.7	0.131		0.066	
		2.3	**0.151**		**0.073**	
	100 bioball	2.3	0.11		**0.073**	

However, the aeration rate employed in this work was most of the time not adequate to create full fluidized bed condition in the fluidized bed airlift filter and, hence, there existed the "still bed condition" which prevented the flow of gas and liquid in the riser of the system. This was subsequently reflected in the low gas holdup and liquid velocity.

2. Nitrification in the trickling filter although was found to be high, but this system required a much larger packing area than other systems employed in this work. Table 5.2 showed that summarized nitrification rate (Total ammonia removal rate; gNH_4-N/m^2-d)

Table 5.2

Rector Type	A_d/A_r	Usg(cm/s)	Total ammonia removal rate (gNH_4-N/m^2-d)
F	1.57	1	0.1854
		1.7	0.1782
		2.3	**0.3087**
	2.78	2.3	0.0501
P	1.57	1	0.3986
		1.7	0.2434
		2.3	**0.6308**
	2.78	2.3	0.0273
S	200 bioball	1	0.2491
		1.7	0.2121
		2.3	**0.3278**
	100 bioball	2.3	0.094
T	-	-	0.109

The superficial velocity 1 cm/s operated after the superficial velocity of 1.7 and 2.3 cm/s had been used respectively. Seen that, at superficial velocity of 1 and 2.3 cm/s higher quantity of microorganism than superficial velocity of 1.7cm/s.When the operation was turned into stationary phase (superficial velocity of 2.3 cm/s). The superficial velocity affect to reduce the nitrification rate had occured. From table 5.2 to obtain that superficial velocity 1 cm/s small nitrification rate than 2.3 cm/s.

From all of the experimental evidence in this investigation, the performance of packed bed airlift filter was best obtained in terms of specific ammonia removal rate at A_d/A_r of 1.57. The fluidized bed airlift filter did not show comparable performance at this condition as the "still bed condition" prevailed the system at all range of gas superficial velocity. However, the situation was reversed at the system with A_d/A_r of 2.78 as the fluidized bed was performed with a better fluidizing condition. However, the system at A_d/A_r of 1.57 was greater than that from A_d/A_r of 2.78. Because of at A_d/A_r 2.78 have high liquid velocity, which produce low residence time and low oxygen transfer rate in liquid phase to solid phase. The specific removal rate of submerged filter was found to be relatively high at all conditions.

5.2 Contributions of this work

Our previous work [in the Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University] indicated that the packed bed external loop airlift contactor [PBLAB, see Silapakul, 2002] could be employed successfully in the removal of nitrogen compounds from the wastewater from marine operation. PBLAB suffered a minor drawback from the low nitrification rate and that was the main motivation for this work. It was initially thought that the fluidized mode would be beneficial for the nitrification as it would help in the turbulence and mass transfer. However, it turned out that the fluidized mode could not be properly obtained with the condition employed in this work. In fact, the fluidized bed might be able to achieved by increasing air flowrate to the system. However, the aeration rate could not be enhanced as excessive aeration in the PBLAB system will lead to a high dissolved oxygen concentration in the denitrification section. This work provides an extension to the previous finding, although the results were not as good as expected. The fluidized bed airlift filter was proven to have poor performance in this regard, except that the aeration rate could be enhanced which might be possible for the system where only nitrification was the only objective. The packed bed airlift system presents a potential alternative for the submerged filter as our experiment illustrated that this system could achieve a relatively high nitrification rate. The results from this work are important for the future development of the PBLAB system.

5.3 Recommendations

Further work should be carried out to investigate the following issues:

1. The use of the packed bed airlift filter as a nitrification section in the PBLAB system. This requires that several conditions be specified, e.g. the ratio between the nitrification and denitrification volumes, the fine-tune of the aeration rate, etc.
2. In the case of fluidized bed, it might be possible that the system is operated with a packing of smaller size. However, smaller packing sets off other operating problems such as clogging at the top barrier (in case where we do not allow the recirculation into downcomer) or clogging at the bottom of the column.
3. The continuous operation of PBLAB should be examined with the use of actual wastewater from the shrimp pond (or other marine ponds).