CHAPTER 5

Conclusions and recommendations

5.1 Performance of gas-liquid contactors

In summary, perforated plates were found to play significant roles in determining the performance of the ALC-P. Fundamentally, the perforated plate increased riser gas holdup which led to an increase in the gas-liquid interfacial area, and consequently the increase in the overall volumetric mass transfer coefficient. However, perforated plates caused a reduction in liquid circulation velocity due primarily to the back pressure or flow resistance produced when liquid collided against the perforated plate. In terms of rate of gas-liquid mass transfer, experimental evidence indicated that the overall volumetric mass transfer coefficient depended largely on the level of riser gas holdup in the ALC.

The comparison between the performance of various kinds of gas-liquid contactors investigated in this work (conventional ALC, ALC-P and bubble column) can be summarized as follows:

Comparative performance on different design of gas-liquid contactors	
Overall gas holdup	BC ≈ ALC ≈ ALC-P
Riser gas holdup	ALC-P > BC > ALC
Liquid velocities	ALC > ALC-P > BC
Mass transfer coefficient	ALC-P > BC > ALC

5.2 Performances of ALC-Ps with various plate configurations

The comparison of the performances in the ALC-P with various design of perforated plates are summarized in the table below:

Comparative performances with various design of perforated plates in the ALC-P			
Performance features	**Designs of perforated plates**		
	Hole diameter	**Number of holes**	**Number of plates**
Overall gas holdup	3 mm > 4 mm. > 5 mm.	13 holes > 21 holes > 37 holes	1 plate ≈ 2 plates ≈ 3 plates
Riser gas holdup	3 mm > 4 mm. > 5 mm.	13 holes > 21 holes > 37 holes	3 plates > 2 plates > 1 plate
Liquid velocities	5 mm > 4 mm. > 3 mm.	37 holes > 21 holes > 13 holes	1 plates > 2 plates > 3 plate
Mass transfer coefficient	4 mm > 5 mm. > 3 mm.	21 holes > 13 holes > 37 holes	3 plates > 2 plates > 1 plate

5.3 Experimental limitations and recommendations

The investigation in this work was limited largely by experimental constraints; these include

1. The location of DO probe:

   DO probe could only be inserted in the top part of the ALC. This is because DO probe had to be placed from the open-end at the top of the column. This did not allow the measurement of DO in the riser particularly when the perforated plates were assembled into the column. It is possible in this case that the k_La at different locations in the column were not identical and the measured k_La was not representing the overall mass transfer coefficient. An inherent assumption from this limitation was that the rate of gas-liquid mass transfer in the ALC-P was not a function of location. This, however, can actually be reasonable particularly in the system in which there was a liquid circulation and no consumption of oxygen. Liquid circulation in the ALC was rather fast and this allows the self-replacement of the liquid in the system. Therefore, if there is no local oxygen consumption, the rate of gas-liquid mass transfer at different locations should not significantly differ from each other. Nevertheless in cases where liquid circulation velocity is low, this assumption might not be correct.

2. Configurations of perforated plates

   The perforated plates employed in this work were made of a simple aluminum plate pierced with an electronic drill to a desired number of circular holes. We limited the size of hole to 3, 4, and 5 mm. It was found from experimental results that the optimal diameter (which gave the best mass transfer rate) lies within this small range. However, the exact optimal hole size on the plate cannot be concluded from the work. The same applies to the experiment with various number of hole where the optimal number was found to be within the range of 13-37.

Nevertheless, this work provides a good starting point for the investigation in this kind. Further work should emphasis on the improvement of mass transfer in the ALC without sacrificing too much of the liquid circulating capability in the system.

It is recommended therefore that:

1. The local k_La should be measured. This necessitates further attention geometrical design of the investigated contactor.
2. The results obtained in this experiment may be suitable for the investigated system. The application in other systems should be further investigated.
3. Plates geometry, i.e. number of holes, holes diameter and distance between each hole, should be improved for the column with different diameter.

To conclude this work, altering the configuration of the ALC by inserting the perforated plate into the system has two major effects on the system performance. Firstly, it increases the gas holdup in the riser: the principal means for enhancing the rate of mass transfer. Secondly, it reduces the liquid velocity and possibly gas velocity. The flow resistance and the back pressure generated from the perforated plate were believed to be the main reason for the reduction in liquid velocity. The overall mass transfer rate in the ALC-P was usually found to be higher than that in the conventional ALC. The detailed design of the perforated plate markedly influences the ALC performance. The designers have to make a decision on what to gain from the ALC-P. For instance, if the circulating velocity is the most important parameter in the design of ALC, one should not use too many perforated plate, nor too small hole size in the plate, nor too sparse hole population, because this will eventually leads to a system with very slow liquid circulation (and if possible, not to insert any perforated plate at all). On the other hand, if the rate of mass transfer is the most important factor, one should consider the opposite. Often, the desired character of the ALC is to have a great mass transfer without sacrificing the liquid circulation. In this case, one needs to find the optimal configuration of plate to be used in the ALC. The authors are still not convinced of the exact answer to this question, and further investigation particularly in the ALC with various scales is urgently needed in order to develop a more comprehensive fundamental in this area.