CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the experimental investigation, results showed that;

- In the absence of 5 kmol/m^3 MEA, the neutral MEA degradation products can be physically extracted by 2-ethyl-1-hexanol (diluent alone) due to their solubility in 2-ethyl-1-hexanol. Though imidazole have the lowest dissociation constant when compared to other neutral MEA degradation products, but it showed the highest extraction efficiency, due to lack of OH group in its structure (least hydrophilic), hence increased contact surface area with the diluent. The extraction efficiency followed this trend imidazole > N-(2-hydroxyethyl)-succinimide > N-acethylethanolamine > 2-oxazolidone.

- In the presence of extractant (Aliquat 336) in 2-ethyl-1-hexanol, the extraction efficiency of neutral MEA degradation products without 5 kmol/m^3 MEA was higher than that of 2-ethyl-1-hexanol alone. The presence of carboxylic group in the neutral MEA degradation products led to an increased interaction (formation of acid-base complex) at the interface of the extractant also enhanced the distribution of neutral MEA degradation products which translated to increased extraction efficiency. Increase in number of carbonyl group, increase in its extraction efficiency, but this will be affected if there's also hydroxyl group present in the structure. Therefore, the average extraction efficiency followed the trend N-(2-hydroxyethyl)-succinimide > 2-oxazolidone > imidazole > N-acethylethanolamine.

- However, when added neutral MEA degradation products are added to 5 kmol/m^3 MEA, their extractability decreased. This is because of competitive reaction between MEA and neutral MEA degradation products with the extractant in diluent (2-ethyl-1-hexanol). The presence of MEA reduced the distribution coefficient of the neutral MEA degradation products at the interface of the extractant.

- The effect of temperature (298 K, 313 K and 333 K) on the average extraction efficiency of neutral MEA degradation products with and without MEA indicated a linear relationship. It is believed that the increase in temperature up to 333 K reduced the viscosity of the extractant, hence increased interaction with the neutral MEA degradation products. Though the temperature under study did not reach the typical regeneration temperature (393 K), it can be said that extraction efficiency will follow same linear relationship with temperature. Most especially, since the boiling points of the extractant, Aliquat 336 (498 K) and diluent, 2-ethyl-1-hexanol (459 K) is further away from the typical regeneration temperature (393 K).At 298 K, it was noticed that the presence of CO_2 also reduced the extraction efficiency of the neutral MEA degradation (in 5 kmol/m^3 MEA) products using extractant in diluent. The extraction efficiency further reduced as the CO_2 loading increases. This was due to the competitive extraction (co-extraction) of bicarbonate (HCO_3^-), carbonate (CO_3^{2-}) and carbamate ($MEACOO^-$) anions and the neutral MEA degradation products with extractant. It is also believed that in the presence of bicarbonate (HCO_3^-), carbonate (CO_3^{2-}) and carbamate ($MEACOO^-$) anions, higher temperatures will also increase the average extraction efficiency of the neutral MEA degradation products.

- Therefore, extraction of neutral MEA degradation products using liquid extraction can provide superior average extraction efficiency in CO_2 capture plants.

5.2 Recommendations

Based on what has been discovered in this study, the following recommendations are suggested:

There are many amine degradation products in the industry. Therefore in the future, it should study others amine degradation products. Effect of extraction degradation products with MEA should change MEA to other amine such as DEA and MDEA. And extraction temperature can improve extractability of all neutral MEA degradation products in absent/present MEA thus, it should find optimum condition. The lastly, effect of CO_2 loading should study more amount of CO_2 loading.

Since extraction of neutral MEA degradation products under difference effect was extracted by extractant, thus extractant that extract neutral MEA degradation products should be removed neutral MEA degradation products from the extractant phase via back-extraction reaction. Therefore, regeneration of extractant was also studied in basic regenerate.

Nevertheless, in this research used Aliquat 336 act as extractant which extractant regeneration by striping may be difficult for Aliquat 336. However, it should be studied because in the industrial concerned about economics of extraction process.

So as to recovery the Aliquat 336 in the extraction process, regeneration of used extractant is required. Which in previous work of Akkarachalanont *et al.* (2012) determined the best regeneration conditions for replenishment of the used aliquat. Regeneration of extractant was also studied in which basic NaOH because of its strong basic. The best condition of regeneration was 4 kmol/m^3 NaOH, 10 minute-contacting time, 50 °C regeneration temperature, and 1:1 volume ratio. At the best condition, the average regeneration showed 54 % regeneration efficiency. Therefore, in the future, the research should be studied the best regeneration condition such as concentration of regenerant, contact time, regeneration temperature and volume phase ratio of Aliquat 336 and regenerant are also optimized. Neutral MEA degradation products binded Aliquat 336 from the extraction experiments were used in this section by mixing with regenarant by shaker. Which regenerant will bind with

neutral MEA degradation products and remove to aqueous phase. Then left extractant and neutral MEA degradation products to separate completely. After that bring the sample from aqueous phase to characterize by GC-FID for measured concentration of neutral MEA degradation products were removed from organic to aqueous phase. Before regeneration of extractatnt was important to know concentration of neutral MEA degradation remaining in organic phase which it could know from my research.

Moreover, in the future should be studied to determine the best regenerant that suitable for neutral MEA degradation products.