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APPENDICES

Appendix A Chemical Preparation

A1. Aqueous Solution without MEA

A stock solution of 1000 ppm of each neutral MEA degradation products was prepared in a 500 mL volumetric flask. The theoretical weight of neutral MEA degradation products in DI water was calculated as follow:

$$\text{Mass of neutral MEA degradation (g)} = \frac{\text{1000 ppm neutral MEA degradation}}{\text{1 ppm neutral MEA degradation}}\Bigg|\frac{\text{1 g neutral MEA degradation}}{10^{6}\text{ g solution}}\Bigg|\frac{\text{1 g solution}}{\text{1 mL solution}}\Bigg|\text{500 mL solution}$$

The solution density of 1 g/mL was assumed. The volume of neutral MEA degradation products in DI water was mass of neutral MEA degradation products in solution divided by its density. After preparing the neutral MEA degradation products concentration, the actual concentrations of neutral MEA degradation products as follow:

$$\text{Concentration of neatral MEA degradation (ppm)} = \frac{\text{1 ppm neutral MEA degradation}}{\text{500 mL solution}}\Bigg|\frac{10^{6}\text{ g neutral MEA degradation}}{\text{1 g solution}}\Bigg|\frac{\text{1 mL solution}}{\text{1 g solution}}\Bigg|\text{g actual mass of neutral MEA degradation}$$

Preparation of Neutral MEA Degradation Products 1000 ppm in Aqueous Solution without MEA

imidazole 1,000 ppm solution was prepared by 0.50 g of imidazole 99 wt% dissolved in 500 mL of DI water.

$$\text{Mass of imidazole (g)} = \frac{1000\text{ ppm imidazole}}{1\text{ ppm imidazole}}\bigg|\frac{1\text{ g imidazole}}{10^6\text{ g solution}}\bigg|\frac{1\text{ g solution}}{1\text{ mL solution}}\bigg|500\text{ mL solution}$$

$$\text{Mass of imidazole (g)} = 0.50\text{ g imidazole}\bigg|\frac{100\text{ g solution}}{99\text{ g imidazole}}$$

$$\therefore\ \text{Mass of imidazole (g)} = 0.50\text{ g imidazole in 500 mL solution}$$

N-acthylethanolamine 1,000 ppm solution was prepared by 0.50 mL of N-acthylethanolamine 88.60 wt% dissolved in 500 mL of DI water.

$$\text{Mass of N}-\text{acthylethanolamine (g)} = \frac{1000\text{ ppm N}-\text{acthylethanolamine}}{1\text{ ppm N}-\text{acthylethanolamine}}\bigg|\frac{1\text{ g N}-\text{acthylethanolamine}}{10^6\text{ g solution}}\bigg|\frac{1\text{ g solution}}{1\text{ mL solution}}\bigg|500\text{ mL solution}$$

$$\text{Mass of N}-\text{acthylethanolamine (g)} = 0.50\text{ g N}-\text{acthylethanolamine}\bigg|\frac{100\text{ g solution}}{88.60\text{ g N}-\text{acthylethanolamine}}$$

$$\therefore\ \text{Mass of N}-\text{acthylethanolamine (g)} = 0.56\text{ g N}-\text{acthylethanolamine in 500 mL solution}$$

$$\text{Volume of N} - \text{acthylethanolamine (mL)} = 0.56\ \text{g N} - \text{acthylethanolamine}\left|\frac{1\ \text{mL N} - \text{acthylethanolamine}}{1.12\ \text{g N} - \text{acthylethanolamine}}\right.$$

$$\therefore \text{Volume of N} - \text{acthylethanolamine (mL)} = 0.50\ \text{mL N} - \text{acthylethanolamine in 500 mL solution}$$

2-oxazolidone 1,000 ppm solution was prepared by 0.51 g of 2-oxazolidone 98 wt% dissolved in 500 mL of DI water.

$$\text{Mass of 2} - \text{oxazolidone (g)} = \frac{1000\ \text{ppm}\ \ 2 - \text{oxazolidone}}{1\ \text{ppm}\ \ 2 - \text{oxazolidone}}\left|\frac{1\ \text{g}\ \ 2 - \text{oxazolidone}}{10^6\ \text{g solution}}\right|\frac{1\ \text{g solution}}{1\ \text{mL solution}}\left|\ 500\ \text{mL solution}\right.$$

$$\text{Mass of 2} - \text{oxazolidone (g)} = 0.50\ \text{g 2} - \text{oxazolidone}\left|\frac{100\ \text{g solution}}{98\ \text{g 2} - \text{oxazolidone}}\right.$$

$$\therefore \text{Mass of 2} - \text{oxazolidone (g)} = 0.51\ \text{g 2} - \text{oxazolidone in 500 mL solution}$$

N-(2-hydroxyethyl)-succinimide 1,000 ppm solution was prepared by 0.53 g of N-(2-hydroxyethyl)-succinimide 95 wt% dissolved in 500 mL of DI water.

$$\text{Mass of N} - (2 - \text{hydroxyethyl}) - \text{succinimide (g)} = \frac{1000\text{ ppm N} - (2 - \text{hydroxyethyl}) - \text{succinimide}}{1\text{ ppm N} - (2 - \text{hydroxyethyl}) - \text{succinimide}}\left|\frac{1\text{ g N} - (2 - \text{hydroxyethyl}) - \text{succinimide}}{10^6\text{ g solution}}\right|\frac{1\text{ g solution}}{1\text{ mL solution}}\left|500\text{ mL solution}\right.$$

$$\text{Mass of N} - (2 - \text{hydroxyethyl}) - \text{succinimide (g)} = 0.50\text{ g N} - (2 - \text{hydroxyethyl}) - \text{succinimide}\left|\frac{100\text{ g solution}}{95\text{ g N} - (2 - \text{hydroxyethyl}) - \text{succinimide}}\right.$$

$$\therefore \text{Mass of N} - (2 - \text{hydroxyethyl}) - \text{succinimide (g)} = 0.53\text{ g N} - (2 - \text{hydroxyethyl}) - \text{succinimide in 500 mL solution}$$

Table A1 Preparation of neutral MEA degradation products 1000 ppm in aqueous solution without MEA

Chemical	Theoretical Concentration (ppm)	Theoretical Weight (g)	Actual Weight (g)	Actual Concentration (ppm)
Imidazole	1000	0.50	0.5050	999.99
N-acethylethanolamine	1000	0.56	0.5643	999.94
2-Oxazolidone	1000	0.51	0.5102	999.99
N-(2-hydroxyethyl)-succinimide	1000	0.53	0.5263	999.97

A2. Aqueous Solution with MEA

MEA 5 M (30 wt%) Preparation

$$\text{5 M of MEA} = \frac{\text{5 mol MEA}}{\text{1000 mL solution}}\left|\frac{\text{61.08 g MEA}}{\text{1 mol MEA}}\right.$$

The solution density of 1 g/mL was assumed.

$$\text{5 M of MEA} = \frac{\text{305.4 g MEA}}{\text{1000 mL solution}}\left|\frac{\text{1 mL solution}}{\text{1 g solution}}\right|100$$

$$\text{5 M of MEA} = 30.54\ \%\text{wt}$$

The density of MEA is 1.02 g/mL. The volume of MEA in solution was mass of MEA in solution divided by its density, the actual volume of MEA as follow:

$$\text{Volume of 5 M of MEA (mL)} = \text{305.40 g MEA}\left|\frac{\text{1 mL MEA}}{\text{1.02 g MEA}}\right.$$

$$\text{Volume of 5 M of MEA (mL)} = \text{299.41 mL MEA in 1000 mL solution}$$

The MEA stock solution with 1000 ppm neutral MEA degradation products in a 100 mL volumetric flask was theoretically calculated similar to the neutral MEA degradation products in aqueous solution without MEA.

$$\text{Volume of MEA (mL)} = \frac{299.41 \text{ mL MEA}}{1000 \text{ mL solution}}\Bigg| 100 \text{ mL solution}$$

$$\therefore \text{ Volume of MEA (mL)} = 29.94 \text{ mL in } 100 \text{ solution}$$

imidazole 1,000 ppm solution was prepared by 0.50 g of imidazole 99 wt% mixed with 29.94 mL of MEA and then adjusted volume by DI water to 100 mL.

N-(2-hydroxyethyl)-succinimide 1,000 ppm solution was prepared by 0.53 g of N-(2-hydroxyethyl)-succinimide 95 wt% mixed with 29.94 mL of MEA and then adjusted volume by DI water to 100 mL.

2-oxazolidone 1,000 ppm solution was prepared by 0.51 g of 2-oxazolidone 98 wt% mixed with 29.94 mL of MEA and then adjusted volume by DI water to 100 mL.

N-(2-hydroxyethyl)-succinimide 1,000 ppm solution was prepared by 0.53 g of N-(2-hydroxyethyl)-succinimide 95 wt% mixed with 29.94 mL of MEA and then adjusted volume by DI water to 100 mL.

Table A2 Preparation of neutral MEA degradation products 1000 ppm in aqueous solution with MEA

Chemical	**Theoretical Concentration 5 M (wt%)**	**Theoretical Volume (mL)**	**Actual Volume (mL)**	**Actual Concentration 5 M (wt%)**
Imidazole	30.54	29.94	29.95	30.55
N-acethylethanolamine	30.54	29.94	29.95	30.55
2-Oxazolidone	30.54	29.94	29.95	30.55
N-(2-hydroxyethyl)-succinimide	30.54	29.94	29.95	30.55

A3. NaOH Preparation

2 M of NaOH for converting extraction in chloride form to extraction in hydroxide$^-$ form was prepared in a 1000 mL volumetric flask.

$$\text{Volume of 2 M of MEA (mL)} = \left.\frac{\text{2 mol NaOH}}{\text{1000 mL solution}}\right|\frac{\text{39.997 g NaOH}}{\text{1 mol NaOH}}$$

$$\text{Volume of 2 M of MEA (mL)} = \left.\frac{\text{79.99 g NaOH}}{\text{1000 mL solution}}\right|\frac{\text{100 g solution}}{\text{99 g NaOH}}$$

$$\therefore \text{Volume of 2 M of MEA (mL)} = \text{80.80 g NaOH in 1000 mL solution}$$

A4. $AgNO_3$ Preparation

0.05 M of $AgNO_3$ used as an indicator in Mohr's titration method was prepared in a 1000 mL volumetric flask.

$$\text{Mass of 0.05 M of AgNO}_3\text{ (g)} = \left.\frac{0.05\text{ mol AgNO}_3}{\text{1000 mL solution}}\right|\frac{169.87\text{ g AgNO}_3}{1\text{ mol AgNO}_3}$$

$$\text{Mass of 0.05 M of AgNO}_3\text{ (g)} = \left.\frac{8.49\text{ g AgNO}_3}{\text{1000 mL solution}}\right|\text{1000 mL solution}$$

$$\therefore \text{Mass of 0.05 M of AgNO}_3\text{ (g)} = 8.49\text{ g AgNO}_3\text{in 1000 mL solution}$$

A5. Na_2CrO_4 Preparation

0.25 M of Na_2CrO_4 used as an indicator in Mohr's titration method was prepared in a 100 mL volumetric flask.

$$\text{Mass of 0.25 M of } Na_2CrO_4 (g) = \frac{0.25 \text{ mol } Na_2CrO_4}{1000 \text{ mL solution}} \left| \frac{161.97 \text{ g } Na_2CrO_4}{1 \text{ mol } Na_2CrO_4} \right.$$

$$\text{Mass of 0.25 M of } Na_2CrO_4 (g) = \frac{40.49 \text{ g } Na_2CrO_4}{1000 \text{ mL solution}} \left| 100 \text{ mL } Na_2CrO_4 \right.$$

$$\therefore \text{Mass of 0.25 M of } Na_2CrO_4 (g) = 4.05 \text{ g in 100 mL solution}$$

Table A3 Preparation coversion of extractant-Cl

Chemical	**Theoretical Concentration (Molar)**	**Theoretical Weight or Volume (g) or (mL)**	**Actual Weight or Volume (mL)**	**Actual Concentration (Molar)**
NaOH	2	80.80	80.80	2
$AgNO_3$	0.05	8.49	8.49	0.05
Na_2CrO_4	0.25	4.05	4.04	0.25

Appendix B Conversion of Extractant

Calculation Example of Conversion from Extractant Chloride form (Extractant-Cl) to Extractant Hydroxide form (Extractant-OH).

$$\text{Extractant-Cl} + \text{NaOH} = \text{Extractant-OH} + \text{NaCl} \qquad \text{B1}$$

Molecular weight of extractant-Cl is 404.16 g/mol. One mole of extractant-Cl consists of one mole of Cl^- ion and one mole of extractant ion and produces one mole of extractant-OH. If the conversion is incomplete, there is extractant-OH and extractant-Cl remaining which extractant-Cl remaining can be determined by titration of Cl^- in extractant-Cl with Ag^+ to find the final conversion. Know that Cl^- and Ag^+ have reaction at the mole ratio of 1:1.

Table B1 Volume of Cl^- ion initial remaining in the extractant-Cl

Weight of Extractant-Cl (g) = W_1	**$AgNO_3$ (mL)**	**mmole of Ag^+ = mmole of Cl^- ($W_1 \times AgNO_3$)**	**Weight of Cl^- (mg = mmole Cl × 35.5 (mg)) =W_2**	**%Cl^- Initial (W_2 *0.001/W_1) × 100**
0.1005	3.9	0.195	6.92	6.89

Example calculation volume of Cl initial remaining in the extractant.

From titration extractant-Cl in Table B1was calculated as follow:

$$\text{Mol of 3.9 mL of 0.05 M of } AgNO_3(\text{mol}) = \frac{0.05\text{ mol } AgNO_3}{1000\text{ mL solution}}\bigg|\, 3.90\text{ mL solution}$$

$$\text{Mol of 3.9 mL of 0.05 M of } AgNO_3(\text{mol}) = 0.000195\text{ mol } AgNO_3 = 0.195\text{ mmol } Ag^{+}$$

$$\text{Mol of 3.9 mL of 0.05 M of } AgNO_3(\text{mol}) = 0.195\text{ mmol } Cl^{-}\text{ remaining in the extractant} - Cl$$

$$\text{Mass of } Cl^{-}\text{remaining in the extractant} - Cl\ (g) = 0.195\text{ mmol } Cl^{-}\bigg|\,\frac{35.50\text{ mg } Cl^{-}}{1\text{ mmol } Cl^{-}}$$

$$\text{Mass of } Cl^{-}\text{remaining in the extractant} - Cl\ (g) = 6.9225\text{ mg } Cl^{-}$$

$$\%Cl^{-}\text{ initial remaining in the extractant} - Cl = \frac{0.0069225\text{ g } Cl^{-}}{0.1005\text{ g extractant} - Cl}\bigg|\,100$$

$$\therefore\ \%Cl^{-}\text{ initial remaining in the extractant} - Cl = .6.8881\ \%$$

Example calculation conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration. From titration of after 1st conversion batch no.1 in Table B B1was calculated as follow.

$$\text{Mol of 2.65 mL of 0.05 M of } AgNO_3\text{(mol)} = \frac{0.05 \text{ mol } AgNO_3}{1000 \text{ mL solution}} \Big| \, 2.65 \text{ mL solution}$$

$$\text{Mol of 2.65 mL of 0.05 M of } AgNO_3 \text{ (mol)} = 0.0001325 \text{ mol } AgNO_3 = 0.1325 \text{ mmol } Ag^+$$

$$\text{Mol of 2.65 mL of 0.05 M of } AgNO_3 \text{ (mol)} = 0.1325 \text{ mmol } Cl^- \text{ remaining in the extractant} - Cl$$

$$\text{Mass of } Cl^- \text{remaining in the extractant} - Cl \text{ after } 1^{st} \text{ conversion (g)} = 0.1325 \text{ mmol } Cl^- \Big| \frac{35.5 \text{ mg } Cl^-}{1 \text{ mmol } Cl^-}$$

$$\text{Mass of } Cl^- \text{remaining in the extractant} - Cl \text{ after } 1^{st} \text{ conversion (g)} = 4.7038 \text{ mg } Cl^-$$

$$\%Cl^- \text{ remaining in the extractant} - Cl \text{ after } 1^{st} \text{ conversion} = \frac{0.0047038 \text{ g } Cl^-}{0.1004 \text{ g extractant} - Cl} \Big| \, 100$$

$$\therefore \ \%Cl^- \text{ remaining in the extractant} - Cl \text{ after } 1^{st} \text{ conversion} = 4.685\%$$

$$\%\text{Extraction Cl} = \frac{(\%\text{Cl}^{-}\text{ initial remaining in the extractant} - \text{Cl} - \ \%\text{Cl}^{-}\text{ remaining in the extractant} - \text{Cl after } 1^{\text{st}}\text{ conversion})}{\%\text{Cl}^{-}\text{ initial remaining in the extractant} - \text{Cl}}\Bigg| 100$$

$$\%\text{Extraction Cl} = \frac{(6.8881 - 4.685)}{6.8881}\Bigg| 100$$

$$\therefore \%\text{Extraction Cl} = 31.98\%$$

Extractant as Aliquat-336 is in the form of chloride (extractant-Cl). It was converted to hydroxide form by reaction.

Table B2 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.1

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1004	2.65	0.13	4.70	4.69	31.98
After 2nd Conversion	0.1006	2.55	0.13	4.53	4.50	34.68
After 3rd Conversion	0.1003	2.40	0.12	4.26	4.25	38.34
After 4th Conversion	0.1008	2.23	0.11	3.95	3.92	43.12
After 5th Conversion	0.1007	2.05	0.10	3.64	3.61	47.54
After 6th Conversion	0.1007	1.80	0.09	3.20	3.17	53.94
After 7th Conversion	0.1006	1.70	0.09	3.02	3.00	56.45
After 8th Conversion	0.1002	1.50	0.08	2.66	2.66	61.42
After 9th Conversion	0.1001	1.45	0.07	2.57	2.57	62.67
After 10th Conversion	0.1006	1.45	0.07	2.57	2.56	62.86
After 11th Conversion	0.1000	1.30	0.07	2.31	2.31	66.50
After 12th Conversion	0.1001	1.30	0.07	2.31	2.31	66.53
After 13th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After Evaporation	0.1005	1.45	0.07	2.57	2.56	62.82

Table B3 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.2

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1005	2.65	0.13	4.70	4.68	32.05
After 2nd Conversion	0.1005	2.50	0.13	4.44	4.42	35.90
After 3rd Conversion	0.1002	2.45	0.12	4.35	4.34	36.99
After 4th Conversion	0.1002	2.20	0.11	3.91	3.90	43.42
After 5th Conversion	0.1003	2.00	0.10	3.55	3.54	48.62
After 6th Conversion	0.1006	1.85	0.09	3.28	3.26	52.61
After 7th Conversion	0.1007	1.70	0.09	3.02	3.00	56.50
After 8th Conversion	0.1001	1.50	0.08	2.66	2.66	61.38
After 9th Conversion	0.1003	1.45	0.07	2.57	2.57	62.75
After 10th Conversion	0.1004	1.45	0.07	2.57	2.56	62.78
After 11th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After 12th Conversion	0.1003	1.25	0.06	2.22	2.21	67.88
After 13th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After Evaporation	0.1001	1.45	0.07	2.57	2.57	62.67

Table B4 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.3

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1000	2.60	0.13	4.62	4.62	33.00
After 2nd Conversion	0.1007	2.55	0.13	4.53	4.49	34.74
After 3rd Conversion	0.1002	2.45	0.12	4.35	4.34	36.99
After 4th Conversion	0.1008	2.25	0.11	3.99	3.96	42.48
After 5th Conversion	0.1000	1.95	0.10	3.46	3.46	49.75
After 6th Conversion	0.1007	1.80	0.09	3.20	3.17	53.94
After 7th Conversion	0.1002	1.65	0.08	2.93	2.92	57.57
After 8th Conversion	0.1000	1.50	0.08	2.66	2.66	61.35
After 9th Conversion	0.1006	1.40	0.07	2.49	2.47	64.14
After 10th Conversion	0.1003	1.45	0.07	2.57	2.57	62.75
After 11th Conversion	0.1001	1.25	0.06	2.22	2.22	67.82
After 12th Conversion	0.1002	1.25	0.06	2.22	2.21	67.85
After 13th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After Evaporation	0.1000	1.50	0.08	2.66	2.66	61.35

Table B5 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.4

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1005	2.65	0.13	4.70	4.68	32.05
After 2nd Conversion	0.1002	2.55	0.13	4.53	4.52	34.42
After 3rd Conversion	0.1000	2.40	0.12	4.26	4.26	38.15
After 4th Conversion	0.1008	2.25	0.11	3.99	3.96	42.48
After 5th Conversion	0.1006	2.05	0.10	3.64	3.62	47.49
After 6th Conversion	0.1007	1.80	0.09	3.20	3.17	53.94
After 7th Conversion	0.1004	1.70	0.09	3.02	3.01	56.37
After 8th Conversion	0.1006	1.50	0.08	2.66	2.65	61.58
After 9th Conversion	0.1006	1.45	0.07	2.57	2.56	62.86
After 10th Conversion	0.1000	1.45	0.07	2.57	2.57	62.63
After 11th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After 12th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After 13th Conversion	0.1002	1.30	0.07	2.31	2.30	66.57
After Evaporation	0.1005	1.45	0.07	2.57	2.56	62.82

Table B6 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.5

Time of Conversion	Weight of Extractant-Cl (g)	AgNO$_3$ (mL)	mmole of Ag$^+$ = mmole of Cl$^-$	Weight of Cl$^-$ (mg)	%Cl$^-$ Remaining	%Extraction Cl
After 1st Conversion	0.1000	2.60	0.13	4.62	4.62	33.00
After 2nd Conversion	0.1002	2.55	0.13	4.53	4.52	34.42
After 3rd Conversion	0.1007	2.45	0.12	4.35	4.32	37.30
After 4th Conversion	0.1000	2.23	0.11	3.95	3.95	42.66
After 5th Conversion	0.1006	2.00	0.10	3.55	3.53	48.77
After 6th Conversion	0.1007	1.85	0.09	3.28	3.26	52.66
After 7th Conversion	0.1007	1.65	0.08	2.93	2.91	57.78
After 8th Conversion	0.1004	1.55	0.08	2.75	2.74	60.22
After 9th Conversion	0.1004	1.45	0.07	2.57	2.56	62.78
After 10th Conversion	0.1003	1.45	0.07	2.57	2.57	62.75
After 11th Conversion	0.1003	1.30	0.07	2.31	2.30	66.60
After 12th Conversion	0.1001	1.30	0.07	2.31	2.31	66.53
After 13th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After Evaporation	0.1005	1.45	0.07	2.57	2.56	62.82

Table B7 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.6

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1005	2.65	0.13	4.70	4.68	32.05
After 2nd Conversion	0.1003	2.50	0.13	4.44	4.42	35.77
After 3rd Conversion	0.1001	2.40	0.12	4.26	4.26	38.22
After 4th Conversion	0.1000	2.23	0.11	3.95	3.95	42.66
After 5th Conversion	0.1007	2.05	0.10	3.64	3.61	47.54
After 6th Conversion	0.1006	1.85	0.09	3.28	3.26	52.61
After 7th Conversion	0.1002	1.65	0.08	2.93	2.92	57.57
After 8th Conversion	0.1003	1.50	0.08	2.66	2.65	61.46
After 9th Conversion	0.1001	1.45	0.07	2.57	2.57	62.67
After 10th Conversion	0.1005	1.45	0.07	2.57	2.56	62.82
After 11th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After 12th Conversion	0.1003	1.25	0.06	2.22	2.21	67.88
After 13th Conversion	0.1002	1.25	0.06	2.22	2.21	67.85
After Evaporation	0.1002	1.50	0.08	2.66	2.66	61.42

Table B8 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.7

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1003	2.65	0.13	4.70	4.69	31.92
After 2nd Conversion	0.1000	2.55	0.13	4.53	4.53	34.29
After 3rd Conversion	0.1001	2.40	0.12	4.26	4.26	38.22
After 4th Conversion	0.1001	2.20	0.11	3.91	3.90	43.36
After 5th Conversion	0.1008	2.05	0.10	3.64	3.61	47.59
After 6th Conversion	0.1007	1.80	0.09	3.20	3.17	53.94
After 7th Conversion	0.1005	1.65	0.08	2.93	2.91	57.69
After 8th Conversion	0.1001	1.50	0.08	2.66	2.66	61.38
After 9th Conversion	0.1006	1.45	0.07	2.57	2.56	62.86
After 10th Conversion	0.1002	1.45	0.07	2.57	2.57	62.71
After 11th Conversion	0.1000	1.30	0.07	2.31	2.31	66.50
After 12th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After 13th Conversion	0.1002	1.25	0.06	2.22	2.21	67.85
After Evaporation	0.1002	1.45	0.07	2.57	2.57	62.71

Table B9 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.8

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1005	2.65	0.13	4.70	4.68	32.05
After 2nd Conversion	0.1004	2.55	0.13	4.53	4.51	34.55
After 3rd Conversion	0.1005	2.40	0.12	4.26	4.24	38.46
After 4th Conversion	0.1004	2.25	0.11	3.99	3.98	42.25
After 5th Conversion	0.1003	2.00	0.10	3.55	3.54	48.62
After 6th Conversion	0.1000	1.80	0.09	3.20	3.20	53.61
After 7th Conversion	0.1000	1.70	0.09	3.02	3.02	56.19
After 8th Conversion	0.1004	1.50	0.08	2.66	2.65	61.50
After 9th Conversion	0.1006	1.45	0.07	2.57	2.56	62.86
After 10th Conversion	0.1005	1.45	0.07	2.57	2.56	62.82
After 11th Conversion	0.1006	1.30	0.07	2.31	2.29	66.70
After 12th Conversion	0.1003	1.30	0.07	2.31	2.30	66.60
After 13th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After Evaporation	0.1005	1.45	0.07	2.57	2.56	62.82

Table B10 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.9

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1008	2.65	0.13	4.70	4.67	32.25
After 2nd Conversion	0.1001	2.50	0.13	4.44	4.43	35.64
After 3rd Conversion	0.1001	2.43	0.12	4.30	4.30	37.57
After 4th Conversion	0.1001	2.20	0.11	3.91	3.90	43.36
After 5th Conversion	0.1003	1.95	0.10	3.46	3.45	49.90
After 6th Conversion	0.1006	1.80	0.09	3.20	3.18	53.89
After 7th Conversion	0.1002	1.70	0.09	3.02	3.01	56.28
After 8th Conversion	0.1000	1.50	0.08	2.66	2.66	61.35
After 9th Conversion	0.1004	1.45	0.07	2.57	2.56	62.78
After 10th Conversion	0.1006	1.45	0.07	2.57	2.56	62.86
After 11th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After 12th Conversion	0.1001	1.25	0.06	2.22	2.22	67.82
After 13th Conversion	0.1000	1.25	0.06	2.22	2.22	67.79
After Evaporation	0.1002	1.50	0.08	2.66	2.66	61.42

Table B11 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.10

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1005	2.65	0.13	4.70	4.68	32.05
After 2nd Conversion	0.1003	2.55	0.13	4.53	4.51	34.48
After 3rd Conversion	0.1006	2.40	0.12	4.26	4.23	38.52
After 4th Conversion	0.1002	2.20	0.11	3.91	3.90	43.42
After 5th Conversion	0.1000	1.95	0.10	3.46	3.46	49.75
After 6th Conversion	0.1007	1.80	0.09	3.20	3.17	53.94
After 7th Conversion	0.1001	1.70	0.09	3.02	3.01	56.24
After 8th Conversion	0.1000	1.55	0.08	2.75	2.75	60.06
After 9th Conversion	0.1004	1.45	0.07	2.57	2.56	62.78
After 10th Conversion	0.1002	1.45	0.07	2.57	2.57	62.71
After 11th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After 12th Conversion	0.1002	1.25	0.06	2.22	2.21	67.85
After 13th Conversion	0.1002	1.25	0.06	2.22	2.21	67.85
After Evaporation	0.1004	1.45	0.07	2.57	2.56	62.78

Table B12 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.11

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1006	2.65	0.13	4.70	4.68	32.12
After 2nd Conversion	0.1000	2.55	0.13	4.53	4.53	34.29
After 3rd Conversion	0.1007	2.45	0.12	4.35	4.32	37.30
After 4th Conversion	0.1002	2.23	0.11	3.95	3.94	42.78
After 5th Conversion	0.1006	2.00	0.10	3.55	3.53	48.77
After 6th Conversion	0.1003	1.85	0.09	3.28	3.27	52.47
After 7th Conversion	0.1002	1.70	0.09	3.02	3.01	56.28
After 8th Conversion	0.1004	1.55	0.08	2.75	2.74	60.22
After 9th Conversion	0.1003	1.40	0.07	2.49	2.48	64.03
After 10th Conversion	0.1002	1.40	0.07	2.49	2.48	63.99
After 11th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After 12th Conversion	0.1002	1.30	0.07	2.31	2.30	66.57
After 13th Conversion	0.1005	1.25	0.06	2.22	2.21	67.95
After Evaporation	0.1003	1.45	0.07	2.57	2.57	62.75

Table B13 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.12

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1006	2.65	0.13	4.70	4.68	32.12
After 2nd Conversion	0.1002	2.50	0.13	4.44	4.43	35.70
After 3rd Conversion	0.1005	2.40	0.12	4.26	4.24	38.46
After 4th Conversion	0.1003	2.20	0.11	3.91	3.89	43.48
After 5th Conversion	0.1007	2.05	0.10	3.64	3.61	47.54
After 6th Conversion	0.1005	1.80	0.09	3.20	3.18	53.85
After 7th Conversion	0.1000	1.70	0.09	3.02	3.02	56.19
After 8th Conversion	0.1005	1.55	0.08	2.75	2.74	60.26
After 9th Conversion	0.1004	1.45	0.07	2.57	2.56	62.78
After 10th Conversion	0.1007	1.40	0.07	2.49	2.47	64.17
After 11th Conversion	0.1005	1.25	0.06	2.22	2.21	67.95
After 12th Conversion	0.1001	1.25	0.06	2.22	2.22	67.82
After 13th Conversion	0.1004	1.25	0.06	2.22	2.21	67.92
After Evaporation	0.1004	1.45	0.07	2.57	2.56	62.78

Table B14 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.13

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1001	2.65	0.13	4.70	4.70	31.78
After 2nd Conversion	0.1006	2.50	0.13	4.44	4.41	35.96
After 3rd Conversion	0.1007	2.40	0.12	4.26	4.23	38.58
After 4th Conversion	0.1003	2.20	0.11	3.91	3.89	43.48
After 5th Conversion	0.1002	2.05	0.10	3.64	3.63	47.28
After 6th Conversion	0.1007	1.80	0.09	3.20	3.17	53.94
After 7th Conversion	0.1002	1.70	0.09	3.02	3.01	56.28
After 8th Conversion	0.1004	1.50	0.08	2.66	2.65	61.50
After 9th Conversion	0.1005	1.45	0.07	2.57	2.56	62.82
After 10th Conversion	0.1002	1.45	0.07	2.57	2.57	62.71
After 11th Conversion	0.1003	1.30	0.07	2.31	2.30	66.60
After 12th Conversion	0.1005	1.30	0.07	2.31	2.30	66.67
After 13th Conversion	0.1004	1.30	0.07	2.31	2.30	66.63
After Evaporation	0.1000	1.45	0.07	2.57	2.57	62.63

Table B15 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.14

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1004	2.65	0.13	4.70	4.69	31.98
After 2nd Conversion	0.1007	2.55	0.13	4.53	4.49	34.74
After 3rd Conversion	0.1007	2.45	0.12	4.35	4.32	37.30
After 4th Conversion	0.1002	2.20	0.11	3.91	3.90	43.42
After 5th Conversion	0.1007	2.00	0.10	3.55	3.53	48.82
After 6th Conversion	0.1005	1.80	0.09	3.20	3.18	53.85
After 7th Conversion	0.1001	1.70	0.09	3.02	3.01	56.24
After 8th Conversion	0.1000	1.50	0.08	2.66	2.66	61.35
After 9th Conversion	0.1007	1.45	0.07	2.57	2.56	62.89
After 10th Conversion	0.1002	1.40	0.07	2.49	2.48	63.99
After 11th Conversion	0.1005	1.30	0.07	2.31	2.30	66.67
After 12th Conversion	0.1003	1.30	0.07	2.31	2.30	66.60
After 13th Conversion	0.1001	1.30	0.07	2.31	2.31	66.53
After Evaporation	0.1003	1.45	0.07	2.57	2.57	62.75

Table B16 Conversion of extractant-Cl to be extractant-OH measured by Mohr's method titration of batch No.15

Time of Conversion	Weight of Extractant-Cl (g)	$AgNO_3$ (mL)	mmole of Ag^+ = mmole of Cl^-	Weight of Cl^- (mg)	%Cl^- Remaining	%Extraction Cl
After 1st Conversion	0.1006	2.65	0.13	4.70	4.68	32.12
After 2nd Conversion	0.1007	2.55	0.13	4.53	4.49	34.74
After 3rd Conversion	0.1003	2.45	0.12	4.35	4.34	37.05
After 4th Conversion	0.1003	2.25	0.11	3.99	3.98	42.19
After 5th Conversion	0.1004	1.95	0.10	3.46	3.45	49.95
After 6th Conversion	0.1006	1.85	0.09	3.28	3.26	52.61
After 7th Conversion	0.1005	1.70	0.09	3.02	3.00	56.41
After 8th Conversion	0.1003	1.50	0.08	2.66	2.65	61.46
After 9th Conversion	0.1003	1.40	0.07	2.49	2.48	64.03
After 10th Conversion	0.1006	1.40	0.07	2.49	2.47	64.14
After 11th Conversion	0.1005	1.30	0.07	2.31	2.30	66.67
After 12th Conversion	0.1003	1.30	0.07	2.31	2.30	66.60
After 13th Conversion	0.1003	1.25	0.06	2.22	2.21	67.88
After Evaporation	0.1002	1.45	0.07	2.57	2.57	62.71

Table B17 Average conversion of extractant-OH after evaporation of water

Bacth · No	%Extraction Cl	Average Conversion (%)	SD	Avg ±SD
1	62.82	62.48	0.57	62.48±0.57
2	62.67			
3	61.35			
4	62.82			
5	62.82			
6	61.42			
7	62.71			
8	62.82			
9	61.42			
10	62.78			
11	62.75			
12	62.78			
13	62.63			
14	62.75			
15	62.71			

Average Molecular Weight of Extractant after Converting

Molecular weight of extractant-Cl is 404.16 g/mol

Molecular weight of Chloride (Cl^-) is 35.45 g/mol

Molecular weight of Hydroxide (OH^-) is 15.95 + 1 = 16.95 g/mol

Therefore, molecular weight of extractant-OH is 404.16 – (35.45 + 16.95) = 385.66 g/mol

$$Mw_{avg} = (Mw_A)(X_A) + (Mw_B)(X_B)\ ;\ \text{where } X_i = \text{mass fraction}$$

$$Mw_{avg} = (385.66)(0.6248) + (404.16)(1 - 0.6248)$$

$$\therefore Mw_{avg} = 392.60\ \text{g/mol}$$

Therefore, the average molecular weight of extractant-OH is 392.60 g/mol.

B1. Extractant-OH Solution

The average molecular weight of extractant-OH was 392.60 g/mol. Therefore, 1 M of extractant-OH in 2-ethyl-hexanol (alcohol group diluents) with a total volume of 1000 mL was calculated mass of extractant-OH as follow:

$$\text{Mass of 1 M of extractant} - \text{OH} = \frac{1\ \text{mol extractant} - \text{OH}}{1000\ \text{mL solution}} \left| \frac{392.60\ \text{g extractnt} - \text{OH}}{1\ \text{mol extractant} - \text{OH}} \right| 1000\ \text{mL solution}$$

$$\therefore \text{Mass of 1 M of extractant} - \text{OH} = 392.60\ \text{g extractnt} - \text{OH}$$

Therefore, 1 M of extractant is equal to 392.60 g of extractant-OH adjusted volume to 1000 mL by adding diluents.

Table B18 Extractant-OH solution preparation

Theoretical Concentration of Extractant-OH (M)	Theoretical Weight of Extractant-OH (g)	Actual Weight of Extractant-OH (g)	Actual Concentration of Extractant-OH (M)
1	392.60	392.6113	1

Appendix C Standard Solution of Neutral MEA Degradation Products Preparation

C1. Standard Solution of Neutral MEA Degradation Products without MEA

Analysis the neutral MEA degradation products concentration must be first before extraction, the characteristic of each neutral MEA degradation, imidazole, N-acethylethanolamine, 2-oxazolidone and N-(2-hydroxyethyl)-succinimide was analyzed by gas chromatography with flame ionization (GC-FID). The retention times of each were 18.00, 20.40, 23.50 and 27.30 minutes, respectively. Chromatogram of each neutral MEA degradation products solution without MEA, imidazole, N-acethylethanolamine, 2-oxazolidone and N-(2-hydroxyethyl)-succinimide was showed that in Figures C1, C2, C3 and C4

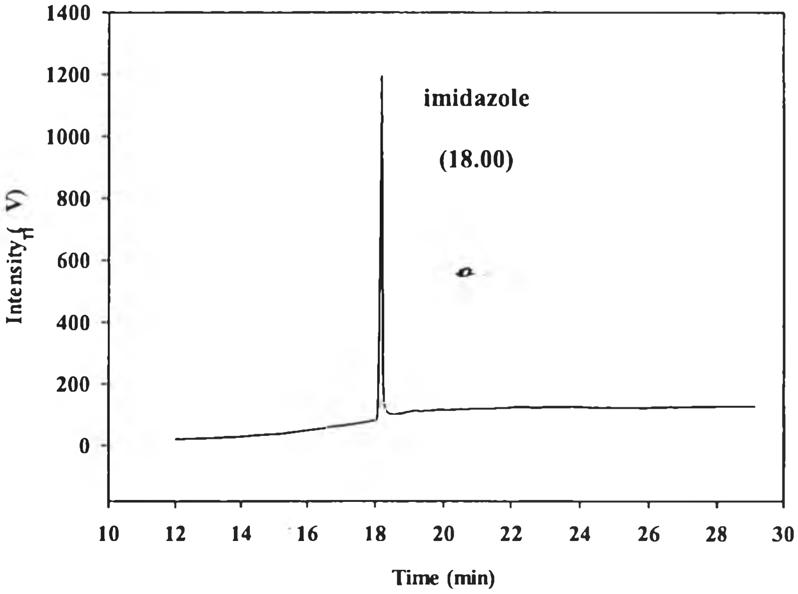

Figure C1 Chromatogram of imidazole without MEA in aqueous solution before extraction.

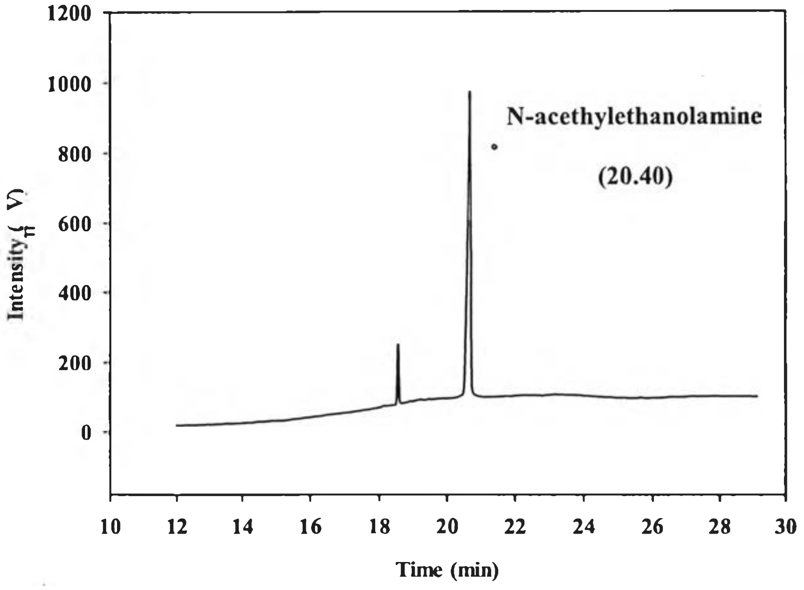

Figure C2 Chromatogram of N-acethylethanolamine without MEA in aqueous solution before extraction.

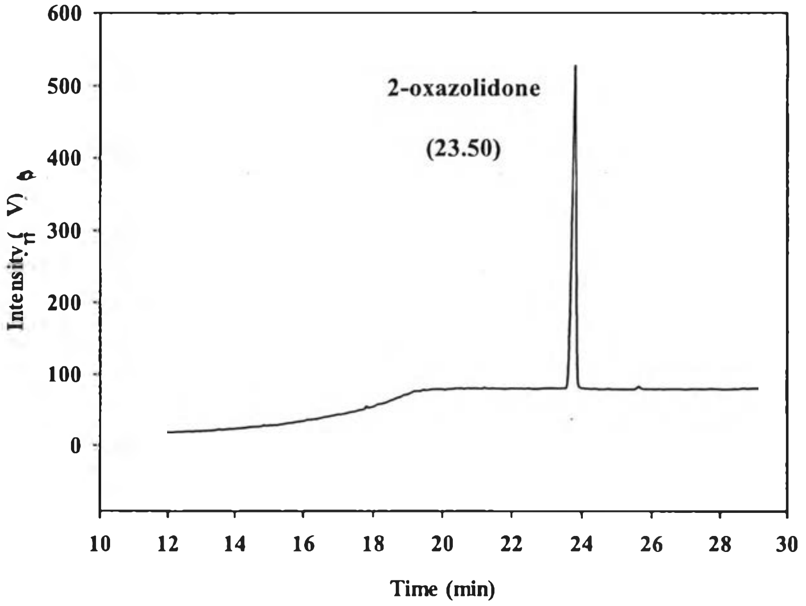

Figure C3 Chromatogram of 2-oxazolidone without MEA in aqueous solution before extraction.

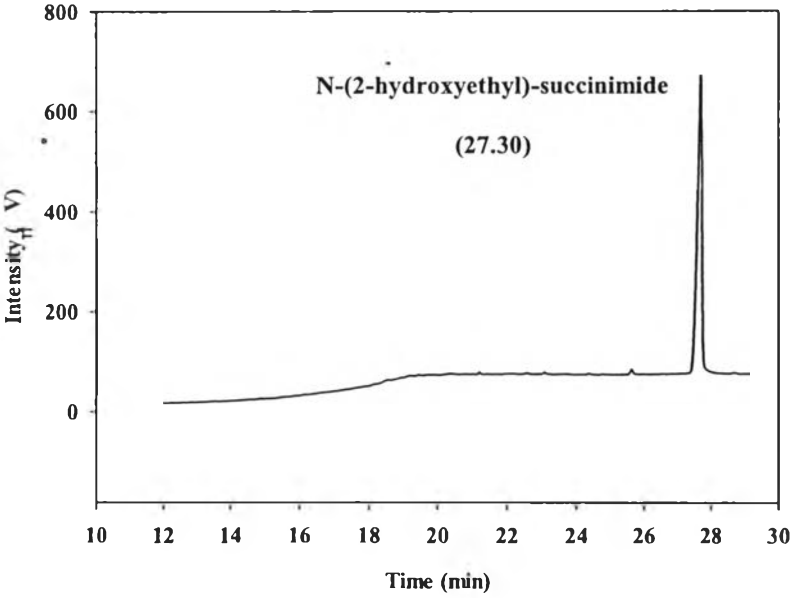

Figure C4 Chromatogram of N-(2-hydroxyethyl)-succinimide without MEA in aqueous solution before extraction.

C2. Standard Solution of Neutral MEA Degradation Products with MEA

Analysis the neutral MEA degradation products with 30wt % MEA concentration must be done before extraction, the characteristic of each neutral MEA degradation, imidazole, N-acethylethanolamine, 2-oxazolidone and N-(2-hydroxyethyl)-succinimide was analyzed by gas chromatography with flame ionization (GC-FID). The retention times of each were 17.70, 20.10, 23.00 and 26.50 minutes, respectively. Chromatogram of each neutral MEA degradation products solution with 30 %wt MEA, imidazole, N-acethylethanolamine, 2-oxazolidone and N-(2-hydroxyethyl)-succinimide is shown that in Figures C13, C14, C15 and C16.

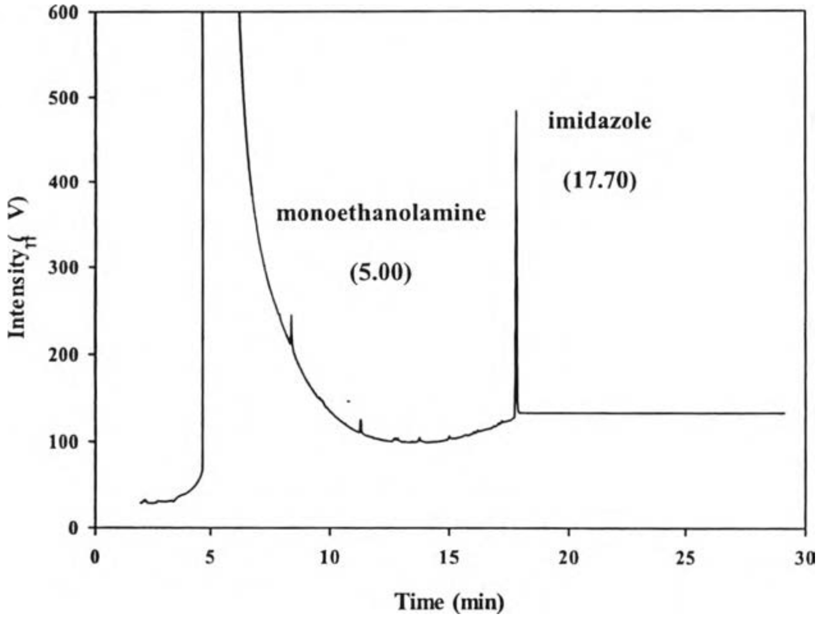

Figure C5 Chromatogram of imidazole with MEA in aqueous solution before extraction.

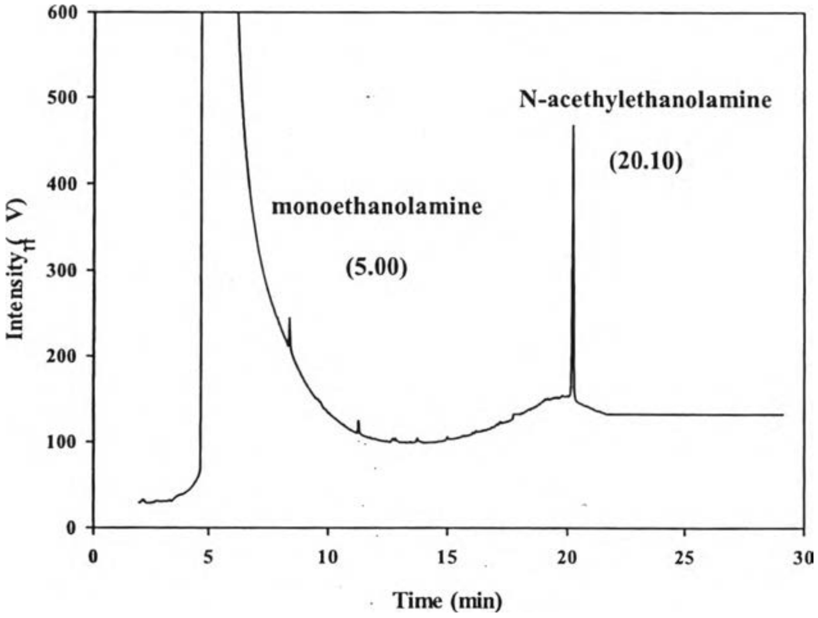

Figure C6 Chromatogram of N-acethylethanolamine with MEA in aqueous solution before extraction.

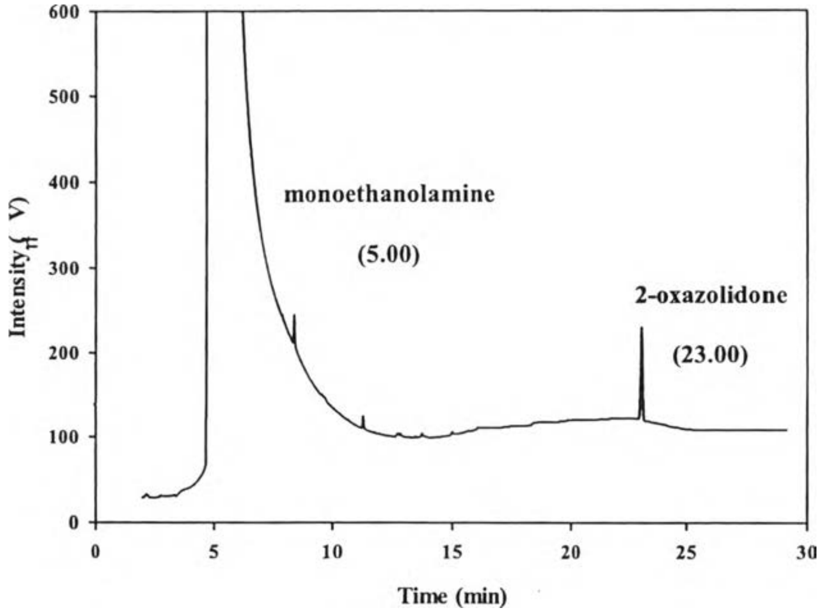

Figure C7 Chromatogram of 2-oxazolidone with MEA in aqueous solution before extraction.

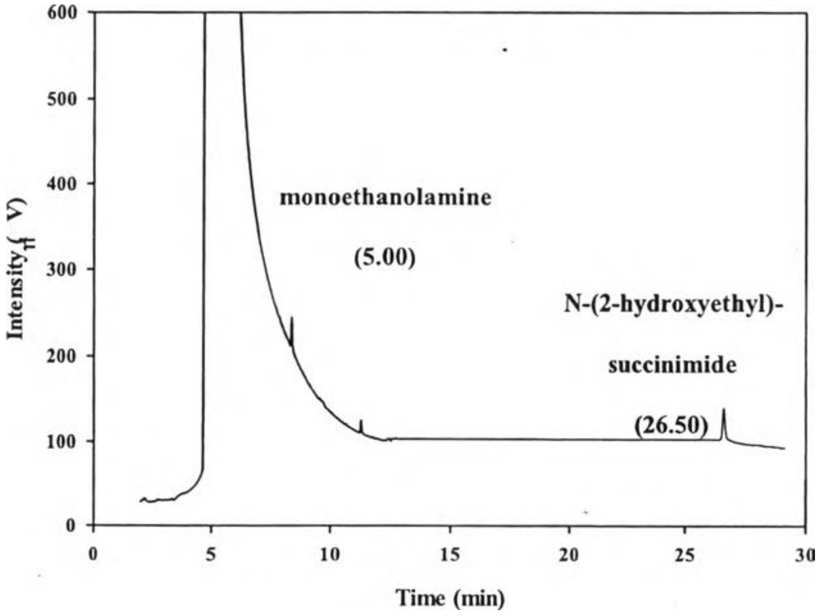

Figure C8 Chromatogram of N-(2-hydroxyethyl)-succinimide with MEA in aqueous solution before extraction.

C3. Standard Solution of Neutral MEA Degradation Products for Calibration Curve Preparation

The standard solution at concentration of neutral MEA degradation products of 1000 ppm in MEA 0.5 M (30 wt%) or DI water was prepared. The standard solution 1000 ppm was diluted to 500, 100, 50, 10 and 5 ppm as follow:

$$C_1V_1 = C_2V_2 \tag{C1}$$

Table C1 Dilution of 1000 ppm calibrating solution without MEA to other concentration

	Concentration of Standard Solution (ppm)					
	5	**10**	**50**	**100**	**500**	**1000**
Total Volume (mL)	10	10	10	10	10	10
Volume of Neutral MEA degradation products without MEA 1000 ppm (mL)	0.05	0.10	0.50	1	5	10
Volume of DI water (mL)	9.95	9.90	9.50	9	5	0

Table C2 Dilution of 1000 ppm calibrating solution with MEA to other concentration

	Concentration of Standard Solution (ppm)					
	5	**10**	**50**	**100**	**500**	**1000**
Total Volume (mL)	10	10	10	10	10	10
Volume of Neutral MEA degradation products with MEA 1000 ppm (mL)	0.05	0.10	0.50	1	5	10
Volume of DI water (mL)	9.95	9.90	9.50	9	5	0

Table C3 GC-FID results of calibration curve of aqueous solution without MEA Run No. 1

Components	**Area Peak at Concentration in Aqueous Solution without MEA.**						
	5 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	17.71	10.03	17.70	10.37	17.71	10.50	10.30
N-acethylethanolamine	20.05	6.44	20.04	6.73	20.04	6.75	6.64
2-oxazolidone	22.94	4.67	22.95	4.66	22.94	4.40	4.58
N-(2-hydroxyethyl)-succinimide	26.54	0.00	26.54	0.00	26.54	0.00	0.00

Table C3 GC-FID results of calibration curve of aqueous solution without MEA Run No. 1 (cont)

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	10 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	17.70	17.27	17.72	17.37	17.72	17.05	17.23
N-acethylethanolamine	20.05	11.11	20.06	10.22	20.05	10.07	10.47
2-oxazolidone	22.96	8.17	22.97	7.97	22.96	9.19	8.44
N-(2-hydroxyethyl)-succinimide	26.54	1.81	26.57	1.66	26.57	1.46	1.64

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	50 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	17.69	63.26	17.69	62.02	17.68	66.28	63.85
N-acethylethanolamine	20.05	41.74	20.05	43.43	20.05	45.56	43.58
2-oxazolidone	22.96	27.17	22.96	27.64	22.96	27.93	27.58
N-(2-hydroxyethyl)-succinimide	26.57	4.52	26.56	5.40	26.57	6.15	5.36

Table C3 GC-FID results of calibration curve of aqueous solution without MEA Run No. 1 (cont)

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	100 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	17.69	153.41	17.69	141.76	17.69	147.18	147.45
N-acethylethanolamine	20.07	121.22	20.07	124.52	20.06	128.60	124.78
2-oxazolidone	22.97	69.12	22.97	68.11	22.97	71.70	69.64
N-(2-hydroxyethyl)-succinimide	26.57	23.43	26.57	23.59	26.57	25.13	24.05
Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	500 ppm.						
	1st		2nd		3rd		
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Average Area
imidazole	17.66	727.03	17.63	754.12	17.65	768.82	749.99
N-acethylethanolamine	20.05	702.72	20.04	723.37	20.04	703.09	709.72
2-oxazolidone	22.93	383.76	22.91	396.45	22.92	392.27	390.83
N-(2-hydroxyethyl)-succinimide	26.50	254.78	26.48	262.27	26.48	239.56	252.21

Table C3 GC-FID results of calibration curve of aqueous solution without MEA Run No. 1 (cont)

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	1000 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	17.75	1571.61	17.73	1570.62	17.72	1566.75	1569.66
N-acethylethanolamine	20.16	1433.07	20.15	1439.27	20.13	1413.74	1428.70
2-oxazolidone	23.08	751.70	23.06	770.44	23.03	767.64	763.26
N-(2-hydroxyethyl)-succinimide	26.69	590.78	26.67	535.25	26.62	575.30	567.11

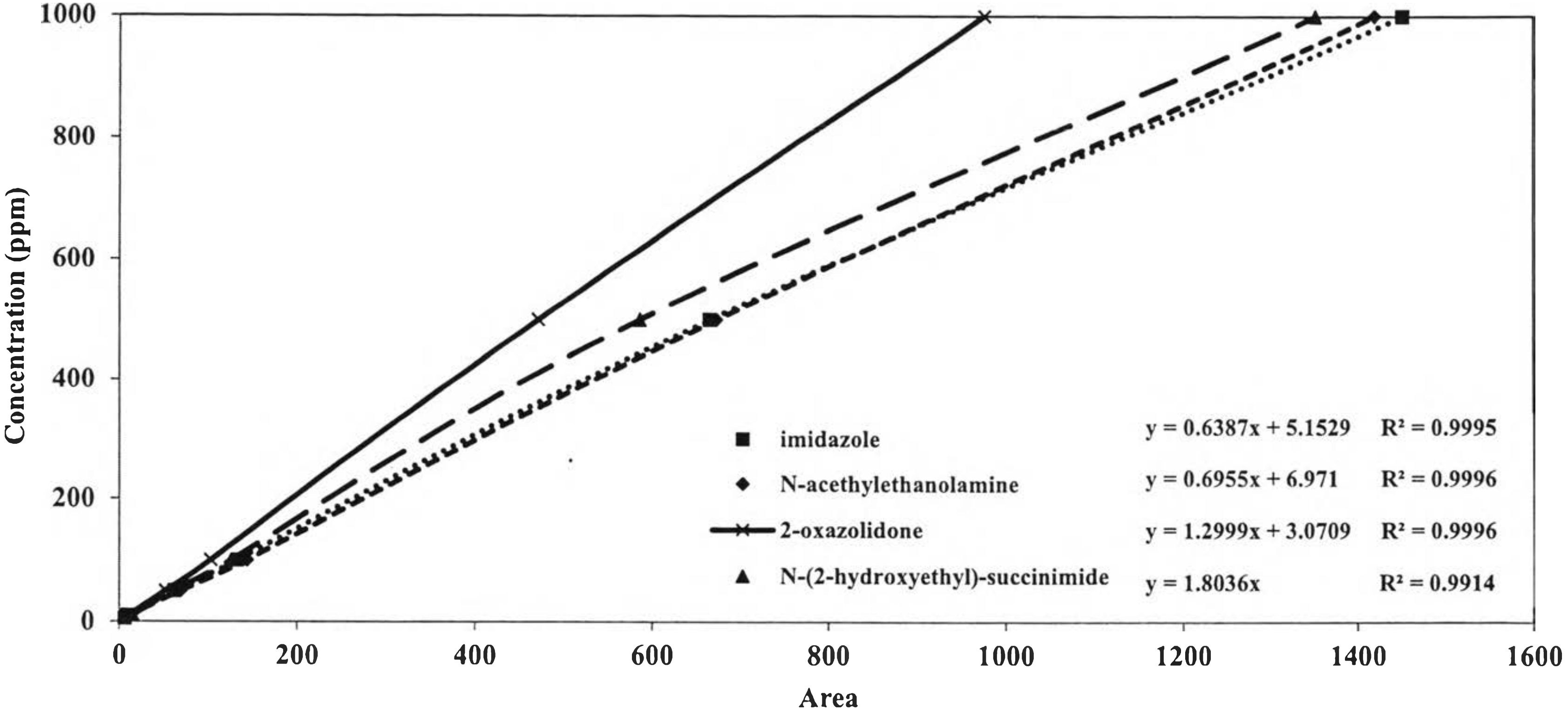

Figure C9 Calibration curve of the neutral MEA degradation products without MEA.

Table C4 GC-FID results of calibration curve of aqueous solution without MEA Run No. 2

Components	**Area Peak at Concentration in Aqueous Solution without MEA.**						
	5 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	18.01	6.23	18.01	6.09	18.00	6.43	6.25
N-acethylethanolamine	20.42	6.20	20.42	5.99	20.42	6.35	6.18
2-oxazolidone	23.49	5.38	23.49	5.76	23.49	5.83	5.66
N-(2-hydroxyethyl)-succinimide	27.30	6.79	27.30	6.65	27.30	6.46	6.63

Components	**Area Peak at Concentration in Aqueous Solution without MEA.**						
	10 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	18.01	9.54	18.01	9.83	18.00	9.51	9.63
N-acethylethanolamine	20.43	12.76	20.43	12.77	20.42	12.65	12.72
2-oxazolidone	23.50	10.82	23.50	10.63	23.49	10.58	10.67
N-(2-hydroxyethyl)-succinimide	27.32	16.50	27.33	14.02	27.31	15.18	15.23

Table C4 GC-FID results of calibration curve of aqueous solution without MEA Run No. 2 (cont)

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	50 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	18.01	64.06	18.01	63.60	18.00	60.47	62.71
N-acethylethanolamine	20.44	68.47	20.44	71.36	20.43	68.41	69.41
2-oxazolidone	23.52	52.94	23.52	53.00	23.51	50.39	52.11
N-(2-hydroxyethyl)-succinimide	27.34	63.01	27.34	60.59	27.33	61.96	61.85

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	100 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	18.01	137.80	18.00	130.77	18.00	130.11	132.89
N-acethylethanolamine	20.45	146.77	20.44	143.34	20.44	142.57	144.23
2-oxazolidone	23.52	103.82	23.52	103.73	23.51	101.99	103.18
N-(2-hydroxyethyl)-succinimide	27.36	125.44	27.34	130.99	27.34	121.98	126.13

Table C4 GC-FID results of calibration curve of aqueous solution without MEA Run No. 2 (cont)

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	500 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	18.05	656.20	18.05	670.82	18.04	667.99	665.01
N-acethylethanolamine	20.51	666.68	20.50	679.97	20.50	672.66	673.10
2-oxazolidone	23.62	466.78	23.60	474.70	23.59	472.34	471.27
N-(2-hydroxyethyl)-succinimide	27.46	581.47	27.45	588.89	27.43	586.61	585.66

Components	Area Peak at Concentration in Aqueous Solution without MEA.						
	1000 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	18.08	1451.35	18.09	1438.88	18.08	1462.78	1451.00
N-acethylethanolamine	20.56	1407.96	20.57	1421.70	20.56	1427.28	1418.98
2-oxazolidone	23.69	964.44	23.70	986.69	23.68	972.84	974.66

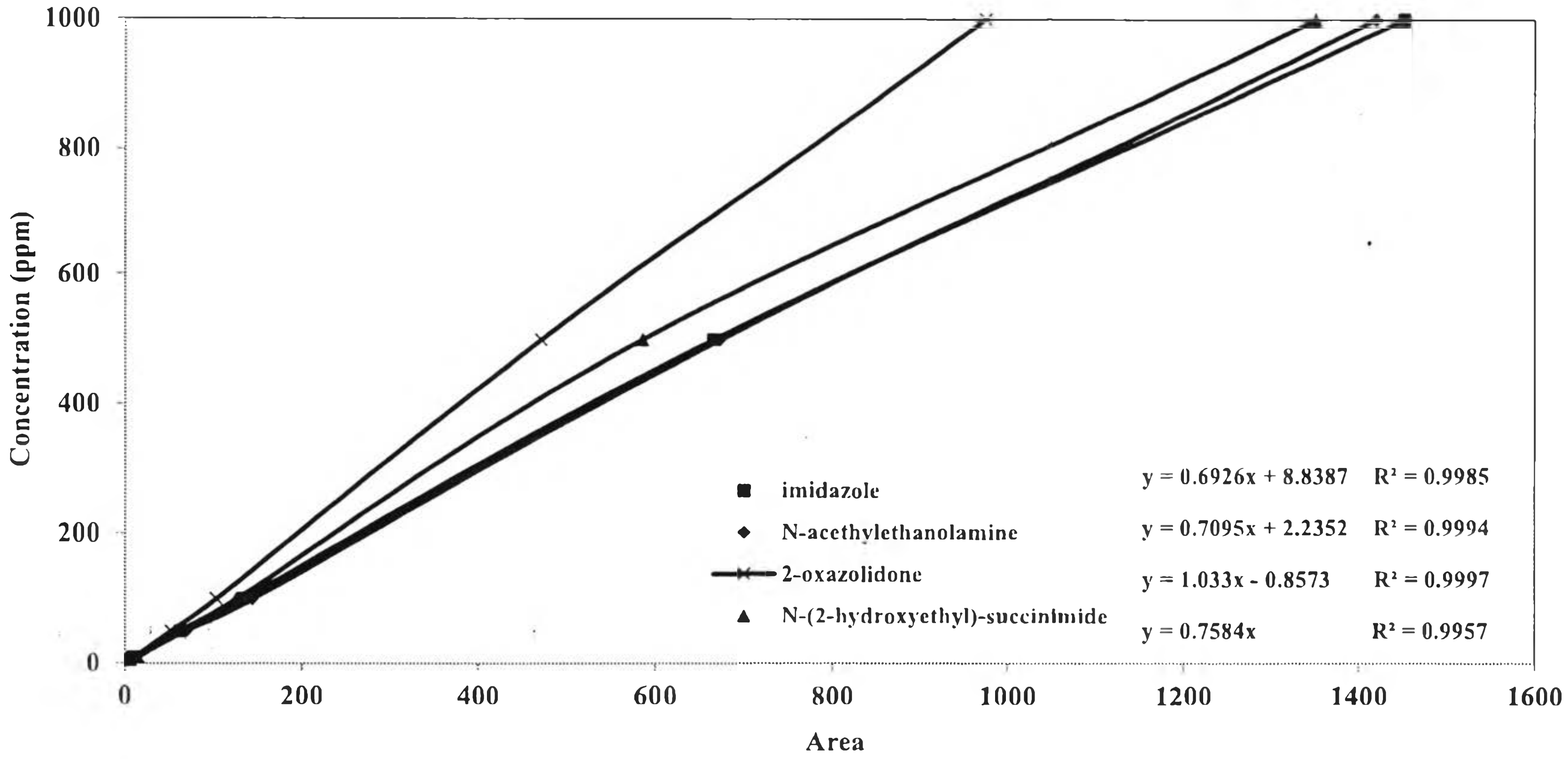

Figure C10 Calibration curve of the neutral MEA degradation products without MEA.

Table C5 GC-FID results of calibration curve of aqueous solution with MEA Run No. 1

Components	**Area Peak at Concentration in Aqueous Solution with MEA.**						
	5 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	17.73	12.26	17.73	11.00	17.74	11.31	11.52
N-acethylethanolamine	20.13	8.28	20.13	8.15	20.13	8.57	8.33
2-oxazolidone	22.97	8.24	22.96	8.71	22.97	8.15	8.36
N-(2-hydroxyethyl)-succinimide	26.53	3.39	26.53	2.86	26.57	2.30	2.85
Components	**Area Peak at Concentration in Aqueous Solution with MEA.**						
	10 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	17.73	22.47	17.79	22.24	17.73	21.04	21.92
N-acethylethanolamine	20.13	19.07	20.16	17.89	20.13	18.24	18.40
2-oxazolidone	22.97	17.45	23.00	18.69	22.97	17.36	17.83
N-(2-hydroxyethyl)-succinimide	26.53	6.15	26.56	6.01	26.54	5.74	5.97

Table C5 GC-FID results of calibration curve of aqueous solution with MEA Run No. 1 (cont)

Components	**Area Peak at Concentration in Aqueous Solution with MEA.**						
	50 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	17.74	74.37	17.73	76.82	17.73	72.98	74.72
N-acethylethanolamine	20.15	75.18	20.14	79.65	20.13	75.46	76.76
2-oxazolidone	22.98	50.51	22.98	49.86	22.97	47.27	49.22
N-(2-hydroxyethyl)-succinimide	26.55	13.03	26.55	12.77	26.54	12.33	12.71
Components	**Area Peak at Concentration in Aqueous Solution with MEA.**						
	100 ppm.						
	1st		**2nd**		**3rd**		**Average Area**
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**	
imidazole	17.75	155.82	17.74	158.40	17.75	162.61	158.94
N-acethylethanolamine	20.17	167.24	20.15	163.79	20.16	169.31	166.78
2-oxazolidone	23.01	77.58	23.00	74.22	23.00	75.74	75.85
N-(2-hydroxyethyl)-succinimide	26.58	29.88	26.56	28.43	26.57	25.27	27.86

Table C5 GC-FID results of calibration curve of aqueous solution with MEA Run No. 1 (cont)

Components	Area Peak at Concentration in Aqueous Solution with MEA.						
	500 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	17.77	636.14	17.77	638.12	17.77	652.34	642.20
N-acethylethanolamine	20.19	687.95	20.20	690.61	20.20	697.01	691.86
2-oxazolidone	23.03	308.40	23.03	305.76	23.04	308.55	307.57
N-(2-hydroxyethyl)-succinimide	26.58	120.27	26.58	124.17	26.60	130.13	124.86

Components	Area Peak at Concentration in Aqueous Solution with MEA.						
	1000 ppm.						
	1st		2nd		3rd		Average Area
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	
imidazole	17.78	1229.51	17.80	1217.21	17.81	1231.51	1226.07
N-acethylethanolamine	20.21	1338.25	20.23	1314.80	20.23	1334.11	1329.05
2-oxazolidone	23.05	590.51	23.06	585.41	23.07	584.06	586.66
N-(2-hydroxyethyl)-succinimide	26.59	252.78	26.60	212.23	26.61	253.84	239.61

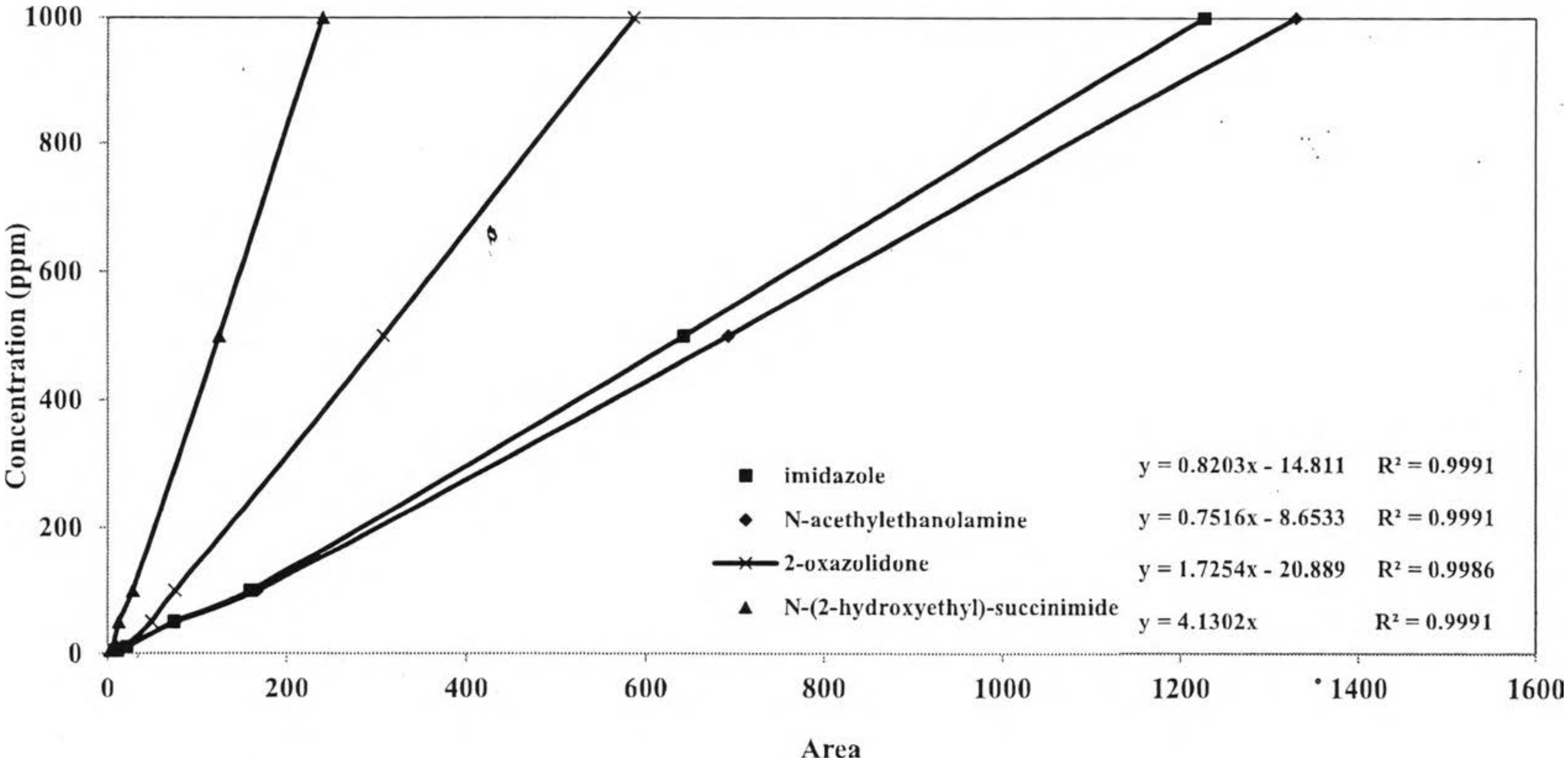

Figure C11 Calibration curve of the neutral MEA degradation products with MEA.

Appendix D Extraction Neutral MEA Degradation Products

D1. Neutral MEA Degradation Extraction Products Preparation

Table D1 1 M of average extractant-OH preparation for neutral MEA degradation products 1000 ppm in aqueous solution with diluent alone. Volume ratio of diluents to neutral MEA degradation products aqueous solution is 1:1

Extraction Neutral MEA Degradation Products with Diluent Alone at 25 °C			
Volume of Extractant-OH (mL)	**Neutral MEA Degradation**	**Volume of Neutral MEA Degradation (mL)**	**Total Volume (mL)**
5	imidazole	5	10
5	N-acethylethanolamine	5	10
5	2-oxazolidone	5	10
5	N-(2-hydroxyethyl)-succinimide	5	10

Table D2 1 M of average extractant-OH preparation for neutral MEA degradation products 1000 ppm in aqueous solution without MEA. Volume ratio of extracntant-OH in diluents to neutral MEA degradation products aqueous solution is 1:1

Extraction Neutral MEA Degradation Products without MEA at 25 °C, 40 °C and 60 °C			
Volume of Extractant-OH (mL)	**Neutral MEA Degradation**	**Volume of Neutral MEA Degradation (mL)**	**Total Volume (mL)**
5	imidazole	5	10
5	N-acethylethanolamine	5	10
5	2-oxazolidone	5	10
5	N-(2-hydroxyethyl)-succinimide	5	10

Table D3 1 M of average extractant-OH preparation for neutral MEA degradation products 1000 ppm in aqueous solution with MEA. Volume ratio of extracntant-OH in diluents to neutral MEA degradation products aqueous solution is 1:1

Extraction Neutral MEA Degradation Products with MEA at 25 °C, 40 °C and 60 °C			
Volume of Extractant-OH (mL)	**Neutral MEA Degradation**	**Volume of Neutral MEA Degradation (mL)**	**Total Volume (mL)**
5	imidazole	5	10
5	N-acethylethanolamine	5	10
5	2-oxazolidone	5	10
5	N-(2-hydroxyethyl)-succinimide	5	10

Table D4 1 M of average extractant-OH preparation for neutral MEA degradation products 1000 ppm in aqueous solution with CO_2 loading. Volume ratio of extracntant-OH in diluents to neutral MEA degradation products aqueous solution is 1:1

Extraction Neutral MEA Degradation Products with CO_2 Loading 0.05, 0.10 and 0.30 (mol/mol amine) at 25 °C			
Volume of Extractant-OH (mL)	**Neutral MEA Degradation**	**Volume of Neutral MEA Degradation (mL)**	**Total Volume (mL)**
5	imidazole	5	10
5	N-acethylethanolamine	5	10
5	2-oxazolidone	5	10
5	N-(2-hydroxyethyl)-succinimide	5	10

D2. Extraction of Neutral MEA Degradation Products Solution without MEA

Extraction efficiency was calculated based on the neutral MEA degradation products concentration before extracted (1000 ppm) and remaining the neutral MEA degradation products concentration in aqueous solution as follow:

$$\%\ \text{Extraction efficiency} = \frac{\text{Remaining concentration of neutral MEA degradation after extraction}}{\text{Concentration of neutral MEA degradation before extraction}} \times 100$$

$$\%\ \text{Extraction efficiency} = \frac{\text{Concentration of neutral MEA degradation before extraction} - \text{Extraction of neutral MEA degradation}}{\text{Concentration of neutral MEA degradation before extraction}} \times 100$$

Extraction of Neutral MEA Degradation Products Solution with Diluent Alone

Table D5 Concentration of neutral MEA degradation products in aqueous solution before extraction with diluent alone

Components	**Y = aX + b**	**Before Extraction of Neutral MEA Degradation Products with Diluent Alone**	
		Peak Area	**Concentration (ppm)**
imidazole	y = 0.6387x + 5.1529	1569.66	1007.69
N-acethylethanolamine	y = 0.6955x + 6.971	1428.70	1000.63
2-oxazolidone	y = 1.2999x + 3.0709	763.26	995.23
N-(2-hydroxyethyl)-succinimide	y = 1.8036x	567.11	1022.84

Note X = Peak Area, Y = Concentration

Table D6 GC-FID Analysis of the extraction of neutral MEA degradation products with diluent alone

Components	Extraction of Neutral MEA Degradation Products with Diluent Alone					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.69	911.77	17.67	901.31	17.67	946.25
N-acethylethanolamine	20.11	1380.54	20.09	1344.38	20.08	1364.94
2-oxazolidone	23.00	763.45	22.97	724.18	22.96	735.69
N-(2-hydroxyethyl)-succinimide	26.57	499.05	26.53	455.69	26.52	467.71

Table D7 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with diluent alone

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with Diluent Alone					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	$y = 0.6387x + 5.1529$	911.77	587.50	901.31	580.82	946.25	609.52
N-acethylethanolamine	$y = 0.6955x + 6.971$	1380.54	967.14	1344.38	941.99	1364.94	956.29
2-oxazolidone	$y = 1.2999x + 3.0709$	763.45	995.47	724.18	944.43	735.69	959.39
N-(2-hydroxyethyl)-succinimide	$y = 1.8036x$	499.05	900.09	455.69	821.89	467.71	843.57

Table D8 Calculation extraction efficiency of neutral MEA degradation products with diluent alone

Components	% Extraction Efficiency of Neutral MEA Degradation Products with Diluent Alone					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	41.70	42.36	39.51	41.19	1.49	41.19±1.49
N-acethylethanolamine	3.35	5.86	4.43	4.55	1.26	4.55±1.26
2-oxazolidone	-0.02	5.10	3.60	2.89	2.64	2.89±2.64
N-(2-hydroxyethyl)-succinimide	12.00	19.65	17.53	16.39	3.95	16.39±3.95

Extraction of Neutral MEA Degradation Products Solution without MEA at 25, 40 and 60°C

Table D9 Concentration of neutral MEA degradation products in aqueous solution before extraction without MEA

Components	**Y = aX + b**	**Before Extraction of Neutral MEA Degradation Products without MEA**	
		Peak Area	**Concentration (ppm)**
imidazole	y = 0.6926x + 8.8387	1451.00	1013.80
N-acethylethanolamine	y = 0.7095x + 2.2352	1418.98	1009.00
2-oxazolidone	y = 1.033x - 0.8573	974.66	1005.97
N-(2-hydroxyethyl)-succinimide	y = 0.7584x	1351.12	1024.69

Note X = Peak Area, Y = Concentration

Table D10 GC-FID Analysis of the extraction of neutral MEA degradation products without MEA at 25 °C

Components	Extraction of Neutral MEA Degradation Products without MEA at 25 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.49	885.25	17.48	871.82	17.49	849.48
N-acethylethanolamine	20.27	1050.40	20.26	1007.03	20.28	1012.27
2-oxazolidone	23.22	150.57	23.20	158.54	23.23	158.33
N-(2-hydroxyethyl)-succinimide	26.93	7.82	26.91	7.67	26.95	7.20

Table D11 Remain concentration of neutral MEA degradation products in aqueous solution after extraction without MEA at 25 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products without MEA at 25 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.6926x + 8.8387	885.25	621.96	871.82	612.66	849.48	597.19
N-acethylethanolamine	y = 0.7095x + 2.2352	1050.40	747.50	1007.03	716.72	1012.27	720.44
2-oxazolidone	y = 1.033x - 0.8573	150.57	154.68	158.54	162.91	158.33	162.69
N-(2-hydroxyethyl)-succinimide	y = 0.7584x	7.82	5.93	7.67	5.81	7.20	5.46

Table D12 Calculation extraction efficiency of neutral MEA degradation products without MEA at 25 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products without MEA at 25 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	38.65	39.57	41.09	39.77	1.23	39.77±1.12
N-acethylethanolamine	25.92	28.97	28.60	27.83	1.66	27.83±1.66
2-oxazolidone	84.62	83.81	83.83	84.09	0.47	84.09±0.47
N-(2-hydroxyethyl)-succinimide	99.42	99.43	99.47	99.44	0.02	99.44±0.02

Table D13 GC-FID Analysis of the extraction of neutral MEA degradation products without MEA at 40 °C

Components	Extraction of Neutral MEA Degradation Products without MEA at 40 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.48	857.37	17.47	851.05	17.48	841.69
N-acethylethanolamine	20.24	1011.82	20.21	1029.72	20.23	1016.11
2-oxazolidone	23.37	156.09	23.35	154.88	23.37	151.97
N-(2-hydroxyethyl)-succinimide	26.87	5.31	26.80	6.39	26.85	5.26

Table D14 Remain concentration of neutral MEA degradation products in aqueous solution after extraction without MEA at 40 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products without MEA at 40 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.6926x + 8.8387	857.37	602.66	851.05	598.28	841.69	591.79
N-acethylethanolamine	y = 0.7095x + 2.2352	1011.82	720.12	1029.72	732.82	1016.11	723.17
2-oxazolidone	y = 1.033x - 0.8573	156.09	160.39	154.88	159.13	151.97	156.13
N-(2-hydroxyethyl)-succinimide	y = 0.7584x	5.31	4.03	6.39	4.85	5.26	3.99

Table D15 Calculation extraction efficiency of neutral MEA degradation products without MEA at 40°C

Components	% Extraction Efficiency of Neutral MEA Degradation Products without MEA at 40°C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	40.56	40.99	41.63	41.06	0.54	41.06±0.54
N-acethylethanolamine	28.63	27.37	28.33	28.11	0.66	28.11±0.66
2-oxazolidone	84.06	84.18	84.48	84.24	0.22	84.24±0.22
N-(2-hydroxyethyl)-succinimide	99.61	99.53	99.61	99.58	0.05	99.58±0.05

Table D16 GC-FID Analysis of the extraction of neutral MEA degradation products without MEA at 60 °C

Components	**Extraction of Neutral MEA Degradation Products without MEA at 60 °C**					
	1st		**2nd**		**3rd**	
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**
imidazole	17.44	520.12	17.45	529.17	17.47	555.36
N-acethylethanolamine	20.16	687.32	20.17	681.16	20.19	660.21
2-oxazolidone	23.30	27.16	23.10	28.77	23.34	24.18
N-(2-hydroxyethyl)-succinimide	26.69	4.71	27.06	4.83	27.16	4.66

Table D17 Remain concentration of neutral MEA degradation products in aqueous solution after extraction without MEA at 60 °C

Components	**Y = aX + b**	**Extraction of Neutral MEA Degradation Products without MEA at 60 °C**					
		1st		**2nd**		**3rd**	
		Peak Area	**Concentration (ppm)**	**Peak Area**	**Concentration (ppm)**	**Peak Area**	**Concentration (ppm)**
imidazole	y = 0.6926x + 8.8387	520.12	369.07	529.17	375.34	555.36	393.48
N-acethylethanolamine	y = 0.7095x + 2.2352	687.32	489.89	681.16	485.52	660.21	470.66
2-oxazolidone	y = 1.033x - 0.8573	27.16	27.20	28.77	28.86	24.18	24.12
N-(2-hydroxyethyl)-succinimide	y = 0.7584x	4.71	3.57	4.83	3.66	4.66	3.53

Table D18 Calculation extraction efficiency of neutral MEA degradation products without MEA at 60 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products without MEA at 60 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	63.60	62.98	61.19	62.59	1.25	62.59±1.25
N-acethylethanolamine	51.45	51.88	53.35	52.23	1.00	52.23±1.00
2-oxazolidone	97.30	97.13	97.60	97.34	0.24	97.34±0.24
N-(2-hydroxyethyl)-succinimide	99.65	99.64	99.66	99.65	0.01	99.65±0.01

Extraction of Neutral MEA Degradation Products Solution with MEA at 25 °C, 40 °C and 60 °C

Table D19 Concentration of neutral MEA degradation products in aqueous solution before extraction with MEA

Components	Y = aX + b	Before Extraction of Neutral MEA Degradation Products with MEA	
		Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	1226.07	990.94
N-acethylethanolamine	y = 0.7516x - 8.6533	1329.05	990.26
2-oxazolidone	y = 1.7254x - 20.889	586.66	991.34
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	239.61	989.66

<u>Note</u> X = Peak Area, Y = Concentration

Table D20 GC-FID Analysis of the extraction of neutral MEA degradation products with MEA at 25 °C

Components	Extraction of Neutral MEA Degradation Products with MEA at 25 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.19	1038.64	17.18	1035.64	17.17	1008.72
N-acethylethanolamine	20.21	1077.97	20.23	1064.96	20.23	1046.65
2-oxazolidone	23.03	264.81	23.05	252.66	23.05	261.27
N-(2-hydroxyethyl)-succinimide	26.17	61.29	26.19	64.63	26.19	73.09

Table D21 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with MEA at 25 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with MEA at 25 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	1038.64	837.19	1035.64	834.72	1008.72	812.64
N-acethylethanolamine	y = 0.7516x - 8.6533	1077.97	801.55	1064.96	791.77	1046.65	778.01
2-oxazolidone	y = 1.7254x - 20.889	264.81	436.01	252.66	415.06	261.27	429.91
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	61.29	253.16	64.63	266.93	73.09	301.90

Table D22 Calculation extraction efficiency of neutral MEA degradation products with MEA at 25 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products with MEA at 25 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	15.52	15.76	17.99	16.42	1.36	16.42±1.36
N-acethylethanolamine	19.06	20.04	21.43	20.18	1.19	20.18±1.19
2-oxazolidone	56.02	58.13	56.63	56.93	1.09	56.93±1.09
N-(2-hydroxyethyl)-succinimide	74.42	73.03	69.49	72.31	2.54	72.31±2.54

Table D23 GC-FID Analysis of the extraction of neutral MEA degradation products with MEA at 40 °C

Components	Extraction of Neutral MEA Degradation Products with MEA at 40 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.16	866.84	17.16	893.82	17.15	870.36
N-acethylethanolamine	20.23	980.79	20.24	985.53	20.23	916.46
2-oxazolidone	23.05	169.43	23.06	177.05	23.05	170.03
N-(2-hydroxyethyl)-succinimide	26.20	63.56	26.23	48.78	26.22	48.78

Table D24 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with MEA at 40 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with MEA at 40 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	866.84	696.26	893.82	718.39	870.36	699.15
N-acethylethanolamine	y = 0.7516x - 8.6533	980.79	728.51	985.53	732.07	916.46	680.16
2-oxazolidone	y = 1.7254x - 20.889	169.43	271.44	177.05	284.59	170.03	272.49
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	50.56	208.82	48.78	201.47	48.78	201.46

Table D25 Calculation extraction efficiency of neutral MEA degradation products with MEA at 40 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products with MEA at 40 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	29.74	27.50	29.45	28.90	1.21	28.90±1.21
N-acethylethanolamine	26.43	26.07	31.32	27.94	2.93	27.94±2.93
2-oxazolidone	72.62	71.29	72.51	72.14	0.74	72.14±0.74
N-(2-hydroxyethyl)-succinimide	78.90	79.64	79.64	79.40	0.43	79.40±0.43

Table D26 GC-FID Analysis of the extraction of neutral MEA degradation products with MEA at 60 °C

Components	Extraction of Neutral MEA Degradation Products with MEA at 60 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.15	676.31	17.15	676.01	17.13	681.41
N-acethylethanolamine	20.21	720.19	20.21	706.58	20.24	716.89
2-oxazolidone	23.03	132.85	23.03	117.43	23.06	139.83
N-(2-hydroxyethyl)-succinimide	26.20	38.98	26.21	34.65	26.25	45.84

Table D27 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with MEA at 60 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with MEA at 60 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	676.31	539.97	676.01	539.72	681.41	544.15
N-acethylethanolamine	y = 0.7516x - 8.6533	720.19	532.65	706.58	522.42	716.89	530.16
2-oxazolidone	y = 1.7254x - 20.889	132.85	208.33	117.43	181.72	139.83	220.37
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	38.98	161.00	34.65	143.13	45.84	189.34

Table D28 Calculation extraction efficiency of neutral MEA degradation products with MEA at 60 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products with MEA at 60 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	45.51	45.53	45.09	45.38	0.25	45.38±0.25
N-acethylethanolamine	46.21	47.24	46.46	46.64	0.54	46.64±0.54
2-oxazolidone	78.98	81.67	77.77	79.47	1.99	79.47±1.99
N-(2-hydroxyethyl)-succinimide	83.73	85.54	80.87	83.38	2.35	83.38±2.35

Extraction of Neutral MEA Degradation Products Solution with CO_2 loading 0.05, 0.10 and 0.30 kmol/m^3 at 25 °C

Table D29 Concentration of neutral MEA degradation products in aqueous solution before extraction with CO_2 loading at 25 °C

Components	**Y = aX + b**	**Before Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.05, 0.10 and 0.30 kmol/m^3 at 25 °C**	
		Peak Area	**Concentration (ppm)**
imidazole	y = 0.8203x - 14.811	1226.07	990.94
N-acethylethanolamine	y = 0.7516x - 8.6533	1329.05	990.26
2-oxazolidone	y = 1.7254x - 20.889	586.66	991.34
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	239.61	989.66

Note X = Peak Area, Y = Concentration

Table D30 GC-FID Analysis of the extraction of neutral MEA degradation products with CO_2 loading 0.05 kmol/m^3 at 25 °C

Components	Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.05 kmol/m^3 at 25 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.83	1079.70	17.82	1092.11	17.77	1075.74
N-acethylethanolamine	20.24	1092.70	20.24	1094.56	20.18	1088.25
2-oxazolidone	23.06	374.05	23.05	352.61	23.02	366.03
N-(2-hydroxyethyl)-succinimide	26.56	101.98	26.55	113.87	26.56	116.84

Table D31 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with CO_2 loading 0.05 kmol/m^3 at 25 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.05 kmol/m^3 at 25 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	1079.70	870.86	1092.11	881.04	1075.74	867.62
N-acethylethanolamine	y = 0.7516x - 8.6533	1092.70	812.62	1094.56	814.02	1088.25	809.28
2-oxazolidone	y = 1.7254x - 20.889	374.05	624.49	352.61	587.50	366.03	610.66
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	101.98	421.18	113.87	470.30	116.84	482.57

Table D32 Calculation extraction efficiency of neutral MEA degradation products with CO_2 loading 0.05 kmol/m^3 at 25 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products with CO_2 Loading 0.05 kmol/m^3 at 25 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	12.12	11.09	12.44	11.88	0.71	11.88±0.71
N-acethylethanolamine	17.94	17.80	18.28	18.00	0.25	18.00±0.25
2-oxazolidone	37.01	40.74	38.40	38.71	1.89	38.71±1.89
N-(2-hydroxyethyl)-succinimide	57.44	52.48	51.24	53.72	3.28	53.72±3.28

Table D33 GC-FID Analysis of the extraction of neutral MEA degradation products with CO_2 loading 0.10 kmol/m^3 at 25 °C

Components	**Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.10 kmol/m^3 at 25 °C**					
	1st		**2nd**		**3rd**	
	Retention Time (min)	**Peak Area**	**Retention Time (min)**	**Peak Area**	**Retention Time (min)**	**Peak Area**
imidazole	17.79	1092.66	17.76	1111.50	17.76	1098.96
N-acethylethanolamine	20.21	1138.26	20.17	1148.26	20.16	1159.02
2-oxazolidone	23.05	422.05	23.01	416.61	23.01	427.03
N-(2-hydroxyethyl)-succinimide	26.60	135.18	26.55	148.25	26.55	142.12

Table D34 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with CO_2 loading 0.10 kmol/m^3 at 25 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.10 kmol/m^3 at 25 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	1092.66	881.50	1111.50	896.95	1098.96	886.66
N-acethylethanolamine	y = 0.7516x - 8.6533	1138.26	846.86	1148.26	854.38	1159.02	862.47
2-oxazolidone	y = 1.7254x - 20.889	422.05	707.31	416.61	697.92	427.03	715.91
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	135.18	558.32	148.25	612.29	142.12	586.99

Table D35 Calculation extraction efficiency of neutral MEA degradation products with CO_2 loading 0.10 kmol/m^3 at 25 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products with CO_2 Loading 0.10 kmol/m^3 at 25 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	11.04	9.48	10.52	10.35	0.79	10.35±0.79
N-acethylethanolamine	14.48	13.72	12.91	13.70	0.79	13.70±0.79
2-oxazolidone	28.65	29.60	27.78	28.68	0.91	28.68±0.91
N-(2-hydroxyethyl)-succinimide	43.58	38.13	40.69	40.80	2.73	40.80±2.73

Table D36 GC-FID Analysis of the extraction of neutral MEA degradation products with CO_2 loading 0.30 kmol/m^3 at 25 °C

Components	Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.30 kmol/m^3 at 25 °C					
	1st		2nd		3rd	
	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area	Retention Time (min)	Peak Area
imidazole	17.79	1112.66	17.76	1131.50	17.76	1158.96
N-acethylethanolamine	20.21	1198.26	20.17	1179.26	20.16	1191.02
2-oxazolidone	23.05	508.47	23.01	502.49	23.01	516.41
N-(2-hydroxyethyl)-succinimide	26.60	175.18	26.55	195.25	26.55	176.12

Table D37 Remain concentration of neutral MEA degradation products in aqueous solution after extraction with CO_2 loading 0.30 kmol/m^3 at 25 °C

Components	Y = aX + b	Extraction of Neutral MEA Degradation Products with CO_2 Loading 0.30 kmol/m^3 at 25 °C					
		1st		2nd		3rd	
		Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)	Peak Area	Concentration (ppm)
imidazole	y = 0.8203x - 14.811	1112.66	897.91	1131.50	913.35	1158.96	935.88
N-acethylethanolamine	y = 0.7516x - 8.6533	1198.26	891.96	1179.26	877.68	1191.02	886.52
2-oxazolidone	y = 1.7254x - 20.889	508.47	942.70	502.49	932.37	516.41	956.39
N-(2-hydroxyethyl)-succinimide	y = 4.1302x	175.18	723.53	195.25	806.41	176.12	727.41

Table D38 Calculation extraction efficiency of neutral MEA degradation products with CO_2 loading 0.30 kmol/m^3 at 25 °C

Components	% Extraction Efficiency of Neutral MEA Degradation Products with CO_2 Loading 0.30 kmol/m^3 at 25 °C					
	1st Extraction	2nd Extraction	3rd Extraction	Average Extraction Efficiency	SD	Avg ±SD
imidazole	9.39	7.83	5.56	7.59	1.93	7.59±1.93
N-acethylethanolamine	9.93	11.37	10.48	10.59	0.73	10.59±0.73
2-oxazolidone	13.61	14.65	12.23	13.50	1.22	13.50±1.22
N-(2-hydroxyethyl)-succinimide	26.89	18.52	26.50	23.97	4.73	23.97±4.73

Appendix E The Neutral MEA Degradation Products Equilibrium Extraction

The neutral MEA degradation products equilibrium extraction was investigated under constant of distribution coefficient or partition coefficient and equilibrium constant (weak acid-amine). First of all, the constants of equilibrium extraction must be determined by undissociation molecule concentration in (ppm) remains in aqueous phase and organic phase.

The concentration of undissociation in organic phase as follow

$$[HA]_{Initial} - [HA]_{aq} = [HA]_{org} \qquad E1$$

Where $[HA]_{initial}$ is represented the initial concentration of undissociation (ppm) before extraction, $[HA]_{aq}$ and $[HA]_{org}$ is concentration of undissociation (ppm) in aqueous phase and organic phase after extraction.

Table E1 Calculation concentration of neutral MEA undissociation (ppm) in organic phase with diluent alone

Components	**Concentration of Undissociation at 25 °C**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	1007.69	592.61	415.08
N-acethylethanolamine	1000.63	955.14	45.49
2-oxazolidone	995.23	966.43	28.80
N-(2-hydroxyethyl)-succinimide	1022.84	855.18	167.66

Table E2 Calculation concentration of neutral MEA undissociation (ppm) in organic phase without MEA

Components	Concentration of Undissociation at 25 °C		
	$[HA]_{Initial}$ (ppm)	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)
imidazole	1013.8	610.60	403.20
N-acethylethanolamine	1009	728.22	280.78
2-oxazolidone	1005.97	160.09	845.88
N-(2-hydroxyethyl)-succinimide	1024.69	5.74	1018.95
Components	**Concentration of Undissociation at 40 °C**		
	$[HA]_{Initial}$ (ppm)	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)
imidazole	1013.8	597.57	416.23
N-acethylethanolamine	1009	725.37	283.63
2-oxazolidone	1005.97	158.55	847.42
N-(2-hydroxyethyl)-succinimide	1024.69	4.29	1020.40
Components	**Concentration of Undissociation at 60 °C**		
	$[HA]_{Initial}$ (ppm)	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)
imidazole	1013.8	379.30	634.50
N-acethylethanolamine	1009	482.02	526.98
2-oxazolidone	1005.97	26.73	979.24
N-(2-hydroxyethyl)-succinimide	1024.69	3.59	1021.10

Table E3 Calculation concentration of neutral MEA undissociation (ppm) in organic phase with MEA

Components	**Concentration of Undissociation at 25 °C**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	990.94	828.18	162.76
N-acethylethanolamine	990.26	790.44	199.82
2-oxazolidone	991.34	426.99	564.35
N-(2-hydroxyethyl)-succinimide	989.66	273.99	715.67
Components	**Concentration of Undissociation at 40 °C**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	990.94	704.60	286.34
N-acethylethanolamine	990.26	713.58	276.68
2-oxazolidone	991.34	276.17	715.17
N-(2-hydroxyethyl)-succinimide	989.66	203.92	785.74
Components	**Concentration of Undissociation at 60 °C**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	990.94	541.28	449.66
N-acethylethanolamine	990.26	528.41	461.85
2-oxazolidone	991.34	203.47	787.87
N-(2-hydroxyethyl)-succinimide	989.66	164.49	825.17

Table E4 Calculation concentration of neutral MEA undissociation (ppm) in organic phase with CO_2 loading

Components	**Concentration of Undissociation at 0.05 (mol/mol amine)**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	990.94	873.18	117.76
N-acethylethanolamine	990.26	811.97	178.29
2-oxazolidone	991.34	607.55	383.79
N-(2-hydroxyethyl)-succinimide	989.66	458.02	531.64

Components	**Concentration of Undissociation at 0.10 (mol/mol amine)**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	990.94	888.37	102.57
N-acethylethanolamine	990.26	854.57	135.69
2-oxazolidone	991.34	707.05	284.29
N-(2-hydroxyethyl)-succinimide	989.66	585.87	403.79

Components	**Concentration of Undissociation at 0.30 (mol/mol amine)**		
	$[HA]_{Initial}$ (ppm)	**$[HA]_{aq}$ (ppm)**	**$[HA]_{org}$ (ppm)**
imidazole	990.94	915.71	75.23
N-acethylethanolamine	990.26	885.39	104.87
2-oxazolidone	991.34	857.55	133.79
N-(2-hydroxyethyl)-succinimide	989.66	752.45	237.21

E1. Distribution Ratio

The undissociation molecule can be extracted by extractant in organic phase measured by distribution in between aqueous and organic phases is referring "the distribution or partition coefficient" as refer to K_D which is a ratio of the solubility of undissociation dissolved in organic phase to the solubility of undissociation dissolved in aqueous phase. Which K_D was calculated by undissociation molecule in organic phase $[HA]_{org}$ divide by undissociation molecule in aquouse phase $[HA]_{aq}$ from GC-FID analysis as follow

$$K_D = \frac{[HA{:}R_4N^+OH^-]_{org}}{[HA]_{aq}} = \frac{[HA]_{org}}{[HA]_{aq}} \qquad \text{E2}$$

Table E5 Calculation distribution ratio of neutral MEA degradation with diluent alone

Components	**Extraction Neutral MEA Degradation Products with Diluent Alone at 25 °C**		
	$[HA]_{aq}$ (ppm)	**$[HA]_{org}$ (ppm)**	**K_D**
imidazole	592.61	415.08	0.70
N-acethylethanolamine	955.14	45.49	0.05
2-oxazolidone	966.43	28.80	0.03
N-(2-hydroxyethyl)-succinimide	855.18	167.66	0.20

Table E6 Calculation distribution ratio of neutral MEA degradation without MEA

Components	Extraction Neutral MEA Degradation Products without MEA at 25 °C		
	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)	K_D
imidazole	610.60	403.20	0.66
N-acethylethanolamine	728.22	280.78	0.39
2-oxazolidone	160.09	845.88	5.28
N-(2-hydroxyethyl)-succinimide	5.74	1018.95	177.52
Components	**Extraction Neutral MEA Degradation Products without MEA at 40 °C**		
	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)	K_D
imidazole	597.57	416.23	0.70
N-acethylethanolamine	725.37	283.63	0.39
2-oxazolidone	158.55	847.42	5.34
N-(2-hydroxyethyl)-succinimide	4.29	1020.40	237.95
Components	**Extraction Neutral MEA Degradation Products without MEA at 60 °C**		
	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)	K_D
imidazole	379.30	634.50	1.67
N-acethylethanolamine	482.02	526.98	1.09
2-oxazolidone	26.73	979.24	36.64
N-(2-hydroxyethyl)-succinimide	3.59	1021.10	284.58

Table E7 Calculation distribution ratio of neutral MEA degradation with MEA

Components	Extraction Neutral MEA Degradation Products with MEA at 25 °C		
	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)	K_D
imidazole	828.18	162.76	0.20
N-acethylethanolamine	790.44	199.82	0.25
2-oxazolidone	426.99	564.35	1.32
N-(2-hydroxyethyl)-succinimide	273.99	715.67	2.61
Components	**Extraction Neutral MEA Degradation Products with MEA at 40 °C**		
	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)	K_D
imidazole	704.60	286.34	0.41
N-acethylethanolamine	713.58	276.68	0.39
2-oxazolidone	276.17	715.17	2.59
N-(2-hydroxyethyl)-succinimide	203.92	785.74	3.85
Components	**Extraction Neutral MEA Degradation Products with MEA at 60 °C**		
	$[HA]_{aq}$ (ppm)	$[HA]_{org}$ (ppm)	K_D
imidazole	541.28	449.66	0.83
N-acethylethanolamine	528.41	461.85	0.87
2-oxazolidone	203.47	787.87	3.87
N-(2-hydroxyethyl)-succinimide	164.49	825.17	5.02

Table E8 Calculation distribution ratio of neutral MEA degradation with CO_2 loading

Components	**Extraction Neutral MEA Degradation Products with CO_2 Loading 0.05 (mol/mol amine).**		
	$[HA]_{aq}$ (ppm)	**$[HA]_{org}$ (ppm)**	**K_D**
imidazole	873.18	117.76	0.13
N-acethylethanolamine	811.97	178.29	0.22
2-oxazolidone	607.55	383.79	0.63
N-(2-hydroxyethyl)-succinimide	458.02	531.64	1.16

Components	**Extraction Neutral MEA Degradation Products with CO_2 Loading 0.10 (mol/mol amine).**		
	$[HA]_{aq}$ (ppm)	**$[HA]_{org}$ (ppm)**	**K_D**
imidazole	888.37	102.57	0.12
N-acethylethanolamine	854.57	135.69	0.16
2-oxazolidone	707.05	284.29	0.40
N-(2-hydroxyethyl)-succinimide	585.87	403.79	0.69

Components	**Extraction Neutral MEA Degradation Products with CO_2 Loading 0.30 (mol/mol amine).**		
	$[HA]_{aq}$ (ppm)	**$[HA]_{org}$ (ppm)**	**K_D**
imidazole	915.71	75.23	0.08
N-acethylethanolamine	885.39	104.87	0.12
2-oxazolidone	857.55	133.79	0.16
N-(2-hydroxyethyl)-succinimide	752.45	237.21	0.32

E2. Equilibrium Extraction

When only undissociate molecule was involved in equilibrium extraction. The extraction of neutral MEA degradation products by extractant thus can be correspond to as

$$[HA]_{aq} + [R_4N^+OH^-]_{org} \leftrightarrow [HA{:}\,R_4N^+OH^-]_{org} \qquad \text{E3}$$

Therefore, extraction the undissociated molecule of neutral MEA degradation by tetra amine interaction is equilibrium complexation equal to

$$K_E = \frac{[HA{:}R_4N^+OH^-]_{org}}{[HA]_{aq}[R_4N^+OH^-]_{org}} \qquad \text{E4}$$

Where K_E is equilibrium extraction of neutral MEA degradation products and $[R_4N^+OH^-]$ is concentration of extractant which base on 1 M. Therefore, equilibrium extraction can be assumed equal to distribution ratio as follow

$$K_D = \frac{[HA{:}R_4N^+OH^-]_{org}}{[HA]_{aq}} \qquad \text{E5}$$

$$K_E = \frac{K_D}{[R_4N^+OH^-]_{org}} \qquad \text{E6}$$

$$K_E = \frac{K_D}{1} \qquad \text{E7}$$

$$\therefore\ K_E = K_D \qquad \text{E8}$$

Table E9 Calculation equilibrium extraction of neutral MEA degradation with diluent alone

Components	Extraction Neutral MEA Degradation Products with Diluent Alone at 25 °C
	K_E
imidazole	0.65
N-acethylethanolamine	0.37
2-oxazolidone	5.22
N-(2-hydroxyethyl)-succinimide	177.20

Table E10 Calculation equilibrium extraction of neutral MEA degradation without MEA

Components	Extraction Neutral MEA Degradation Products without MEA		
	25 °C	40 °C	60 °C
	K_E	K_E	K_E
imidazole	0.66	0.70	1.67
N-acethylethanolamine	0.39	0.39	1.09
2-oxazolidone	5.28	5.34	36.64
N-(2-hydroxyethyl)-succinimide	177.52	237.95	284.58

Table E11 Calculation equilibrium extraction of neutral MEA degradation with MEA

Components	Extraction Neutral MEA Degradation Products with MEA		
	25 °C	40 °C	60 °C
	K_E	K_E	K_E
imidazole	0.20	0.41	0.83
N-acethylethanolamine	0.25	0.39	0.87
2-oxazolidone	1.32	2.59	3.87
N-(2-hydroxyethyl)-succinimide	2.61	3.85	5.02

Table E12 Calculation equilibrium extraction of neutral MEA degradation with CO_2 loading

Components	Extraction Neutral MEA Degradation Products with CO_2 Loading		
	0.05 (mol/mol amine)	0.10 (mol/mol amine)	0.30 (mol/mol amine)
	K_E	K_E	K_E
imidazole	0.13	0.12	0.08
N-acethylethanolamine	0.22	0.16	0.12
2-oxazolidone	0.63	0.40	0.16
N-(2-hydroxyethyl)-succinimide	1.16	0.69	0.32

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1. Krajangpit, W.; Saiwan, C.; and Supap, T. (2015, April 21) Liquid-liquid extraction of degradation products in monoethanolamine (mea) absorption solution used in carbon dioxide (co_2) capture. Paper presented at The 6th Research Symposium on Petroleum, Petrochemicals and Advanced Materials and The 21st PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.
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