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## APPENDICES

### Appendix A The Amount of Methane Adsorbed on all Adsorbents

**Table A1** The amount of methane adsorption on non-treated activated carbon at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0                           |
| 43.13                       | 1.588                       |
| 104.38                      | 2.482                       |
| 189.38                      | 3.148                       |
| 303.75                      | 3.877                       |
| 399.38                      | 4.270                       |
| 498.75                      | 4.506                       |
| 598.13                      | 4.641                       |
| 699.38                      | 4.751                       |
| 804.38                      | 4.797                       |
| 903.75                      | 4.797                       |

**Table A2** The amount of methane adsorption on activated carbon with 5 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0                           |
| 52.5                        | 1.881                       |
| 105                         | 2.722                       |
| 206.25                      | 3.631                       |
| 315                         | 4.288                       |
| 408.75                      | 4.599                       |
| 504.38                      | 4.785                       |
| 600                         | 4.923                       |
| 705                         | 5.054                       |
| 800                         | 5.099                       |
| 901.88                      | 5.130                       |

**Table A3** The amount of methane adsorption on activated carbon with 10 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0.000                       |
| 46.88                       | 1.847                       |
| 106.88                      | 2.818                       |
| 193.13                      | 3.613                       |
| 292.5                       | 4.281                       |
| 395.63                      | 4.679                       |
| 500.63                      | 4.997                       |
| 601.88                      | 5.121                       |
| 699.38                      | 5.222                       |
| 800.63                      | 5.216                       |
| 901.88                      | 5.246                       |

**Table A4** The amount of methane adsorption on activated carbon with 15 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0                           |
| 46.88                       | 1.849                       |
| 99.38                       | 2.918                       |
| 187.63                      | 3.711                       |
| 289.63                      | 4.389                       |
| 398                         | 4.789                       |
| 496.88                      | 5.056                       |
| 607.88                      | 5.182                       |
| 710.65                      | 5.283                       |
| 804.5                       | 5.293                       |
| 899.38                      | 5.325                       |

**Table A5** The amount of methane adsorption on activated carbon with 20 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0.000                       |
| 45                          | 1.863                       |
| 100.25                      | 2.917                       |
| 191.25                      | 3.718                       |
| 294.15                      | 4.400                       |
| 395.5                       | 4.801                       |
| 504.13                      | 5.118                       |
| 600                         | 5.236                       |
| 705                         | 5.346                       |
| 809.13                      | 5.404                       |
| 907.5                       | 5.431                       |

**Table A6** The amount of methane adsorption on activated carbon with 25 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0.000                       |
| 48                          | 1.884                       |
| 108.5                       | 3.022                       |
| 200                         | 3.845                       |
| 298.88                      | 4.467                       |
| 402.5                       | 4.883                       |
| 505.25                      | 5.170                       |
| 605.5                       | 5.302                       |
| 702.5                       | 5.435                       |
| 799.25                      | 5.496                       |
| 904.38                      | 5.537                       |

**Table A7** The amount of methane adsorption on activated carbon with 30 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0.000                       |
| 46.88                       | 1.884                       |
| 102.13                      | 2.929                       |
| 191.25                      | 3.719                       |
| 292.38                      | 4.421                       |
| 399.38                      | 4.868                       |
| 506.25                      | 5.157                       |
| 602.5                       | 5.298                       |
| 708.75                      | 5.427                       |
| 808.13                      | 5.486                       |
| 918.75                      | 5.504                       |



**Table A8** The amount of methane adsorption on activated carbon with 35 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0.000                       |
| 48.75                       | 1.775                       |
| 112.5                       | 2.715                       |
| 202.5                       | 3.418                       |
| 302.63                      | 4.031                       |
| 406.88                      | 4.496                       |
| 508.13                      | 4.681                       |
| 607.5                       | 4.802                       |
| 706.88                      | 4.899                       |
| 811.88                      | 4.916                       |
| 909.38                      | 4.946                       |

**Table A9** The amount of methane adsorption on activated carbon with 40 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0                           | 0.000                       |
| 52.5                        | 1.684                       |
| 112.5                       | 2.583                       |
| 200.63                      | 3.372                       |
| 300                         | 3.947                       |
| 399.38                      | 4.378                       |
| 506.25                      | 4.588                       |
| 605.63                      | 4.764                       |
| 705                         | 4.839                       |
| 811.88                      | 4.860                       |
| 907.5                       | 4.918                       |

**Table A10** The amount of methane adsorption on activated carbon with 45 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0.00                        | 0.000                       |
| 48.75                       | 1.613                       |
| 106.88                      | 2.542                       |
| 185.63                      | 3.312                       |
| 283.13                      | 3.937                       |
| 393.75                      | 4.330                       |
| 506.25                      | 4.569                       |
| 605.63                      | 4.715                       |
| 706.88                      | 4.829                       |
| 806.25                      | 4.833                       |
| 907.50                      | 4.907                       |

**Table A11** The amount of methane adsorption on activated carbon with 60 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0.00                        | 0.000                       |
| 50.63                       | 1.582                       |
| 103.13                      | 2.229                       |
| 198.75                      | 2.948                       |
| 313.13                      | 3.460                       |
| 401.25                      | 3.695                       |
| 498.75                      | 3.877                       |
| 596.25                      | 4.030                       |
| 693.75                      | 4.185                       |
| 798.75                      | 4.181                       |
| 896.25                      | 4.184                       |

**Table A12** The amount of methane adsorption on activated carbon with 120 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0.00                        | 0.000                       |
| 54.38                       | 1.443                       |
| 106.88                      | 2.108                       |
| 202.50                      | 2.764                       |
| 307.50                      | 3.227                       |
| 399.50                      | 3.418                       |
| 495.00                      | 3.622                       |
| 598.13                      | 3.815                       |
| 695.63                      | 3.892                       |
| 802.50                      | 3.911                       |
| 901.88                      | 3.855                       |

**Table A13** The amount of methane adsorption on activated carbon with 240 min ozone treated at 35 °C

| Equilibrium pressure (psia) | Methane adsorption (mmol/g) |
|-----------------------------|-----------------------------|
| 0.00                        | 0.000                       |
| 52.50                       | 1.295                       |
| 114.38                      | 2.024                       |
| 204.38                      | 2.647                       |
| 301.88                      | 3.052                       |
| 393.75                      | 3.280                       |
| 502.50                      | 3.462                       |
| 600.00                      | 3.558                       |
| 693.75                      | 3.624                       |
| 796.88                      | 3.712                       |
| 894.38                      | 3.702                       |

**Appendix B****Table B1** pH of activated carbon in water and ozone treatment time(min)

| Ozonation time (min) | pH   |
|----------------------|------|
| 0                    | 8.45 |
| 10                   | 6.52 |
| 15                   | 5.88 |
| 20                   | 5.24 |
| 25                   | 4.98 |
| 30                   | 4.72 |
| 35                   | 4.50 |
| 40                   | 4.36 |
| 60                   | 3.89 |
| 120                  | 3.07 |
| 240                  | 2.54 |

## CURRICULUM VITAE

**Name:** Mr. Pradinun Seangnak

**Date of Birth:** December 12, 1989

**Nationality:** Thai

**University Education:**

2008–2012 Bachelor Degree of Petrochemical and Polymeric materials, Faculty of Engineering and Industrial Technology, Silpakorn University, Nakorn Phathom, Thailand

**Work Experience (trainee):**

March-May 2010 Position: Technical engineering

Company name: PTT Gas Separation Plant (GSP),  
Rayong

**Proceeding**

1. Seangnak, P.; Kitiyanan, B.; Rangsunvigit, P.; and Kulprathipanja, S. (2014, April 22) The effect of ozone treatment on activated carbon for methane adsorption. Proceedings of the 5<sup>th</sup> Research Symposium on Petrochemical and Materials Technology and The 20<sup>th</sup> PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

**Presentations:**

2. Seangnak, P.; Kitiyanan, B.; Rangsunvigit, P.; and Kulprathipanja, S. (2014, April 22) The effect of ozone treatment on activated carbon for methane adsorption. Proceedings of the 5<sup>th</sup> Research Symposium on Petrochemical and Materials Technology and The 20<sup>th</sup> PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.