REFERENCES

Ahmed, S. and Krumpelt, M. (2001) Hydrogen from hydrocarbon fuels for fuel cells. International Journal of Hydrogen Energy, 26(4), 291-301.

An, L., Dong, C., Yang, Y., Zhang, J., and He, L. (2011) The influence of Ni loading on coke formation in steam reforming of acetic acid. Renewable Energy, 36(3), 930-935.

Aneggi, E., de Leitenburg, C., and Trovarelli, A. (2012) On the role of lattice/surface oxygen in ceria-zirconia catalysts for diesel soot combustion. Catalysis Today, 181(1), 108-115.

Atsadang, T. (2014) Autothermal steam reforming of acetic acid: Catalytic activity and stability of $Ni/Ce_{0.75}Zr_{0.25}O_2$ catalyst. M.S. Thesis, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.

Basagiannis, A.C. and Verykios, X.E. (2007) Catalytic steam reforming of acetic acid for hydrogen production. International Journal of Hydrogen Energy, 32(15), 3343-3355.

Dantas, S.C., Escritori, J.C., Soares, R.R., and Hori, C.E. (2007) $Ni/CeZrO_2$-based catalysts for H_2 production. Studies in Surface Science and Catalysis, 167, 487-492.

Dantas, S.C., Resende, K.A., Rossi, R.L., Assis, A.J., and Hori, C.E. (2012) Hydrogen production from oxidative reforming of methane on supported nickel catalysts: An experimental and modeling study. Chemical Engineering Journal, 197, 407-413.

De lima, S., Dacruz, I., Jacobs, G., Davis, B., Mattos, L., and Noronha, F. (2008) Steam reforming, partial oxidation, and oxidative steam reforming of ethanol over $Pt/CeZrO_2$ catalyst. Journal of Catalysis, 257(2), 356-368.

Dong, W.S., Roh, H.S., Jun, K.W., Park, S.E., and Oh, Y.S. (2002) Methane reforming over $Ni/Ce\text{-}ZrO_2$ catalysts: Effect of nickel content. Applied Catalysis A: General, 226(1–2), 63-72.

Fornasiero, P. and Graziani, M. (2011) Renewable Resources and Renewable Energy: A Global Challenge. New York: CRC Press.

Graschinsky, C., Giunta, P., Amadeo, N., and Laborde, M. (2012) Thermodynamic analysis of hydrogen production by autothermal reforming of ethanol. International Journal of Hydrogen Energy, 37(13), 10118-10124.

Gutierrez, A., Karinen, R., Airaksinen, S., Kaila, R., and Krause, A.O.I. (2011) Autothermal reforming of ethanol on noble metal catalysts. International Journal of Hydrogen Energy, 36(15), 8967-8977.

Haynes, D. J. and Shekhawat, D. (2011) Oxidative steam reforming. In Shekhawat, D., Spivey, J.J., and Berry, D.A. (Eds.), Fuel Cells (pp. 129-190). Amsterdam: Elsevier.

Hu, R.R., Yan, C.F., Zheng, X.X., Liu, H., and Zhon, Z.Y. (2013) Carbon deposition on Ni/ZrO_2-CeO_2 catalyst during steam reforming of acetic acid. International Journal of Hydrogen Energy, 38, 6033-6038.

Koehle, M. and Mhadeshwar, A. (2013) Nanoparticle catalysis for reforming of biomass-derived fuels. In Suib, S.L. (Ed.), New and Future Developments in Catalysis (pp. 63-93). Amsterdam: Elsevier.

Li, B., Maruyama, K., Nurunnabi, M., Kunimori, K., and Tomishige, K. (2004) Temperature profiles of alumina-supported noble metal catalysts in autothermal reforming of methane. Applied Catalysis A: General, 275, 157-172.

Li, Z., Hu, X., Zhang, L., and Lu, G. (2012a) Renewable hydrogen production by a mild-temperature steam reforming of the model compound acetic acid derived from bio-oil. Journal of Molecular Catalysis A: Chemical, 355, 123-133.

Li, Z., Hu, X., Zhang, L., Liu, S., and Lu, G. (2012b) Steam reforming of acetic acid over Ni/ZrO_2 catalysts: Effects of nickel loading and particle size on product distribution and coke formation. Applied Catalysis A: General, 417-418, 281-289.

Miao, Q., Xiong, G., Sheng, S., Cui, W., Xu, L., and Guo, X. (1997) Partial oxidation of methane to syngas over nickel-based catalysts modified by alkali metal oxide and rare earth metal oxide. Applied Catalysis A: General, 154(1–2), 17-27.

Moulder J.F., Stickle W.F., Sobol P.E., and Bomben K.D. (1992) Handbook of X-ray Photoelectron Spectroscopy. Minnesota: Perkin-Elmer Corporation.

Nat, P. (2013) Acetic acid steam reforming on Ni/ and Co/$Ce_{0.75}Zr_{0.25}O_2$ catalysts. M.S. Thesis, The Petroleum and Petrochemical College, Chulalongkorn University, Bangkok, Thailand.

Otsuka, K., Wang, Y., and Nakamura, M. (1999) Direct conversion of methane to synthesis gas through gas–solid reaction using CeO_2-ZrO_2 solid solution at moderate temperature. Applied Catalysis A: General, 183(2), 317-324.

Pant, K.K., Mohanty, P., Agarwal, S., and Dalai, A.K. (2013) Steam reforming of acetic acid for hydrogen production over bifunctional Ni-Co catalysts. Catalysis Today, 207, 36-43.

Pengpanich, S., Meeyoo, V., and Rirksomboon, T. (2004) Methane partial oxidation over Ni/CeO_2-ZrO_2 mixed oxide solid solution catalysts. Catalysis Today, 93–95(0), 95-105.

Rabenstein, G. and Hacker, V. (2008) Hydrogen for fuel cells from ethanol by steam-reforming, partial-oxidation and combined auto-thermal reforming: A thermodynamic analysis. Journal of Power Sources, 185(2), 1293-1304.

Ruiz, J.A.C., Passos, F.B., Bueno, J.M.C., Souza-Aguiar, E.F., Mattos, L.V., and Noronha, F.B. (2008) Syngas production by autothermal reforming of methane on supported platinum catalysts. Applied Catalysis A: General, 334(1-2), 259-267.

Sato, K., Nagaoka, K., Nishiguchi, H., and Takita, Y. (2009) n-C4H10 autothermal reforming over MgO-supported base metal catalysts. International Journal of Hydrogen Energy, 34(1), 333-342.

Sehested, J. (2006) Four challenges for nickel steam-reforming catalysts. Catalysis Today, 111(1-2):103-10.

Simeone, M., Salemme, L., and Allouis, C. (2008a) Reactor temperature profile during autothermal methane reforming on Rh/Al_2O_3 catalyst by IR imaging. International Journal of Hydrogen Energy, 33, 4798-4808.

Simeone, M., Salemme, L., Scognamiglio, D., Allouis, C., and Volpicelli, G. (2008b) Effect of water addition and stoichiometry variations on temperature profiles in an autothermal methane reforming reactor with Ni catalyst. International Journal of Hydrogen Energy, 33, 1252-1261.

Slagtern, Å., Swaan, H.M., Olsbye, U., Dahl, I.M., and Mirodatos, C. (1998) Catalytic partial oxidation of methane over Ni-, Co- and Fe-based catalysts. Catalysis Today, 46(2-3), 107-115.

Solsona, B., Concepción, P., Hernández, S., Demicol, B., and Nieto, J.M.L. (2012) Oxidative dehydrogenation of ethane over NiO-CeO_2 mixed oxides catalysts. Catalysis Today, 180, 51-58.

Srisiriwat, N., Therdthianwong, S., and Therdthianwong, A. (2009) Oxidative steam reforming of ethanol over Ni/Al_2O_3 catalysts promoted by CeO_2, ZrO_2 and CeO_2-ZrO_2. International Journal of Hydrogen Energy, 34(5), 2224-2234.

Takanabe, K., Aika, K., Seshan, K., and Lefferts, L. (2004) Sustainable hydrogen from bio-oil: steam reforming of acetic acid as a model oxygenate. Journal of Catalysis, 227(1), 101-108.

Takeguchi, T., Furukawa S., and Inoue, M. (2001) Hydrogen spillover from NiO to the large surface area CeO_2-ZrO_2 solid solutions and activity of the NiO/CeO_2-ZrO_2 catalysts for partial oxidation of methane. Journal of Catalysis, 202(1), 14-24.

Thaicharoensutcharittham, S., Meeyoo, V., Kitiyanan, B., Rangsunvigit, P., and Rirksomboon, T. (2011) Hydrogen production by steam reforming of acetic acid over Ni-based catalysts. Catalysis Today, 164(1), 257-261.

Thammachart, M., Meeyoo, V., Risksomboon, T., and Osuwan, S. (2001) Catalytic activity of CeO_2-ZrO_2 mixed oxide catalysts prepared via sol-gel technique: CO oxidation. Catalysis Today, 68, 53-61.

Tomishige, K., Nurunnabi, M., Maruyama, K., and Kunimori, K. (2004) Effect of oxygen addition to steam and dry reforming of methane on bed temperature profile over Pt and Ni catalysts. Fuel Processing Technology, 85, 1103-1120.

Trane, R., Dahl, S., Skjøth-Rasmussen, M.S., and Jensen, A.D. (2012) Catalytic steam reforming of bio-oil. International Journal of Hydrogen Energy, 37(8), 6447-6472.

Trimm, D.L. (1977) Mechanisms of carbon formation on nickel-containing catalysts. Journal of Catalysis, 48, 155-165.

Vagia, E.C. and Lemonidou, A.A. (2008) Thermodynamic analysis of hydrogen production via autothermal steam reforming of selected components of aqueous bio-oil fraction. International Journal of Hydrogen Energy, 33(10), 2489-2500.

Vagia, E.C. and Lemonidou, A.A. (2010) Investigations on the properties of ceria-zirconia-supported Ni and Rh catalysts and their performance in acetic acid steam reforming. Journal of Catalysis, 269(2), 388-396.

Wang, D., Montané, D., and Chornet, E. (1996) Catalytic steam reforming of biomass-derived oxygenates: Acetic acid and hydroxyacetaldehyde. Applied Catalysis A: General, 143, 245-270.

Wang, H., Liu, Y., Wang, L., and Qin, Y. (2008) Study on the carbon deposition in steam reforming of ethanol over Co/CeO_2 catalyst. Chemical Engineering Journal, 145(1), 25-31.

Wu, C. and Liu, R. (2010) Carbon deposition behavior in steam reforming of bio-oil model compound for hydrogen production. International Journal of Hydrogen Energy, 35(14), 7386-7398.

Yamazaki, O., Tomishige, K., and Fujimoto, K. (1996) Development of highly stable nickel catalyst for methane steam reforming under low steam to carbon ratio. Applied Catalysis A: General, 136, 49-56.

Zhu, T. and Flytzani-Stephanopoulos, M. (2001) Catalytic partial oxidation of methane to synthesis gas over Ni-CeO_2. Applied Catalysis A: General, 208(1–2), 403-417.

APPENDICES

Appendix A Experimental Data of Gas Calibration for Shimadzu GC-14B

Table A1 Gas chromatograph with thermal conductivity detector (GC-TCD, model: GC-14B) conditions

Temperature	**°C**	**Pressure**	**kPa**	**Current**	**mA**
Column	50	Carrier Pressure (P)	500	Detector	120
Injector	120	Carrier Pressure (M)	450		
Detector	120	TCD-Ref	120		
TCD-T	120				

1. Nitrogen

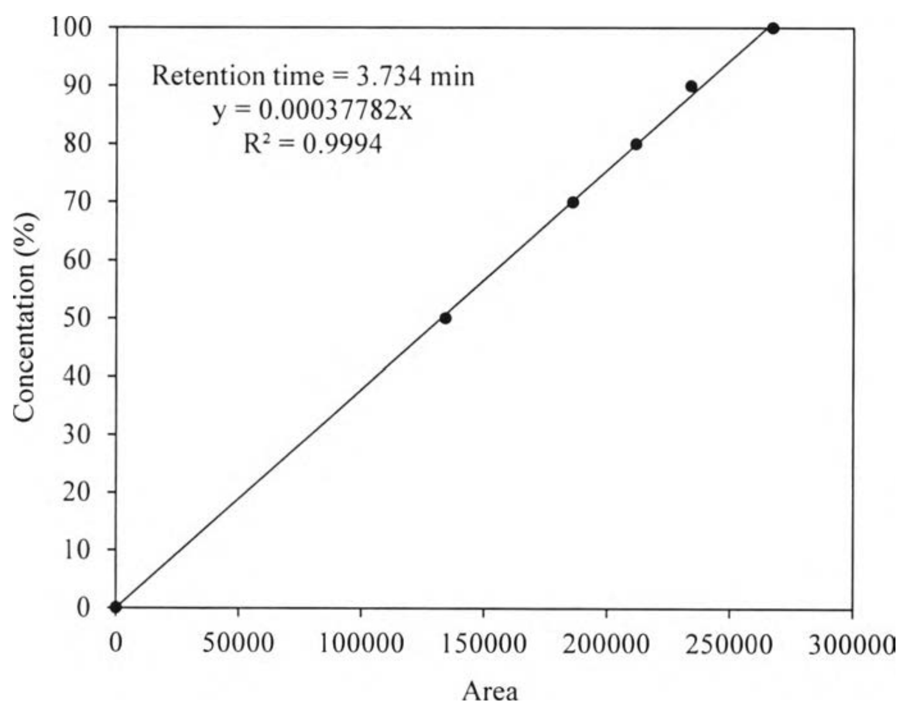

Figure A1 Relationship between area and concentration of nitrogen.

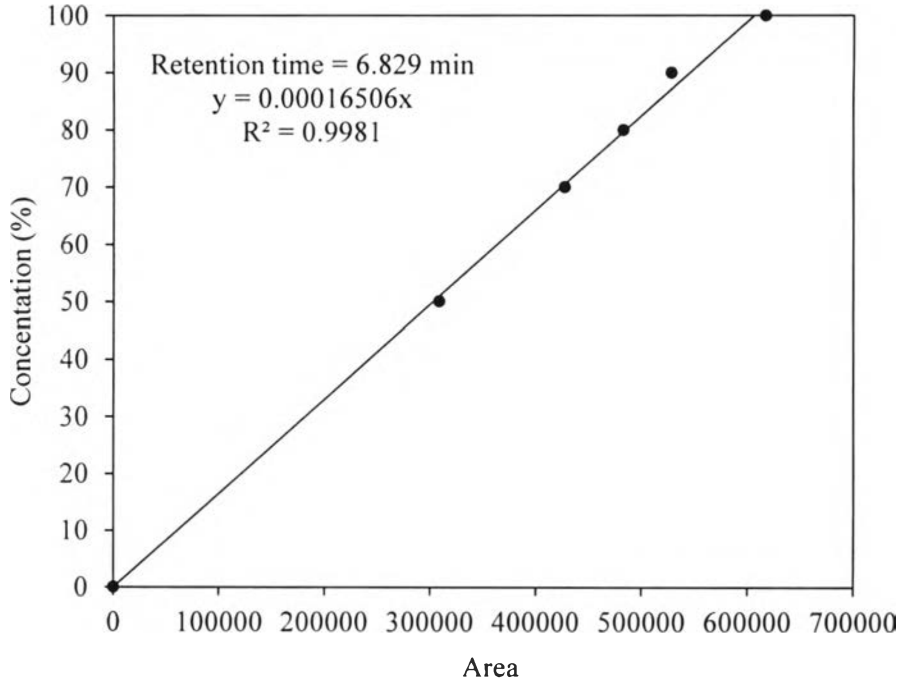

Figure A2 Relationship between area and concentration of nitrogen.

2. Hydrogen

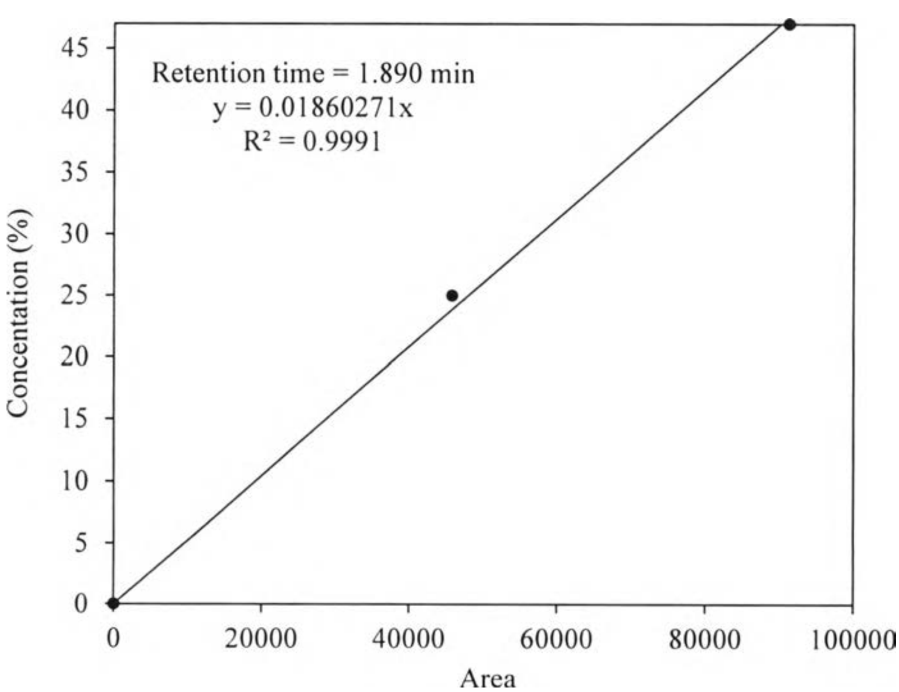

Figure A3 Relationship between area and concentration of hydrogen.

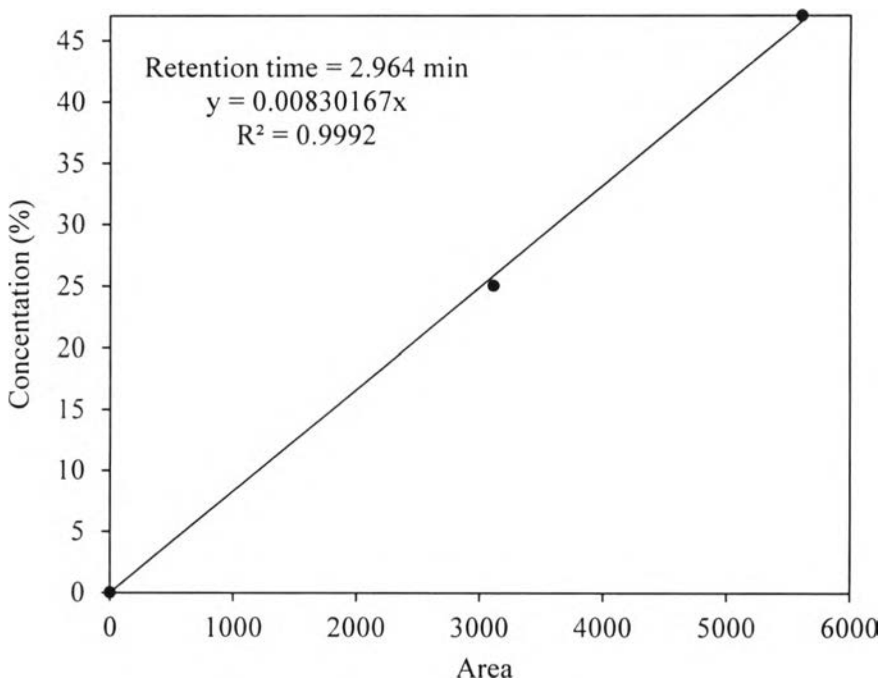

Figure A4 Relationship between area and concentration of hydrogen.

3. Carbon monoxide

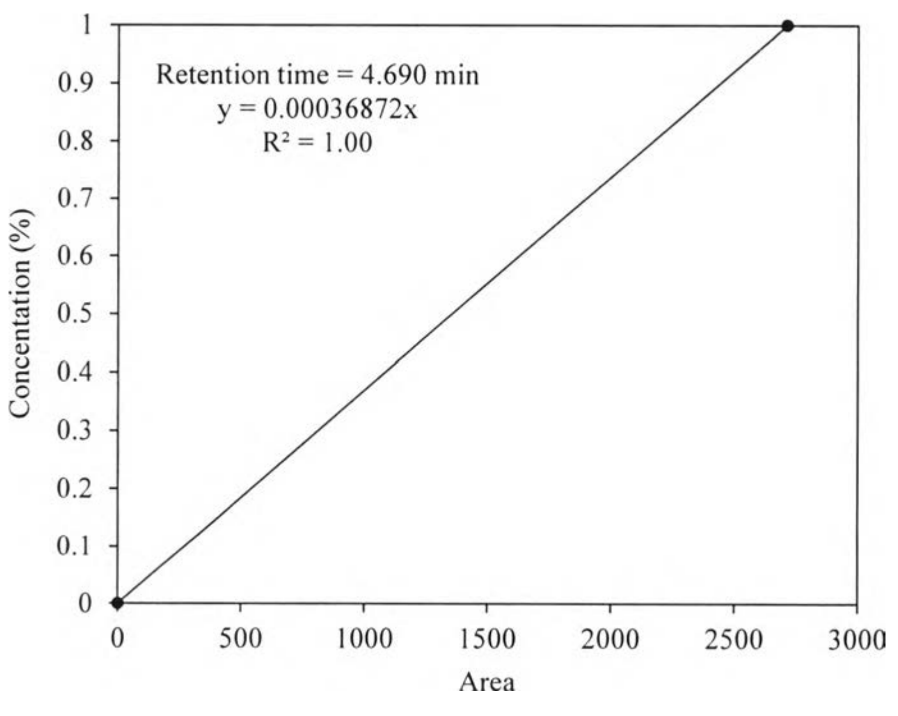

Figure A5 Relationship between area and concentration of carbon monoxide.

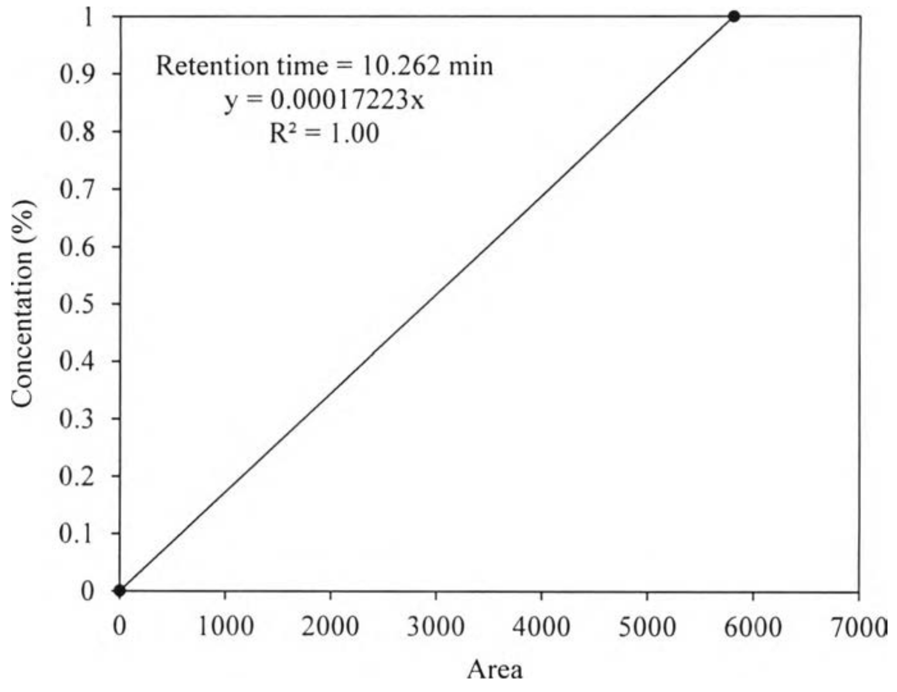

Figure A6 Relationship between area and concentration of carbon monoxide.

4. Carbon dioxide

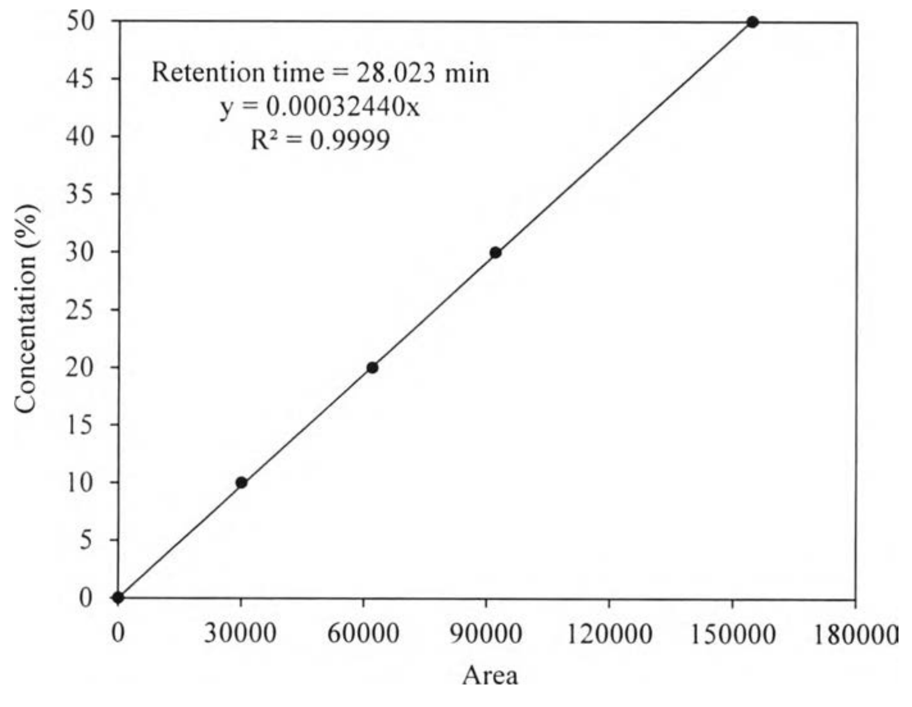

Figure A7 Relationship between area and concentration of carbon dioxide.

5. Methane

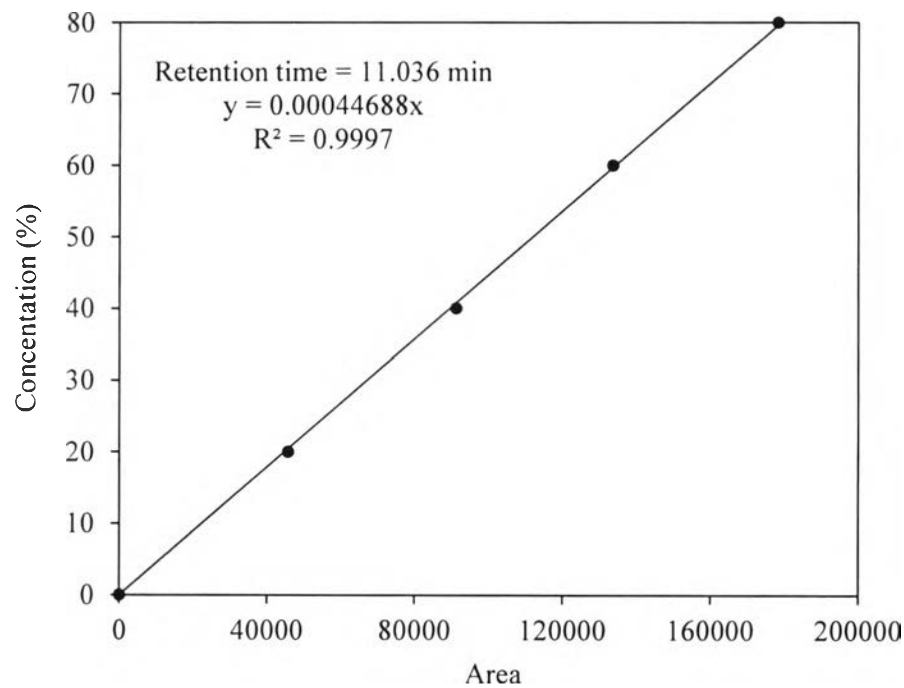

Figure A8 Relationship between area and concentration of methane.

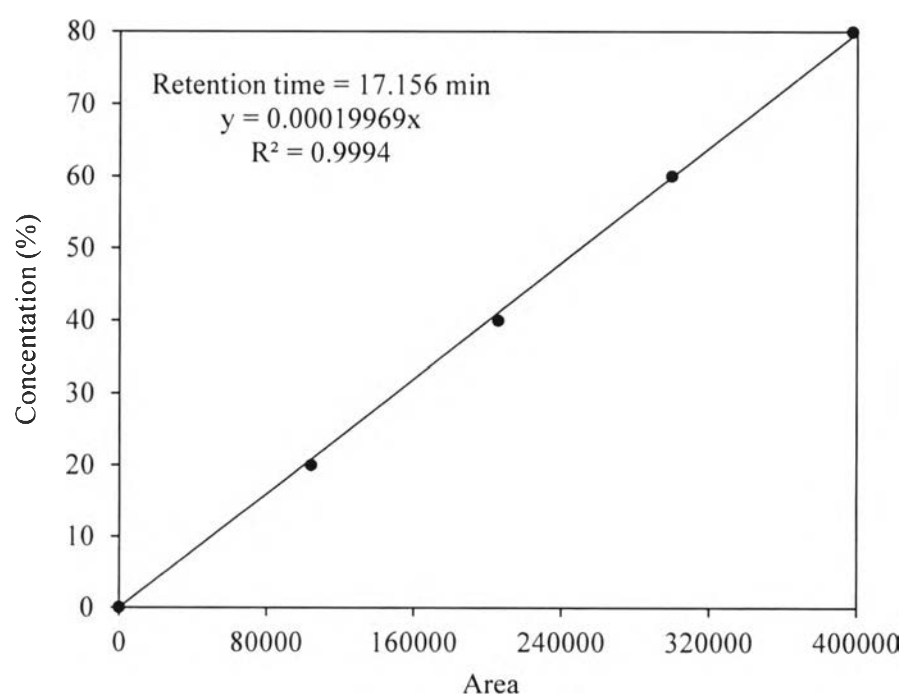

Figure A9 Relationship between area and concentration of methane.

6. Oxygen

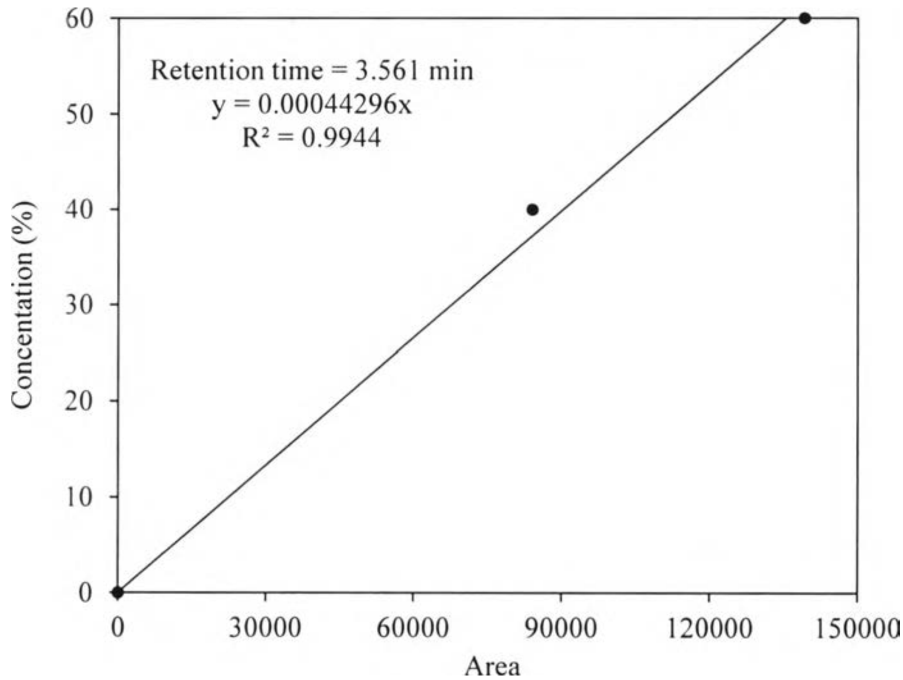

Figure A10 Relationship between area and concentration of oxygen.

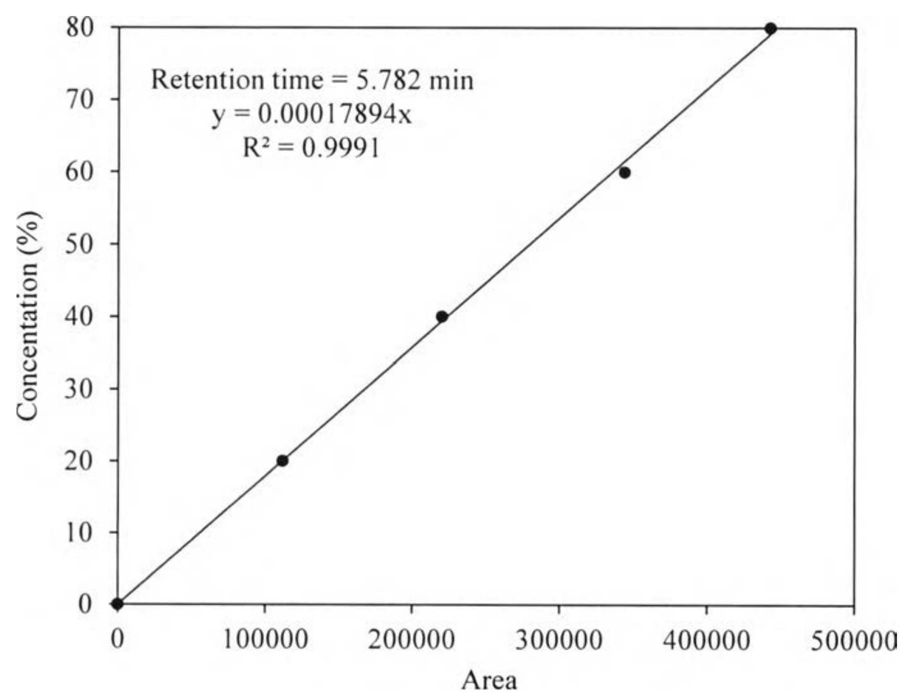

Figure A11 Relationship between area and concentration of oxygen.

Appendix B Experimental Data of Gas Calibration for Shimadzu GC-17A

Table B1 Gas chromatograph with flame ionization detector (GC-FID, model: GC-17A) conditions

Pressure	kPa	Temperature	°C	Current	mA
Hydrogen (H_2)	80	Column	150	Detector	120
Air Zero	30	Injector	200		
AUX1 Nitrogen (N_2)	60	Detector	200		
AUX2 Nitrogen (N_2)	60				

1. Acetone

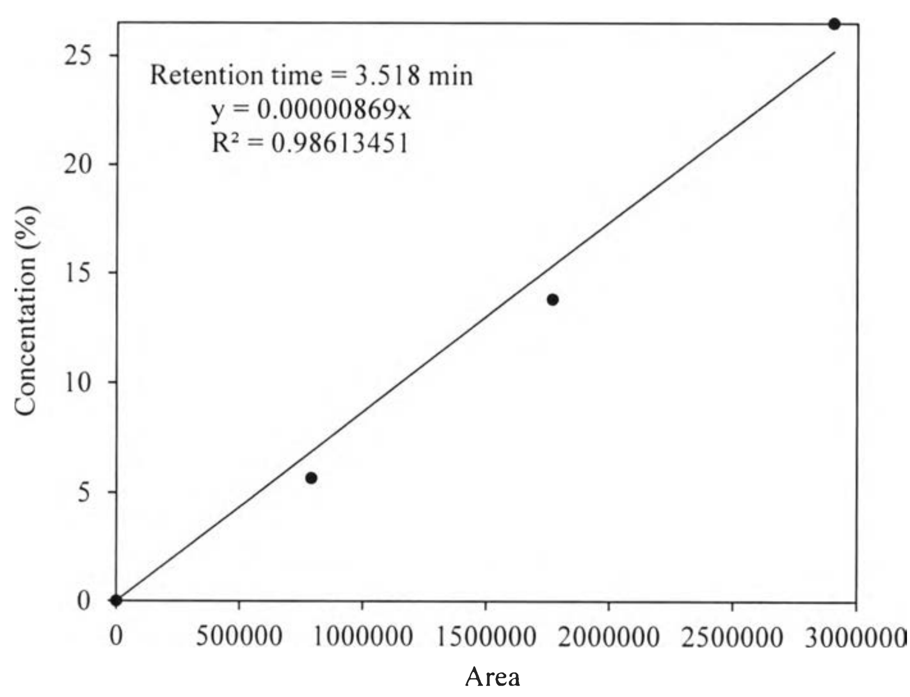

Figure B1 Relationship between area and concentration of acetone.

2. Acetic acid

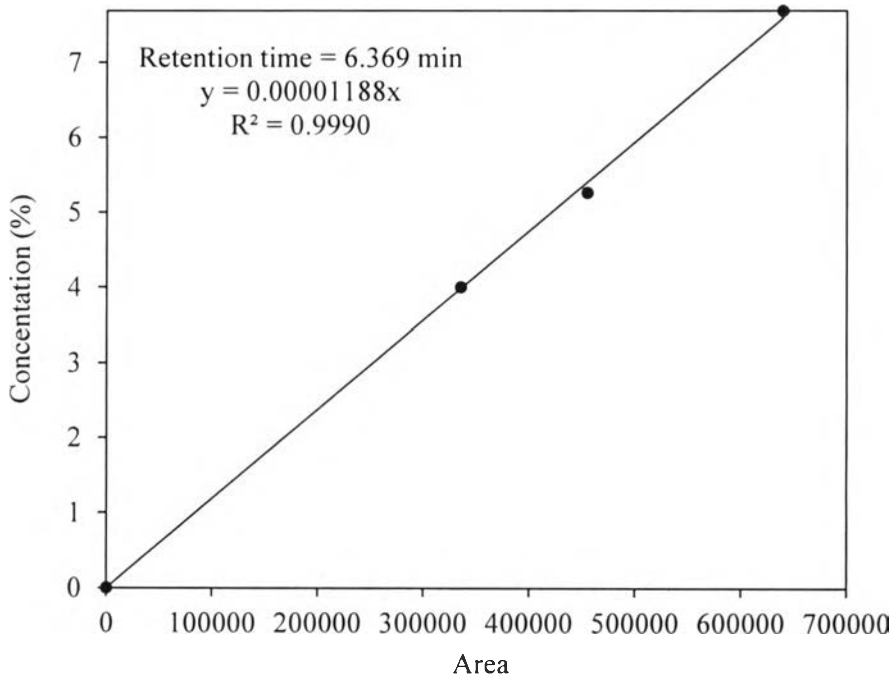

Figure B2 Relationship between area and concentration of acetic acid.

Appendix C Calibration Curve of Brooks 5850E Mass Flow Controllers

1. Nitrogen

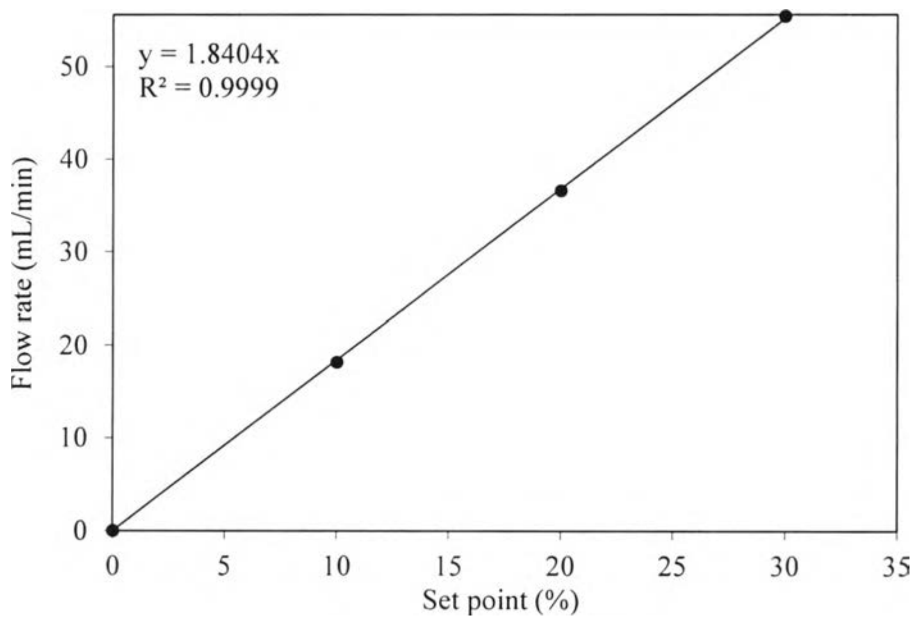

Figure C1 Relationship between set point and volumetric flow rate of nitrogen.

2. Hydrogen

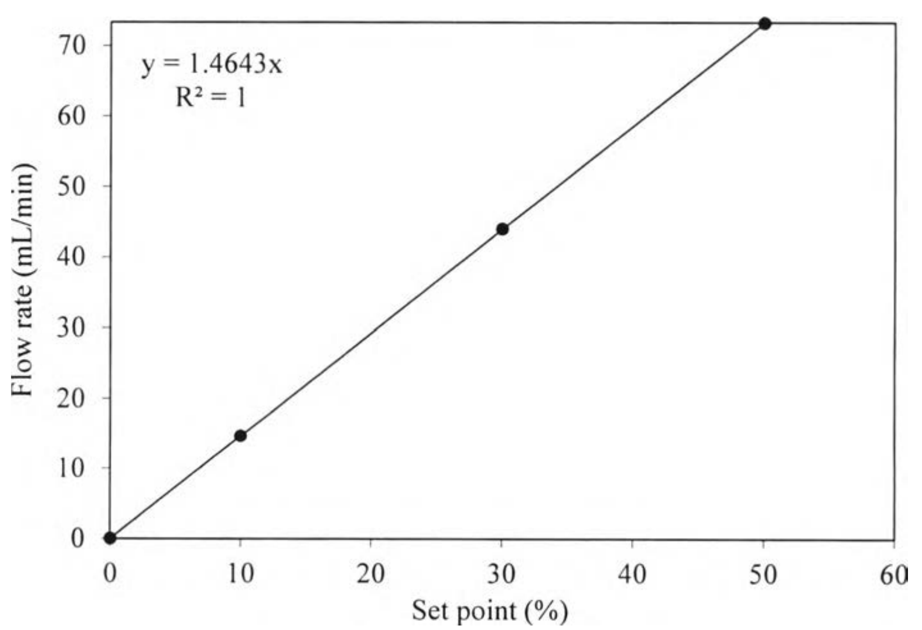

Figure C2 Relationship between set point and volumetric flow rate of hydrogen.

3. Oxygen

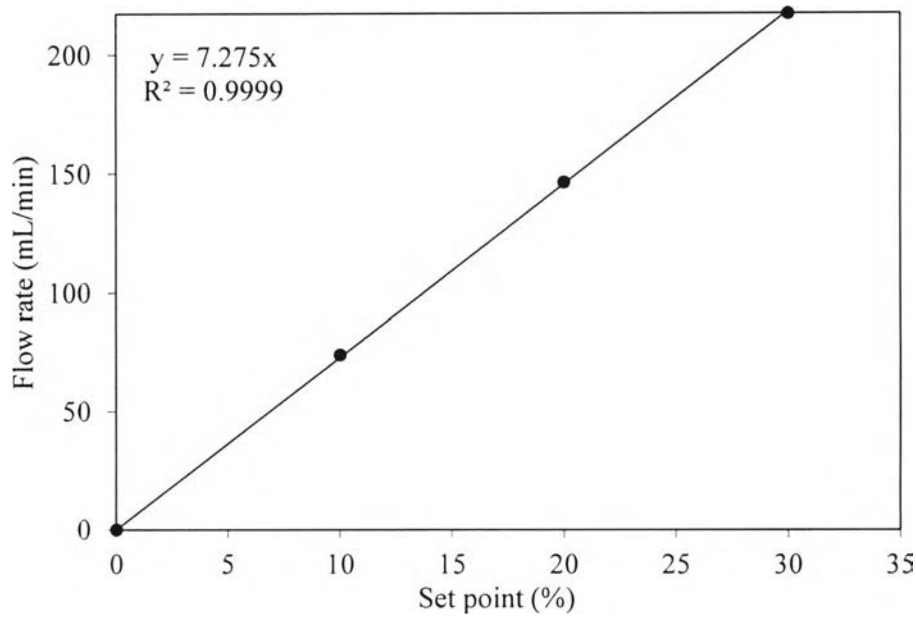

Figure C3 Relationship between set point and volumetric flow rate of oxygen.

Appendix D Calibration Curve of Eldex ReciPro Liquid Metering Pumps

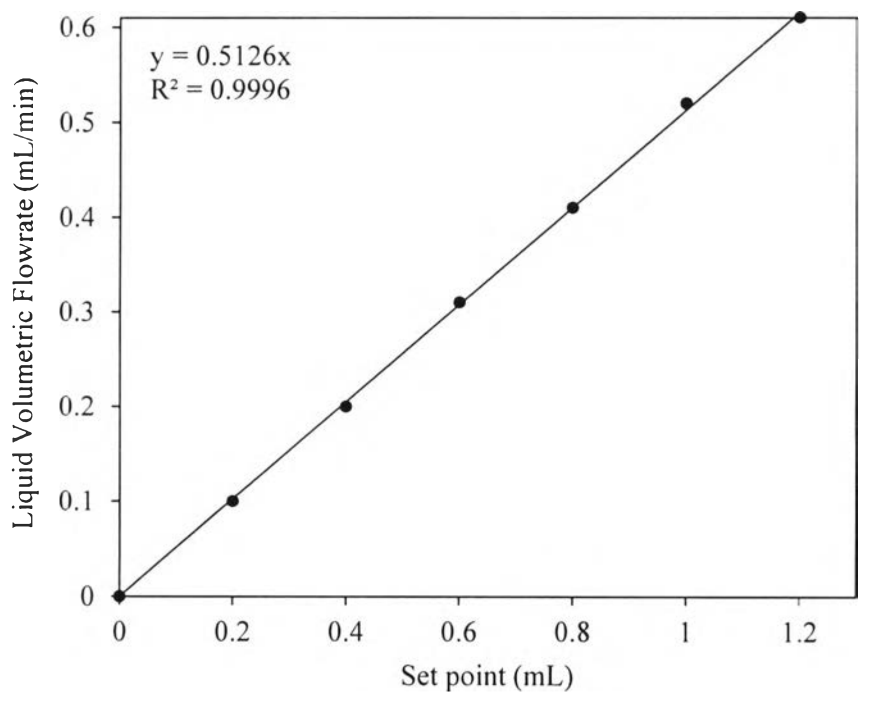

Figure D1 Relationship between volume set point and volumetric flow rate.

Appendix E Experimental Data of Catalytic Activity Tests

Table E1 Catalytic activity test of $Ce75Zr25O_x$ and quartz wool at 650 °C, total flow rate 170 ml/min, W/F = 0.352 g·h·mol^{-1}, S/C molar ratio = 6 (for SR and ATR), and O_2/acetic acid molar ratio = 0.35 (for POX and ATR)

Parameters	$Ce75Zr25O_x$			Quartz Wool		
	SR	POX	ATR	SR	POX	ATR
C-C breakage conversion (%)	44.41	6.73	45.68	1.07	0.54	1.12
CH_3COOH conversion (%)	65.20	11.32	67.01	1.43	1.62	1.28
O_2 conversion (%)	-	26.86	40.31	-	4.05	5.80
H_2 Yield (%)	26.71	1.77	19.51	0.48	0.08	0.30
CO Yield (%)	3.37	0.14	3.21	0.15	0.06	0.10
CO_2 Yield (%)	32.12	2.39	34.25	0.59	0.29	0.73
CH_4 Yield (%)	0.50	1.09	0.00	0.18	0.14	0.14
CH_3COCH_3 Yield (%)	2.42	2.51	0.00	0.60	0.46	0.59
CO Selectivity (%)	8.54	2.43	8.31	9.15	7.04	6.44
CO_2 Selectivity (%)	82.21	41.38	88.72	40.91	33.97	49.62
CH_4 Selectivity (%)	1.19	19.04	0.00	12.83	16.02	9.14
CH_3COCH_3 Selectivity (%)	4.59	33.48	0.00	31.46	39.53	30.11

Table E2 Catalytic activity test of 15%Ni/Ce75Zr25O_x catalyst at 650 °C, total flow rate 170 ml/min, S/C molar ratio = 6 (for SR and ATR), and O_2/acetic acid molar ratio = 0.35 (for POX and ATR)

W/F ($g \cdot h \cdot mol^{-1}$)	Parameters	SR	POX	ATR
0.088	C-C breakage conversion (%)	39.83	8.14	45.46
	CH_3COOH conversion (%)	78.55	19.82	66.56
	O_2 conversion (%)	-	94.96	89.97
	H_2 Yield (%)	51.69	11.54	40.15
	CO Yield (%)	5.08	1.47	3.68
	CO_2 Yield (%)	29.26	4.96	37.28
	CH_4 Yield (%)	0.40	0.24	0.82
	CH_3COCH_3 Yield (%)	3.43	1.66	3.04
	CO Selectivity (%)	13.32	17.67	8.21
	CO_2 Selectivity (%)	76.64	59.54	83.17
	CH_4 Selectivity (%)	1.06	2.86	1.83
	CH_3COCH_3 Selectivity (%)	6.74	14.94	5.09
0.176	C-C breakage conversion (%)	61.51	10.73	57.52
	CH_3COOH conversion (%)	95.91	24.62	92.97
	O_2 conversion (%)	-	99.60	98.32
	H_2 Yield (%)	64.30	14.70	55.84
	CO Yield (%)	8.31	2.35	8.03
	CO_2 Yield (%)	44.88	5.41	41.02
	CH_4 Yield (%)	0.00	0.63	0.43
	CH_3COCH_3 Yield (%)	0.81	1.05	0.72
	CO Selectivity (%)	15.40	24.88	15.99
	CO_2 Selectivity (%)	83.11	57.30	81.71
	CH_4 Selectivity (%)	0.00	6.71	0.86
	CH_3COCH_3 Selectivity (%)	1.12	8.33	1.08

Table E2 (con't) Catalytic activity test of 15%Ni/Ce75Zr25O$_x$ catalyst at 650 °C, total flow rate 170 ml/min, S/C molar ratio = 6 (for SR and ATR), and O_2/acetic acid molar ratio = 0.35 (for POX and ATR)

W/F ($g \cdot h \cdot mol^{-1}$)	Parameters	SR	POX	ATR
0.264	C-C breakage conversion (%)	76.08	13.58	78.66
	CH_3COOH conversion (%)	100.00	29.23	100.00
	O_2 conversion (%)	-	100.00	100.00
	H_2 Yield (%)	72.89	19.29	64.50
	CO Yield (%)	10.26	3.09	9.11
	CO_2 Yield (%)	55.55	6.23	60.44
	CH_4 Yield (%)	0.00	1.17	0.00
	CH_3COCH_3 Yield (%)	0.00	0.09	0.00
	CO Selectivity (%)	15.60	29.17	13.10
	CO_2 Selectivity (%)	84.41	58.90	86.90
	CH_4 Selectivity (%)	0.00	11.06	0.00
	CH_3COCH_3 Selectivity (%)	0.00	0.65	0.00
0.352	C-C breakage conversion (%)	75.44	13.95	78.86
	CH_3COOH conversion (%)	100.00	30.43	100.00
	O_2 conversion (%)	-	100.00	100.00
	H_2 Yield (%)	73.07	21.71	64.81
	CO Yield (%)	9.73	3.23	8.90
	CO_2 Yield (%)	55.97	6.42	61.07
	CH_4 Yield (%)	0.00	1.08	0.00
	CH_3COCH_3 Yield (%)	0.00	0.00	0.00
	CO Selectivity (%)	14.81	30.08	12.72
	CO_2 Selectivity (%)	85.19	59.87	87.28
	CH_4 Selectivity (%)	0.00	10.05	0.00
	CH_3COCH_3 Selectivity (%)	0.00	0.00	0.00

CURRICULUM VITAE

Name: Mr. Thanakorn Thanasujaree

Date of Birth: July 29, 1990

Nationality: Thai

University Education:

2009-2012 Bachelor Degree of Petrochemicals and Polymeric Materials, Silpakorn University, Thailand

2013-2015 Master of Science in Petrochemical Technology, the Petroleum and Petrochemical College, Chulalongkorn University, Thailand

Working Experience:

2011 Position: Trainee (2 months)

Company name: Thai Polyacetal Co.,Ltd., Rayong, Thailand and Thai Polycarbonate Co.,Ltd., Rayong, Thailand

Proceedings:

1. Thanasujaree, T., Rirksomboon, T., and Meeyoo, V. (2015, April 21) Investigation of Carbon Formation on Ni-based Ceria Zirconia Catalyst in the Autothermal Steam Reforming of Acetic Acid. Proceedings of 6th Research Symposium on Petrochemical and Materials Technology and 21th PPC Symposium on Petroleum, Petrochemicals and Polymers, Bangkok, Thailand.