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APPENDICES

APPENDIX A

THERMODYNAMIC DATA OF SELECTED COMPONENTS

Table A1 Heat capacities of selected components (C_p)

Components	$C_p = a + bT + cT^2 + dT^3 + eT^4$ [J/mol K]				
	a	$b\times 10^3$	$c\times 10^5$	$d\times 10^8$	$e\times 10^{13}$
Ethanol	27.091	110.55	10.957	-15.046	461.01
Water	33.933	-8.4186	2.9906	-1.7825	36.934
Methane	34.942	-39.957	19.184	35.103	393.21
Carbon monoxide	29.556	-6.5807	2.0130	-1.2227	22.617
Carbon dioxide	27.437	42.315	-1.9555	0.3997	-2.9872
Hydrogen	25.399	20.178	-3.8549	3.1880	-87.585

Table A2 Heat of formation (H_f) and entropy (S^0) of selected components

Components	$H_f = a + bT + cT^2$ [kJ/mol]			S^o [J/mol.K]
	a	$b\times 10^3$	$c\times 10^5$	
Ethanol	-216.961	-69.572	3.1744	282.59
Water	-241.80	0	0	188.72
Methane	-63.425	-43.355	1.7220	186.27
Carbon monoxide	-112.19	8.1182	-8.0425	197.54
Carbon dioxide	-393.42	0.1591	-0.1395	213.69
Hydrogen	0	0	0	130.57

APPENDIX B

THERMODYNAMIC CALCULATIONS

B1. Determining Gibbs energy (G) at any temperature

Calculation by these equations:

$$G = H - TS \quad \text{(B1)}$$

$$dG = dH - d(TS) \quad \text{(B2)}$$

Integrate the above equation and obtain the solution:

$$\int dG = \int dH - \int d(TS) \quad \text{(B3)}$$

$$G_T - G_{STD} = \int_{298}^{T} dH - \int_{298}^{T} d(TS) \quad \text{(B4)}$$

where

$$H_f(T) = H_f^o + \int_{298}^{T} C_p \, dT \quad \text{(B5)}$$

$$S(T) = S^o + \int_{298}^{T} \frac{C_p}{T} dT \quad \text{(B6)}$$

B2. Determining the equilibrium constant (K)

$$G_T = RTlnK \quad \text{(B7)}$$

Rearrange the equation:

$$K = \exp(-\frac{G_T}{RT}) \quad \text{(B8)}$$

APPENDIX C

LIST OF PUBLICATIONS

International Conference

V. Sukwattanajaroon, S. Charojrochkul, W. Kiatkittipong, W. Wiyaratn, A. Soottitantawat, A. Arpornwichanop, N. Laosiripojana and S. Assabumrungrat; "Effect of membrane type on performance of bioethanol-fuelled solid oxide fuel cell system integrated with pervaporation", Regional Symposium on Chemical Engineering (RSCE 2010), Bangkok, November 22-23, 2010 (oral presentation).

National Publication

Vorachatra Sukwattanajaroon, Sumittra Charojrochkul, Worapon Kiatkittipong, Amornchai Arpornwichanop and Suttichai Assabumrungrat, Performance of membrane-assisted solid oxide fuel cell system fuelled by bioethanol, Engineering Journal 15, 2 (2011): 53-66.

VITAE

Mr. Vorachatra Sukwattanajaroon was born in May 4th, 1987 in Bangkok, Thailand. He finished high school from Sarawittaya School, Bangkok in 2005, and received his Bachelor's Degree in Chemical Engineering from the Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok in 2009. Afterward, he continued studying Master's Degree of Chemical Engineering, Chulalongkorn University since June 2009.