
Tables

Table 1 Diffusion volume of simple molecules $\sum V$ (cm³/mol)

H ₂	CO ₂	N ₂	CH ₄	He	H ₂ O
7.07	26.9	17.9	24.4	2.88	35.9

Table 2 Electrochemical reaction kinetic parameters^{39,40}

Parameter	Value
Charge transfer coefficient, α_a^a	0.55
Charge transfer coefficient, α_c^a	0.45
HOR active energy, E_A (kJ/mol)	34.6
Reference temperature, T_{ref} (K)	296.15
Exchange current density, j_0^a (mA/cm ²)	134

Table 3 Parameters for model validation

Item	H ₂ /N ₂ ^{15,16,18}		H ₂ /CH ₄ ²²	H ₂ /He ²²	H ₂ /CO ₂ ¹⁹
Applied potential, E (mV)	0 - 140	0 - 550	0 - 550	0 - 550	100 - 700
Operating temperature, T (K)	333.15	323.15	323.15	323.15	333.15
Volume flowrate, V_F (cm ³ /s)	0.64	16.67	16.67	16.67	0.40
Cathode pressure, P_c (MPa)	0.1	0.13	0.13	0.13	0.1
Anode pressure, P_a (MPa)	0.1	0.1	0.1	0.1	0.1
Feedstock H ₂ content (mol%)	1 - 99	20 - 80	20 - 80	20 - 80	29 - 86
MEA area, A (cm ²)	10	50	50	50	1.9

Table 4 Parameters of purity and cathode pressured test			
Item	Purity ^{15,22}	Pressure ¹⁵	Pressure ⁴⁹
Applied potential, E (mV)	0 - 450	0 - 100	0 - 250
Operating temperature, T (K)	323.15	333.15	343.15
Volume flowrate, V_F (cm ³ /s)	16.67	0.64	13.0
Cathode pressure, P_c (MPa)	0.13	0.1 - 1.0	1.0
Anode pressure, P_a (MPa)	0.1	0.1	0.1
Feedstock H ₂ content (mol%)	20 - 80	100	100
MEA area, A (cm ²)	50	10	25

Table 5 Permeability data of Nafion 212 PEM²²

Component	Permeability k (mol · m ⁻¹ · s ⁻¹ · Pa ⁻¹)
H ₂	4.16×10^{-15}
N ₂	8.71×10^{-17}
CO ₂	8.04×10^{-16}
CH ₄	3.42×10^{-17}
He	3.12×10^{-15}
H ₂ O	2.19×10^{-12}

Table 6 Simulation parameters for EHP performance study

Parameter	Value
Applied potential, E (mV)	100 - 2500
Operating temperature, T (K)	298.15 - 373.15
Volume flowrate, V_F (cm ³ /s)	16.67
Cathode pressure, P_c (MPa)	0.13 - 20
Anode pressure, P_a (MPa)	0.1 - 0.5
H ₂ feedstock content (mol%)	20 - 80
MEA area, A (cm ²)	50

Table A1 RWGS kinetic expressions⁴¹⁻⁴³

Rate	Expression
r_1	$k_1\theta_{CO}$
r_{-1}	$k_{-1}\theta_{CO}\theta_0$
r_2	$k_2P_{H_2O}\theta_0$
r_{-2}	$k_{-2}\theta_{H_2O}$
r_3	$k_3\theta_{H_2O}$
r_{-3}	$k_{-3}\theta_{OH}\alpha_{H^+}$
r_4	$k_4P_{CO_2}\alpha_{H^+}\theta_0^2$
r_{-4}	$k_{-4}\theta_{CO}\theta_{OH}$
r_5	$k_5\theta_0^2P_{H_2}$
r_{-5}	$k_{-5}\theta_H^2$
r_6	$k_6\theta_H$
r_{-6}	$k_{-6}\theta_0\alpha_H^+$

Table A2 Key parameters ⁴¹⁻⁴³		
Parameter	Value	Unit
k_1	1.5×10^{-9}	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_{-1}	0.12×10^{-5}	$\text{mol} \cdot \text{m}^{-2} \cdot \text{Pa}^{-1} \cdot \text{s}^{-1}$
k_2	0.002	$\text{mol} \cdot \text{m}^{-2} \cdot \text{Pa}^{-1} \cdot \text{s}^{-1}$
k_{-2}	200	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_3^0	7.0×10^{-10}	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_{-3}^0	6	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_4^0	0.3×10^{-11}	$\text{mol} \cdot \text{m}^{-2} \cdot \text{Pa}^{-1} \cdot \text{s}^{-1}$
k_{-4}^0	0.6	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_5	4.93×10^{-5}	$\text{mol} \cdot \text{m}^{-2} \cdot \text{Pa}^{-1} \cdot \text{s}^{-1}$
k_{-5}	80	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_6^0	70	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
k_{-6}^0	15	$\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$
α_a^a	0.55	-
α_{H^+}	1.0	mol