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APPENDIX

Calculations

All catalysts preparations were based on the information below.

Table A1 Molecular weight and density of precursors

Compound	MW. (g/mol)	Density (g/cm^3)
$Ce(C_2H_4O_2)_2$	260.22	
$Gd(NO_3)_3.6H_2O$	451.36	
$Ni(CH_3COO)_2.4H_2O$	248.86	
$Cu(CH_3COO)_2.H_2O$	199.65	
HNO_3 (14.4 M)	63.01	1.4
H_2O	18	1

Table A2 Amounts of starting materials at $h = 29$ and $A = 0.3$ of 10%Ni/GDC10

Compound	Comp. Mole	Weight or Volume	H_2O Mole in Comp.
$Ce(C_2H_4O_2)_2$	0.00090	0.23420 g	
$Gd(NO_3)_3.6H_2O$	0.00010	0.04514 g	0.00060
$Ni(CH_3COO)_2.4H_2O$	0.00010	0.02489 g	0.00040
$Cu(CH_3COO)_2.H_2O$			
HNO3	0.00027	19 µl	
H_2O	(0.02610-0.0010) =0.02510	451 µl	

Therefore, the starting materials used were as follows

$Ce(C_2H_4O_2)_2$	0.23420×3	= 0.7026	g
$Gd(NO_3)_3.6H_2O$	0.04514×3	= 0.1354	g
$Ni(CH_3COO)_2.4H_2O$	0.02489×3	= 0.0747	g
HNO_3	19×3	= 57	µL
H_2O	451×3	= 1353	µL

Table A3 Amounts of starting materials at h = 29 and A = 0.3 of 10 %Cu/GDC10

Compound	Comp. Mole	Weight or Volume	H_2O Mole in Comp.
$Ce(C_2H_4O_2)_2$	0.00090	0.23420 g	
$Gd(NO_3)_3.6H_2O$	0.00010	0.04514 g	0.00060
$Ni(CH_3COO)_2.4H_2O$			
$Cu(CH_3COO)_2.H_2O$	0.00010	0.01997 g	0.00010
HNO3	0.00027	19 µl	
H_2O	(0.02610-0.0007) =0.02540	457 µl	

Therefore, the starting materials used were as follows

$Ce(C_2H_4O_2)_2$	0.23420×3	= 0.7026	g
$Gd(NO_3)_3.6H_2O$	0.04514×3	= 0.1354	g
$Cu(CH_3COO)_2.H_2O$	0.01997×3	= 0.0599	g
HNO_3	19×3	= 57	µL
H_2O	457×3	= 1371	µL

The methanol conversion, hydrogen yield, hydrogen selectivity, carbon monoxide selectivity, carbon dioxide selectivity, and methane selectivity were calculated by equations. A1 – A6.

$$X = \frac{CO + CO_2 + CH_4}{MeOH_{(in)}} \cdot 100\% \qquad \text{(A1)}$$

where

X = methanol conversion (%)

$MeOH_{(in)}$ = mole of methanol inlet

$$Y_{H_2} = X * S_{H_2} \tag{A2}$$

where

$$S_{H_2} = \frac{H_2}{H_2 + CH_4 + CO + CO_2} \cdot 100\% \tag{A3}$$

$$S_{CO} = \frac{CO}{H_2 + CH_4 + CO + CO_2} \cdot 100\% \tag{A4}$$

$$S_{CO_2} = \frac{CO_2}{H_2 + CH_4 + CO + CO_2} \cdot 100\% \tag{A5}$$

$$S_{CH_4} = \frac{CH_4}{H_2 + CH_4 + CO + CO_2} \cdot 100\% \tag{A6}$$

where

Y_{H_2} = H_2 yield (%)

S_{H_2} = hydrogen selectivity (%)

S_{CO} = carbon monoxide selectivity (%)

S_{CO_2} = carbon dioxide selectivity (%)

S_{CH_4} = methane selectivity (%)

H_2 = mole of hydrogen in the product stream

CO = mole of carbon monoxide in the product stream

CO_2 = mole of carbon dioxide in the product stream

CH_4 = mole of carbon methane in the product stream

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Proceedings:

1. Asavaputanapun, K.; Luengnaruemitchai, A.; Chaisuwan, T.; and Wongkasemjit S. (2010, April 22) Steam reforming of methanol over GDC and metal loaded GDC catalysts prepared via sol-gel route. Proceedings of the 1st National Research Symposium on Petroleum, Petrochemicals, and Advanced Materials and the 16th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

Presentations:

1. Asavaputanapun, K.; Luengnaruemitchai, A.; Chaisuwan, T.; and Wongkasemjit S. (2010, March 21-25) Synthesis of $Ce_{0.9}Gd_{0.1}O_{1.95}$ and Metal loaded $Ce_{0.9}Gd_{0.1}O_{1.95}$ by novel sol-gel method. Paper presented at the 239th ACS National Meeting & Exposition Conference, San Francisco, USA
2. Asavaputanapun, K.; Luengnaruemitchai, A.; Chaisuwan, T.; and Wongkasemjit S. (2010, April 22) Steam reforming of methanol over GDC and metal loaded GDC catalysts prepared via sol-gel route. Paper presented at the 1st National Research Symposium on Petroleum, Petrochemicals, and Advanced Materials and the 16th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.