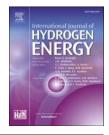


Available online at www.sciencedirect.com

### **ScienceDirect**

journal homepage: www.elsevier.com/locate/he



# Syngas production from methane dry reforming over Ni/SBA-15 catalyst: Effect of operating parameters



## Osaze Omoregbe <sup>a</sup>, Huong T. Danh <sup>b</sup>, Chinh Nguyen-Huy <sup>c</sup>, H.D. Setiabudi <sup>a</sup>, S.Z. Abidin <sup>a</sup>, Quang Duc Truong <sup>d</sup>, Dai-Viet N. Vo <sup>a,e,\*</sup>

<sup>a</sup> Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia

<sup>b</sup> Clean Energy and Chemical Engineering, Korea University of Science and Technology (UST), Daejeon, 305-350, Republic of Korea

<sup>c</sup> School of Energy & Chemical Engineering, Ulsan National Institute of Science and Technology (UNIST),

50 UNIST-gil, Eonyang-eup, Ulju-gun, Ulsan, 689-798, Republic of Korea

<sup>d</sup> Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Katahira 2-1-1, Aoba-Ku, Sendai, 980-8577, Japan

<sup>e</sup> Centre of Excellence for Advanced Research in Fluid Flow, Universiti Malaysia Pahang, 26300, Gambang, Kuantan, Pahang, Malaysia

### ARTICLE INFO

Article history: Received 4 January 2017 Received in revised form 25 February 2017 Accepted 21 March 2017 Available online 7 April 2017

Keywords: Methane dry reforming Syngas Hydrogen SBA-15 support Ni-based catalysts

### ABSTRACT

The influence of operating conditions including reactant partial pressure and reaction temperature on the catalytic performance of 10%Ni/SBA-15 catalyst for methane dry reforming (MDR) reaction has been investigated in this study. MDR reaction was carried out under atmospheric pressure at varying CH<sub>4</sub>/CO<sub>2</sub> volume ratios of 3:1 to 1:3 and 923–1023 K in a tubular fixed-bed reactor. SBA-15 supported Ni catalyst exhibited high specific surface area of 444.96 m<sup>2</sup> g<sup>-1</sup> and NiO phase with average crystallite size of 27 nm was detected on catalyst surface by X-ray diffraction and Raman measurements. H<sub>2</sub> temperatureprogrammed reaction shows that NiO particles were reduced to metallic Ni<sup>0</sup> phase with degree of reduction of about 90.1% and the reduction temperature depended on the extent of metal-support interaction and confinement effect of mesoporous silica support. Catalytic activity appeared to be stable for 4 h on-stream at 973–1023 K whilst a slight drop in activity was observed at 923 K probably due to deposited carbon formed by thermodynamically favored CH<sub>4</sub> decomposition reaction. Both CH<sub>4</sub> and CO<sub>2</sub> conversions increased with rising reaction temperature and reaching about 91% and 94%, respectively at 1023 K with CO<sub>2</sub> and CH<sub>4</sub> partial pressure of 20 kPa. CH<sub>4</sub> conversion improved with increasing CO<sub>2</sub> partial pressure,  $P_{CO_2}$  and exhibited an optimum at  $P_{CO_2}$  of 30–50 kPa depending on reaction temperature whilst a substantial decline in CO<sub>2</sub> conversion was observed with growing  $P_{CO_2}$ . Additionally, CH<sub>4</sub> and CO<sub>2</sub> conversions decreased significantly with rising CH<sub>4</sub> partial pressure because of increasing carbon formation rate via CH<sub>4</sub> cracking in CH<sub>4</sub>-rich feed.

E-mail address: vietvo@ump.edu.my (D.-V.N. Vo).

http://dx.doi.org/10.1016/j.ijhydene.2017.03.146

<sup>\*</sup> Corresponding author. Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia. Fax: +60 9 549 2889.

<sup>0360-3199/© 2017</sup> Hydrogen Energy Publications LLC. Published by Elsevier Ltd. All rights reserved.