EMCMRE-1
Marrakech-Morocco
November 21-25 2011

First Euro-Mediterranean Conference on Materials and Renewable Energies (EMCMRE-1) 21-25 November 2011

Dry Reforming Combined With Steam Reforming Of Methane For Hydrogen Production Over Ni/Ceo$_2$ Catalyst

A. Rakib[1,2], C. Gennequin[1,2], T. Dhainaut[3], S. Ringot[3], A. Aboukaïs[1,2], E. Abi-Aad[1,2,]*

[1]Université Lille Nord de France, F-59000 Lille, France
[2]Université du Littoral Cote d'Opale, Unité de Chimie Environnementale et Interactions sur le Vivant (UCEIV) (EA. 4492), 145, Avenue Maurice Schumann, 59140 Dunkerque, France
[3]EDF-Centre d'Ingénierie Thermique, Tour Cèdre, 7 Allée de l'Arche, 92099 Paris La Défense, France
*E-mail: edmond.abiaad@univ-littoral.fr

Abstract:

Hydrogen offers a range of benefits as a clean energy carrier that can be produced from any available primary energy source, contributes to a diversification of automotive fuel sources and provides the long-term possibility of being solely produced from renewable energy sources [1]. Recently, the major research efforts have been concentrated on the CO_2 reforming (dry reforming) and steam reforming of methane (originated from biogas) for hydrogen production [2, 3]. The combination of these two reactions has substantial interest in alternative routes for the conversion of methane to hydrogen.

In this work, we present new results on the catalytic dry reforming combined with steam reforming of methane over Ni/CeO$_2$ catalyst. The main objective is to elucidate the reaction pathway and the influence of the process parameters (reaction temperature, CO_2/H_2O feed-ratio...) on the activity and selectivity. The Ni catalyst was prepared by impregnation method with a Ni loading of 15 wt%. The methane reforming was carried out at temperatures between 600-800℃ under atmospheric pressure. In the simultaneous CO_2 and steam reforming, the conversion of methane and CO_2 as well as H_2/CO product ratio are strongly influenced by the CO_2/H_2O feed-ratio and by the reaction temperature. Ni-CeO$_2$ catalyst showed an excellent reactivity in CO_2 and steam reforming of methane at 650℃ : 90% CH_4 conversion and about 68% CO_2 conversion and a H_2/CO molar ratio equal to 2.3 were obtained. No deactivation and loss of activity were observed during experimental test. These results were correlated with those of DTA/TG analysis, which confirmed the absence of coke formation on the catalyst.

It can be concluded that the dry reforming combined with steam reforming of methane can not only produce hydrogen with desired H_2/CO ratio, but also could inhibit carbon formation (originated from methane decomposition (Eq. (1) and Boudouard reaction (Eq. (2)) which is usually a serious problem in the CO_2 reforming of methane.

$$CH_4 \rightarrow C + 2H_2 \qquad (\Delta H^\circ = 76 \text{ kJ/mol}) \qquad (1)$$
$$2CO \rightarrow C + CO_2 \qquad (\Delta H^\circ = -173 \text{ kJ/mol}) \qquad (2)$$

REFERENCES:

[1] D.G. Avraam, T.I. Halkides, D.K. Liguras, O.A. Bereketidou, M.A. Goula, An experimental and theoretical approach for the biogas steam reforming reaction, Inter. J. of Hydrogen Energy, vol. 35, pp. 9818-9827, 2010.
[2] C. Gennequin, M. Safariamin, S. Siffert, A. Aboukaïs, E. Abi-Aad, CO_2 reforming of CH_4 over Co–Mg–Al mixed oxides prepared via hydrotalcite like precursors, Catal. Today (2011) In press.
[3] C.S. Lau, A. Tsolakis, M.L. Wyszynski, Biogas upgrade to syn-gas (H_2-CO) via dry and oxidative reforming Inter. J. of Hydrogen Energy, vol. 36, pp. 397-404, 2011.