Artificial Neural Network Modeling Of Hydrogen-Rich Syngas Production From Methane Dry Reforming Over Novel Ni/CaFe\textsubscript{2}O\textsubscript{4} catalysts

M. Anwar Hossain\textsuperscript{a}, Bamidele V. Ayodele\textsuperscript{a}, Chin Kui Cheng\textsuperscript{b,c}, Maksudur R. Khan\textsuperscript{a,c}

\textsuperscript{a} Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang Kuantan, Pahang, Malaysia
\textsuperscript{b} Rare Earth Research Centre, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang Kuantan, Pahang, Malaysia
\textsuperscript{c} Center of Excellence for Advanced Research in Fluid Flow, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang Kuantan, Pahang, Malaysia

ABSTRACT

In this study, the application of artificial neural networks (ANN) for the modeling of hydrogen-rich syngas produced from methane dry reforming over Ni/CaFe\textsubscript{2}O\textsubscript{4} catalysts was investigated. Multi-layer perceptron (MLP) and radial basis function (RBF) neural network architectures were employed for the modeling of the experimental data obtained from methane dry reforming over novel Ni/CaFe\textsubscript{2}O\textsubscript{4} catalysts. The Ni/CaFe\textsubscript{2}O\textsubscript{4} catalysts were synthesized and characterized by XRD, SEM, EDX and FTIR. The as-synthesized Ni/CaFe\textsubscript{2}O\textsubscript{4} catalysts were tested in a continuous flow fixed bed stainless steel reactor for the production of hydrogen-rich syngas via methane dry reforming. The inputs to the ANN–MLP and ANN–RBF-based models were the catalyst metal loadings (5–15wt %), feed ratio (0.4–1.0) and the reaction temperature (700–800 °C). The two models were statistically discriminated in order to measure their predictive capability for the hydrogen-rich syngas production. Coefficient of determination ($R^2$) values of 0.9726, 0.8597, 0.9638 and 0.9394 obtained from the prediction of H\textsubscript{2} yield, CO yield, CH\textsubscript{4} conversion and CO\textsubscript{2} conversion respectively using ANN–MLP-based model were higher compared to $R^2$ values of 0.9218, 0.7759, 0.8307 and 0.7425 obtained for the prediction of H\textsubscript{2} yield, CO yield, CH\textsubscript{4} conversion and CO conversion respectively using ANN–RBF-based model. The statistical results showed that the ANN–MLP-based model performed better than ANN–RBF model for the prediction of hydrogen-rich syngas from methane dry reforming over the Ni/CaFe\textsubscript{2}O\textsubscript{4} catalysts. Further t-test performed based on the target outputs from the ANN–MLP and ANN–RBF network shows that the models were statistically significant.

KEYWORDS: Artificial neural network; Calcium ferrite; Methane dry reforming; Multi-layer perceptron; Nickel; Radial basis function

DOI: 10.1016/j.ijhydene.2016.04.034