

## Production of CO-rich Hydrogen from Methane Dry Reforming Over Lanthania-Supported Cobalt Catalyst: Kinetic and Mechanistic Studies

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### ABSTRACT

In this study, the production of CO-rich hydrogen from methane dry reforming over lanthania-supported Co catalyst was investigated. The Co/La<sub>2</sub>O<sub>3</sub> catalyst was synthesized via wet-impregnation method and characterized using instrument techniques such as TGA, FTIR, XRD, FESEM-EDX and N<sub>2</sub> adsorption-desorption analysis. The catalytic activity of the Co/La<sub>2</sub>O<sub>3</sub> catalyst tested in a fixed bed stainless steel reactor yielded highest CH<sub>4</sub> and CO<sub>2</sub> conversion of 50% and 60% respectively at 1023 K and feed ratio of 1.0. The methane dry reforming reaction gave highest H<sub>2</sub> and CO yield of 45% and 58% respectively. Furthermore, kinetics and mechanistic behavior of the La<sub>2</sub>O<sub>3</sub> supported Co catalyst in methane dry reforming reaction was investigated as a function of temperature and partial pressure of reactants (CH<sub>4</sub> and CO<sub>2</sub>). The experimental data obtained from the kinetics measurements were fitted using the empirical power-law rate expression, as well as six different Langmuir–Hinshelwood kinetics models. The six models were then statistically and thermodynamically discriminated. Consequently, the Langmuir–Hinshelwood kinetics model (dual-site associative adsorption of both CH<sub>4</sub> and CO<sub>2</sub> with bimolecular surface reaction) was adjudged the best representative model. Activation energy values of 96.44 and 98.11 kJ mol<sup>-1</sup> were obtained for the CH<sub>4</sub> consumptions from the power-law and Langmuir–Hinshelwood models, respectively. A lower activation energy of *circa* 72 kJ mol<sup>-1</sup> obtained for CO<sub>2</sub> consumption showed that the rate of consumption of CO<sub>2</sub> was speedier than CH<sub>4</sub>.

**KEYWORDS:** Cobalt; Dry reforming; Methane; Lanthanum; Langmuir–Hinshelwood; Syngas

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