ONLINE ISSN : 1349-273X
PRINT ISSN : 1346-8804

Journal of the Japan Petroleum Institute
Vol. 48 (2005) , No. 5 pp.290-300

Partial Oxidation of Methane to Synthesis Gas over Oxidized Diamond Supported Catalysts—Catalytic Behavior of Nickel and Cobalt Species—

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(Received: December 7, 2004)

Characterization of nickel and cobalt catalysts supported on oxidized diamond (O-dia) in the partial oxidation of methane to synthesis gas was carried out by X-ray photoelectron spectroscopy (XPS) and the transient response pulse technique. Carbon deposition occurred on nickel/O-dia, but not on cobalt/O-dia catalyst at 873 K throughout prolonged reaction. XPS analyses observed partially reduced nickel oxides on nickel/O-dia catalyst after reaction with methane/oxygen (5/1) at 873 K. Co(0), partially reduced cobalt oxide, and Co(III) oxide phases were found on cobalt/O-dia catalyst after reaction at 873 K. Transient response methane/oxygen (2/1) pulse studies found a large amount of hydrogen production occurred immediately at 873 K over the nickel/O-dia catalyst. However, a very small amount of hydrogen production was seen over the cobalt/O-dia catalyst, indicating that nickel and cobalt species supported on O-dia exhibited different behavior. Transient response of the catalyst bed temperature found that endothermic reaction occurred on the nickel/O-dia catalyst at 873 K, but exothermic reaction proceeded on the cobalt/O-dia catalyst. These results suggest that methane decomposition to hydrogen is the primary reaction path over nickel/O-dia catalyst, whereas complete oxidation is the primary reaction followed by steam and carbon dioxide reforming to produce synthesis gas over the cobalt/O-dia catalyst.

Keywords: Partial oxidation, Diamond, Methane, Synthesis gas, Pulse method

To cite this article:
Hiro-aki Nishimoto, Na-oki Ikenaga, Kiyoharu Nakagawa, Toru Konishi and Toshimitsu Suzuki, *Journal of the Japan Petroleum Institute*, Vol. **48**, No. 5, p.290 (2005) .

doi:10.1627/jpi.48.290
JOI JST.JSTAGE/jpi/48.290