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Author:  [ADVANCED](#) | Volume  Page   
Keyword:     

[TOP](#) > [Available Issues](#) > [Table of Contents](#) > [Abstract](#)

ONLINE ISSN : 1349-273X

PRINT ISSN : 1346-8804

**Journal of the Japan Petroleum Institute**

Vol. 46 (2003) , No. 2 pp.99-104



[\[PDF \(304K\)\]](#) [\[References\]](#)

## **Catalyst Deactivation in Distillate Hydrotreating (Part 2) Raman Analysis of Carbon Deposited on Hydrotreating Catalyst for Vacuum Gas Oil**

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(Received: July 16, 2002)

Carbon deposited on spent vacuum gas oil (VGO) hydrotreating catalysts from a commercial plant was investigated by elemental analysis and Raman spectroscopy. The samples of spent catalysts were separately recovered from the catalyst bed at several depths in the reactor after one year of commercial operation at 8 MPa, 360-400°C and LHSV 2 h<sup>-1</sup>. The amount of coke deposited increased with depth in the catalyst bed, whereas volatile components in the spent catalyst decreased. The Raman spectrum of the carbon deposits on all catalyst samples showed bands at 1600 cm<sup>-1</sup> and 1350 cm<sup>-1</sup>, which became more pronounced at greater depths in the catalyst bed. Calcination of the catalyst at 500°C for 2 h under a nitrogen gas stream caused marked enhancement of the bands of coke on the catalysts recovered from the upper part of the bed, but had no effect on the bands of coke on the catalysts recovered from the lower part of the bed. The asphaltene fraction contaminated with VGO was adsorbed on the catalyst in the upper parts of catalyst bed and condensed at the designed reaction temperature. In contrast, the higher temperatures at the lower parts of the catalyst bed due to the heat released by the hydrogenation reaction had extensively carbonized the adsorbed VGO to form partially graphitized carbon on the catalyst surface. Raman spectroscopy indicated the reaction temperature at each location of the catalyst bed and the progress of exothermic reactions.

**Keywords:** [Catalyst deactivation](#), [Raman spectroscopy](#), [Coke](#), [Vacuum gas oil](#), [Graphite](#)

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To cite this article:

Masaomi AMEMIYA, Yozo KORAI and Isao MOCHIDA, *Journal of the Japan Petroleum Institute*, Vol. **46**, No. 2, p.99 (2003) .

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doi:10.1627/jpi.46.99

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