Passive Nitrogen Oxides Removal from a Diesel-engine Exhaust Gas Using a Biomass-carbon Catalyst

Melvina Tan[a], Ibrahim Yakub[*,a] and Taufiq-Yap Yun Hin[b,c]
[a]*Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia*
[b]*Catalysis Science and Technology Research Centre (PutraCAT), Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[c]*Chancellory Office, Universiti Malaysia Sabah, 88400 Kota Kinabalu, Malaysia*

Abstract

Nitrogen oxides (NO_x) removal from a diesel-engine exhaust gas requires the utilization of ammonia/urea as a reducing agent (SCR) which arose environmental concerns over the use of this chemical. Therefore, this study explored the potential of using a sustainable NO_x removal system by replacing ammonia with intrinsic reductants present in the exhaust gas, such as hydrocarbons and carbon monoxide, and by application of cost-effective carbon-supported transitional metals catalyst. Copper-cerium catalyst supported over palm kernel shell activated carbon (Cu-Ce/PKS) was synthesized via deposition-precipitation method. The characterization shows that the catalyst has a considerably high surface area (though lower than the support). The high NO_x removal by Cu-Ce/PKS in a passive catalytic reaction is attributable to the surface area provided by the carbon support, the low copper reducibility which leads to the low optimum operating temperature, and the synergistic effect between Cu and Ce which resulted in the wide temperature window at low-temperature range. It is concluded that Cu-Ce supported over palm kernel shell activated carbon can be further developed to reduce NO_x in a passive catalytic removal for a sustainable and cost-effective SCR system.

Keywords: *NO_x removal, Passive catalytic reduction, Carbon-supported catalyst, Deposition-precipitation method, Synergistic effect*

1. Introduction

Nitrogen oxides (NO_x) emitted from combustion/incineration processes typically consist of 95 % nitric oxide (NO) and 5 % nitrogen dioxide (NO_2), where NO is considered as the most difficult compound to remove from ambient air for it is nearly insoluble in water [1] [2]. Ammonia-selective catalytic reduction (SCR) is a commonly used technique to remove this toxic gas from an exhaust/flue gas emission. However, a phenomenon called ammonia slip, where the unreacted ammonia is also emitted in the exhaust gas prompted studies on the ammonia replacement as a reducing agent. Among the attractive methods to reduce NO_x emissions from the combustion flue gas is selective catalytic reduction with hydrocarbons (HC-SCR) and/or carbon monoxide (CO-SCR). It is known that both HC and CO are present in a diesel engine exhaust gas due to the incomplete combustion of the fuel. By utilizing the intrinsic carbon monoxide and unburned hydrocarbons to replace ammonia as a reductant in SCR, the cost of NO_x removal can be reduced because of the elimination of ammonia/urea injection

* Corresponding author. Tel.: +082-584584; Fax: +082-583410
E-mail address: yibrahim@unimas.my

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