Surface characteristics of porous coconut shell carbon impregnated with bimetallic catalysts

IBRAHIM Yakub[1, a], KHAIRUL Anwar Mohd Said[1, b], NORSUZAILINA Mohamed Sutan[1, c], YUN Hin Taufiq-Yap[2, d] and SURAHIM Mohamad[2, e]

[1]Faculty of Engineering, Universiti Malaysia Sarawak, Malaysia

[2]Catalysis Science and Technology Research Centre, Faculty of Science, Universiti Putra Malaysia, Malaysia

[a]yibrahim@feng.unimas.my, [b]mskanwar@feng.unimas.my, [c]msnorsuzailina@feng.unimas.my, [d]taufiq@upm.edu.my, [e]surahim88@gmail.com

Keywords: Surface chemistry, morphology, coconut shell, SCR, catalyst, characterization

Abstract. Selective Catalytic Reduction catalyst (Cu-Mn/CSC) was derived from coconut shell carbon (CSC). The bimetallic catalysts, Copper and Manganese (Cu-Mn), were deposited onto CSC using wet impregnation technique while the calcination stage was performed under low temperature ambient air. The samples were then characterized using nitrogen adsorption-and-desorption, carbon dioxide temperature-programmed desorption, ammonia temperature-programmed desorption, hydrogen temperature-programmed reduction as well as scanning electron microscopy. The results showed that the synthesis process increased the external surface area and regulated the distribution of slit-shape pores on Cu-Mn/CSC. Besides, Cu-Mn was found to be reduced and the surface has more acidic groups compared to basic. These findings indicated the potential of using CSC as a precursor for NOx- Selective Catalytic Reduction catalyst.

Introduction

It has been established that Nitrogen Oxides (NOx) from stationary sources such as incinerators and power plants are toxic environmental pollutants that cause acid rain, ozone destruction and respiratory cell damage in humans and animals. This has led to the extensive search for effective measure and materials to reduce NOx. Selective catalytic reduction (SCR) is currently the most widely used method to reduce NOx emissions in power plants and automobile applications [1].

SCR commonly uses expensive materials such as Titanium Dioxide as the catalyst supports [2]. The search for alternative materials that are relatively cheap and readily available leads to the discovery of carbon support such as activated carbon (AC), carbon fiber and activated coke that show high NOx removal efficiency at low temperatures (100 – 250 ^{o}C) due to its high porosity and high surface area [1]. AC from biomass is cheaper than non-renewable source of commercially available AC such as coal. It is typically produced by carbonizing biomass such as olive husk, coffee endocarp, cotton stalks and flamboyant pods followed by activation process with steam at high temperature. These processes create micropores, thus increase the specific surface areas and heavy metal adsorption capacity besides the basic group created on the surface [3].

Nevertheless, they have the drawback of a narrow temperature window (300 – 400 ^{o}C) and within such a temperature range, the exhaust contains particulate matter that may cause catalyst deactivation and poisoning, as well as other pollutants such as SO_2 and Arsenic [4]. Therefore, much attention has been paid to the development of low-temperature SCR catalysts, capable of undergoing a reaction under 300 ^{o}C [1]. In this study, surface chemistry and morphology of an SCR catalyst derived from coconut shell carbon was investigated to determine its potential in low-temperature SCR system.