Synthesis and characterization of carbon-zeolite ZSM-5 composite from the rice husk using tetrapropylammonium bromide template: determination of calcination temperature

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Abstract

Zeolite ZSM-5 is one of Zeolite MFI which has wide application and profitable in chemical industry. In Indonesia, rice husks is an abundant waste which containing a relatively large amount of silica and carbon. Zeolite ZSM-5 can be synthesized from rice husk by utilizing the content of silica and carbon in it. This research aims to produce a composite carbon-zeolite ZSM-5 which derived from rice husks and to determine its calcination temperature stability. Composite carbon-zeolite was synthesized using tetrapropylammonium bromide template and its calcination temperature stability was observed. The research methods include the preparation of rice husk, the synthesis of composite carbon-zeolite by conventional hydrothermal and calcination at a temperature of 400, 500, 600, 700, 800, and 900°C under air and argon atmosphere. The Composite carbon-zeolite was characterized by Fourier Transform Infrared (FTIR), X-Ray Difraction (XRD), and Scanning Electron Microscope-Electron dispersive X-ray Spectrometer (SEM-EDX). The results showed that the composite carbon-zeolite produced is ZSM-5 type which began to change into cristobalite phase at calcinations temperature 800°C.

Key words: Rice husk, zeolite ZSM-5, and calcination.

Introduction

Nowadays, the use of zeolite showed the increasing both in small and large industry. Zeolite can be applied as ion changer, adsorbent, catalyst, and filter or separation media (Fatha, 2007). Synthetic zeolites, as result of engineering chemical process, were used more intensively than natural zeolite. It can be modified to achieve particular specification. ZSM-5, kind of MFI zeolite, has wide application and profitable in industry. The ratio of silica and alumina in it is 80-200 (Panpa & Jinawath, 2009). ZSM-5 can be applied as adsorbent, especially for relatively nonpolar compounds (Pope, 1986). In addition, it can be modified as catalyst (Vu et al., 2008) and membrane (Mabande et al., 2004).

Rice husk contains large amount of silica. In addition, it's very abundant and cheap. I can be produced as silica derivatives products.

According to previous research (Katsuki et al., 2005), which synthesized carbon-zeolite ZSM-5 composite using rice husk charcoal and tetrapropylammonium bromide as template. In this research was conducted synthesis of carbon-zeolite ZSM-5 composite from rice husk charcoal with the addition of various weights of tetrapropylammonium and sodium hydroxide.

Materials and Methods

Materials

Argon, dry rice husks, nitric acid, sodium hydroxide, and tetrapropylammonium bromide (TPABr) were used in this research.

Methods

Rice husks were carbonized, crushed, and then sieved (-100/+325 mesh). The obtained charcoal powder was refluxed in nitric acid solution and the result was characterized by using FTIR. X-Ray Difraction (XRD) and Scanning Electron Microscope-Electron dispersive X-ray Spectrometer (SEM-EDX). The results showed that the composite carbon-zeolite produced is ZSM-5 type which began to change into cristobalite phase at calcinations temperature 800°C.

Results and Discussion

Crystallinity of synthetic carbon-zeolite composite at various weights of sodium hydroxide and TPABr can be identified from the XDR patterns (Figure 1). There are similar XRD patterns of whole synthetic carbon-zeolite the patterns. Base line of XRD pattern of sample 1320 is not liner comparing with other samples. It indicated that carbon-zeolite composite of sample 1320 has more amorphous phase and lower crystallinity than the others.

The SEM photograph revealed carbon-zeolite composite (sample 2025), which was obtained by addition of 2.01 g sodium hydroxide and 2.50 g TPABr, composed of 64.89% carbon and 29.35%