



Original Research Paper

Optimizing conditions for preparation of MnOx/RHA catalyst particle for the catalytic oxidation of NO

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ABSTRACT

Rice husk ash (RHA) was utilized as support to synthesize MnOx/RHA catalyst by incipient wetness impregnation. In order to detailedly investigate the influence of preparation variables on the catalytic activity of MnOx/RHA for NO oxidation, the quadratic regression orthogonal rotation design (QRROD) was employed. An empirical model was developed to correlate preparation variables with the conversion of NO to NO₂. The surface species and morphology of the catalyst were also analyzed by SEM and XRD, respectively. It was found that most of MnOx supported on RHA were granular with micron-size and in the form of amorphous phase. The preparation variables except for calcination time (x_2) had significant effect on the catalytic activity of MnOx/RHA. The model could accurately describe the relationship between the preparation variables and NO conversion through the analysis of variance (ANOVA) and the comparison of experimental results and predicted results. The particles size of MnOx was increased from 0.1 to 1.0 μm , as the calcination temperature was raised from 200 to 800 °C, and the fraction of crystal MnOx also increased. The surface structure of RHA was markedly affected by incineration temperature. With incineration temperature increasing, the surface structure becomes compacter.

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1. Introduction

Air pollution caused by the emissions of sulfur compound (mainly SO₂) and nitrogen oxides (mainly NO) from the combustion of the fossil fuels has become a serious environmental problem in recent years. Many technologies have been developed for the control of SO₂ and NOx [1–3]. Among these technologies, the combination of low NOx burner technology, wet flue gas desulphurization (WFGD) and selective catalytic reduction (SCR) are proved to be the most effective method for removal SO₂ and NOx. However, high cost of capital investment and operation limit their application, especially in the developing country such as China. Thus, particular efforts have been directly made to find a suitable method for simultaneous removal of NOx and SO₂ in one absorption cell [4–7]. Selective catalytic oxidation (SCO) is a popular choice for simultaneous removal of NO and SO₂ from the flue gas [8]. NO is first oxidized to NO₂ under the action of catalysts, and then absorbed along with SO₂ simultaneously from flue gas in the conventional FGD process.

The oxidation of NO to NO₂ is a key step for this technology, which has received considerable researchers' attention. Besides the familiar strong oxidant such as KMnO₄, O₃ and NaClO₂ used

to oxidize NO, NO catalytic oxidation is also widely studied. At present, it is mainly achieved by using pt-based catalyst. However, some problems, such as high cost, SO₂ poisoning, H₂O poisoning, etc. limit the commercial application of pt-based catalyst. Recently it has been found that the transition metal oxides, such as MnOx and Co₃O₄, supported on the surface of the porous material also exhibited high catalytic activity for NO oxidation. Yung et al. [9] synthesized the cobalt based catalysts supported on TiO₂ and ZrO₂ for the oxidation of NO to NO₂ in excess oxygen. Wang et al. [10] prepared the Co/KxTi₂O₅ catalyst by ion exchange method for NO oxidation at low temperature. Jeong et al. [11] synthesized the multi-walled carbon nanotubes by using Co-Fe-Mo/Al₂O₃ catalytic powders in a fluidized bed reactor. The catalysts consisting of the transition metals and porous materials have potential for NO oxidation in the presence of low concentration of SO₂ and water vapor.

However, the catalytic activity of transition metal varies significantly for being supported on different types of porous materials. Catalyst supports had a significant effect on the catalytic activity of the transition metals. Presently silica, titania, alumina and carbon materials are widely used as the catalyst support to increase the mechanical strength and surface area of the catalysts due to their superior physical and chemical properties. However, the costs of these supports are high, and some of them are not appropriate in

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