CATALYTIC ELIMINATION OF CARBON MONOXIDE IN GAS STREAMS BY THERMAL AND OZONE OXIDATIONS

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Abstract

The catalytic activities of Pt-Pd, 0.25 wt.% Mn and 0.56 wt.% Mn coated on Al\textsubscript{2}O\textsubscript{3} pellets during catalytic thermal oxidation and catalytic ozone oxidation were investigated. The results reveal that the activity of catalysts in catalytic ozone oxidation differed substantially from that in catalytic thermal oxidation.

Keywords: CO, ozone, catalytic thermal oxidation, catalytic ozone oxidation

INTRODUCTION

Noble metals, such as palladium and platinum, are well-known highly active catalysts for the thermal oxidation of carbon monoxide, methane and olefins [1-4]. Compared with noble metals, base metal catalysts, which are much cheaper, show a lower but still sufficient activity during catalytic oxidation processes [5]. The activity of Mn catalysts in oxidizing CO was reported to exceed those of Cr, Fe, Co and Ni catalysts [6].

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By contrast to thermal catalytic oxidation, which usually processes at a higher temperature, ozone catalytic oxidation can take place at room temperature. However, ozone catalytic oxidation requires the addition of ozone into contaminated gas streams before they are passed through a catalyst bed to enable catalytic oxidation reactions \[7\]. The acceleration of CO oxidation on Au/Fe2O3 \[8\], CeO2 \[9\], Co-Cr \[10\], Pd-Pt \[11\] and Mn catalysts \[12-13\] by ozone have been reported.

This work intends to compare the influences of the packing of Pt-Pd and Mn catalytic materials on the removal efficiency of CO in the catalytic thermal oxidation as well as the catalytic oxidation of ozone. Furthermore, the effects of packing materials on the decomposition of ozone would be also evaluated.

**EXPERIMENTAL**

Catalytic reactions were performed with a packed reactor. Pt-Pd/Al2O3 and Al2O3 pellets with a diameter of 5 mm purchased from K.J. Environmental Technology Co. Ltd. (Taiwan) were used as packing materials in this study. The impregnation method was utilized to prepare Mn catalytic pellets. Al2O3 pellets, as metal supports, were impregnated with an aqueous solution of Mn(NO3)2⋅4H2O (analytical grade, Merck). The Al2O3 pellets and impregnating aqueous solution were placed in a custom-made furnace equipped with a rotary device for 12 h at (1) a rotation speed of 5 rpm and (2) a temperature of 120°C. Then, the impregnated pellets were calcined in air at 600°C for another 8 h. The Mn catalyst content on the Al2O3 pellets could be varied by changing the concentration of Mn(NO3)2⋅4H2O. The Pt and Pd contents on the Al2O3 pellets were 0.081 and 0.075 wt.%, respectively. Support pellets with 0.25 and 0.56 wt.% Mn were tested in this work. The surface areas of Al2O3, Pt-Pd, 0.25 wt.% Mn and 0.56 wt.% Mn pellets are 293, 199, 187 and 82 m²/g, respectively.

The XRD pattern of the Mn catalyst is presented in Fig. 1. The XRD patterns of manganese oxides treated at 600°C show diffraction peaks at 23.2, 32.9, 38.3, 45.2, 49.4, and 55.2° corresponding to Mn2O3. The XRD patterns of commercial Pt-Pd/Al2O3 were not obtained in this study probably because the amounts of Pt and Pd on the Al2O3 pellets were very small. However, the commercial catalysts were reduced at 300°C in a stream of hydrogen during the last make-up process. Then, the Pt and Pd would be at the reduced state on Al2O3 pellets.

The dry-grade compressed CO (10% CO in pure N2) and air (80%N2 and 20% O2) cylinders were used to supply CO and air streams. The CO concentration was controlled by adjusting the diluted airflow rates. The flow