Dehydrogenation of 1-Butene over Pt/SnO$_2$-SiO$_2$ Catalysts in the Presence of Steam

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1. Introduction

The demand of 1, 3-butadiene (BD) has been increasing by motorization in Asia. The supply of BD will decrease, because ethylene source changes from naphtha to ethane. Therefore, the development of new processes for BD production is expected [1]. Recently, we focused on the simple dehydrogenation (SDH) of 1-butene, and found that Pt/SnO$_2$-Al$_2$O$_3$ catalysts having a high SnO$_2$ content showed a high activity and selectivity to BD.

In this study, we prepared the Pt/SnO$_2$-SiO$_2$ catalysts and used for the 1-butene dehydrogenation. Moreover, the relationship between PtSn species and the performance of the catalyst was discussed.

2. Experimental

2.1. Preparation of the catalyst

SnO$_2$-SiO$_2$ Supports were prepared by an impregnation method with SiO$_2$ (JRC-SIO-10) and an appropriate amount of an ethanol solution containing SnCl$_2$. After the calcination of the supports at 550 °C, the precursors of the Pt catalysts were prepared by an impregnation method with an aqueous solution of H$_2$PtCl$_6$. To obtain the Pt/SnO$_2$-SiO$_2$ catalysts, the precursors were dried in an oven at 130 °C overnight and reduced at 550 °C in a H$_2$ flow.

2.2. 1-butene dehydrogenation

SDH of 1-butene was carried out using a fixed bed isothermal reactor. Prior to the reaction, the catalysts (0.50 g) were reduced for 1 h at the reaction temperature (600 °C). The molar ratio of the feed gas was 1-butene:He:H$_2$O = 1:4:3 with the total flow rate was 99 ml/min.

3. Results and discussion

Fig.1 shows the results of 1-butene SDH over five kinds of the Pt/SnO$_2$-SiO$_2$ catalysts having different Sn/Pt molar ratios (1.1, 1.7, 2.3, 2.8, and 3.3). The catalysts with Sn/Pt=1.7-2.3 exhibited a higher BD yield and stability for 6 h compared to the other catalysts. Meanwhile, both the catalysts having higher and lower Sn/Pt ratios (Sn/Pt=1.1, 2.8 and 3.3) showed the serious deactivation.

REFERENCES