

Effect of Cr, Ni, Fe and Mn dopants on the performance of hydrothermal synthesized vanadium phosphate catalysts for n-butane oxidation

Abstract

Vanadium phosphorus oxide (VPO) catalysts synthesized via hydrothermal method were introduced with some different dopants, Cr, Ni, Fe, and Mn during the preparation of the precursors, $\text{VOHPO}_4 \cdot 0.5\text{H}_2\text{O}$. All modified precursors were subsequently transformed under reaction conditions to give the active phase, $(\text{VO})_2\text{P}_2\text{O}_7$. Several techniques were used to characterize the physicochemical properties of the catalysts, such as X-ray diffraction (XRD), Brunauer-Emmett-Teller (BET), H_2 -temperature programmed reduction (TPR), laser Raman spectroscopy (LRS), and chemical analysis. The catalytic performance of the catalysts for selective oxidation of n-butane to maleic anhydride has been carried out by using a fixed bed microreactor (673 K, gas hourly space velocity [GHSV] = 2,400 hr^{-1}). The results show that the addition of dopants into the VPO catalysts increased the surface area of the catalysts and induced the formation of V^{5+} phases as shown in XRD and LRS spectra that promoted the catalytic performance. A further water reflux treatment to all the precursors gave catalysts with only $(\text{VO})_2\text{P}_2\text{O}_7$ phase. However, the activity and selectivity of these catalysts were reduced markedly.

Keyword: Butane oxidation; Cr; Fe; Hydrothermal; Mn; Ni; TPR; VPO