Effects of Bi and Ni on the properties of a vanadium phosphorus oxide catalyst

Abstract

Vanadium phosphorus oxide (VPO) catalysts were synthesized by the dihydrate method which involved the two steps for the preparation of the dihydrate (VOPO4·2H2O) and the precursor hemihydrate (VOHPO4·0.5H2O). Bi and Ni salt were added into the mixture of VOPO4·2H2O and isobutanol, and the obtained precursors were calcined in a flow of a n-butane/air mixture to produce the promoted VPO catalysts. The catalysts were characterized by X-ray diffraction (XRD), N2 adsorption-desorption, inductively coupled plasma-atomic emission spectroscopy, scanning electron microscopy (SEM), and H2 temperature-programmed reduction (H2-TPR). Their catalytic properties were tested using a fixed-bed microreactor. All the catalysts gave main XRD peaks at 2θ = 22.9°, 28.5°, and 30.0°, attributing to the (020), (204), and (221) planes of the pyrophosphate phase (VO)2P2O7, respectively. The promoted catalysts have smaller crystallite size and higher specific surface areas. SEM micrographs revealed the formation of more prominent plate-like crystallites that were arranged as rosette clusters. H2-TPR results showed that the promoted catalysts had lower reduction peak temperatures and possessed higher amounts of V5+-O2– and V4+-O– pairs, which gave higher selectivity and activity in the selective oxidation of n-butane to maleic anhydride.

Keyword: Vanadium phosphorus oxide catalyst; Promoter; n-Butane oxidation; Maleic anhydride selectivity