On the mechanism of the selective oxidation of n-butane, but-1-ene and but-1,3-diene to maleic anhydride over a vanadyl pyrophosphate catalyst

Abstract

The mechanism of the selective partial oxidation of n-butane, but-1-ene and but-1,3-diene over a vanadyl phosphate catalyst has been investigated by temperature-programmed desorption (TPD) and by anaerobic temperature-programmed oxidation (TPO). TPD showed lattice oxygen to be desorbed in two states at 998 and 1023 K. The anaerobic TPO of n-butane produced butene and butadiene at 1020 K; anaerobic TPO of but-1-ene produced butadiene and furan at 990 K and dehydrofuran at 965 K, while anaerobic TPO of but-1,3-diene produced dehydrofuran at 970 K, furan at 1002 K and maleic anhydride at 1148 K. The total amount of oxygen removed from the lattice in these anaerobic selective partial oxidations was the same as that evolved from the vanadyl phosphate catalyst by TPD. This, and the fact that the selective oxidation reactions occurred at the same temperature at which the oxygen evolves from the lattice, suggests that the lattice oxygen is uniquely selective when it appears at the surface of the catalyst. (Under identical conditions of flow rate, weight of catalyst, heating rate etc., the reaction of n-butane or of but-1,3-diene in air produced only CO2 and H2O.)