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Alumina Supported Copper-Manganese-Cobalt Catalysts for CO and VOCs Oxidation

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Abstract : Formaldehyde production by selective oxidation of methanol is an important industrial process. The main by-products in the waste gas are CO and dimethyl ether (DME). The idea of this study is to combine the advantages of both Cu-Mn and Cu-Co catalytic systems by obtaining a new mixed Cu-Mn-Co catalyst with high activity and selectivity at the simultaneous oxidation of CO, methanol, and DME. Two basic Cu-Mn samples with high activity were selected for further investigation: (i) manganese-rich Cu-Mn/γ–Al2O3 catalyst with Cu/Mn molar ratio 1:5 and (ii) copper-rich Cu-Mn/γ-Al2O3 catalyst with Cu/Mn molar ratio 2:1. Manganese in these samples was replaced by cobalt in the whole concentration region, and catalytic properties were determined. The results show a general trend of decreasing the activity toward DME oxidation and increasing the activity toward CO and methanol oxidation with the increase of cobalt up to 60% for both groups of catalyst. This general trend, however, contains specific features, depending on the composition of the catalyst and the nature of the oxidized gas. The catalytic activity of the sample with Cu/(Mn+Co) molar ratio of 2:1 is gradually changed with increasing the cobalt content. The activity of the sample with Cu/(Mn+Co) molar ratio of 1: 5 passes through a maximum at 60% manganese replacement by cobalt, probably due to the formation of highly dispersed Co-based spinel structures (Co3O4 and/or MnCo2O4). In conclusion, the present study demonstrates that the Cu-Mn-Co/γ–alumina supported catalysts have enhanced activity toward CO, methanol and DME oxidation. Cu/(Mn+Co) molar ratio 1:5 and Co/Mn molar ratio 1.5 in the active component can ensure successful oxidation of CO, CH3OH and DME. The active component of the mixed Cu-Mn-Co/γ–alumina catalysts consists of at least six compounds - CuO, Co3O4, MnO2, Cu1.5Mn1.5O4, MnCo2O4 and CuCo2O4, depending on the Cu/Mn/Co molar ratio. Chemical composition strongly influences catalytic properties, this effect being quite variable with regards to the different processes.

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