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2012

Dostupný z http://www.nusl.cz/ntk/nusl-126627

Dílo je chráněno podle autorského zákona č. 121/2000 Sb.

Tento dokument byl stažen z Národního úložiště šedé literatury (NUŠL).

Datum stažení: 10.04.2024

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Pelletized catalysts for VOC oxidation with non-uniform distribution of mixed oxides – preparation and characterization

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Catalytic total oxidation is employed most frequently for abatement of volatile organic compounds (VOC) by reason of low operating temperature and high efficiency. As a cheaper alternative to noble metal based catalysts using of metal mixed oxide catalysts is possible. For practical application, the catalysts are usually supported on various carriers. Since this reaction is very fast, it proceeds in the outer shell of the catalyst predominantly. Therefore, to avoid diffusion limitations and utilize the catalytic active phase effectively and, in particular, to minimize the cost of the catalyst, it is desirable to deposit the active phase on supporting material in a thin layer.

In this work, preparation methods were explored to prepare catalysts with non-uniform distribution of active components. Physical-chemical properties of the catalysts were examined, as well as their activity in total oxidation of ethanol as a model VOC.

Three ways of catalyst preparation were applied to obtain the catalysts with non-uniform distribution of Co-Mn-Al mixed oxides over two commercial supports (TiO_2, Al_2O_3):
Pore-filling method of a support impregnation by nitrates solutions, impregnation by spraying of a support with a solution of Co, Mn, and Al nitrates in a rotating pan and by coating of a support with mixed oxides precursor in a rotating pan. For comparison, unsupported catalysts were prepared by pelletization of a mixed oxides precursor to pellets. All catalysts were calcined 4 h at 500 °C.

The prepared catalysts were characterized by chemical analysis, sorption of nitrogen at -195 °C, consumption of H_2 during temperature programmed reduction (TPR), desorption of NH3 and CO_2 during temperature programmed desorption (NH_3-TPD, CO_2-TPD), by scanning electron microscopy (SEM) and activity and selectivity in total oxidation of ethanol.

It was found out that the catalysts with thin outer layer of mixed oxides over support (approximately 10 times lower content) exhibit the same catalytic activity as the catalysts prepared by pelletization of pure active components precursors.

Acknowledgement: The authors thank the Grant Agency for the financial support (GA ČR P106/10/1762).