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Hydroxylation of benzene to phenol over magnetic recyclablenanostructured CuFe mixed-oxide catalyst

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Abstract

A highly active and magnetically recyclable nanostructured copper–iron oxide (CuFe) catalyst has been synthesized for hydroxylation of benzene to phenol under mild reaction conditions. The obtained catalytic results were correlated with the catalyst structure, which was characterized by XRD, SEM, TEM, EDX, H(sub2-)TPR and BET. The catalytic results indicated that the CuFe mixed oxide samples exhibited superior performance compared to its analogous single nano-oxide catalysts. The influence of the reaction condition variables, such as the solvent, reaction temperature, time, and amount of H(sub2)O(sub2) oxidant, were investigated. Under optimized conditions, CuFe resulted in benzene conversion of 44% at a phenol selectivity of 91% and a corresponding combined hydroquinone/catechol/benzoquinone selectivity of 9%. In addition, the catalytic activity of the nano-oxide CuFe was significantly affected by the different calcination temperatures due to the induced catalyst structure, which was confirmed by the characterization results. This enhanced activity was due to the structural phases and redox modification resulting from the interface between the Cu and Fe metals, which was caused by varying calcination temperatures. The activity of CuFe does not require the formation of the typical favored CuFe(sub2)O(sub4) spinel to achieve a highly active catalyst, which results from the enhanced redox potentials. CuFe is highly recyclable due to its magnetic nature, which results in an excellent ecofriendly catalyst for the direct synthesis of phenol from benzene hydroxylation.