Enhancement of Catalytic Stability of Ruthenium-Copper-Based Catalysts for the Epoxidation of Propylene to Propylene Oxide

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Propylene oxide (PO) is an important chemical feedstock for producing various commercial materials, such as polyether polyols and propylene glycol. Currently, chlorohydrin and organic hydroperoxide processes are commonly used for the PO production. However, the chlorohydrin produces chlorinated hydrocarbons as by-products causing an environmental impact and the hydroperoxide process requires H_2O_2 which is a costly reagent. This research presents an alternative process to produce PO by using ruthenium-copper-based catalysts for the direct gas-phase epoxidation using propylene and O_2 under atmospheric pressure. The catalysts were prepared by co-impregnation method and their catalytic activity was monitored with time on stream for 6 hours. Various studies affecting the PO formation rate, such as Ru/Cu metallic weight ratios, total metal loading on SiO_2 support, additional promoters (TeO_2, Cs_2O, NaCl, TiO_2) were investigated. The results showed that the optimal PO formation rate was about 1068 $g_{PO}\ h^{-1}\ kg_{cat}^{-1}$ (3.19 % PO selectivity and 21.5 % propylene conversion) at the Ru/Cu ratio of 3/1 and total metal loading of 14.28%. Unlike NaCl, the additions of TeO_2, Cs_2O, and/or TiO_2 have improved the PO selectivities with a high stability of the catalysts under the testing condition.

Keywords: propylene, propylene oxide, epoxidation, RuO_2, CuO