Mechanism of deactivation of iron based catalyst in carbon dioxide to hydrocarbon

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The compositions of iron-based catalysts are deactivated significantly during CO_2 hydrogenation due to mainly catalyst poisoning as well as carbon deposit. The formation and composition of these iron phases depend on the process conditions, catalyst deactivation, and catalyst composition. The catalytic activity of each of these phases with respect to the CO_2 hydrogenation is still controversial. We report the results of a detailed investigation of deactivated Fe-K/γ-Al_2O_3 catalyst. The characterizations of deactivated catalyst were also carried out to provide information on the deactivation pathway as function of time and catalyst position. The deactivation occurred on Fe-K/γ-Al_2O_3 during the reaction, although the long run activity was 35% above. As the time progress, the hematite (Fe_3O_4), formed after H_2 reductions, is gradually carburized to χ-Fe_5C_2. Finally, χ-Fe_5C_2 phase is converted to θ-Fe_3C, which is inactive species for CO_2 hydrogenation. The deactivation of the bottom part in reactor is coke deposit due to adsorption of the produced hydrocarbon.