Enhanced low temperature reaction for the CO_2 methanation over Ru promoted Fe/Mn-Al_2O_3 catalyst using double reactor system.

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Abstract

The iron with manganese (Fe/Mn) on alumina (Al_2O_3) support have been considered as potential catalyst for the carbon dioxide methanation due to the low cost and its unique ability to facilitate the conversion of CO_2 to CH_4. However, the operating at high temperature reaction limit their large scale industrial application. In order to address this challenge, a series low content of Ru promoted Fe/Mn on Al_2O_3 have been design by wet impregnation method with one and two stages reactor. The influences of Ru contents on Fe/Mn-Al_2O_3 the catalytic activities and physicochemical properties of prepared catalysts were investigated. The addition Ru can improve the catalytic activity and the basicity of the catalysts surface. As a result, their low-temperature reaction had been enhanced over these doped Ru promoted catalysts. The optimal catalyst was 2Ru60Fe/Mn-Al_2O_3 which the CO_2 conversion reached 90.2% with the methane selectivity of 100% at 250°C when using single reactor. Intrestingly, the temperature raction was significantly reduced at 200°C when using double reactor which the CO_2 conversion reached 91.1% with the methane selectivity of 100%. The stability test showed that the Ru promoted on Fe/Mn-Al_2O_3 catalyst maintained its high reactivity after 8 hours.

4.0 Conclusion

The present study investigated the influence of Ru addition on catalytic performance of Fe/Mn-Al_2O_3 catalysts for CO_2 methanation reaction by using single and double reactor. The characterization results indicated that the dispersion of Ru on the catalysts was affected by the structure of the supports, and the RuO_2 promoted catalysts could stabilize the Cu species more effectively. In addition, the interaction among the Fe and Mn active sites, the promoter RuO_2 and the support alumina could promote the activation of adsorbed CO_2. In this work, 3Ru60Fe/Mn-Al_2O_3 showed the best catalytic performance with CO_2 conversion and CH_4 selectivity reaching the highest value of 95.6% and 100%. Besides, the RuO_2 promoted catalyst not only exhibited great catalytic performance but also showed good catalytic stability and work at low temperature reaction, suggesting great potential in reducing the cost for industrial application and could be a solution for the CO_2 reduction.

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