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Carbon dioxide reforming of methane over modified iron-cobalt alumina catalyst: Role of promoter

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ABSTRACT

Background: Cobalt-based catalysts are widely employed in methane dry reforming but tend to deactivate quickly due to coke deposits and metal sintering. To enhance the performance, iron, a cost-effective promoter, is added, improving cobalt's metal dispersibility, reducibility, and basicity on the support. This addition accelerates carbon gasification, effectively inhibiting coke deposition.

Methods: A series of iron-doped cobalt alumina MFe-5Co/Al_2O_3 (M= 0, 0.4, 0.8, 1, 2 wt.%) were prepared via simple incipient-wetness impregnation. The catalysts were thoroughly characterized via modern techniques including BET, XRD, H_2-TPR, CO_2-TPD.

Significant findings: The addition of iron had a minimal impact on the properties of γ-Al_2O_3, but it significantly affected the dispersibility of cobalt. At an optimal dosage of 0.8 wt.%, there was a notable decrease of 29.44% in Co_3O_4 particle size. However, excessive iron loading induced agglomeration of Co_3O_4, which was reversible. The presence of iron also resulted in a decrease in the reduction temperature of Co_3O_4. The material's basicity was primarily influenced by the loading of iron, reaching its highest value of 705.7 μmol CO_2 g^{-1} in the 2Fe-5Co/Al_2O_3. The correlation between catalytic activity and the physicochemical properties of the material was established. The 0.8Fe-5Co/Al_2O_3 sample exhibited excellent performance due to the favorable dispersibility of cobalt, its reducibility, and its affordable basicity.

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