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Iron Catalyst for Decomposition of Methane: Influence of Al/Si Ratio Support

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Abstract : Hydrogen is the expected future fuel since it produces energy without any pollution. It can be used as a fuel directly or through the fuel cell. It is also used in chemical and petrochemical industry as reducing agent or in hydrogenation processes. It is produced by different methods such as reforming of hydrocarbon, electrolytic method and methane decomposition. The objective of the present paper is to study the decomposition of methane reaction at 700°C and 800°C. The catalysts were prepared via impregnation method using 20%Fe and different proportions of combined alumina and silica support using the following ratios [100%, 90%, 80%, and 0% Al_2O_3/SiO_2]. The prepared catalysts were calcined and activated at 600 OC and 500 OC respectively. The reaction was carried out in fixed bed reactor at atmospheric pressure using 0.3g of catalyst and feed gas ratio of 1.5/1 CH_4/N_2 with a total flow rate 25 mL/min. Catalyst characterizations (TPR, TGA, BET, XRD, etc.) have been employed to study the behavior of catalysts before and after the reaction. Moreover, a brief description of the weight loss and the CH_4 conversions versus time on stream relating the different support ratios over 20%Fe/Al_2O_3/SiO_2 catalysts has been added as well. The results of TGA analysis provided higher weights losses for catalysts operated at 700°C than 800°C. For the 90% Al_2O_3/SiO_2, the activity decreases with the time on stream using 800°C reaction temperature from 73.9% initial CH_4 conversion to 46.3% for a period of 300min, whereas the activity for the same catalyst increases from 47.1% to 64.8% when 700°C reaction temperature is employed. Likewise, for 80% Al_2O_3/SiO_2 the trend of activity is similar to that of 90% Al_2O_3/SiO_2 but with a different rate of activity variation. It can be inferred from the activity results that the ratio of Al_2O_3 to SiO_2 is crucial and it is directly proportional with the activity. Whenever the Al/Si ratio decreases the activity declines. Indeed, the CH_4 conversion of 100% SiO_2 support was less than 5%.

Keywords : Al_2O_3, SiO_2, CH_4 decomposition, hydrogen, iron
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