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Production of gasoline range hydrocarbons from catalytic reaction of methane in the presence of ethylene over W/HZSM-5

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Abstract

The catalytic conversion of a methane and ethylene mixture to gasoline range hydrocarbons has been studied over W/HZSM-5 catalyst. The effect of process variables, such as temperature, percentage of volume of ethylene in the methane stream and catalyst loading on the distribution of hydrocarbons was studied. The reaction was conducted in a fixed-bed quartz-micro reactor in the temperature range of 300–500 °C using percentage of volume of ethylene in methane stream between 25 and 75% and catalyst loading of 0.2–0.4 g. The catalyst showed good catalytic performance yielding hydrocarbons consisting of gaseous products along with gasoline range liquid products. The mixed feed stream can be converted to higher hydrocarbons containing a high-liquid gasoline product selectivity (>42%). Non-aromatics C_5–C_{10} hydrocarbons selectivity in the range of 12–53% was observed at the operating conditions studied. Design of experiment was employed to determine the optimum conditions for maximum liquid hydrocarbon products. The distribution of the gasoline range hydrocarbons (C_5–C_{10} non-aromatics and aromatics hydrocarbons) was also determined for the optimum conditions.

Keywords: Gasoline range hydrocarbons; Catalytic conversion; Methane and ethylene mixture; Design of experiment; Optimum condition

Abbreviations: ANOVA, analysis of variance; BET, Brunauer–Emmet–Teller; CCD, central composite design; DF, degree of freedom; FID, flame ionization detector; FT, Fischer–Tropsch; GC, gas chromatography; MS, mean square; MTG, methanol to gasoline; OCM, oxidative coupling of methane; RSM, response surface methodology; R^2, the coefficient of determination; Si/Al, silicon to aluminium ratio; SS, sum of squares; SSE, sum of squares due to residuals; SSR, sum of squares due to regression; SST, total of sum of squares; TCD, thermal conductivity detector; ZSM-5, zeolite secony mobil five

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