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Abstract
A radio frequency (RF) plasma system which combined a fixed-bed reactor was used to decompose methane (CH4) and carbon dioxide (CO2) into intermediates, for example, ethylene (C2H4), acetylene (C2H2), ethane (C2H6) and propane (C3H8), and then the intermediates passed through the ZSM-5 fixed-bed reactor to obtain higher hydrocarbons and aromatic compound by alkylation and aromatization reactions. First, the conditions for obtaining the goal products, C6H6 and C7H8, were investigated by testing with or without plasma, catalyst and heating of the catalyst bed. Subsequently, the operational parameters, including input power wattage, feeding concentration of carbon dioxide and reaction temperature of fixed-bed reactor were chosen. Further, the influence of these operational parameters on the conversion of reactants and the selectivity of aim product were investigated and discussed. The source reactants are composed of CH4/CO2/Ar, and the products are benzene (C6H6), toluene (C7H8), C2H4, C2H2, C2H6, C3H8 and carbon monoxide (CO).

The result of the first stage shows that two minimum requirement are needed to convert CH4 and CO2 into C6H6 and C7H8. First, some active species must be formed from the plasma, and second, those active species should go through a ZSM-5 catalyst reactor with a temperature over 200℃.

The yields of C6H6 and C7H8 and the decomposition fraction of CH4 and CO2 were increasing with the raising of input power. And the maximum CH4 and CO2 decomposition fraction were 97.57 % and 87.21 % respectively, under the condition of 5% of CH4 and CO2 feeding concentration, 50 sccm of total flow rate, 15 torr of operational pressure, 300℃ of catalyst reactor temperature, and 100 watt of input power wattage. The yields of C6H6 and C7H8 were increasing in advance and then decreasing, while the raising of CO2 feeding concentration in this reaction system. This result shows that a moderate amount of CO2 concentration will be appropriate for the formation of C6H6 and C7H8. In the circumstances of 60 Watt of input power wattage, 5 % of CH4 feeding concentration and 3 % of CO2 feeding concentration, 15 torr of operational pressure, 50 sccm of total flow rate, and 300℃ of fixed-bed reactor temperature, the maximum yields of C6H6 and C7H8 are observed, and they are 2.38 % and 1.4 % for C6H6 and C7H8 respectively. At the same time, the maximum energy efficiency of C6H6 and C7H8, 5.3×10-2 mole KW-1h-1 and 2.66×10-2 mole KW-1h-1, are attained. In addition, while the temperature of ZSM-5 fixed-bed reactor increased from 100℃ to 300℃, the decomposition efficiencies of CH4 and CO2 were improved, and the

yields of C_6H_6 and C_7H_8 also increased. In another word, the rate of converting reaction was increasing with the raising of the reaction temperature in the catalyst reactor, and so that the amount of products, C_6H_6 and C_7H_8, was raised.
Advisory Committee Wei-Tung Liao - advisor

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