Abstract

Kinetics of acetol steam reforming was studied over wide ranges in temperature, 623-773 K, acetol concentration, 5-20 wt.%, and W/F_O ratio, 0.93-4.66 g h/mol, using 5% Pt/C catalyst. It was found that high temperature; S/C ratio and space time facilitates H_2 production from acetol. Maximum liquid feed conversion (81%) and H_2 yield (0.66 mol/mol) were achieved at 773 K at a W/F_O ratio equal to 4.66 g h/mol. The investigated reaction belonged to the kinetically controlled reaction regime systems. Analysis of the experimental data using a power law model suggested that the reaction order with respect to acetol was equal to 0.85, 0.82, 0.78 and 0.88 at 623, 673, 723 and 773 K. A single-site heterogeneous kinetic model was proposed to gain further insight into reaction mechanism and kinetics. This model assumed that the surface reaction between adsorbed acetol and water in the gas phase is rate-controlling. Reaction rates predicted by this model were in good agreement with the experimental rates. The efficacy of Ni/Al_2O_3, Ru/Al_2O_3, Ru/C and Pd/C for the catalytic processing of acetol was investigated at 773 K, W/F_O=4.66 g h/mol and S/C=12.3 mol/mol. Several byproducts such as acetone, acetaldehyde and 2-propanol were formed during reaction. Catalyst coking was largely due to the formation of acetone, which is a major coke precursor. The plausible reactions involved in the reforming process were highlighted and a comprehensive reaction pathway was described.

Catalytic transformation of PG into H_2 at low temperature 773 K was investigated using several commercial catalysts (such as Ni/Al_2O_3, Ru/Al_2O_3, Ru/C, Pt/C and Pd/C). Ni/Al_2O_3 and Ru/Al_2O_3 showed stable conversion for at least 6 h. Among the C-supported catalysts, both Ru/C and Pd/C demonstrated stable operation; however, the Pt/C catalyst exhibited deactivation during time-on-stream. It was found that H_2 selectivity decreases in the order Ru > Pt > Pd, when C-supported catalysts are used. The efficacies of the catalysts were presented as H_2, CO, CO_2 and CH_4 selectivity, and PG conversion into gas-phase. Wide ranges of temperature (573-773 K), W/F_O (18.6-92.9 g h/mol) and S/C ratio (5.6-12.7 mol/mol) were examined using Ni/Al_2O_3. The increase in temperature and W/F_O ratio facilitated H_2 production. The performance of Ni/Al_2O_3 was enhanced at high S/C ratio. At 773 K, H_2 selectivity (66.2%) and PG conversion (73.7%) were maximized using W/F_O=18.6 g h/mol and S/C=12.7 (i.e. 10 wt% PG solution).
Using alumina- and carbon-supported catalysts, steam reforming of ethyl acetate was investigated over the ranges of temperature, 573-773 K, W/F₀ ratio, 49.1-196.5 g h/mol and ethyl acetate concentration, 1-5 wt.%. A comparison of the efficacy of the investigated catalysts was presented at T=773 K and W/F₀=49.1 g h/mol after 1 h of time-on-stream. Conversion to gas phase products was 76.3%, whereas H₂ selectivity was 70.8% when Ni/Al₂O₃ was used. Contrarily, H₂ selectivity was low (49.2%) when Ru/Al₂O₃ was used; gas phase conversion was equal to 69.1 %. The reactivity and H₂ selectivity of carbon-supported catalysts decreased in the order Ru > Pt > Pd. Using Ru/C, conversion and H₂ selectivity values were 61.1 and 36.4%, respectively. From analysis of the reaction products, the formation of ethanol and acetaldehyde was ascertained.

Steam reforming of glyoxal is being investigated over Ru/Al₂O₃ catalyst. The reaction temperature is being varied from 623-773 K, whereas glyoxal concentration is being varied from 1-5 wt %. The effects of these reaction variables on the efficacy of the catalyst are being considered. The importance of diffusion limitations is being examined and reaction kinetics is being studied.

**Keywords:** hydrogen, catalyst, kinetics, H₂ selectivity, reaction mechanism