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Utilization of acetone-butanol-ethanol-water mixture obtained from biomass fermentation as renewable feedstock for hydrogen production via steam reforming: Thermodynamic and energy analyses

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Abstract

A thermodynamic equilibrium analysis on steam reforming process to utilize acetone-butanol-ethanol-water mixture obtained from biomass fermentation as biorenewable fuel has been performed to produce clean energy carrier H_2 via non-stoichiometric approach namely Gibbs free energy minimization method. The effect of process variables such as temperature (573-1473 K), pressure (1-10 atm), and steam/fuel molar feed ratio (F_{ABE}=5.5-12) have been investigated on equilibrium compositions of products, H_2, CO, CO_2, CH_4 and solid carbon. The best suitable conditions for maximization of desired product H_2, suppression of CH_4, and inhibition of solid carbon are 973 K, 1 atm, steam/fuel molar feed ratio=12. Under these conditions, the maximum molar production of hydrogen is 8.35 with negligible formation of carbon and methane. Furthermore, the energy requirement per mol of H_2 (48.96 kJ), thermal efficiency (69.13%), exergy efficiency (55.09%), exergy destruction (85.36 kJ/mol), and generated entropy (0.29 kJ/mol.K) have been achieved at same operating conditions.

Keywords: Hydrogen**,** steam reforming, energy, exergy, acetone-butanol-ethanol-water mixture.

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