Abstract

Biomass gasification process involves complex chemical reactions which converts solid biomass into gaseous fuel, water vapour, char (solid carbon) and tar (aromatic higher hydrocarbons). Air is widely used as gasifying medium for producing syngas used for electrical and thermal applications. Thermodynamic equilibrium models, which are independent of gasifier design, are quite often used for prediction of biomass gasification performance parameters such as the gas composition, lower heating value and process efficiency. In case of non-stoichiometric equilibrium model, no particular chemical reaction mechanisms are required for simulation. In this study, the Chemical Equilibrium with Applications Program (CEA), developed by NASA based on Gibbs free energy minimization technique is used for simulation of biomass gasification process. This simulation technique is based on non-stoichiometric equilibrium modeling. The parametric evaluation over wide range of operating conditions is studied for estimation of gas composition and lower heating value of the product gas. The variable parameters for the optimization process are viz; type of biomass (wood chips Casuarinas, saw dust, rice husk and bagasse), equivalence ratio (ER), gasification temperature and carbon conversion. The simulation result shows that as the gasification temperature increases (from 600 to 1400 °C), the CO volume fraction increases (from 19 to 32% for casuarinas, 20 to 32% for rice husk, 22 to 33% for saw dust and 22 to 33% for bagasse) for ER=0.25. It is also found as the C/O ratio changes (change in biomass), the volume fraction of CO_2 changes for a particular gasification temperature. It is found as the ER decreases (from 0.5 to 0.2) the volume fraction of CO_2 decreases at all gasification temperature (600 to 1400°C). The CO fraction decreases as the fraction of carbon conversion decreases from 100% to 70%. In this simulation, an analytic comparison is also performed for H_2 fraction in the syngas and this analysis shows that the H_2 fraction increases with decrease in ER for a particular temperature and for a particular ER this fraction increases with increase in temperature. However, the actual performance of gasifier deviates from the model prediction, as the equilibrium conditions are difficult to achieve in any field installations. However, the overall trends of gas composition predicted by the model at various operating parameters remain unchanged.