CO-GASIFICATION OF BIOMASS-COAL AND VARIOUS BIOMASS BLENDS: MECHANISTIC INVESTIGATIONS AND PILOT SCALE APPLICATION

Abstract:

Fluidized bed gasification has emerged as a viable technology for power generation in rural and remote areas in developing countries like India. Given its potential for large scale implementation which could help meeting power needs for rural population, there is an urgent need to study the intricacies of the gasification process from fundamental viewpoint. Still much research is needed to ascertain the feasibility of blends of multiple biomasses and also coal-biomass blends. In this view, the current work is aimed at conducting a mechanistic investigation of co-gasification of biomass-coal and various biomass blends by studying pyrolysis kinetics and also experimentation on a 50 kW_e pilot scale circulating fluidized bed (CFB) gasifier. Three different biomasses were selected for the current work, viz. rice husk, sawdust and bamboo dust, and locally available Meghalaya coal was also used. The pyrolysis kinetics of biomass-coal and various biomass blends were analyzed using three iso-conversional models, viz. Flynn-Wall-Ozawa (FWO) method, Kissinger-Akahira-Sunose (KAS) method, and Friedman method. The sawdust-rice husk blend in a wt. ratio of 50:50 gave the best results amongst all biomass blends and the highest synergistic effects in co-pyrolysis of coal/biomass blends were observed for the composition 60:40 wt%. Co–gasification of coal/biomass blends in the CFB gasifier was conducted with dual aim of assessing influence of process parameters on gasification performance, and secondly, investigating the synergistic effects in the gasification of two feedstock. Maximum gas yield (1.91 Nm^3/kg) and minimum tar yield (5.61 g/kg of dry fuel) was obtained for coal biomass composition of 60:40 wt% at equivalence ratio (ER) = 0.29, which can be attributed to synergistic effect due to presence of alkali and alkaline minerals in biomass that enhances gasification of char and tar. Use of in-bed catalyst of dolomite was also beneficial to gasification of coal/biomass blends as it resulted in higher H_2 and producer gas yield with lower tar production. For gasification of biomass blends, maximum LHV was obtained for rice husk-bamboo dust blend (5.06 MJ/Nm^3) at ER = 0.19. Tar content reduced with increasing ER and minimum tar yield of 2.01 g/kg of dry fuel at ER = 0.35 was obtained for the same blend. The studies showed feasibility of co-gasification of blends (both biomass-biomass and coal-biomass) which adds to the flexibility of operations of gasifier in different locations under different operating conditions. On a whole, the concept of co–gasification of coal/biomass blends has shown distinct merits and high promise in the current studies as compared to individual gasification of coal and biomass.