INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

High ash coal (HAC) is a low quality fuel, which is present in abundance in India. To improve the utility of Indian HAC, it can be utilized with various wastes to enhance the efficiency of combustion and gasification processes. In the present study, co-gasification of blend of HAC was performed with high density polyethylene (HDPE), biomedical plastic waste (overall gown) and e-waste-printed circuit board (PCB) was performed to analyze the co-gasification process. When HAC was gasified with HDPE (in 1:1 weight ratio), the calorific value of the syngas obtained is increased by around 7 MJ/Nm^3 as compared to HAC alone at 1000°C. Similarly, when gasification of HAC was carried out with overall gown (OG) in 4:1 weight ratio, the syngas had higher fraction of hydrogen and hydrocarbons by 3.46% and 4.91% respectively. Thus, the calorific value of syngas improved by 2.92 MJ/Nm^3. The net gas yield also raises from 2.65 m^3/kg for pure HAC to 3.96 m^3/kg for HAC-OG fuel mixture (4:1 ratio of HAC and OG). PCB was separated into their components such as PCB plastic, PCB resin and PCB mixture (mixture of all components) for co-gasification. Adding PCB fuels decreased the syngas calorific value by around 0.5 MJ/Nm^3, compared to HAC alone. PCB fuel based co-gasification with HAC in 4:1 (HAC:PCB) weight ratio did not significantly affect the gas yield (2.69, 2.65 and 2.62 m^3/kg respectively). Adding PCB mixture and PCB plastic negatively affected H_2 concentration decreasing by 0.7 and 0.8%, respectively, as compared to HAC. Further, the utilization of Indian coals in thermal power plants based on steam turbines with municipal solid wastes (MSW) was simulated in Aspen plus. The co-combustion of high and low ash coals (LAC) was carried out in air and oxyfuel conditions. It was found that the co-combustion of MSW with HAC negatively affected levelized cost of electricity (LCOE) and efficiency of the power plant. The LCOE of the power plant increased by around 15 $/MWh while the efficiency reduced by 1.77-2.8% under subcritical conditions. Supercritical conditions based power plants enhanced the net efficiency by around 8% under air and oxy-fuel conditions. The LCOE of MSW based power plant was found to be 40-60% higher than the LAC and HAC based power plant. However, MSW blend with HAC and LAC lowered NO_X emissions by 0.29 to 19 mg/m^3 respectively. LAC and MSW co-combustion reduced SO_X emissions by 11 to 105 mg/m^3 approximately. Thus, it can be concluded that PCB addition had negative synergy on HAC gasification while OG and HDPE had positive synergy in terms of syngas production.