Modelling and optimization of torrefied pellet fuel production

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ABSTRACT

Torrefaction is a thermal process to convert biomass into a coal-like material, which has better fuel characteristics than the original biomass. Torrefied biomass has more energy density and hydrophobic which is superior quality for handling and storage. The objective of this research was to develop a simulation model of the torrefied pelletization process from empty fruit bunch (EFB). The process was simulated using ASPEN Plus. Optimization involved a selection of the model option that produced the maximum mass yield and minimum energy requirement, with a converged base case simulation as a starting point. Torrefied biomass pellet offered coal-like properties such as high heating value, brittle, high bulk energy density and more hydrophobic. These properties could potentially avoid costly power plant modifications. On the other hand, Malaysia has issued National Biomass Strategy 2020 with target to solve the problem of under-utilized biomass in this country. Base model was based on previous study. For optimization of mass yield and overall energy consumption, six model options of design configurations were analysed. Design model 0 was used as the base model. For design model 1, flue gas from combustion reactor was channelled to torrefaction reactor. For design model 2, flue gas from combustion reactor was split to dryer and torrefaction reactor. For design model 3, combustion reactor was removed. For design model 4, flue gas was channelled to dryer reactor without combustion reactor. For design model 5, flue gas separator after dryer was removed. Out of five options, results were tabulated for the optimum one. The results showed that the highest mass yield was achieved by simulation Model 5 at 90.76 % and lowest energy requirement was achieved by simulation Model 4 at 411.336 kW. Optimization result meanwhile had shown that Model 4 was selected because it gave the maximum profitability of RM 72834.45 by considering the yield and the energy consumption simultaneously.

KEYWORDS

ASPEN Plus; Empty fruit bunch (EFB); Optimization; Torrefaction and pelletization (TOP)

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