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Energetic Analysis of The Gasification Process

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ABSTRACT

The growing demand for sustainable energy alternatives to replace fossil fuels has reinforced the relevance of gasification technologies. Among these, Bubbling Fluidised Bed (BFB) reactors represent a promising pathway for producing gas that can be used directly as a fuel or as a precursor for synthetic fuels. This study aims to evaluate the thermal efficiency of the gasification process in a BFB reactor externally heated by an electric furnace, using pine chips (PC) and low-density polyethylene (LDPE) as feedstocks. Experimental tests were conducted with different gasification agents, air, steam, and air–steam mixture by varying the equivalence ratio and steam-to-biomass ratio. Thermal efficiency was defined as the ratio of useful to supplied energy. Useful energy corresponded to the chemical energy of the produced gas, while supplied energy included the chemical energy of the biomass, the energy required to preheat the gasification agents, the sensible heat of the exit gas, and the energy input of the furnace, which also accounted for thermal losses through the furnace walls. The experiments showed thermal efficiencies ranging between 43.38% and 20.25% for PC, and between 34.76% and 21.47% for LDPE, depending on operating conditions. Across both feedstocks, the highest efficiencies were obtained when only air was used as the gasification agent, while the lowest were observed with steam-only operation. These findings highlight the influence of feedstock type and gasification agent on process efficiency and provide valuable insights for optimizing BFB gasification toward sustainable energy production.

Keywords: Biomass; Energy, Heat transfer; Thermal efficiency; Virgen plastics.