Plasma gasification of biomass using nitrogen plasma reactor to produce synthesis gas for small scale-communities

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The most common set of problems encountered when using biomass-to-energy (BTE) processes relate to tar formation and product gas composition. However, using plasma technology to convert biomass provides a solution, because it unlocks more energy than can be achieved by other BTE systems by using a heat supply derived from electricity. The research presented in this paper focuses on the conversion of biomass to chemical energy (in gaseous form) with the aid of the electrical energy supplied by a water-cooled, nitrogen plasma torch. The authors conducted a series of experiments in a pyrolysis set up in which wood pellets were converted to syngas in a small-scale laboratory nitrogen plasma torch reactor, with a maximum power supply of 15 kW. The efficiency of the process was measured in terms of the carbon conversion to all product gases, which changed from 43 to 77 %, at temperatures ranging from 400 ^{0}C to 1000 ^{0}C respectively. The combined carbon monoxide and hydrogen (syngas) mole concentration in the produced gas was 86 % at 1:1 ratio for all temperatures studied. Syngas yield increased with increase in temperature. The overall biomass conversion obtained increased from 46 % to 82 % for the temperatures 400 ^{0}C to 1000 ^{0}C respectively, with the balance comprising carbon-rich solid residue and liquid. This tells us that plasma gasification can be a viable method for converting industrial and agricultural biomass into energy and small-scale systems have potential to help produce energy in communities.

Key Words: Plasma; Gasification; Biomass; Syngas; Renewable energy