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Demonstration Operation of Distributed Power Generation System Based on Carbonized Biomass Gasification

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Abstract : Small-scale, distributed and low-cost biomass power generation technologies are highly required in the modern society. There are big needs for these technologies in the disaster areas of developed countries and un-electrified rural areas of developing countries. This work aims to present a technical feasibility of the portable ultra-small power generation system based on the gasification of carbonized wood pellets/briquettes. Our project is designed for enabling independent energy production from various kinds of biomass resources in the open-field. The whole process mainly consists of two processes: biomass and waste pretreatment; gasification and power generation. The first process includes carbonization, densification (briquetting or pelletization), and the second includes updraft fixed bed gasification of carbonized pellets/briquettes, syngas purification, and power generation employing an internal combustion gas engine. A combined pretreatment processes including carbonization without external energy and densification were adopted to deal with various biomass. Carbonized pellets showed a better gasification performance than carbonized briquettes and their mixture. The 100-hour continuous operation results indicated that pelletization/briquetting of carbonized fuel realized the stable operation of an updraft gasifier if there were no blocking issues caused by the accumulation of tar. The cold gas efficiency and the carbon conversion during carbonized wood pellets gasification was about 49.2% and 70.5% with the air equivalence ratio value of around 0.32, and the corresponding overall efficiency of the gas engine was 20.3% during the stable stage. Moreover, the maximum output power was 21 kW at the air flow rate of 40 $Nm^3 \cdot h^{-1}$. Therefore, the comprehensive system covering biomass carbonization, densification, gasification, syngas purification, and engine system is feasible for portable, ultra-small power generation. This work has been supported by Innovative Science and Technology Initiative for Security (Ministry of Defence, Japan).

Keywords : biomass carbonization, densification, distributed power generation, gasification
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