Feasibility Study and Energy Conversion Evaluation of Agricultural Waste Gasification in the Pomelo Garden, Taiwan

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Abstract : The planting area of Pomelo in Hualien, Taiwan amounts to thousands of hectares. Especially in the blooming season of Pomelo, it is an important producing area for Pomelo honey, and it is also a good test field for promoting the "Under-forest Economy". However, in the current Pomelo garden planting and management operations, the large amount of agricultural waste generated by the pruning of the branches causes environmental sanitation concerns, which can lead to the hiding of pests or the infection of the Pomelo tree, and indirectly increase the health risks of bees. Therefore, how to deal with the pruning of the branches and avoid open burning is a topic of social concern in recent years. In this research, afeasibility study evaluating energy conversion efficiency through agricultural waste gasification from the Pomelo garden, Taiwan, is demonstrated. we used a high-temperature gasifier to convert the pruning of the branches into syngas and biochar. In terms of syngas composition and calorific value assessment, we use the biogas monitoring system for analysis. Then, we used Raman spectroscopy and electron microscopy (EM) to diagnose the microstructure and surface morphology of biochar. The results indicate that the 1 ton of pruning of the branches can produce 1797.03m3 of syngas, corresponding to a calorific value of 9.1MJ/m3. The main components of the gas include CH4, H2, CO, and CO2, and the corresponding gas composition ratio is 16.8%, 7.1%, 13.7%, and 24.5%. Through the biomass syngas generator with a conversion efficiency of 30% for power generation, a total of 1,358kWh can be obtained per ton of pruning of the branches. In the research of biochar, its main characteristics in Raman spectroscopy are G bands and D bands. The first-order G and D bands are at 1580 and 1350 cm^{-1}, respectively. The G bands originates from the in-plane tangential stretching of the C−C bonds in the graphitic structure, and theD band corresponds to scattering from local defects or disorders present in carbon. The area ratio of D and G peaks (D/G) increases with the decrease of reaction temperature. The larger the D/G, the higher the defect concentration and the higher the porosity. This result is consistent with the microstructure displayed by SEM. The study is expected to be able to reuse agricultural waste and promote the development of agricultural and green energy circular economy.

Keywords : agricultural waste, gasification, energy conversion, pomelo garden
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