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Production of Hydrogen and Carbon Monoxide Fuel Gas From Pine Needles

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Abstract : Forestry wastes are readily available in large quantities around the world. Based on European Green Deal for the deployment of renewable and decarbonized energy by 2050, as well as global energy crisis, energy recovery from such wastes reducing greenhouse gas emissions is very attractive. Gasification has superior environmental performance to combustion, producing a clean fuel gas utilized in internal combustion engines, gas turbines, solid oxide fuel cells, or for synthesis of liquid bio-fuels and value-added chemicals. In this work, pine needles, which are abundantly found in Mediterranean countries, were gasified by either steam or carbon dioxide via a two-step process to improve reactivity and eliminate tar, employing a fixed bed unit and a thermal analysis system. Solid, liquid and gaseous products from the whole process were characterized and their energy potential was determined. Thermal behaviour, reactivity, conversion and energy recovery were examined. The gasification process took place above 650°C. At 950°C conversion and energy recovery were 77% dry and 2 under a flow of steam and 85% dry and 2.9 under a flow of carbon dioxide, respectively. Organic matter was almost completely converted to syngas, the yield of which varied between 89% and 99%. The higher heating values of biochar, bio-oil and pyrolysis gas were 27.8 MJ/kg, 33.5 MJ/kg and 13.6 MJ/m3. Upon steam or carbon dioxide gasification, the higher heating value of syngas produced was 11.5 MJ/m3 and 12.7 MJ/m3, respectively.

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