

***Integration of coal and biomass gasification process with fuel cell system
for small scale industrial CHP applications***

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Abstract

Clean syngas from coal or biomass gasification could be used for a series of applications such as power generation and production of hydrogen, substitute natural gas, liquid fuels and chemicals.

Currently, Sotacarbo is engaged in a series of experimental tests in its pilot platform, which includes a fixed-bed air-blown gasifier equipped with complete syngas treatment line for hydrogen production and power generation based on an internal combustion engine. But it is under evaluation the possibility to equip the plant with a high efficiency fuel cell system directly fed by clean syngas.

This study analyses the possibility to apply the Sotacarbo coal and biomass gasification technology for high efficient power generation in a small-scale combined heat and power (CHP) industrial system by a potential integration of the gasification process itself with a molten carbonate fuel cell (MCFC) system.

The mass and thermal balances of the gasification and syngas treatment processes (the pilot plant is equipped with a catalytic COS hydrogenation system followed by a zinc oxides-based hot gas desulphurization process; this system allows a final H₂S concentration lower than 1 ppm by volume, compatible with the fuel cell specifications) have been evaluated on the basis of the experimental data collected during the gasification and hot gas desulphurization tests. In particular, according to the results obtained from about 1350 hours of experimental tests in the Sotacarbo plant, coal gasification process is characterized by a relatively high cold gas efficiency, whereas raw syngas composition and properties strongly depend on the feedstock and the specific operating conditions. On the other hand, the performance of the MCFC fuel cell stack has been assessed by developing a mathematical model based on thermodynamic-electrochemical analysis.

Keywords: Gasification; Pilot plant; Molten carbonate fuel cell; Distributed power generation; Combined heat and power.

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