Environmental Impact Assessment of a Biogas Chemical Looping Reforming system through Life Cycle Analysis

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Abstract

To mitigate greenhouse gas emissions, the adoption of renewable and sustainable fuels like bio- and hydrogen-fuels have generated an increasing interest in literature. The Chemical Looping Reforming (CLR) of a natural gas and biogas mixture proved to be a feasible technology (Cabello et al., 2022) to generate hydrogen or syngas through thermochemical transformation processes. More recently, pure biogas CLR has been numerically studied by coupling a simple hydrodynamic model of a Dual Fluidized Bed reactor system and a kinetic 1D, static, and isothermal model (Piso et al. 2023).

In the present work, a comprehensive Life Cycle Analysis (LCA), encompassing all life cycle stages, was performed to assess the overall environmental impact of this latter biogas CLR process. The LCA assessment was carried out by using the OpenLCA software. Different environmental impact categories were evaluated and additional sensitivity analyses of relevant process parameters were made to investigate their influence on the environmental impact categories. Finally, the performance of the Biogas CLR system was systematically compared to that of a conventional Natural Gas-based CLR process (Diglio et al., 2017) to identify the most environmentally sustainable technology.

Keywords: Life Cycle Assessment, Biogas, Chemical looping reforming, Syngas, Environmental impact, Sustainable energy.

References:

A. Cabello, T. Mendiara, A. Abad, M.T. Izquierdo, F. García-Labiano, Production of hydrogen by chemical looping reforming of methane and biogas using a reactive and durable Cu-based oxygen carrier, Fuel 322 (2022), 124250, https://doi.org/10.1016/j.fuel.2022.124250.

G. C. Piso, P. Bareschino, P. Brachi, C. Tregambi, G. Ruoppolo, F. Pepe, E. Mancusi, Numerical simulation of biogas chemical looping reforming in a dual fluidized bed reactor, Renewable Energy 212 (2023), 0960-1481, https://doi.org/10.1016/j.renene.2023.05.060.

G. Diglio, P. Bareschino, R. Solimene, E. Mancusi, F. Pepe, P. Salatino, Numerical simulation of hydrogen production by chemical looping reforming in a dual fluidized bed reactor, Powder Technol. 316 (2017) 614–627, https://doi.org/10.1016/j.powtec.2016.12.051.