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Life cycle assessment of magnetically induced catalysis for power to gas

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PURPOSE OF THE ABSTRACT

The increase of greenhouse gas emissions along with the depletion of fossil fuels impose the development of technologies that make use of renewable energy sources. These sources being intermittent, an efficient way to store them appears as an absolute necessity. A large-scale solution is the conversion of electric overproduction into energetic gaseous vectors; this is the concept of Power-to-Gas (P2G). In this context, iron-based nanoparticles used as magnetically stimulated heating agents activate catalytic reactions that store energy chemically [1]. Products of added value such as methane could be efficiently obtained using CO2 as a source through the Sabatier exothermic reaction in the frame of P2G process [2]. Thus, this technology could play a major and disruptive role in P2G process at different steps, including water electrolysis for local hydrogen production followed by the use in methanation units.

The energy efficiency of catalysis by magnetic hyperthermia has to be comparable to the one of traditional heterogeneous catalysis in order to be considered as a sustainable alternative. In the case of Sabatier reaction, 29% energy efficiency has been demonstrated by traditional heterogeneous catalysis [3]. As published by Bordet et al., using FeC as heating agent supported on Ru-Siralox, 16,1W (H2 incoming flow) are converted into 12,6W (CH4 outgoing flow) by using 1,82kW power input for field generation, which corresponds to a global energy efficiency of roughly 0,7%. Our team is currently working on the increase of this efficiency.

However, those considerations concern exclusively the catalytic system, which does not take into account the energy required for reactant production (H2, CH4, CO2) and its potential environmental impact. Such analysis has been performed in the case of traditional heterogeneous catalysis as opposed to fossil fuels in the case of hydrogen and methane production [4]. Thus, every single step from raw resources extraction to use of products and recycling through a multi-criteria environmental analysis is studied in the case of P2G by magnetic hyperthermia including our last development steps (Figure 1).

In order to fully assess the sustainable potential of magnetically induced catalysis for P2G applications, the integration of the technology in an eco industrial park will be implemented as well [5].

Up to this date, such study has not been performed on catalysis activation by magnetic induction but it appears as a necessity in order to evaluate this technology potential, integrated to a fully low-carbon P2G process for renewable energy storage.

FIGURES

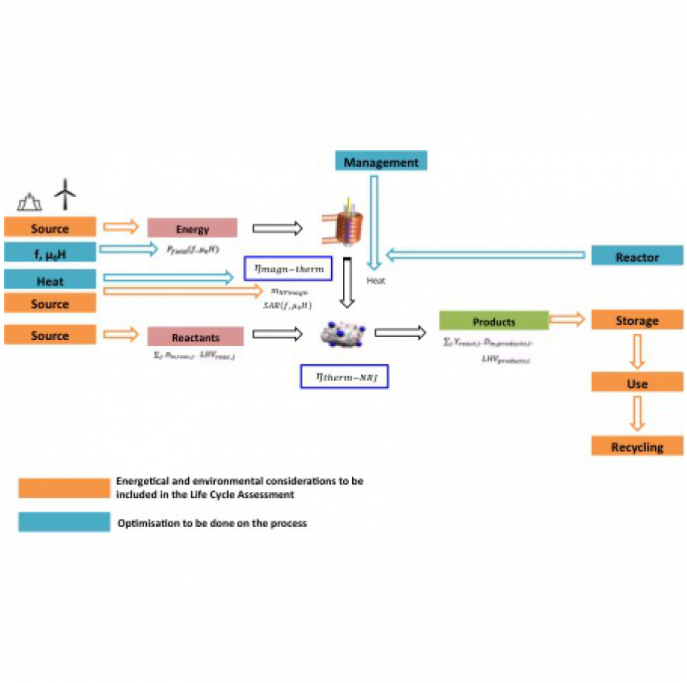

FIGURE 1
LCA implementation of Power To Gas process using magnetically induced catalysis

FIGURE 2

KEYWORDS
CO2 hydrogenation | Magnetically induced catalysis | Power To Gas

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