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OVERVIEW ON BIOHYDROGEN PRODUCTION FROM WASTE: CURRENT TECHNOLOGIES AND PERSPECTIVES

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Abstract

In a near future, and among the potential energy vectors that can be used, hydrogen is considered as one the most serious alternatives to fossil energies. The "traditional" production processes require its extraction from hydrocarbon fossil resources with high environmental impacts. Therefore, the development of green technologies to produce H_2 from renewable resources is one of the key issues to be addressed prior to a wide usage of this vector. To date, in addition to hydrogen production by water electrolysis based on renewable resources (wind,...), the most promising green technologies are those using raw biomass, and any type of organic waste. They involve both thermochemical and biological conversion processes.

The objective of this overview is to present a wide state of the art of these alternative processes for converting organic waste to hydrogen. This study addresses the main technical issues by identifying, describing and characterizing the most useful processes suitable for waste conversion. The relevance of this work is to consider and compare both thermal and biological processes for H_2 production.

First, an overview of the main waste streams and resources available for H_2 production in France, Europe and in the World has been carried out. The main operating conditions as well as the limits of the systems are described and compared: temperature, pressure, pH, quality of the layers, undesirable, gear robustness, etc. For the thermal processes, theoretical examples of integrated processes will be presented and an economical estimate of the process costs is introduced. Regarding biological processes, the study identifies and analyses the most up-to-date projects operated at a pilot-scale showing promising results. In summary, by considering the current hydrogen market, the biohydrogen-producing technologies appear inappropriate to outcompete the traditional processes on a large scale. Indeed, the traditional processes are strongly economically competitive. The competitiveness of the bioH_2 processes, with respect to the classical processes like steam-reforming or electrolysis, seems difficult to reach without energy optimization of the processes. Nonetheless, a cost- distances analysis between classical producer classical and consumer highlights advantageous areas for competitiveness achievement. The best short term opportunity relies on the "biogas" resource available on anaerobic digestion units. At a longer term, biological dark fermentation processes could be inserted in such stream to produce H_2 from waste at the lowest costs and environmental impacts. A mixture of H_2/CH_4 (so called biohythane) used as biofuel could be favored if the re-injection conditions in the gas domestic network of conditioned biogases are facilitated. This scenario has the advantage of requiring only investments for production equipment: transport and distribution infrastructures already exist on a large scale. It appears to be the

least complex stage for the development of reported technologies. Regarding the hydrogen mobility, the sector struggles to get structured and particularly by the need of feeding the hydrogen service station networks. Biomass waste resources availability on the whole territory offers a place to decentralized solutions of small biohydrogen productions, avoiding hydrogen transport and leading them to be more competitive (in particular gasification technologies).

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