Biofuels-2015: Production of bio-hydrogen as fuel to feed transportation infrastructure - J. Javier Brey - Spanish Hydrogen Association

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The use of hydrogen as transportation fuel is currently growing. the various renewable energy sources, biohydrogen is gaining a lot of traction as it has very high efficiency of conversion to usable power with less pollutant generation. The various technologies available for the production of biohydrogen from lignocellulosic biomass such as direct biophotolysis, indirect biophotolysis, photo, and dark fermentations have some drawbacks (e.g., low yield and slower production rate, etc.), which limits their practical application. Among these, metabolic engineering is presently the most promising for the production of biohydrogen as it overcomes most of the limitations in other technologies. Microbial electrolysis is another recent technology that is progressing very rapidly. However, it is the dark fermentation approach, followed by photo fermentation, which seem closer to commercialization. Biohydrogen production from lignocellulosic biomass is particularly suitable for relatively small and decentralized systems and it can be considered as an important sustainable and renewable energy source. The comprehensive life cycle assessment (LCA) of biohydrogen production from lignocellulosic biomass and its comparison with other biofuels can be a tool for policy decisions. In this paper, we discuss the various possible approaches for producing biohydrogen from lignocellulosic biomass which is an globally available abundant resource. The main technological challenges are discussed in detail, followed by potential solutions. On the one hand, manufacturers such as Hyundai and Toyota are already mass producing and selling fuel cell vehicles, while others like Honda, BMW and Nissan will follow suit in the next two years. Hydrogen has been suggested as the ideal fuel of the future. It is considered as one of the cleanest energy carriers to be generated from renewable sources. It has a high energy yield (122 kJ/g) which is 2.75 times greater than hydrocarbon fuels. It can be easily used in fuel cells for generation of electricity. Though not a primary energy source, it serves as a medium through which primary energy sources (such as H2 produced from nuclear power and/or solar energy) can be stored, transported and utilized to fulfill our energy needs. The major problem facing H2 as a fuel is its unavailability in Nature. H2 can be produced safely, is environmentally friendly when combusted, and versatile i.e., has many potential energy uses, including powering non-polluting vehicles, heating homes and offices, and fueling aircraft. Current H2 production technologies such as steam reforming of natural gas, thermal cracking or coal gasification are not environmentally friendly. Biological H2 production is a promising alternative. There are two methods to produce H2 from microorganisms. The first method uses photosynthetic microorganisms such as bacteria or algae (photofermentative processes) and the second method uses fermentative organisms (dark fermentation processes). Fermentative H2 production has the advantage of producing H2 under mild conditions with the additional benefit of allowing residual biomass valorization. The dark fermentation process is more attractive as it has the potential to use wastewater and organic wastes and has higher production rates compared to photofermentative processes. So far, few studies have used real wastewater for the production of H2 due to inhibition by both substrate and/or product in the fermentation process In addition, certain areas like northern Europe, Japan, South Korea and California are already addressing the deployment of infrastructure to ensure that there are sufficient refueling stations available for these vehicles. The conventional methods for producing H2 gas include steam reforming of methane and hydrocarbons, non-catalytic partial oxidation of fossil fuels and autothermal reforming. However, most of these methods are energy intensive processes requiring high temperatures (>850 °C). A general scheme of H2 production from renewable sources. Biological methods of H2 production are preferable to chemical methods because of the possibility to use sunlight, CO_2 and organic wastes as substrates for environmentally benign conversions, under moderate conditions. However, we now have to address the following issue: how are we going to produce the hydrogen required to supply these stations, to fuel these vehicles? Obviously, hydrogen can be produced using conventional sources: natural gas reforming, ome are carbon neutral or even negative, though, especially perennial crops. The amount of carbon sequestrated and the amount of GHG (greenhouse gases) emitted will determine if the total GHG life cycle cost of a biofuel project is positive, neutral or negative. A carbon negative life cycle is possible if the total below-ground carbon accumulation more than compensates for the total life-cycle GHG emissions above ground. In other words, to achieve carbon neutrality yields should be high and emissions should be low. The modern world is facing three critical problems: high fuel prices, climate change, and air pollution. Biohydrogen: For Future Engine Fuel Demands covers the production, purification, storage, pipeline transport, usage, and safety of biohydrogen. Hydrogen promises to be the most significant fuel source of the future, due to its global availability and the fact that water is its only by-product. Biofuels such as bioethanol, biodiesel, bio-oil, and biohydrogen are produced using technologies for thermochemically and biologically converting biomass. Hydrogen fuel production technologies can make use of either non-renewable sources, or renewable sources such as wind, solar, and biorenewable resources. Biohydrogen: For Future Engine Fuel Demands reviews all of the modern biomass-based transportation fuels, including bioethanol, biodiesel, biogas, biohydrogen, and fuel cells. The book also discusses issues of biohydrogen economy, policy and environmental impact. Biohydrogen looks set to be the fuel of choice in the future, replacing both fossil fuels and bio-renewable liquid fuels, but many countries are looking to hydrogen as a way to contribute to energy sustainability, to ensure security of supply and promote local development.Similarly to third-generation biofuels, fourth-generation biofuels are made using non-arable land. However, unlike third-generation biofuels, they do not require the destruction of biomass. This class of biofuels includes electrofuels and photobiological solar fuels. Some of these fuels are carbon-neutral This leads them to consider processes for producing hydrogen from biofuels, which has been called bio-hydrogen. From biogas reforming to bioethanol reforming; from conventional catalysis to biological approaches, the production of bio-hydrogen is conceived as a real and economic alternative for the production of hydrogen to power our transportation.

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