Environmental and Economic Life Cycle Analyses of Hydrogen As A Transportation Fuel

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With the increase in environmental concerns over the globe, especially global warming, and depletion of crude oil, it is essential to find another source of fuel to heat our homes and fuel our vehicles. It is being anticipated that hydrogen may be an alternative fuel with many useful applications in transporting and storing energy derived from fossil fuels, solar, hydro, nuclear systems, and so on. In Korea, recently based on the increasing interest of government, industry, and academia various researches have been conducted for the hydrogen production, storage & distribution and application methods and so on. Now it is realized that the development of a hydrogen system in an environmentally efficient as well as economically affordable way is crucially important.

In this study, both environmental and economic aspects of several hydrogen pathways with different production, capacity and distribution options are analyzed using life cycle assessment(LCA) and life cycle cost analysis(LCCA) methods. For hydrogen production, natural gas steam reforming(NGSR), natural gas thermal cracking(NGTC), water electrolysis and naphtha steam reforming(Naphtha SR) are considered. And both centralized and decentralized pathways are analyzed for distribution options. The baseline vehicle selected for Tank to Wheel analysis is a Tucson FCV and baseline vehicle simulation models are FTP-75 mode and ECE 15+EUDC. Then, the results are compared with those of gasoline and diesel.

NGTC and Naphtha SR methods show the significant reduction of greenhouse gases by 17.4~32.1ton CO2 equiv., compared with the gasoline system for 160,000km driving. On the other hand, water electrolysis method shows the increase of greenhouse gases by 14.5 ton CO2 equiv., due to the high portion of thermal power in the current electricity grid in Korea. If renewable resources are used for the electricity generation, water electrolysis method will become one of the environmental-friendly methods.

Economic analysis shows that the life cycle costs depends on not only hydrogen production method but also production capacity, distribution & storage options and distribution distance etc. At present, the Naphtha SR method with centralized distribution and the NGTC method with decentralized distribution turn out to be cost effective in Korea.

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