Potential Fusion Market for Hydrogen Production Under Environmental Constraints

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As a candidate of future energy, fusion must consider its possible market to be deployed. It is anticipated that the supply of limited reserve of fossil fuel will be tighter while it will not be exhausted in the near future. At the same time, constraint of environmental problem, particularly suspected global warming due to the increase of green house gas such as carbon dioxide will require a shift of energy source from fossil resources to carbon-free technologies. This is the major reasoning for most of the new energy technologies. It should be noted that a large fraction of energy consumption in the future remains in the form of fuel for heat and transportation. Synthetic fuels, particularly hydrogen is regarded as a major secondary energy medium that may have larger market share than electricity. In order to maximize the benefit of fusion, technical possibility of non-electric use of its energy must be evaluated, and it is the objective of the present study.

Hydrogen production processes that can be applied for fusion reactor are compared. Electrolysis of water is one of the straight forward choice, because fusion is primarily considered as source of electricity. However although it is a conservative and established technology, it cannot expect very high efficiency. Unlike light water reactors or renewables, fusion can generate high temperature by selecting blanket design and materials regardless whether it is MCF or ICF. If fusion reactor can generate temperature above 900 degree C, processes such as high temperature vapor electrolysis, thermochemical decomposition of water, steam reforming and other chemical reactions can be considered. Vapor electrolysis, combined with high temperature gas turbine will be efficient and regarded as an adequate technology to be combined with fusion when it is in the phase of commercial use. Chemical reaction of biomass with water vapor; $C_nH_{\square n}O_n...+2nH_2O \rightarrow nCO_2 + 3nH_2$ generates hydrogen from abundant renewable resource, and is proposed as one of an attractive energy use for fusion. Large endothermic energy of 120KJ/mol effectively converts fusion heat to chemical energy. Exhausted carbon dioxide is regarded as carbon neutral, that does not release additional carbon dioxide but recycles it from and to the atmosphere. There will be additional technical issues to be developed if such a process is planned as a possible energy use of fusion. Fusion blanket to be operated at higher temperature is needed, and the chemical process to use eternal heat source must also be developed, with particular attention on tritium contamination.

Socio-economic impacts of fusion is also analyzed and its significance in the global energy market and environmental strategy for the cases of both electricity and hydrogen supply. Unlike in the case of electricity generation, hydrogen market is far more complicated because it is affected by other raw materials, fossil sources, and infrastructure for storage, delivery and use. However it is estimated to increase fusion share in the global primary energy sources to at least 1.5 times larger. In any case, fusion energy must pay attention on the social aspects and continuously consider its possible future market and be flexible to adopt itself to the market.