REFORMING OF LIQUID HYDROCARBONS IN A NOVEL HYDROGEN-SELECTIVE MEMBRANE-BASED FUEL PROCESSOR

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ABSTRACT

The major focus on PEMFC technology is to develop fuel cell system for transportation applications, which require development of low cost cell components and reliable, high-purity H_2-fuel source. The PEMFC technology is attractive because of its low operating temperature and ease of start-up. Reformed methanol and liquid hydrocarbons are expected to be major fuel source in PEMFCs for terrestrial transportation application as envisioned in Vision 21 for the 21st century. The poisoning of the expensive electrocatalysts by CO in the reformed fuel is a major concern. Crossover of methanol in direct methanol PEMFC is also problematic. Thus, there is a need for developing technology for reforming methanol and liquid hydrocarbons as a source of hydrogen to the fuel cells. In this context, membrane-based technology as fuel processor appears very attractive.

We propose to develop an inorganic metal-metal composite membrane to study reforming of liquid hydrocarbons and methanol by equilibrium shift in membrane-reactor configuration, viewed as fuel processor. Based on our current understanding and experience in the Pd-ceramic composite membrane, we propose to further develop this membrane to a palladium-silver alloy membrane on microporous stainless steel support to provide structural reliability from distortion due to thermal cycling and hydrogen embrittlement. Because of the metal-metal composite structure, we believe that the associated end-seal problem in the Pd-ceramic composite membrane in tubular configuration would not be an issue at all. The major objective of this research is to further develop these materials and to test them for reforming liquid hydrocarbons and methanol for simultaneous production and separation of high-purity hydrogen for PEM fuel cell applications.

The proposed membrane-reactor for steam reforming of methanol would be capable of simultaneously producing and separating hydrogen (in nearly pure form due to excellent perm-selectivity of the membrane) for use in PEM fuel cell. Because of single-unit operation, the method proposed will be cost effective, in terms of both capital and energy savings when compared with the conventional reforming process. Furthermore, by selective removal of hydrogen, the reaction could be easily shifted to the right to near 100% conversion as opposed to significantly lower equilibrium conversion in conventional catalytic packed-bed reactor. Thus, the temperature limitations of the equilibrium-limited reaction can be resolved without compromising the conversion.