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Perspective

Separation Techniques for Hydrogen Involving in Production of Natural Gas

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DESCRIPTION

Energy plays a crucial role in the global economy growth. One of the greatest challenges for the energy system is to meet the fast-growing energy demand simultaneously with less or no greenhouse gas emissions, which is the major driver for climate change. The breakdown of primary energy consumption shows that traditional energy sources such as coal, oil and gas remain to be the major fuels in the global energy market. The production and consumption of fossil fuels produce anthropogenic greenhouse gas.

One of the main approach to enhance the storage and reserve the production capacity of renewable energy is the power to hydrogen (P_2H) process chain, in which is used to convert water to H_2 *via* technologies such as alkaline electrolysis, proton exchange membrane electrolysis and solid oxide electrolysis, thereafter, hydrogen can be transported and consumed by end-users for combustion, carbon hydrogenation or methanation etc., Hydrogen is preferable for renewable energy storage due to its higher mass energy density (142 $MJ \cdot kg^{-1}$) in comparison with other fuels such as natural gas and gasoline.

However, since the traditional natural gas pipelines are commonly made of ferritic stainless steel, plastic and cast iron, the suggested hydrogen injection concentration in natural gas pipelines is up to 40 bar pipeline pressure to minimise the ignition risks, leakage issues and pipeline fatigues. The hydrogen/natural gas mixture, also called Hydrogen Enriched Natural Gas (HENG), can be utilised directly for power generation and household appliances.

Therefore, the development of high efficiency and cost-effective technologies for the recovery of H_2 from its low concentration streams is a key to extend the P_2H technology. Membrane technology is economically viable that approaches for gas separation and has been commercialized in natural gas sweetening and hydrogen recovery from ammonia pure gas.

Membrane for hydrogen separation

Fundamental of hydrogen transport in membranes are barrier that selectively separates some of the components from a mixture based on the physical nature of penetrants and the interactions between penetrants and penetrant-membrane. The transport mechanism of H_2 and CH_4 through membranes varies depending upon the membrane types and generally follows one or a combination of the following 4 mechanisms: Knudsen diffusion, Surface diffusion, Molecular sieving, and Solution-diffusion model. Hydrogen is also be used in several industries like hydrocarbon reforming and ammonia synthesis. The minimum hydrogen purity requirements in fuel gas, polymer electrolyte fuel cells and rocket engine fuel industries are respectively. The major challenge for hydrogen transportation and storage is its low volumetric density and the possibility of hydrogen induced fracture on the pipelines and storage facilities. A more cost-effective option for hydrogen transport, especially in the market development phase, is to inject hydrogen into the existing natural gas pipelines as the global natural gas pipelines are well built and distributed.

Dense metallic membranes have been extensively studied for hydrogen separation including dense metallic membranes, porous inorganic membranes, metal organic membranes and polymeric membranes. Among these, dense metallic membranes have attracted great interests due to their high hydrogen selectivity and commercial availability. Dense metallic membranes are not suitable for separation of hydrogen from heng pipelines at at low temperatures.

Ceramic protonic conducting membranes have been intensively studied for hydrogen separation with advantages including high mechanical stability and lower manufacturing cost than dense membranes. The transport of H_2 through dense ceramic proton conducting membranes follows solution diffusion mechanism, in which H_2 in the feed gas diffuses through the membrane in form of H^+ along with the electrons.

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CONCULSION

About 80% of the world demands fossil fuels. Unlike fossil fuels, the use of hydrogen as energy sources it produces water as the only by-product. It could help to address the issues related to the energy security which includes global climate change and local air pollution. Moreover, hydrogen is most abundantly available in the universe and possesses the highest energy content per unit of weight when compared to any of the known fuels. Consequently, the demand for hydrogen energy and production has been growing in the recent years.