CO_2 CAPTURE OVER H_2 BY POLYMERIC MEMBRANES FOR CARBON-FREE H_2 PRODUCTION

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Key Words: Alkanolamine, CO_2 capture, Hydrogen, Membrane separation, Polymer

Membrane separation is potential alternative technology for liquid amine scrubbing in CO_2 capture at mass CO_2 emission sources, such as coal-fired plants, due to the low-energy and cost effective process, and various membranes have been developed for effective CO_2 capture. Among them, polymeric membranes would be promising because of versatile chemical approaches, synthetic feasibility, large-scale productivity, and good processability in comparison to inorganic membranes. In this research group, polymeric membranes have been investigated for pre-combustion CO_2 capture, where CO_2 is separated over H_2. For preferential CO_2 permeation over smaller H_2, amines, such as poly(amidoamine)s (PAMAMs), are used to enhance CO_2 solubility to the polymeric membrane. When PAMAMs are physically immobilized in cross-linked PEG or PVA to form polymeric membranes, the resulting membranes exhibit high CO_2 separation properties over H_2 especially under humidified conditions and lower CO_2 partial pressure than 100 kPa [1-5]. The PAMAM membrane is waiting for demonstration test by Research Institute of Innovative Technology for the Earth (RITE, Japan).
The amine-containing polymeric membranes can be also applicable to on-site H_2 refilling station to make the H_2 production process carbon-free by capturing CO_2 in the off-gas by the membranes as shown in Figure 1. The off-gas consists of H_2 and CO_2 at ambient pressure and temperature (CO2 partial pressure: 40-50 kPa). In comparison to mass CO_2 emission sources, the amount of CO2 is smaller and thus the captured CO_2 can be utilized for plant growth or even refrigerant. However, the CO_2 permeability should be improved for implementation.

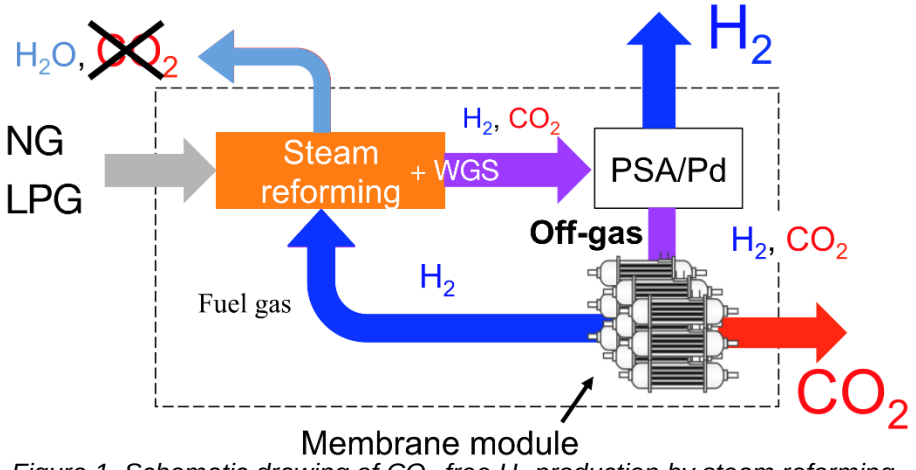

Figure 1. Schematic drawing of CO_2-free H_2 production by steam reforming.

After screening amines with various chemical structures, it was found that alkanolamines, such as 2-(2-aminoethylamino)ethanol, shows higher CO_2 separation performance than PAMAMs in the same polymer matrices with the same weight fractions. The hydroxyl group adjacent to amino one helps interaction between CO_2 and amino group by reducing the activation energy, which would result in elevating CO_2 diffusion in the membrane.
In this presentation, preparation of amine-containing polymeric membranes and the CO_2 separation properties are introduced under various operation conditions. Fabrication with larger membrane area and durability of the polymeric membrane will be also discussed.

References

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