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Selective H2 Separation Using Mixed Matrix Membranes and Its Utilization

Abstract.

Over 90% of the H_2 produced in the United States comes from fossil fuels utilizing a multi-step steam-reforming, oxidation, or pyrolsis process. This conversion process uses high temperature, catalyst, and oxygen to a convert hydrocarbon feedstock into a mixture of H_2, CO, CO_2, CH_4, and H_2O. A membrane-based H_2 separation technology has many advantages over conventional unit operations such as cryogenic distillation, absorption, and adsorption-based upon overall energy, economics, and environmental impact. Several polymeric membranes have been demonstrated in large industrial gas separations such as H_2 from gas mixtures (H_2/CH_4, H_2/CO, and H_2/CH_4), and CO_2 from flue gas (CO_2/N_2). The technical challenge is separating H_2 from this multi-component stream that primarily uses a pressure swing adsorber (PSA) to achieve this goal. H_2 is an important facet for energy production, chemicals, and transportation. Today, over 95% of H_2 is produced via fossil fuels (oil, coal, natural gas) using well-developed reforming technologies, and renewable resources such as $H_2$0 and biomass are future sources for hydrogen. H_2 produced using fossil fuels and biomass will need to address carbon sequestration in order to curb rising levels of atmospheric CO_2. Human activities and growth are overwhelming the natural carbon cycle as evidenced by the significant increase in atmospheric CO_2 due to fossil fuel burning, deforestation, coal mining, and extraction and use of petroleum from the earth. Polymers are highly attractive for many industrial separation efforts due to their processing flexibility, low cost, and good physical properties. Oganic-Ionganic nanocomposite (OIN) membranes may offer new H_2 and CO_2 separation possibilities due to synergistic and interfacial properties using composition and spatial distribution of functional groups. This proposed research effort would create fundamental knowledge linked to material design and separation concepts for Nebraska and our Nation.