Permeability, Solubility, and Diffusivity of HFC-32 and HFC-125 in Polymeric Membranes

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Project EARTH (Environmentally Applied Research Towards Hydrofluorocarbons) is focused on identifying sustainable processes for the selective separation of hydrofluorocarbon (HFC) refrigerant mixtures. HFCs and HFC mixtures were developed to replace chlorofluorocarbons (CFCs), which were linked to the depletion of the Earth's ozone layer. However, the current concern is some HFCs and HFC mixtures have high global warming potentials (GWPs) and recent legislation such as the Kigali agreement are calling for restrictions in certain applications with an eventual phase-out of HFCs. Currently, millions of kilograms of HFCs and HFC mixtures are in use with no efficient method for their disposal. In order to avoid incinerating or venting HFC refrigerants into the atmosphere—processes that are harmful to the environment and would waste millions of kilograms of refrigerants—Project EARTH aims to develop environmentally responsible methods for separating azeotropic refrigerant mixtures so that low-GWP components can be repurposed into next-generation refrigerants. Membranes are an attractive method for separating HFC refrigerant mixtures due to lower energy consumption and smaller capital requirements compared with alternative separation methods such as distillation. This project focuses on the use of polymeric membranes for the separation of R-410A—a 50-50 weight percent mixture of difluoromethane (HFC-32, CH_2F_2) and pentafluoroethane (HFC-125, CHF_2CF_3). Permeability was measured using a static membrane apparatus and pressure-rise method. Solubility and diffusivity were measured using a Hiden gravimetric microbalance. The permeability, solubility, and diffusivity of HFC-32 and HFC-125 in various polymers will be presented.