Seminar

Topic： Development of Thin Flat Sheet Molecular Sieve Membranes for Energy-efficient Products and Processes

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Venue： **Multifunction Hall, IPE Mansion**

Abstract

Zeolite materials are widely used as catalysts or adsorbents in today's industries due to their molecular-sieving functions and stability. Making a membrane of zeolitic framework structures enables continuous separation and simultaneous reaction/separation, and would result in significant savings in energy consumption and capital cost over conventional adsorption and catalytic reaction processes. Thus, zeolite membranes have attracted considerable research interest worldwide for recent two decades. The fundamental feasibility of zeolite membrane preparation and unique performance attributes have been demonstrated in various literature studies and patent publications. However, the widespread industrial application has not occurred yet. High cost and low membrane surface area packing density are viewed as the major barrier. Development of some new membrane products to address these problems has been reported in the literature, such as small-channel monoliths and capillary tubes.

Our recent innovation of thin flat sheet zeolite membrane technologies will be introduced in this presentation. The membrane is fabricated by deposition of an ultra-thin (<3μm) zeolite membrane layer on a thin (50μm), unique porous metal sheet support. The fabrication process renders potential low-cost, roll-to-roll manufacturing of the membrane product, like many current planar commodity products, such as papers, metal foils, glasses, and polymeric membranes. The metal foil-like zeolite membrane sheet would have a surface area packing density comparable to polymeric membrane sheets/plates.

There are a number of significant application opportunities for zeolite membranes in both existing and new industries. Ethanol/water separation and air dehumidification will be presented as two application examples for the respective ethanol fuel and building efficiency industry. One major problem associated with bio-fuel production is dehydration. The flat sheet zeolite membrane shows excellent separation performances for ethanol/water mixtures with a water permeation flux of 10 $kg/m^2/h$ and H_2O/ethanol separation factor above 10,000 for a 10 wt% water/ethanol mixture. The membrane separation could reduce the energy consumption in ethanol fuel production by over 65% compared to the distillation and adsorption process.

Air dehumidification and gas drying in general are a common process, and actually consume a lot of energy with conventional approaches (solvent absorption, solid adsorption, cooling and condensation). Our H_2O-selective flat sheet zeolite membrane shows unprecedented performances for selective removal of H_2O molecule from a gas mixture. The water vapor permeance and H_2O/air separation factor are about 1.0×10^{-5} $mol/m^2/s/Pa$ and above 400, respectively, for dehumidification of hot, humid air (30 - 90% relative humidity, 32°C). Such a high water vapor permeance enables fabrication of very compact membrane dehumidifiers and air conditioners for building HVAC applications. Compared to conventional technologies for air conditioning in hot and humid climate, the present membrane dehumidification enables >50% energy saving.

The flat sheet zeolite membrane provides a critical technology component for development of energy-efficient separation equipment and membrane reactors to improve existing industrial processes and facilitate industrialization of emerging products and processes.