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Plasticization-Enhanced Hydrogen Purification Using Polymeric Membranes


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Hydrogen is the cleanest burning fuel and, as such, has been considered one of the leading alternative energy sources for the future to help reduce America's growing dependence on foreign oil. It can be produced from fossil fuels, nuclear power, and renewable sources. However, until technology development of renewable sources of hydrogen becomes viable on a large scale, virtually all hydrogen is (and will be) produced from hydrocarbon fuels. The resulting hydrogen product, though, must be purified of carbon dioxide and other polar gaseous impurities before end use. This paper discusses a new family of polymeric membranes that could potentially help make industrial hydrogen purification cheaper and more energy-efficient, bringing the envisioned "hydrogen economy" a step closer to reality.

The new membranes, developed jointly with The University of Texas at Austin, exhibit excellent hydrogen separation performance in gas streams containing high-pressure carbon dioxide and other polar gases. Highly permeable to and highly selective for the larger carbon dioxide and hydrogen sulfide over the smaller hydrogen (i.e., highly reverse-selective), the new membranes can efficiently remove these larger species from hydrogen, thereby generating purified hydrogen at or near the high pressure of the feed gas. Retaining the product hydrogen at pressure minimizes or avoids the costs of recompressing the hydrogen for use. In contrast, existing conventional gas-separation membranes display the opposite behavior (i.e., higher permeability and higher selectivity for hydrogen over the larger polar impurities) and produce hydrogen at low pressure. More interestingly, the new membranes take advantage of plasticization by gases such as carbon dioxide and water vapor to enhance their separation efficiency. In contrast, plasticization of traditional polymer membranes is typically detrimental to membrane performance, resulting in poorer selectivity.

The novel polymer membranes described in the paper represent a significant technological advance in the important area(s) of hydrogen separation and, more generally, gas separation. While other hydrogen purification methods still have advantages, there exists great potential for incorporating the new membranes into established processes through hybrid process approaches in the near term to improve process efficiency and decrease costs.

Link: http://www.sciencemag.org/cgi/content/abstract/311/5761/639