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Microporous crystalline membranes for Kr/Xe Separation

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ABSTRACT: The separation of Krypton (Kr) from Xenon (Xe) is an industrially relevant problem. Kr and Xe are widely used in fluorescent light bulbs. High-purity Xe, has been used in commercial lighting, medical imaging, anaesthesia and neuroprotection. During the reprocessing of used nuclear fuel, two of the gases of concern is radioactive 133Xe and 85Kr. By the time fuel is processed, Xe would decay down to stable isotope however Kr has long half-life as a result can not be released into atmosphere freely. Effectively separating Kr from Xe in nuclear reprocessing plants, would lead to a considerable reduction in storage costs, and in potential revenue generated from the sale of pure Xe. The conventional method to separate these two gases is fractional distillation at cryogenic temperatures, which is an energy intensive process. Furthermore, even after cryogenic distillation, trace levels of radioactive Kr in the Xe-rich phase are too high to permit further use. Alternative environmental friendly separation technologies therefore could save energy. In this respect, membrane technology could play a key role in making this separation less energy intensive and therefore economically feasible. Membrane separation processes have several advantages over conventional fractional distillation; for instance, it is a viable energy-saving method, since it does not involve any phase transformation, furthermore, the required membrane process equipment is simple, easy to operate, control and scale-up. In particular, if prepared in membrane form, microporous crystals (zeolites and metal organic frameworks) combine highly desirable properties, such as uniform micropores, high surface areas, and exceptional thermal and chemical stability, making them ideal candidates for challenging molecular gas separations, such as Kr/Xe separation. In this presentation I gave two examples of microporous crystalline membranes (ZIF-8 and SAPO-34) that effectively separate Kr/Xe gas mixtures. To our best knowledge these membranes developed at our laboratory are the first examples of any microporous crystalline membrane displaying effective separation for Kr/Xe gas mixtures at industrially relevant feed compositions. In the presentation, I discuss the prevailing separation mechanisms of these membranes.

BIOGRAPHY: Moises A. Carreon is Associate Professor in the Chemical & Biological Engineering Department at Colorado School of Mines. He earned his PhD degree from University of Cincinnati. He worked as postdoctoral fellow at University of Toronto, and University of Colorado at Boulder. His research focuses on molecular gas separations, heterogeneous catalysis, and gas storage, and aims at tackling highly relevant societal issues related to energy and environment, including (but not limited to) carbon dioxide capture and utilization, biomass conversion to fuels, natural gas purification and storage, and nuclear spent fuel treatment. Carreon has over 70 refereed publications, and 5 US granted patents. Carreon awards as independent scientist include: 2014 Innovator Award. Society of Hispanic Professional Engineers (SHPE); 2014 List of 12 extraordinary personalities that moved Mexico in 2014 ; 2013 PECASE (Presidential Early Career Award for Scientists and Engineers) ; 2013 AIChE Separations Division Kunesh Award; 2011 NSF CAREER award; and 2009 ACS-PRF Doctoral New Investigator award.