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CIVE 6111 Graduate Seminar

Biomimetic Ideas for Sustainable Separations

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Abstract
Membranes are rapidly becoming the fastest growing platform for water purification, wastewater reuse, and desalination. They are also emerging in importance for carbon capture, hydrocarbon separations, and are being considered for applications involving catalysis and sensing. All synthetic membranes have selectivity-permeablility tradeoffs, i.e if a membrane has high permeability, it will have a lower selectivity between two solutes or between a dissolved solute and a solvent. This is due to the mechanism of solution-diffusion through a wide distribution of free volume elements in non-porous membranes such as reverse osmosis membranes used for desalination and reuse, and a wide pore size distribution in porous membranes. A simple solution, in concept, to such a challenge is to do what nature does – design precise angstrom to micron scale pores with no polydispersity. However, so far such an ideal has not been realized in synthetic membranes and in particular for angstrom scale separations. We will discuss bioinspired ideas, and its realization in our lab, that could lead to an achievement of such an ideal membrane based on biological protein channels and artificial channels that mimic their structure.

Keywords: Separations, reverse osmosis, biomimetic membranes, artificial channels

Bio
Manish Kumar is an Associate Professor of Environmental Engineering at UT Austin. He received his bachelors from the National Institute of Technology in Trichy, India in Chemical Engineering. He completed masters in environmental engineering at the University of Illinois and then worked for approximately seven years in the environmental consulting industry on applied research projects primarily centered around membranes for water treatment, desalination, and reclamation. He returned to Illinois to complete a PhD in the area of biomimetic membranes and then conducted postdoctoral research at the Harvard Medical School on the structure of water channel proteins, aquaporins. He works in the areas of sustainable filtration, biophysical transport characterization, membrane protein-based membranes and devices and on developing artificial membrane proteins (based on synthetic supramolecular macrocycles). His group also works on improving membrane processes to prevent biofouling and colloidal fouling and for treating water from conventional and unconventional sources.