# DEPARTMENTAL SEMINAR

**DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING**
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| **TOPIC** | ***Integrated Distillation Membrane Separation Processes for Petrochemicals and Biofuels*** |
| **SPEAKER** | **Dr Huang Yu** |
| **HOST** | **Prof Neal Chung** |
| **DATE** | **20 September 2011 (Tuesday)** |
| **TIME** | **2:00 PM** |
| **VENUE** | **Block E5, 2nd Floor, Room 32 (E5-02-32)**<br>**Interactive Map of NUS** |

**SYNOPSIS**

There are approximately 40,000 distillation columns of various types in operation in the United States. These columns use about five quads (1 quad ≡ $10^{15}$ Btu) of energy or 6% of total energy consumption. Distillation is widely used because of its simplicity, low capital cost and reliability. The key disadvantage of distillation is its low energy efficiency. In the past, the energy cost of distillation was not a serious issue; this is no longer the case. Economical methods of reducing the energy costs of distillation operations are being aggressively pursued.

The use of vapor permeation/pervaporation membranes as a low-energy alternative to distillation has been proposed for more than 30 years, yet the current market for this technology is not more than $20 million/year, almost all for the separation of water from ethanol or isopropanol in the pharmaceutical and fine chemicals industry. In the early 1990s, major oil companies such as Exxon, Texaco, and Mobil all had research programs focused on developing membrane technology for refinery separations. Most of these programs have since been abandoned or scaled back. The problem was not the lack of suitably selective membrane materials, but the difficulty of making reliable and economical membranes and membrane modules. Membrane and module components able to operate at temperatures above 100°C in hydrocarbon liquids were required. Also, early developers of the technology often linked the membrane systems and distillation as a simple series of unit operations. This overlooked the advantages of very substantial reductions in the energy of separation achieved if heat integrated process designs are used.

In this presentation, a low-energy separation process combining distillation and membrane pervapoation/vapor permeation is introduced as an alternative to conventionaldistillation. The process can be applied to any liquid mixture for which appropriatelyselective membranes are

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| | available. Typical applications include separation of mixtures of water and alcohol (such as ethanol, isopropanol and butanol), water-acetic acid mixtures and petrochemical aromatic-aliphatic mixtures. This presentation is focused on separation of water from organic solvents using membranes that preferentially permeate water. Such membranes are available or under development. The process is illustrated with two representative mixtures: ethanol (light component)/water (heavy component), and acetic acid (heavy component)/water (light component) mixtures. In both cases, the combination process reduces the energy consumption of the same separation by almost 50% compared to stand-alone distillation. A laboratory demonstration of the new process has confirmed the low energy usage. The membranes suitable for the above two applications are also briefly discussed. |
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| **BIOGRAPHY** | Dr. Huang began her professional training at Tsinghua University in Beijing, China, where she completed her undergraduate studies. She received her Master's degree in Civil Engineering (Environmental Engineering Division) at the National University of Singapore in 1996, her Master's degree in 2002 and Ph. D. in 2005 in Chemical Engineering from the University of Texas at Austin.<br><br>Dr. Huang joined Membrane Technology and Research in 2005 as a Senior Research Scientist and has already led seven MTR projects to develop membranes for use in ethanol/water and other biofuel process separations. She is currently leading a group to transfer the technology from MTR's biofuels laboratory studies into commercial product offerings. She has been an active researcher since she was at Tsinghua University. Dr. Huang has participated in a number of research projects sponsored by the Singaporean Government, U.S. Government agencies and private clients. These programs range from fundamental membrane research to the design and development of membrane separation systems. Dr. Huang earned several honors for her university work in China and in Singapore, and received a Graduate Student Professional Development Award from UT Austin in 2004.<br><br>Dr. Huang has almost 20 technical publications in peer-reviewed journals and eight patents or patents pending; among these, the three recent publications and all of the pending and issued patents are from her work at MTR. Dr. Huang has served several times as a reviewer for peer-reviewed journals and as meeting chairperson. |

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