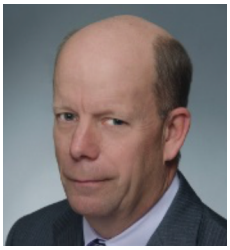
James R. Fair
Process Science and Technology Center

The University of Texas at Austin

In this issue

Note from the Program Head



EPIXC: The road mapping workshop (Jan. 31, Feb. 1) was an invitation only event with only companies who promised a "large" cost-share commitment being invited. This is probably not how I would have done it, but the project is being run by our colleagues at Arizona State. I apologize for any inaccurate announcements I sent out earlier to my PSTC sponsors. As far as PSTC/ SRP pilot plant support, funds UT committed for the pilot plant modifications and modernization will be directly tied to DOE funds sent to UT Austin; no DOE funds for specific projects – no UT funds for the pilot plant. We do have a proposal for a jump-start project submitted which could provide matching UT funding for the electrification of the pilot plant steam system and an electric reboiler for the 6-inch diameter distillation column (see Frank's note for a project summary). Should funds not become available from UT, we will pursue a band-aid approach, fixing issues as equipment is needed for funded research projects. This may increase testing costs but is the only workable solution.

Frank intends to retire sometime this summer (there is a house under construction on the Texas gulf coast). We are in discussions with replacement candidates but are waiting on clarification of the EPIXC effort before posting the position formally (see pilot plant funding discussion above). This next part is important: Frank's colleagues and friends in the AIChE Separations Division have graciously agreed to use the Spring AIChE meeting dinner to honor him for his forty years of service. The event will be on Monday night, March 25th. If you are at the New Orleans meeting, please plan on attending – I can think of few people who have supported what we do as well, and for as long, as Frank.

Continued

Administrative support changes: We have hired Noemi Ortiz to replace RoseAnna Goewey as our administrative assistant. Noemi's e-mail address is: noemi.ortiz@austin.utexas.edu. Please contact her with any contract, meeting, or other administrative questions.

My working plan is to attempt to set the program up for long-term success and then evaluate my future. This approach will have me around for a couple more years. I would argue that there remain key challenges for both our industry and the planet that the PSTC / SRP can address. The need for well-trained graduates at both the undergraduate and graduate level who actually know how traditional chemical processes work, will be very important moving forward. As always, your support and financial assistance will be critical to ensure we have a high-quality workforce.

Best wishes for a safe and happy start to the New Year.

SRP Update

Frank Seibert

Since 1986, the SRP pilot facilities (Figure 1) have been primarily supported by industrial projects providing an indicator of the latest separations interest. In the early years ranging from 1986 to 1998, interest focused on improving the understanding of mass transfer devices such packing and trays for distillation. After 1999, interest began to shift to process demonstrations such as testing new amine solvents for carbon dioxide absorption and stripping. Different contacting devices were often explored during these process demonstrations. Since 2008, our industrial sponsored studies shifted towards improving energy efficiency, reducing emissions, water purification and sustainability projects. Nevertheless, interest continues in the packing characterization packings and improved models.

Figure 1. Photograph of SRP Pilot Plant

Dividing wall distillation is an example of our recent trends. This technology offers the potential of significant energy and capital savings relative to conventional distillation. Past projects have often focused on process simulation validation and process control. A new project, supported by Eastman Chemical, will investigate the application of a lab-scale (one inch diameter) dividing wall distillation configuration assembled with Oldershaw distillation components. Two custom-made "tee-shape glass sections" are incorporated with standard glass components.

SRP Update continued

This study is being performed by Natalie Czarnecki, a doctorate student of Dr. Bruce Eldridge. Lorenzo Giannetti, a Visiting Scholar from Italy, will provide process simulation support. A well-characterized azeotropic ternary mixture has been selected for study. The lab scale testing will begin in January 2024. This study will be followed up with a pilot scale test a few months later. Preparations for the pilot study are currently underway. The pilot plant study will provide direct scale-up of these lab-scale results. We wish to thank Eastman Chemical for their generous support of this interesting study.

Our expanding lab-scale distillation and water purification projects created the need to increase the floor space in our high bay hood. The original hood was fabricated by SRP technicians in the early 1990s as part of a project involving caustic scrubbing of microelectronics related contaminates from air. Through the generous support of Eastman Chemical, funding allowed for doubling of the hood's floor space. At present, the hood is supporting three lab scale distillation studies and a produced water purification project.

Oil/water membrane separation studies continue to increase with projects continuing in 2024. The studies involve a collaboration with UT-Austin Professors Lynn Katz, Kerry Kinney and me and a Kuwait University Professor, Dr. Abdalrahman Alsulaili. The initial project included determining the effects of oil concentrations (25-250 ppm), transmembrane pressure, oil viscosity, salt concentration (0-50,000 ppm), surfactant types and solids handling.

A recent PhD student, Carolyn Cooper, has provided an interesting dissertation covering this work. A new area of study with higher oil concentrations (250-1,000 ppm) and the effect of solids is underway.

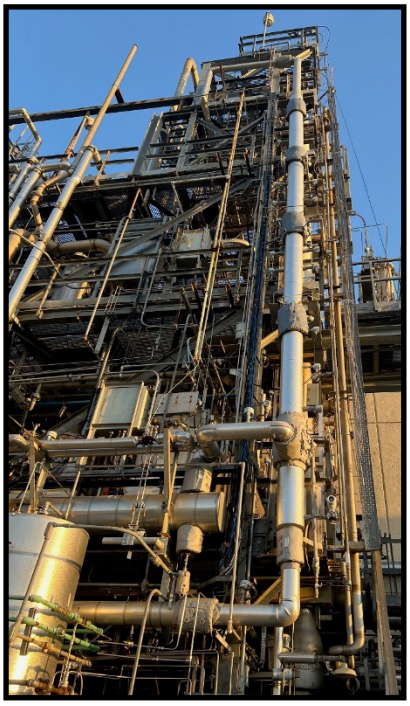


Figure 2. Graduate Students, Natalie Czarnecki & Lorenzo Giannetti, preparing for the Lab-Scale Dividing Wall Distillation Experiments (top). The Dividing Wall Distillation Pilot System (bottom).

SRP Update continued

A ceramic (non-layered) tubular membrane is being studied to reject solids while allowing permeation of both water and oil (Figure 3 Photo of Skid).

A second membrane will separate the oil from the water. The new study will focus on using produced water obtained from the Eagleford formation. The solids filtration study will be the "first" in SRP history. The proposed membrane filtration system will require relatively short cycle times (4 -10 minutes) of operation followed by a brief regeneration time (5-20 seconds). The project required modification of the original system to allow for a dynamic operation. We wish to thank Emerson for supporting these modifications.

The new two-step membrane filtration followed an oil/water membrane separation system will allow for a 24/7 operation. Initially, the effects of transmembrane pressure, cross-flow velocity, solids concentration and particle size will be determined using a bench scale membrane. The effects of oil concentration will be added to the filtration study. Lastly, a two-step pilot process will be tested to treat an oil/ water/ solids feed to yield a clean water stream, clean oil stream and a concentrated solids stream.

Exciting plans are underway that potentially will maintain the University's unique separations piloting operations for the next 30 years.

Figure 3. New Walk-in Hood Extension (Note the New Ceramic Membrane Filtration System in Front of the Hood)

The Engineering College and the UT Energy Institute are promoting this effort. If successful, the pilot plant will be refurbished with new stainless steel equipment. As an initial step, a U.S. Department of Energy proposal is being prepared to add an electric reboiler to the pilot Dividing Wall Distillation System. The existing steam reboiler will remain. The proposed research will include comparing the relative heating dynamics of the electrical reboiler with the traditional steam reboiler. A hybrid system, electrical heating with traditional steam heating, will also be proposed. The effects, beneficial and detrimental, of control with fluctuating heat inputs are also proposed. It is hoped the EPICX project will ultimately lead to the refurbishment of the Pilot Facilities.

Freeman Group Update

Benny Freeman won the 2022 AIChE Separations Division Founders Award, the 2023 AIChE Materials Engineering & Sciences Division Braskem Award for Excellence in Materials Science and Engineering and was elected to the U.S. National Academy of Engineering and Texas Academy of Medicine, Engineering, Science & Technology (TAMEST).

Student Accomplishments:

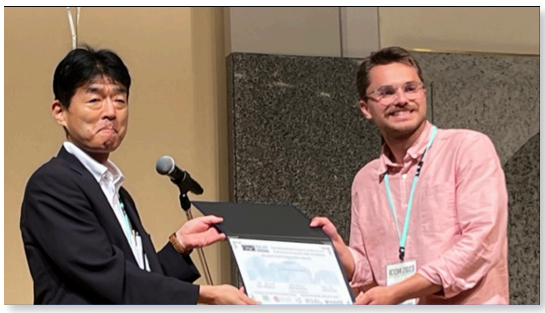
- Former PSTC Ph.D. student Josh Moon has now started as a professor of chemical engineering at the University of Florida.

- Current PSTC postdoctoral fellow Rachel Huang was named to the 2024 Forbes 30 under 30 list.

- Former PSTC Ph.D. student Marshall Allan, coadvised with Zak Page, recently started a position at Exponent, Inc. in Palo Alto, CA.

- Former PSTC Ph.D. student Alec Bridge, coadvised with Joan Brennecke, recently started a position with UOP in Des Plaines, IL.

- Former PSTC Ph.D. student Everett Zofchak won several awards recently, including outstanding presentation winner at the International Congress on Membranes (ICOM) in Tokyo, July 2023. Everett also won a Department of Energy PI Meeting Lightning Talk Winner, 2023, and North American Membrane Society Best Student Poster Award, 2023.



- Current PSTC Ph.D. student Nico Marioni, coadvised with Venkat Ganesan, won an outstanding presentation award and outstanding poster presentation award at the International Congress on Membranes (ICOM) in Tokyo, July 2023.

Freeman Group Update continued

- Former PSTC Ph.D. student Rahul Sujanani won a 2024 PMSE Future Leader Award from the PMSE Division of ACS.

  Rahul is currently a postdoctoral fellow at UC Santa Barbara.

Baldea Group Update

Michael Baldea is now the CTO of EPIXC – DOE's latest clean energy manufacturing innovation institute focused on electrified process heating. Baldea started a new role as the Editor in Chief of Industrial & Engineering Chemistry Research, the oldest and largest general chemical engineering journal in the world.

Student Accomplishments:

• Sophia B. Shi, UT Chevron Energy Graduate Fellows Award, UT Austin (2023-2024)

• Calvin Tsay, 2022 AIChE Computing and Systems Technology Division W. David Smith, Jr. Graduate Publication Award

• Morgan T. Kelley, US DOE 2022 Howes Scholar in Computational Science

Publications

Baldea, Michael: https://sites.utexas.edu/baldea/publications/

Eldridge, Bruce: https://sites.utexas.edu/eldridge/publications/

Freeman, Benny D: https://sites.utexas.edu/membraneresearch/publications/

Ritter, Jim:

H. Jiang, A. D. Ebner and J. A. Ritter, "Theoretical Analysis of the Pressure Regions where Adsorption Azeotropes Exist in Binary Gas Mixtures," *ACS Omega*, 7, 43242-43253 (2022).

S. A. Adegunju, A. D. Ebner and J. A. Ritter, "Kinetically Limited Linear Driving Force Model for Diffusion Based Adsorptive Separations," *Ind. Eng. Chem. Res.*, 61, 17615-17630 (2022).

N. Mohammadi, R. T. Sanders, C. E. Holland, A. D. Ebner and J. A. Ritter, "Non-Experimental Methodology for Developing Pressure Drop Correlations for Structured Adsorbents with Parallel Channels," *Adsorption*, 29, 29-43 (2023).

S. A. Adegunju, P. B. C. A. Amalraj, C. E. Holland, M. J. Nicholson, A. D. Ebner and J. A. Ritter, "Assessment of the New Kinetically Limited LDF Model for Diffusion Limited Separations by PSA," *Ind. Eng. Chem. Res.*, 63, 579-593 (2024).

S. A. Adegunju, P. B. C. A. Amalraj, C. E. Holland, M. J. Nicholson, A. D. Ebner and J. A. Ritter, "Assessment of the New Kinetically Limited Linear Driving Force Model for Predicting Diffusion Limited Adsorption Breakthrough Curves," *Adsorption*, published 14 December 2023 (2023).

J. A. Ritter, A. D. Ebner and C. E. Holland, "Extremely Large Scale Pressure Swing Adsorption Processes for Flue Gas Treatment," USP 11,717,786 B1 (2023).

Rochelle, Gary: https://sites.utexas.edu/rochelle/publications-2/