

James R. Fair Process Science & Technology Center



Summer 2018 Newsletter

Note from the Program Head

<https://sites.utexas.edu/pstc/>

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This summer marks both my 60th birthday and 22 years of teaching at UT Austin. Both events have caused me to reflect on the state of the education for students entering the “traditional” chemical engineering industry at both the graduate and undergraduate levels. The field of chemical engineering continues to evolve into new and exciting areas which have attracted both student interest and research support. This is a good thing but raises concerns about how academia will maintain support for the traditional refining and chemical industries while still pushing the frontiers of science and technology. Almost all newly hired faculty at top-tier academic programs will conduct research in the areas which are not associated with oil, gas, and chemical production and I can count on one hand the academic research programs focused on “traditional” process engineering technology. This reality impacts the pool of undergraduate and graduate students available to industry.

I once read a biography of George Washington which claimed his most effective trait was to see things as they were not how he wished they would be. That thought pattern is appropriate here; we will never return to a time of unit operations being a hot topic in chemical engineering (this is an opinion based on many years of teaching at several institutions). So the question becomes – what do we do to support and maintain an indus-

try which continues to be critical to all facets of our lives?

My thoughts:

We are quickly moving to an academic structure which has two components – a set of teaching faculty who teach core undergraduate courses and a set of research faculty who will only teach courses focused on their research area. Provided university administrations allocate adequate support for the teaching faculty – and this is an open question – this approach will be a positive. There is no benefit having a unit operations instructor who has never seen a pump or designed a distillation column. Some enlightened departments are actually allocated funds for tenured Professor of Practice positions which are filled by an experienced engineer drawn from industry. Industry can certainly help by providing funding support for these positions and retiring engineers should consider this as a second career option. One cautionary note – there is more to the teaching process than just having an industrial background.

At the graduate level it is clear that the DOE and NSF are not going to support traditional process engineering research so student support must come from industry. *cont.* →



As I have mentioned multiple times, unless industry steps up uniformly there will be a shortage of trained Ph.D. engineers as the baby boomer generation retires. I also believe simply sweeping up students somebody else has supported in graduate school is not okay. Everybody needs to have skin in the game for the process to be fair and effective.

So the conclusion: traditional industries must step up their support for academia if they are to meet the challenges of the future. We look forward to seeing you at the fall PSTC meeting,

Best wishes,
Bruce

SRP Update: Frank Seibert



The SRP project activity has increased significantly with future studies in the areas of carbon dioxide capture (with Gary Rochelle and Eric Chen), oil/water separations, Oldershaw distillation, and packing characterization.

Several plant upgrades are underway.

The entire distillation column and overhead condenser have been re-insulated. Several dividing wall distillation-related piping runs and the “Baby Feed Tank” have also been re-insulated.

In addition, the distillation system is being modified to allow for pressure drop and flooding characterization using n-heptane. The modifications will allow for independent adjustments of the liquid and vapor rates similar to the air/water hydraulic characterization procedure. ARI will donate a high turndown, high capacity Fractal liquid distributor for this activity. A new, much higher capacity pump has been installed along with most of the wiring. Some minor piping modifications and insulation remain before testing.

The Appleton Group, a subsidiary of Emerson Process Management, is donating LED lighting for the pilot plant and in two of our indoor labs. The scope of work will involve replacing 28 outside lights and 21 indoor lights. The proposed work is expected to result in demonstrating the improved energy efficiency of LED lighting along with improve overall lighting in the plant and labs.

A significant oil/water separation study extending the Ph.D. work of Aurore Mercelat is near completion. The work focused on the effect of interfacial tension on the oil recovery efficiency

and includes data associated with a 30-day continuous run. The results will become available in the fall.

Future 2018/2019 SRP pilot plant and lab scale operations will include:

- ◆ Pilot Plant Demonstration of the Advanced Flash Stripper and a Membrane Contactor for Carbon Dioxide Capture
- ◆ Lab Scale Distillation Studies
- ◆ Effect of a Fractal Distributor on Distillation Packing Performance
- ◆ Distillation and Air/Water Related Packing Characterization
- ◆ Gas Film Mass Transfer in Co-Current Spray Contactor
- ◆ Effect of Interfacial Tension on the Oil/Water Separation using a Novel Membrane Process
- ◆ Effect of Plastic Random and Structured Packing as Coalescers in Liquid Extraction



Current SRP pilot plant lighting

In the News

Explorers Club

On July 10th, we hosted an Explorers Club meeting. Approximately 27 STEM (Science, Technology, Engineering, and Math) students from local area schools visited and toured the Separations Pilot Plant. The students, ranging in age from 5 to 18, introduced themselves and their areas of interest. Also joining the meeting were 15 adults which included parents, teachers, and a Round Rock Independent School District board member. A brief presentation on the application of advanced technology in oil and chemical plants was provided which also included a discussion on distillation.



Awards & Honors

The members of the Freeman Group have had an outstanding summer:

Alumnus **Zachary Smith**, now a professor at MIT, has won the prestigious [DOE Early Career Award](#) based on his proposal “Rational Sub-Nanometer Manipulation of Polymer Morphology for Efficient Chemical Separations.” As one of 54 winners, Zach receives \$750,000 over 5 years towards his research.

Melanie Merrick and **Joshua Moon** brought home honors from the annual meeting of the North American Membrane Society (NAMS). Melanie earned Second Place in the Gas Separations Research Poster competition and Josh earned Second Place in the Materials Research Poster category. Additionally, Joshua presented his work at a special oral symposium as part of his NAMS Student Fellowship Award.



Alysha Helenic was a runner-up in the McKetta Department of Chemical Engineering’s 2018 [Graduate Student Seminar Series](#) for her presentation “Separation of Monovalent Ions for Water Purification and Resource Recovery.”



Constanza Sanchez has been selected as a semi-finalist in the Exxon Mobil LOFT Fellowship (final results pending). The LOFT fellowship recipient receives mentoring from an ExxonMobil engineer/scientist as well as a \$1,000 stipend.



Rahul Sujanani has received the Eastman Chemical Graduate Fellowship in Chemical Engineering. One second- or third-year graduate student in the Department of Chemical Engineering is selected to receive a \$10,000 award and to present their research to the company.



Student Spotlight: Marc Panu



In this issue of the newsletter we travel all the way to College Station, Texas, to meet Marc Panu, a Ph.D. student in the El-Halwagi Group at Texas A & M University.

Marc was born and raised in Atlanta, Georgia where from time immemorial he had an affinity for the natural world. By the time

he reached five years of age, he had already accumulated multiple books on the solar system, no doubt inspired by his father, a chemistry professor. A businessman at heart, Marc discovered engineering at the intersection of his science and business interests.

Moving to Nashville, Tennessee, to attend Vanderbilt University, Marc decided to study chemical engineering, in part due to his affinity for chemistry, but also due to his desire to engineer new products for the world. His introduction to process systems engineering (PSE) came during his senior year when his class learned about heat integration in a plant design class—it immediately grabbed his attention for its practical nature and for the impact it has on economics and sustainability of a chemical process.

Marc graduated with a B.Eng. in Chemical & Biomolecular Engineering then set his sights on graduate school. His plant design professor at Vanderbilt was a former student of Dr. El-Halwagi and after conversing further with him about heat integration, PSE in general, and working with Dr. El-Halwagi, Marc decided that the El-Halwagi Research Group at Texas A & M was an ideal fit for him.

The focus of Marc's graduate research is on developing pathways to convert carbon dioxide into useful chemicals in the context of an eco-industrial park. He was drawn to this topic by the understanding of the main reason why we are struggling to reduce CO₂ emissions—pure economics. Releasing CO₂ into the atmosphere is much less expensive than sequestering it. Marc states that if we can develop a free-market solution for reducing carbon dioxide emissions, then we can make significant progress toward a cleaner chemical manufacturing industry. He suggests finding pathways to economically convert CO₂

into useful chemicals, making it more valuable as a feedstock than as a waste material.

Beyond this research, Marc is interested in sustainable design, particularly in regards to reducing CO₂ emissions—it's a topic that touches upon many other areas of chemical engineering. He is also drawn to the utilization of alternative energy sources (*e.g.*, optimizing production of intermediates to minimize the challenges associated with using an inconstant energy source like wind or solar) and the development of systematic process intensification tools.

Marc has also added depth to his studies by working as a software implementation consultant for a supply chain software company in Antwerp, Belgium. This experience gave him a good foundation for the computational aspects of his research as well as an appreciation for how big companies make decisions. Outside of the lab and office, Marc really enjoys cooking (well, mostly drinking wine) with his girlfriend Kristen and hanging out with his dog Charlie. He also has a penchant for playing around with whatever new tech development is available to him.

Nevertheless Marc is still keeping an eye on the future of his field of research. Sustainable design will continue to be a major focus of research efforts and he believes that there will be key developments in the practicality of grass roots industrial symbiosis as well as intensified manufacturing processes in the short- to mid-term future. We wish Marc Panu all the best in his research and his future work in industry!



PI Spotlight: Dr. Mahmoud El-Halwagi

For our PI spotlight this month, once again we look towards College Station and visit with Dr. Mahmoud El-Halwagi at Texas A & M University.

Originally from Baltimore, Maryland, Mahmoud grew up in Cairo, Egypt, where from a young age he was fascinated by the field of chemical engineering—he found exciting the transformation of numerous natural resources into value-added products. Both his father and grandfather were chemical engineers so he was well acquainted with the field but it wasn't until high school, where he formally studied chemistry and physics, that his attention was well and truly caught. His curiosity developed into a passion. He went on to earn B.S. and M.S. degrees in chemical engineering from Cairo University.

Mahmoud recalls one of the first research grants he ever received, the National Science Foundation's Young Investigator Award. The five-year funding award enabled his research and outreach efforts in the area of pollution prevention through process integration. This work, in his own words, "involved the development of systematic and generally applicable design tools to mitigate negative environmental impact of industrial processes while aligning or reconciling the environmental metrics with the techno-economic objectives of the industrial plants."

Initially drawn to Texas A & M by its very strong ties to the process industry and the energy sector, Mahmoud has developed a deep appreciation for working with the amazing students there. He believes A & M has done a phenomenal job in attracting students who embody the "Aggies Core Values" (respect, excellence, leadership, loyalty, integrity, and selfless service).

Mahmoud has been following the Separations Research Program (SRP) and its major contributions ever since Dr. Fair established it in the 1980s. As SRP transitioned into the Process Science and Technology Center (PSTC), Dr. Bruce Eldridge approached him about joining the group. Mahmoud was immediately interested in the inspiring opportunity to work alongside a remarkable group of scholars and partners.

Currently, Mahmoud's research is focused on the sustainable design of industrial processes with a focus on process integration and optimization as enabling tools. This process integration is a holistic approach to the design and operation of industrial facilities that emphasize the system's unity. The El-Halwagi Group develops conceptual frameworks, fundamental approaches, and working tools to systematize the enhancement of economic, environmental, and societal objectives of industrial processes. Beyond process design, Mahmoud is interested in the broader process systems engineering field which includes optimization, control, operation, scheduling, and planning. He is also interested in separations and environmental applications.

As for the future of his field, Mahmoud foresees continued growth and applicability of his field—there is substantial growing interest in sustainability and a recognition of the tremendous impact of process integration and design. As he notes, "industrial facilities exert some of the most profound impact on the environment, consume significant amounts of natural resources, and provide enormous contribution to economic growth and societal progress." For a more sustainable future, systems approaches are highly critical for enhancing the desired objectives and trading off the complex metrics involved in industrial plant design and operations. *cont.* →



El-Halwagi's Process Integration & Systems Optimization Group Retreat and Reunion



When not grappling with the intricate puzzles of his field, Mahmoud loves spending time with his family, especially traveling. He considers just finding the time for the whole family to travel together a tough, but nevertheless enjoyable optimization problem. In his free time,

Mahmoud indulges in reading about history and culture.

We are very appreciative of Dr. Mahmoud El-Halwagi's contributions to the Process Science and Technology Center and wish him all the best in his future work!

Articles We've Published

Freeman Group

- ◆ Kamcev, J.; Paul, D. R.; Manning, G. S.; Freeman, B. D. "[Ion Diffusion in Ion Exchange Membranes: Significance of Counterion Condensation](#)," *Macromolecules* **2018**, *51*, 5519-5529.
- ◆ Abdellah, M. H.; Scholes, C. A.; Freeman, B. D.; Liu, L.; Kentish, S. E. "[Transport of Terpenes Through Composite PDMS/PAN Solvent Resistant Nanofiltration Membranes](#)," *Separation and Purification Technology* **2018**, *207*, 470-476.
- ◆ Yan, N.; Paul, D. R.; Freeman, B. D. "[Water and Ion Sorption in a Series of Cross-linked AMPS/PEGDA Hydrogel Membranes](#)," *Polymer* **2018**, *146*, 196-208.
- ◆ Scholes, C. A.; Freeman, B. D. "[Thermal Rearranged Poly\(imide-co-ethylene glycol\) Membranes for Gas Separation](#)," *Journal of Membrane Science* **2018**, *563*, 676-683.
- ◆ Freeman, B. D. "Ion Transport in Charged Polymer Membranes," *Abstracts of Papers of the American Chemical Society* **2018**, 255.

Fall 2018 Meeting

Please join us for our annual PSTC Fall Meeting October 16-17, 2018, here at the University of Texas at Austin. Once again, we will be at the [Commons Learning Center](#) located on the Pickle Research Campus. [Registration](#) and [accommodation](#) information are available on our website. Handouts of the presentations will be available for attendees; pdf copies will be posted on our website closer to meeting time.

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