



# James R. Fair Process Science and Technology Center

## Spring 2017 Newsletter

<http://dept.ceer.utexas.edu/ceer/pstc/>



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### Note from the Program Head

Dr. Ted Pettijohn (an ex-Phillips Petroleum colleague and our primary PSTC contact at Evonik) and I had the opportunity to participate in a panel discussion for the UT College of Natural Sciences last month. The goal was to present techniques for effective academic / industry research partnerships to CNS faculty.

The event made me reflect on the level of success the PSTC / SRP has enjoyed over the program's thirty-plus years. We are very fortunate to have earned a reputation that allows us to participate in projects funded by a broad cross-section of industrial and federal funding organizations.

One example of this is UT's participation in the DOE-funded RAPID effort lead by AIChE. Tom Edgar and Michael Baldea sold a dividing wall column (DWC) project to DOE based in large part on unique experimental equipment the SRP has available. As is the case in all our efforts, we are indebted to our industrial sponsors for supporting the acquisition of new equipment, including the new DWC.

During the panel, Ted asked me to discuss the impact industrial interaction has on graduate student development. I told the story of Dr. Zach Smith (PhD with Benny Freeman and a post-doc with Jeff Long at UC-Berkeley). Zach has just started his academic career at MIT and the best way to explain the impact PSTC sponsor support has on student development is to have him tell the story:

*During my second visits, I received a lot of feedback on my application package. There seemed to be a common theme that hiring committees thought*

*my application stood out from the others because I was able to frame research questions in terms of real applications that were of relevance to industry. Without the interactions I had at PSTC, I would have been severely limited in my understanding of relevant challenges in the separations industry today. Looking back at all of the PSTC meetings I attended, it is very clear that PSTC played a critical role in my professional development!*

I have often thought the PSTC's primary goal should be the production of knowledgeable students – it sounds like we are doing OK.

In keeping with the student training theme, I should comment on the potential impact the new administration will have on federal research support. Our colleagues at the National Science Foundation are anticipating a 5 percent budget reduction while the DOE will face renewed budget pressure. *cont.* →



Both organizations have historically supported the research programs of PSTC PIs with a significant amount of the research being reported to our sponsors at PSTC meetings. These funding cuts, if not replaced by industrial funds, will impact our ability to conduct important research and produce students for our sponsors to hire.

The fall PSTC meeting will be held on October 17<sup>th</sup> and 18<sup>th</sup>. A component of that meeting will be a gathering of the Tier II sponsors to discuss the PSTC's future direction and potential research opportunities. I look forward to seeing you in Austin – have a great start to summer.

*Bruce*

## SRP Update: Frank Seibert

The 2017 SRP Pilot Plant activities continue with several significant infrastructure enhancements.



Plans are underway to replace our 1970s-era steam boiler with a new energy-efficient steam boiler which will be provided through matching College of Engineering funds associated with a US Department of Energy Project managed by Professor Tom Edgar and funds associated with my "Equipment Use Fee" account. The total cost of boiler installation is estimated to be \$200,000. Professor Gary Rochelle and Dr. Eric Chen recently

completed significant structural and piping modifications which include adding a new level to the SRP Pilot Plant and a new stainless steel absorber spool section allowing for a total of three packed beds (see bottom right photo). The extra bed also allows for a water wash section. Additional modifications were performed on the advanced flash stripper, absorber sump, replacement of the large plate and frame heat exchanger, and improved FTIR sampling capability. The modification cost of \$800,000 was funded by the US Department of Energy and Gary Rochelle's C<sub>2</sub>P<sub>3</sub> program to support continued pilot-scale carbon dioxide capture research. Plans are also underway to update all of the SRP process control computers and associated DeltaV hardware. Emerson Process Management will support and fund this effort.

Steve Briggs recently left our technical staff team after 15 years of outstanding service. He played a significant role in enhancing our experimental capabilities. In an attempt to duplicate his mechanical background and expertise, Steve and I searched for

an ex-US Navy nuclear submarine machinist and identified an outstanding candidate in Henry Bautista. Originally from San Antonio, Henry served in the Navy for 12 years and obtained the title of Navy Nuclear Qualified Machinist's Mate First Class.



**Henry Bautista**

Henry also earned seven Navy achievement medals. Thankfully, Henry accepted our offer and has been working with us for eight months. Henry is high energy and has already proven to be an outstanding mechanic and operator of the total reflux, dividing wall distillation, and the carbon dioxide capture systems. For fun, Henry is also a certified cross-fit trainer.

*cont. →*



**Photograph of SRP Pilot Plant—note the additional level.**

Along with the infrastructure improvements, the SRP pilot plant and lab scale operations continue to be very active with projects in the following general areas:

- ◆ Pilot Plant Demonstration of the Advanced Flash Stripper and Three Bed Absorber for Carbon Dioxide Capture
- ◆ Distillation Packing Characterization
- ◆ Gas Film Mass Transfer in Co-Current Spray Contactor
- ◆ Effect of Liquid Viscosity of Packing Liquid Film

- ◆ Mass Transfer Coefficients
- ◆ Pilot Scale Dividing Wall Distillation and Advanced Control
- ◆ Effect of Interfacial Tension on the Oil/Water Separation using a Novel Membrane Process
- ◆ Effect of Plastic Random Packing as a Coalescer in Liquid Extraction
- ◆ Lab Scale Stripping Operations
- ◆ Lab Scale High Temperature/Pressure Flash Operations

## In the News



Professor and Fulbright Distinguished Scholar Benny Freeman was recently announced as [CSIRO's 2017 Sir Jerry Price Lecture presenter](#).

The lecture series was established in 1990 in an effort to encourage the collaboration between industry, CSIRO and university scientists. Its namesake, Sir Jerry Price, was the former CEO of CSIRO and a leading mind in organic chemistry.

Professor Freeman's presentation titled, "Science and Technology to Secure the Future for Water and Energy" framed the water/energy nexus challenges and opportunities, and provided a glimpse of potential paths forward to supply the world with low energy, abundant access to water.

Professor Freeman was awarded the U.S. Fulbright Distinguished Chair in Science, Technology and Innovation in 2016. His is the first Fulbright distinguished chair sponsored by CSIRO.

The lecture took place Thursday, Feb. 23, 2017 at the Australian Synchrotron.

## Student Spotlight: Bailee Roach

Our spring student spotlight focuses on Bailee Roach, a graduate research assistant nearing graduation. Originally from Franklin, Virginia, Bailee attended Virginia Tech, picking up a bachelor's degree in chemical engineering (per Bailee, "GO HOKIES!!!"). Her father is an engineer and her mother a fourth-generation schoolteacher, inspiring a lifelong love of learning and education. Bailee says that it's "just a part of who I am and I love solving problems, so engineering was just a perfect fit for me."

Her curiosity and imagination were fueled by an internship at International Paper, where she got the chance to climb inside a power boiler. Imagining

she was a droplet of water, she journeyed to the top of the boiler, where steam was formulating; she followed the steam to a turbine where it was converted to electricity. The fact that something as common as water could flow through a car-sized turbine and generate enough electricity to power her entire city four times over was both extraordinary and fascinating.

Bailee selected the University of Texas at Austin for the opportunity to work with Dr. Bruce Eldridge—the Eldridge group investigates the development of separations technologies to meet industrial needs, both current and future. *cont.* →

She notes that PSTC's equipment and capability of running experiments are unsurpassed by any other university. As a result, UT Austin's separations research program is the top in the nation and the only possible place where she could build a 30-foot, 6-inch column for her research. Eldridge's group in particular snagged her interest because the group's work fits with her desire to combine industry with academic research—her background in procurement makes her acutely aware of the impact her research has beyond the laboratory.

The focus of Bailee's time spent in the PSTC is in the building and experimental use of a pilot-scale Dividing Wall Column (DWC) at the J.J. Pickle Research Center. Distillation, the most common separation technique in refinery and chemical plants, typically operates less than ideally and consumes a significant amount of energy, averaging approximately half of a plant's total usage. A DWC offers a ground-breaking approach to distillation: instead of a traditional, binary separation, the DWC allows a tertiary separation in one column, minimizing energy usage and capital costs.

While investigating a variety of mixtures under a broad range of pressure and temperature conditions, she has been able to successfully replicate and validate process models and simulations, laying the groundwork for industrial applications and further use of the DWC. In fact, DWCs are becoming more prevalent, with more than a hundred in service, and their potential applications are expanding, making this an exciting time for conducting research and making a substantial impact on industry.

Bailee has been able to pursue internships out in the field, adding fuel to her love of engineering, research, and industrial applications. Back at IP, she worked on ways of reducing carbon dioxide emissions released from burning coal in their power plant. The changes made had a significant impact on the plant's environmental emissions without hindering the plant's performance. She enjoyed the research that she did and realized that she had the power to help revolutionize current industrial practices by applying what she learned in chemical engineering—this is what led her to graduate school, the greater scientific freedom and explo-

ration she could earn with a doctorate.

When she's not crawling into power boilers or putting the DWC through its paces, Bailee can be found out about in Austin, enjoying its variety of live music, ballet, and comedy shows. An ideal Saturday, spent outside the lab, would be spent hiking with her husband and Jack Russell terrier. When asked what other research areas might interest her, she quips, "Well, my PhD is in alcohol distillation, so a whiskey distillery is always a possibility!"

With curiosity, creativity, a fascination of how machines work, and a love of interdisciplinary research, no doubt Bailee will accomplish a great deal in her future as a chemical engineer. We wish her all the best as she winds down her academic career and prepares to launch one in industry.

—Lauren Murrah



**Bailee Roach and the Pilot Plant**

## PI Spotlight: Dr. Benny Freeman

This spring, we meet another one of our principal investigators, Dr. Benny Freeman, a professor at the University of Texas at Austin (UT Austin) since 2002. Freeman grew up on an apple farm in Hendersonville, North Carolina. Since he was interested in both math and chemistry, upon entering college at North Carolina State University (NC State), he chose chemical engineering as his major as it seemed to combine his interests into one program. During his summer breaks from college, he worked as a technical hire at E.I. DuPont, Inc. in Brevard, NC.

Freeman's area of focus, membranes, came about as the result of an undergraduate research project with Professor Bill Koros at NC State. Koros, a PhD graduate from UT Austin and a longtime member of PSTC, was the first to introduce him to membranes. Freeman then pursued a PhD in Chemical Engineering at the University of California, Berkeley, where his first major research project was the barrier properties of liquid crystals and polymers.

After graduation, he earned a NATO postdoctoral fellowship and spent two years working in France at the Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (ESPCI) working under Professors Lucien Monnerie and Liliane Bokobza. Freeman was subsequently hired to teach at his

alma mater NC State, rising from assistant professor to full professor and serving as associate department head.

Freeman was eventually recruited to UT Austin and once ensconced at UT Austin, he has worked on several research topics including new membrane materials for gas separation and water purification and ion transport in polymers, as well as various areas of separations and materials science. He notes that the field of separations research has a good future with the shale gas revolution bringing in new separations opportunities; he is hopeful that membranes will play a larger role in the future of separations science.

When not conducting research in his labs or receiving awards for his work, including being named a Fulbright Distinguished Chair and a North American Membrane Society Fellow within the last year, Freeman enjoys spending time out and about in Austin. His passion is riding his bike around town and, when he's not traveling for work, he hits the road every weekend to get quality cycling time in. Between this and his productive research group, Benny Freeman certainly keeps busy and the PSTC is certainly blessed to have him on board.

—Lauren Murrah



The Freeman Group

## Articles We've Published

Full citations and abstracts are available on the [PSTC website](#).

### El-Halwagi Group

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- ◆ Dickinson, S.; Mientus, M.; Frey, D.; Aminihajibashi, A.; Ozturk, S.; Shaikh, F.; Sengupta, D.; El-Halwagi, M. M. A review of biodiesel production from microalgae. *Clean Technol. Envir.* **2017**, DOI: 10.1007/s10098-016-1309-6.

### Freeman Group

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## Rochelle Group

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- ◆ Song, D.; Rochelle, G. Reaction kinetics of carbon dioxide and hydroxide in aqueous glycerol. *Chem. Eng. Sci.* **2017**, 161, 151-158.
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## Fall 2017 Meeting

Please join us for our annual PSTC Fall Meeting October 17-18, 2017, 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.

Questions? Please feel free to contact us:

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