AIChE®

TEP News

Transport and Energy Processes Division Newsletter

<<<At the Core of Chemical Engineering>>> June 2016 Issue 3

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WELCOME TO THE TEP DIVISION

Chemical engineers apply the principles of chemistry, biology, physics and math to solve problems. These problems range from the production or use of chemicals, fuels, drugs, food and many other products to designing processes and equipment for safe and sustainable operations at nano-scale through commercial scale. Besides the traditional chemical process industries (CPI), they are also actively involved in newer, less-traditional industries such as biotechnology, semi-conductors, advanced materials and nanotechnology.

The TEP Division reports on promising technologies being considered globally at various scales. Alternative sustainable energy through biomass, wind, solar, etc. and innovation through computation are a few examples of such.

Through the coordination of meetings and conferences, the TEP Division's core focus is to promote the sharing of knowledge and experiences in the "fundamentals of transport phenomena and energy systems" across all traditional and emerging chemical engineering disciplines. The TEP division interest covers both practical and academic topics and both experimental and modeling related work.

More about TEP Mission Statement

MESSAGE FROM THE DIVISION CHAIR

Raj Dasari, Ph.D.
Principle Process Engineer
Myriant Corporation

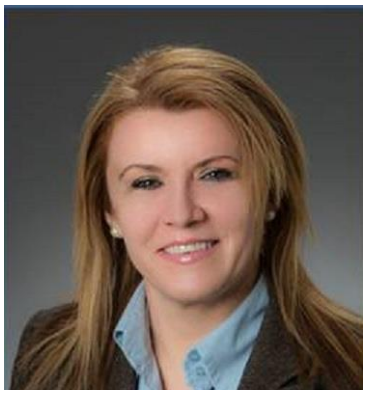
As an incoming Chair for the TEP division of AIChE, I am very excited and feel a deep sense of responsibility to be working for the division and you, the members. The overall goal is to uphold and advance the TEP Mission.

I would like to extend a warm welcome to the newly elected division officers and I have great confidence in the team that we will do the best in our capacity for the division. Thanks to the vigilant efforts by the previous leadership team for their accomplishments giving off to a great start this year.

On behalf of the TEP executive' office, I invite all the members for a greater involvement in the division's Technical Program for the Fall & the Spring meetings by proposing relevant sessions, submitting high quality papers, chairing the sessions, and encouraging peers to do so.

We plan to expand the division's activities beyond the conference programming, specifically for professional development, and we will announce the events as they are available. However, I believe that improvement is a continuous process and therefore, I encourage you all to get in touch with any of the officers for any questions or suggestions on how we can continue to become a better part of AIChE.

PAST CHAIR NOTE



Corina Mihut
Past Division Chair – 2015
Lead Scientist, at SABIC

Dear TEP Division Member,

Having recently completed my term as the 2015 TEP Division Chair, it has given me the opportunity to reflect over the past several years in which I have been involved with the TEP Division in various roles. My activities with the Division have started back in 2010 as the Programming Chair, and continued throughout the past several years as the Division's Vice-Chair, and eventually 2015 Chair. It has been a privilege to have the opportunity to serve the Division in a technical programming role and ultimately to lead the Division over the last year, serving the needs of the larger TEP membership. The Division has had many accomplishments over the last year, due to the diligent effort of the members of the Executive Committee. Some of these accomplishments are highlighted below, and I would like to take the opportunity to thank everyone involved in making these a reality.

The Division's Technical Programming has steadily evolved over the last several years, as we added new session topics in keeping with the technical interests of the community and latest developments in the area. I would like to thank the Division's Programming Chairs of the past two year, prof. Ryan Anderson and prof. Shengnian Wang for their efforts and contributions to the program at both the Annual and Spring AIChE meetings.

The prestigious Donald Q. Kern award for 2015 was presented to prof. Kenneth Goodson from Stanford University. This prestigious award is sponsored by Dana Corporation and is presented to members of the TEP Division who have conducted outstanding research in the area of heat transfer. The award was presented at the 1st Pacific Rim Thermal Engineering Conference in Hawaii. The award lecture presented by prof. Goodson was titled "Electronics Thermal Management at the Extremes" was very well attended and received by the scientific community. Special thanks to prof. Masahiro Kawaji for chairing the award selection committee and organizing the award presentation.

The spring AIChE meeting in Houston has also given us the opportunity to organize the first TEP Division sponsored dinner, where members of the TEP Division had the opportunity to meet each other and interact in an informal way. We hope to be able to continue organizing such events, and we would like to encourage you, the Division's member, to look up our events schedule at the upcoming meetings and join us.

Last but not least, the division has held elections early in January, and I would like to thank all of you who took time out of your busy schedules to vote for the nominees. As a result of the elections we have a new leadership team leading the Division in 2016. Please visit our updated webpage to meet the new Division officers and read the updated Division's mission statement.

As we prepare for a new election cycle later this year, we would like you to consider becoming involved with the Division's activities. If this is something that you would be interested in, please feel free to reach out to any one of the Division's board members for guidance. Opportunities for involvement with TEP include chairing and/or co-chairing sessions, as well as becoming one of the board members in a Director or Programming Vice-Chair capacity.

As we look towards the future, the division's success relies on its membership and continued growth in the technical programming areas. I'm confident in our abilities as a technical community to continue growing, and

EPIC Highlights

Building on past success with the topic, the 2016 AIChE Spring Conference in Houston had five sessions devoted to **'Enabling Process Innovation through Computation' (EPIC)**. This session was part of the broader theme "Topical 5: Emerging Technologies in Clean Energy". **This year the EPIC sessions were divided into two sub-topics: a focus on modeling efforts (three sessions) and a focus on optimization (two sessions).** Considering the broad applicability of these topics, the Transport and Energy Processes division shared co-sponsorship with Process Research and Innovation, Process Development Division, and Computing Systems and Technology Division.

The optimization session focused on simulations to optimize complex processes in the chemical and energy industries. The sessions brought together people from industry and Universities including Texas A&M University, The University of Texas at Austin, University of Pannonia (Hungary), and Gaia Energy Research Institute LLC. The session chairs came from Rockwell Automation and Sabic. The topics were broad and included plant design of high temperature fuel cell systems, monetizing shale gas, natural gas purification and storage, process design, and chemical transportation.

The modeling session focused on flow simulations related to reaction, separation, or blending processes. Researchers presented work from a range of companies and universities, including: Halliburton, Cameron Corporation, CD-adapco, Technische Universität Berlin, Ghent University, Universidad Nacional de Colombia, ANSYS, Lamar University, and Tridiagonal Solutions Inc. A host of topics were covered such as predictions for hazardous gas leak flows, flow distributers, spatially resolved reactors, heat exchanger fouling, and CFD analysis of coating processes. As with the optimization session, these diverse topics are of value to a range of attendees. These sessions were also marked by high attendance, with nearly 30 people in some sessions.

The Spring sessions are generally scheduled for 25 minutes for the talk and 5 minutes for questions. This format allows for a deeper investigation to be presented and more interaction with audience members. These talks and presenters highlight the diverse nature of the conference**. Practitioners came from around the world representing universities and industries to discuss transport phenomena related to energy systems**. In well attended sessions, there are excellent networking opportunities as attendees can discuss with other experts in the field.

The EPIC sessions have been a part of TEP for years and will continue in the future. Major effort is being applied to the TEP division's partnership with the Process Development division. In broadening the sponsorship, the division aims to keep the quality of presentation high and provide relevant content to attendees and TEP members. **Individuals interested in starting a session, participating in EPIC, or presenting their work are encouraged to reach out to the current programming chair, Whitney Colella. The Spring 2017 conference is in San Antonio, and TEP hopes to see you there**.

Stay tuned for upcoming Webinars!

Transport phenomena play a major role in many clean energy technologies. One such technology being studied where transport phenomena relate to system performance is proton exchange membrane (PEM) fuel cells. Hydrogen and oxygen react electrochemically to produce electricity with heat and water as byproducts. PEM fuel cells offer the benefits of high power density and no emissions (e.g. NO_x, CO_2) at the point of use. However, one problem is the management of the product water, which is difficult as the system is non-isothermal, multiphase, and reacting with transport occurring through mini-channels, porous media, and membranes. Our focus is on two-phase flow in the channels and the porous media via experimental and numerical methods.

Dr. Ryan Anderson
Assistant Professor
Montana State University

Dr. Lifeng Zhang
Assistant Professor
University of Saskatchewan

In the gas channels, focus has been on droplet detachment dynamics, flow regime observation/prediction, and pressure drop predictions for this unique two-phase flow. The uniqueness is the water's non-uniform introduction into the channel through the porous layer perpendicular to the direction of the gas flow. Identified flow patterns of this air/water system include an effectively single-phase flow, slugs, film/droplets, and 'accumulating'. In the 'accumulating' regime, there is insufficient gas flow and the water remains in the channels, hindering performance (1). Force balance analyses relating to critical droplet sizes have corroborated these results (2). For pressure drop prediction, the Lockhart-Martinelli approach has been modified to include the effects of the flow in mini channels and to account for the non-uniform injection of water into the channel (3). For more detailed understanding, CFD VOF methods have been used to study the dynamics of droplets in the channel including the introduction of water from the pores, effects of various contact angles, and channel geometries. An important focus area of the group is the advancing and receding contact angles and how these can be accurately implemented in a VOF framework (4). An additional complication to studying these systems is that materials in operating fuel cells are not optically transparent. Thus, to study droplets in the actual channels or water saturation in the porous layer, our group has recently begun investigations with Synchrotron X-Ray radiography at the Canadian Light Source.

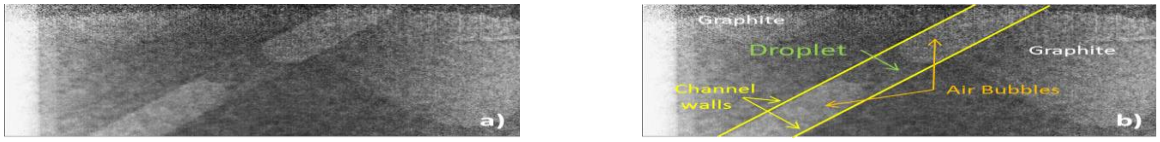


Figure 1. a) Sagittal plane X-ray radiograph distinguishing between channel walls, air bubbles, and droplet b) Labeled image

Using specially designed flow cells, the graphite porous layers with accumulated water can be visualized in 3D with CT scans. Once baseline saturation values are quantitatively determined, images can be taken under flow conditions to see how convection and evaporation reduce saturation in the cell. Knowing these rates of saturation reduction, the porous saturation levels can be tied directly to cell performance (e.g. voltage) via numerical models. CFD studies are also being used to study vapor fluxes through the various fuel cell layers as a function of flow rates, temperature gradients, and local pressure. These parameters are manipulated experimentally in operating cells in our lab, providing a connection between the X-Ray results, performance models, and CFD models. All of these studies hope to elucidate fundamental transport phenomena and improve performance in electrochemical systems. The results can be extended to other electrochemical systems (methanol fuel cells, wastewater treatment etc.), filters, and other porous media systems.

[1]Anderson, R., Eggleton, E., & Zhang, L. (2015). Development of two-phase flow regime specific pressure drop models for proton exchange membrane fuel cells. International Journal of Hydrogen Energy, 40(2), 1173-1185.
[2] Zhang, L., & Anderson, R. (2015, July). An Updated Two-Phase Flow Regime Map in Active PEM Fuel Cells Based on a Force Balance Approach. In ASME 2015 13th International Conference on Nanochannels, Microchannels, and Minichannels (pp. V001T03A011-V001T03A011). American Society of Mechanical Engineers.
[3] Zhang, L., Bi, X. T., Wilkinson, D. P., Anderson, R., Stumper, J., & Wang, H. (2011). Gas–liquid two-phase flow behavior in minichannels bounded with a permeable wall. Chemical engineering science, 66(14), 3377-3385.
[4] Cauble, E., & Owkes, M. (2015). Numerical Simulations of Droplet Dynamics in PEM Fuel Cell Microchannels. Bulletin of the American Physical Society, 60.

The 2015 Transport and Energy Processes Division's

Donald Q. Kern Award

Presented to

Kenneth E. Goodson

at the 1st Pacific Rim Thermal Engineering Conference,
Hawaii, HI, March 13-17, 2016
Supported by Dana Corporation, USA

Bio of Dr. Kenneth E. Goodson

Prof. Kenneth Goodson is the Bosch Chairman of the Mechanical Engineering Department and the Davies Family Provostial Professor at Stanford University.His lab has graduated 40 PhDs, nearly half of whom are professors at schools including MIT, UC Berkeley, and Stanford. Goodson studied at MIT (PhD 93) and is a Fellow with ASME, IEEE, APS, and AAAS. Recognition includes the ASME Kraus Medal, the Heat Transfer Memorial Award, the THERMI Award, plenary lectures at INTERPACK, ITHERM, PHONONS, SEMITHERM, and THERMINIC, and best/outstanding paper awards at SEMITHERM, ITHERM, and the IEDM. Goodson co-founded Cooligy, which built microfluidic cooling systems for the Apple G5 and was acquired by Emerson in 2006.

2015 Award Lecture - "*Electronics Thermal Management at the Extremes*"

The heat generated by semiconductor devices and electronic components is a big problem for a variety of products and systems including smartphones, electric vehicles, servers, and satellites. "Extreme" is a unifying theme, from nanometer features and 10+ kW chips to severe materials heterogeneity. This presentation will summarize these challenges and our progress on research topics including electron and phonon transport in transistors and novel electronic materials, nanostructured packaging materials, and microfluidic two-phase heat sinks.

Left Picture: Dr. Goodson in Award Lecture; Right Picture: Dr. Kenneth Goodson (Center) with Dr. Masahiro Kawaji (Right) and Mr. John Burgers of Dana Corporation. (Left)

About Donald Q. Kern Award

Established in 1973 by the executive committee of the TEP division of AIChE, the award honors Donald Q. Kern, a pioneer in the field of process heat transfer, and commemorates his outstanding contributions as a researcher, educator, author, and practicing engineer. The Donald Q. Kern Award is bestowed annually in recognition of the expertise in a given field of heat transfer, transport phenomena, and energy processes. Special emphasis is given to contributions that have significant practical applications.

Call for Nominations has just ended on May, 10, 2016 for the year 2016
Check Previous Award Recipients

TEP Division in 2016 AIChE Spring Meeting

First TEP Division Ticketed Dinner
at AIChE Spring Meeting
Monday, April 11, 2016
at the restaurant of Sambuca Houston

TEP Division Executive Committee Meeting Event
at AIChE Spring Meeting,
Tuesday, April 12, 2016
in the hotel of Hilton Americas

Meet us at
2016 AIChE Annual Meeting, Nov 13-18, San Francisco, CA

The Call for Abstracts was due by **May 20, 2016**, 11:59pm EDT. All submissions will be reviewed in June. Acceptance notices will be sent in July.

Don't miss the Mini-symposium on Solar Energy for Power Generation and Chemical Processing sponsored by TEP and co-sponsored by Sustainable Energy.

Details about TEP Sponsored Sessions

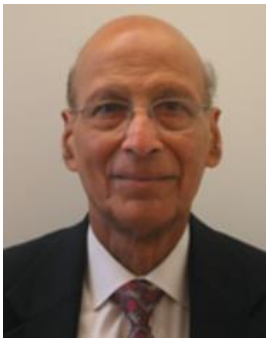
How to Join TEP Division

- To join us, please click the link
- Or call AIChE Customer Service at 1-800-242-4363 in US, +1-203-702-7660 international
- Annual TEP Membership: $7

TEP Division Officers

Raj Dasari
Chair

Raj Dasari, Ph.D. is currently a Principal Process Engineer at Myriant Corp. Raj is highly motivated, organized, self-directed and flexible chemical engineer with 12 years of demonstrated experience at the lab, pilot plant, and commercial production scales in downstream purification of fermentation based chemicals including using renewable biomass feedstocks. Raj has been an AIChE member since 2005. He has served as chair, co-chair for TEP sessions and served as the Division Director in the past.

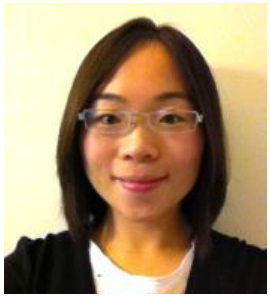


Virendra K. Mathur
Division Advisor

Ravindra Aglave
1st Vice Chair

Daniela Mainardi
2nd Vice Chair

Whitney G. Colella
Programming Chair



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