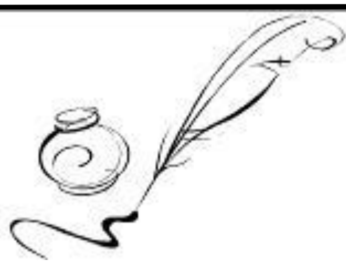
# The PTF Newsletter



## *Editorial:*

*Regardless of your professional affiliation or geographic location, summer time provides a brief respite from the unending deadlines for reading, relaxation, rejuvenation and to make plans for the rest of the year. In that spirit, this newsletter covers technical topics, some reflections and copious pointers towards upcoming events in the Fall and the Winter.*

*In my opinion, there are three key objectives of our newsletter — to Communicate, to Share (knowledge and information) and to Educate. To meet these objectives, I am seeking more active participation from **all** of our members through contributions, such as technical articles, conference reviews, research snippets, research news and organizational updates. It should not be left to a few to carry the torch.*

*The Fall issue will highlight Groups 3a and 3d. Looking forward to your contributions, including new ideas and concepts.*

***Shrikant Dhodapkar, Newsletter Editor***

Dow Chemical

## PTF Elections

We are currently seeking nominations for 4 positions on the Executive Committee for the PTF. The positions are designated as 2 from industry/government and 2 from academia, with 4-year terms from start of 2017 to end of 2020. Responsibilities include attendance at the Executive Committee meeting on Sunday (typically around 5pm) at the start of the AIChE Annual Meeting, in addition to conference calls and contribute to PTF tasks and activities throughout the year.

Both self-nominations and nominations of others (with their consent) are encouraged. The nominator and the nominee should both be members of the PTF.

***Please email a short bio of the nominee to me at***

***Reza.Mostofi@Honeywell.com by August 15th, 2016 .***

Once the nominees are in place, the on-line voting process will be opened up to PTF members during the 3rd quarter 2016. All industrial liaisons who have served on the PTF executive committee during any of the last six calendar years are eligible to be nominated for the vice-chair position.

Please indicate in your email if you are from industry or academia or if the nomination is for the PTF vice-chair position.

***Reza Mostofi-Ashtiani, Chair, PTF***

UOP

## In this issue…



## 2016 AIChE Annual Meeting

**November 13-18, 2016**

**San Francisco, CA**

# Letter from The Chair

Hello my fellow particle technology devotees. Before providing you with a brief summary of what is going on at PTF, I would like to remind you all about the upcoming election and voting once more:

- AIChE's constitution.
- PTF bylaws.
- PTF Executive Committee members.

Please look for these in your mailbox and make your voice heard by voting for all three.

Now let me provide a short report about PTF:

Dr. Raj Dave and his award team (of many members) have concluded this year's awardees selection process and the results are shared with the winners and all the nominators. I would like to thank all the people involved with this difficult task including all the nominators, award committee members who have helped this year. From putting together the nomination packets to reviewing all the documents, this a time consuming process and takes many dedicated individuals from the start to the finish line. Also a big thank you to all awards sponsors for their continued support.

All PTF members should have received an email with regard to the EC nomination. If you are interested in becoming more active at this capacity within PTF or know a good candidate, I urge you to send me your information and a short bio at reza.mostofi@honeywell.com . Elections will be held prior to the annual meeting.

I am happy to report that the amendments to our bylaws are approved by the EC and were also reviewed by some of our prior EC members. The changes are summarized in a different section of this newsletter.

Finally, the PTF sessions at the national meeting in fall are all finalized and our PTF dinner, poster session and awards session are also planned. More information about all of these will be provided in the next issue of the newsletter. Thanks to Dr. Manuk Colakyan who has handled all the details of this big effort.

***Reza Mostofi-Ashtiani, Chair, PTF***

*UOP*

# PTF Awards—Update

PTF Executive Committee (EC) worked towards making the PTF awards more consistent with the AIChE awards. In addition, differing rules between various awards were made more consistent with each other. One of the main change is regarding the requirement of the PTF membership, which in past has been an implicit requirement. Going forward staring 2016, it is made explicit. Overview of the awards guidelines is below. Further details can be found on the AIChE PTF web-site.

It is preferred that the nominators are current PTF members and going forward, this will become a rule rather than exception for certain awards :

- If the nominator is not a PTF member, at least one support letter must be from a current PTF member
- For the PTF Lifetime Achievement Award, one of the support letters must be from a former PTF Award winner
- All award nominees must be PTF members
- Nominees must have been the member of AIChE-PTF for prior 3 calendar years; with one exception:
- Best PhD must be a current member at the time of nomination and the year of award. Exceptions will require the EC board approval
- In a given year, the same person cannot win more than one PTF award
- A former PTF award winner cannot be nominated for another award for at least three years after receiving any previous PTF award

Nomination process is in two steps: (1) Short online form will be due mid-March providing the name of nominee, and up to five names of those who will provide letters of support, along with their PTF membership status. (2) Full package due early May, containing items specific to each award

If the nominee has previously received any award from AIChE or one of its divisions/forums, an explicit statement of new accomplishments or work over and above those cited for the earlier award(s) must be included (maximum one double spaced page).

This year, all PTF awards except for the Dow Particle Processing Recognition Award will be made and recognized at the PTF Awards Dinner in San Francisco. The PTF Award dinner is on **November 16th**, please reserve your tickets early.

***Raj Dave, Vice-Chair, PTF***

*NJIT*

## Uniflow Cyclones: Dedusting with High Efficiency at Compact Design

**Michael Kraxner**
*Head of R&D and Tech Transfer*
*Engineering and Life Science*
*Departments*
*MCI, Innsbruck, Austria*
*michael.kraxner@mci.edu*

The simplicity of design and the lack of moving parts in cyclone separators are key to their ubiquitous presence in process industry.  In some applications, where high gas flow rates must be processed, the physical size of a conventional reverse flow cyclonic unit can become very large. A clever alternate design, called the uniflow cyclone or axial flow cyclone, is able to deliver similar efficiencies in a very compact geometry. The name is derived from the flow field pattern generated inside the cyclone. Unlike reverse flow cyclone, the gas enters and leaves the cyclone in the same direction (see Figure 1).

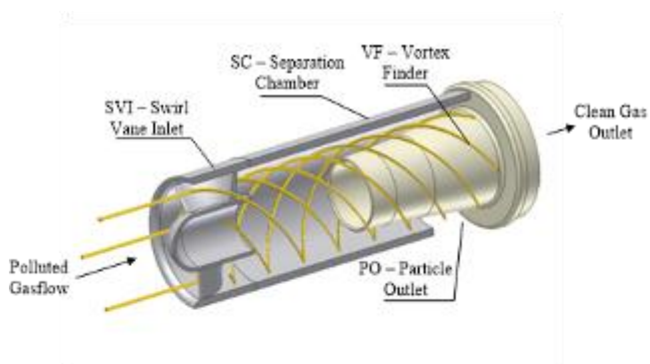



*Figure 1: Depiction of a uniflow cyclone and its flow field pattern.*

Compared to a reverse flow cyclone design, the uniflow cyclones can be built approximately two-third smaller in volume at similar efficiencies. Wide spread adoption of this design has been limited by the absence of universally accepted and validated design approach. The existing literature mainly focuses on special applications, as shown in the research work of Gauthier et al. (1990) or Zhang et al. (1999). The highly turbulent particle flow patterns offer a complex parameter system which makes the dimensional analysis rather complicated.  For instance, numerous design variations of the inlet swirl generator (Figure 1) are possible, and each approach will result in remarkably different flow field within the cyclone. Therefore, an empirical approach is most apt for studying uniflow cyclones.

To facilitate the understanding of its operation, the design structure of a uniflow cyclone can be divided into four major sections in the direction of the flow, namely Swirl Vane Inlet, Separation Chamber, Vortex Finder and Particle Outlet. The swirl vane inlet (SVI) is the first section in the flow direction with a number of possible design variables. The number of vanes, the vane angle, the core diameter and the overlap of the vanes represent a set of inter-related parameters. Due to the fact that nearly half of the pressure drop occurs during the generation of the swirl, it is important to understand the formation and characteristics of the swirl. CFD simulations, which where validated by non-invasive PIV-measurements, show an optimal compromise between high circumferential velocities at a low pressure drop using an ingenious design ( Figure 2). More information can be found in references 3 and 4.

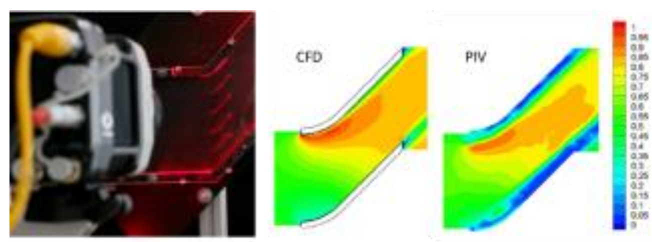



*Figure 2: Particle-tracking (left), CFD-simulations and PIV-measure-ments of the magnitude in-between the vanes of a swirl vane inlet (right).*

An alternating design of the inlet vanes leads to an additional acceleration of the particles towards the wall at nearly the same pressure drop. These results can be corroborated by dedusting tests with various types of particles and helps to understand the phenomena inside this cyclone type (Kraxner et al., 2012).

The second section in the flow direction is the separation chamber (SC). The geometric parameters are the length and geometry of the conical insert. The critical sedimentation path is important in estimating the length of the cone. High swirl numbers lead to high acceleration of the particles towards the wall which reduces the cut size. It is important to note that there are additional mechanisms in play here, such as the entrainment of particles that must be considered as well (Figure 3).

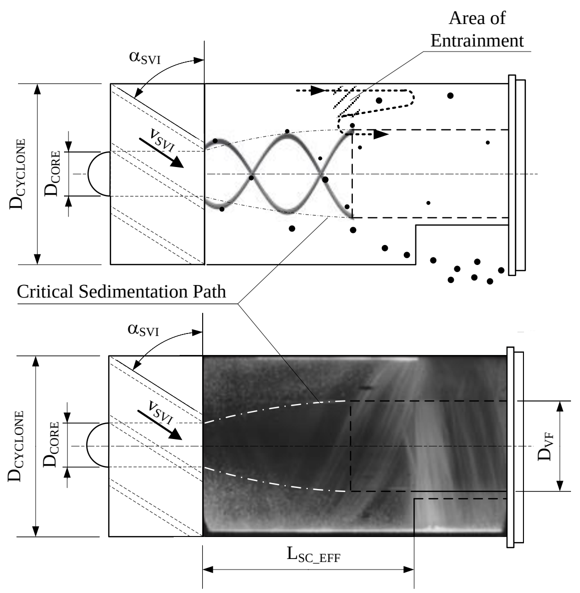



*Figure 3: Critical sedimentation path as function of geometric parameters (top), laser-induced particle distribution inside the separation chamber (down).*

The high swirl number also leads to high velocities, which are responsible for a high superficial velocity within the vortex finder (VF), and therefore low static pressure. These observations in the third major section of a uniflow cyclone show that high velocities could decrease the separation efficiency due to re-entrainment of particles. The sedimentation and re-entrainment mechanisms counteract each other. Laser-induced PIV-measurements show an increasing axial backflow next to the vortex finder inlet (Figure 4, Detail A), which is covered by a radial velocity gradient (Figure 4, Detail B), that causes re-entrainment of already separated particles back into the clean gas outlet.

The velocities next to the vortex finder inlet, which represents the critical zone, are responsible for the separation of particles. An analysis of force balance on the particle in this zone will result in the calculation of the cut size $d_p$ as function of the vortex finder size (radius $r_{VF}$) for this type of cyclone (see Figure 5).

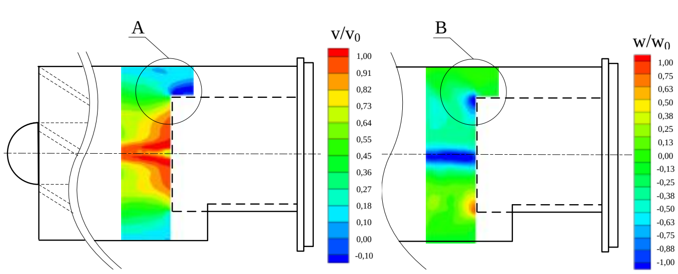



*Figure 4: PIV-measured axial velocity (left) and radial velocity (right) next to the vortex finder zone.*

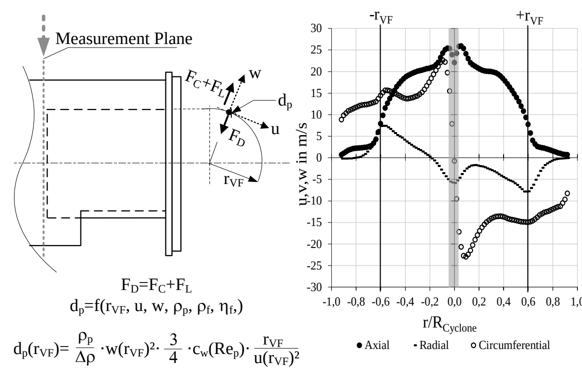



*Figure 5: Cut size calculation $d_p(r_{VF})$ of a uniflow cyclone by the appearing forces within the centrifugal flow field at the vortex finder inlet.*

A rising radial velocity component (compare Detail B, Figure 4) next to the vortex finder inlet, which entrains particles back into the clean gas flow, is the main influence on the cut size. This phenomenon can be seen more distinctly a high velocities (Pillei et al. 2014). Therefore, investigations have been carried out to identify the optimal operating conditions to achieve highest efficiencies in a uniflow cyclone. Figure 6 shows the dust emission($\varepsilon$) for five different cyclone types (A, B, C, D, E) at different operating conditions (dust type and distribution, loading, temperature, cyclone size) as a function of the superficial gas velocity in the vortex finder, which has been achieved by changing the gas flow rates.

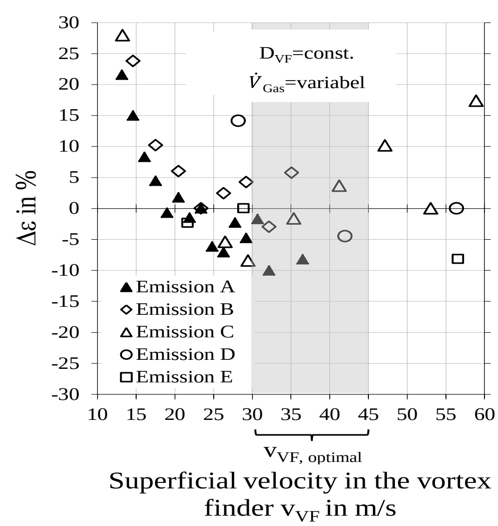



*Figure 6: Dust emission $\varepsilon$ of different cyclone types and applications as function of the superficial gas velocity $v_{VF}$ in the vortex finder.*

To handle the enormous number of parameters in the cyclone optimization procedure, a statistical design of experiments was set up. By using a DOE approach, 700,000 full-factorial test series were reduced to 500 tests, which were then carried out on precisely manufactured uniflow cyclones with rapid prototyping on a test stand according ISO 5011:2014.

This data and additional data (see references 3,4) form the basis of the diagram shown in Figure 7. This diagram can be used to identify the most efficient size of a uniflow cyclone at lowest pressure drop.

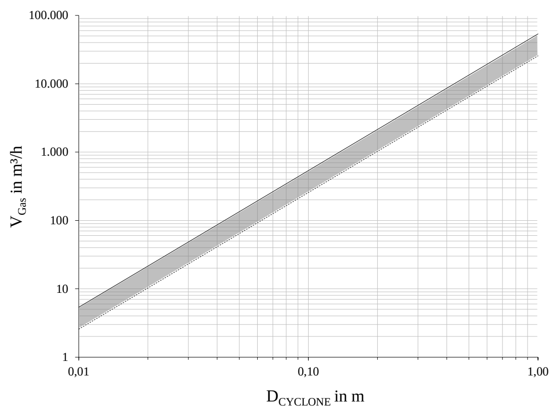



*Figure 7: Optimal size ($D_{CYCLONE}$) of a uniflow cyclone as function of the gas flow rate represented by the grey area.*

We hope that our research on uniflow cyclones will rejuvenate the research interests, and facilitate its adoption in the process industry.

**References:**

1. Gauthier, T.A., Briens, C.I., Bergougnou, .A., Galtier, P., Uniflow cyclone efficiency study, Powder Technology, Nr.62: 217-225, 1990.
2. Zhang, Y., Wang, X., Riskowski, G.L., Christianson, L.L., Ford, S.E. Particle separation efficiency of a uniflow deduster with different types of dust, Transactions of ASHRAE, 1999.
3. Kraxner, M., U. Muschelknautz, S. Wechner, S. Ackermann, V. Greif, J. Bolda, Influence of the Inlet Vane Geometry on the Uniflow Cyclones Performance, AIChE-Annual Meeting, Pittsburgh, 2012.
4. Pillei, M., Kofler, T. and Kraxner, M., Fluid flow investigation in the separation chamber of a uniflow cyclone with 3C-PIV and CFD, GALA-German Association for Laser Ane-

## Seeking Volunteers For Annual Meeting

Dear PTF Academic Colleagues:

We are seeking ~20 graduate student/post-doc volunteers to help with session attendance counts at this year's AIChE Annual Meeting. The volunteer will nominally be responsible for counts of a single time block per day (morning, afternoon, or evening) on Sunday – Thursday. A planning meeting will be held on site on Sunday morning of the conference. Accommodations will be made to work around speaking commitments, etc.

As recompense, AIChE is offering discounted registration to volunteers, namely the 1-day graduate student early bird member rate ($254) . This translates to a savings of $60 - $115 for graduate students and $445-$855 for post-docs depending on their member status.

If you are interested, please have the students/post-docs contact Kelsey Kettelhut at kelsk@aiche.org .Kelsey can also answer any questions you may have.

Looking forward to seeing you in San Francisco!

Christine Hrenya

***Chair, 2016 AIChE Annual Meeting***

## Advances In Particle Technology and Additive Manufacturing for Energetic Materials

**Nicholas Piekiel**
*US Army Research Laboratory, Adelphi, MD, USA*

At a very fundamental level, most energetic materials are simply a mixture of a fuel and an oxidizer that react exothermically. It is the mixing length scale of the fuel and oxidizer that predominantly defines different classes of energetic materials; for example, explosives have a fuel (carbon atoms) and oxidizer (oxygen atoms) mixed at the molecular level creating negligible diffusion lengths, allowing the fuel and oxidizer to quickly react in an oxidation reaction. The 'explosive' effect of these materials is a result of the large amount of stored energy, but more so the ability to release that energy at a very rapid rate. While explosives are unique thanks to their extreme energy release rates, they generally lack tunability for various applications. For a more tunable energetic material we often look to thermites, which also have a greater potential energy compared to most explosives, especially on a volumetric basis. Thermites are typically made of micro or nanoparticles of aluminum and metal oxides providing diffusion length scales on the micro or nanoscale. Therefore, diffusion times for aluminum to react with the oxygen in the metal oxide (e.g., $CuO$, $Fe_2O_3$, $Bi_2O_3$) to form alumina ($Al_2O_3$) are relatively long, and reaction times are often considerably slower than those of explosives. However, the use of particles allows for a tunable reaction profile by altering the stoichiometry, particle packing density, particle size, etc.

Thermites made with microscale particles have long been used in certain welding applications due to high reaction temperatures. However, developments in nanoparticle production in the late 1990's and early 2000's fueled a new subset of thermites, nanothermites, which has been a steady research field in the energetic materials community for over a decade. With fuel and oxidizer compositions made of nanoparticles, the mixing length scale decreased by several orders of magnitude, thus decreasing initial reaction times*, while maintaining the high energy release rates and tunable performance. This is a prime example how advances in particle technology can have a profound impact in complimentary fields, in this case driving a new field of energetic materials. In the past 10-20 years, nanothermites and their reactions have been thoroughly investigated; as that research continues to progress, other advances in particle technology are again affecting this field.

There are two areas where recent particle technology advancements are starting to be realized in nanothermite (and other energetic material) research:

**1. New methods for tuning performance**:

Previous methods to tune nanothermite performance focus on the nanoscale, whether by varying particle size, packing density, or stoichiometry (affects bulk reactions properties, but also mixing at the nanoscale), however flame propagation can also be altered by changes at the micro, meso, or macroscale. This was recently demonstrated by electrophoretic deposition of aluminum/copper oxide nanothermite onto printed metal electrodes, which were oriented in channels or hurdles to highlight the role of convective heat transfer and particle advection in nanothermite combustion.[1] Electrophoretic deposition was used to apply different layer thicknesses, and by varying thickness and the spacing (up to 8-10 mm) of hurdles and channels of nanothermite, the authors were able to alter the controlling energy transfer mechanism from convection to advection of hot reaction product particles providing enhanced flame propagation speeds. A schematic showing common bulk energy transfer mechanisms during a combustion process based on material structure is provided in Figure 1. A similar use of structure has been used with porous silicon energetic materials to switch between conductive and convective heat transfer modes, which similarly can be used to tune flame propagation speed.[2, 3]

**2. Implementing nanothermites at the microscale:**

For nanothermites at the microscale we consider those formed with bulk dimensions at the sub-100 micron length scale in at least 2-dimensions. Microscale energetic materials have many potential uses in creating phase changes or actuation in small-scale electronics or as compact fuze delay timers, but there are fundamental issues that have limited their use; mainly it is difficult to apply nanothermites or most other energetic materials at the microscale (although this is quickly changing as additive manufacturing methods evolve), and uncertain combustion propagation at the microscale.

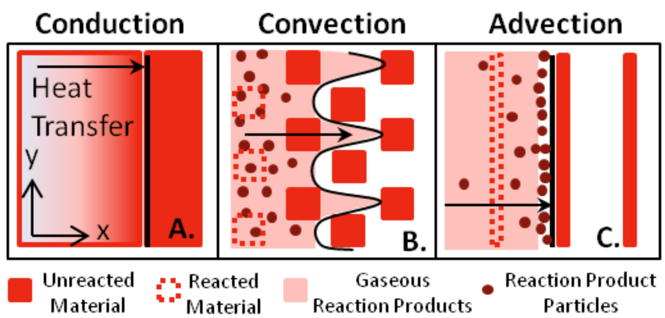



***Figure 1:*** *Schematic of energy transfer mechanisms for deflagrating energetic materials. A. Solid material or packed particles where heat conduction is often the dominant mechanism. B. Material spacing at the micro or mesoscale allows for the flow of hot product gases and convection is dominant. C. Larger spacing at the meso to macroscale, hot reaction product particle, or reacting particle advection can be dominant.*

As the width and thickness of an energetic material decrease in size, eventually a critical area is reached where heat losses to the surroundings will no longer allow for combustion propagation. Unfortunately, limited experimental research has been performed to explore these bounds, mainly due to the difficulties of implementing energetic materials at the necessary length scale in a consistent, reliable way. Recently, a process called evaporation driven assembly (EDA), previously used for improvement of electronic components by filling embedded microscale features with magnetic nanoparticles [4], was used to deposit high-density nanothermite films within silicon microchannels as shown in Figure 2 [5]. EDA consists of a reservoir (see Figure 2) connected to a microchannel, formed through a deep reactive ion etch in a silicon wafer. The reservoir is filled with a solution of suspended nanoparticles, which is then drawn through the microchannel by capillary forces. As the fluid in the channels begins to evaporate, the particles remain in the channel and more particle solution is drawn from the reservoir into the microchannel, until a high density film is formed within the channel. The channels shown in Figure 2 demonstrated steady combustion at ~3 m/s.

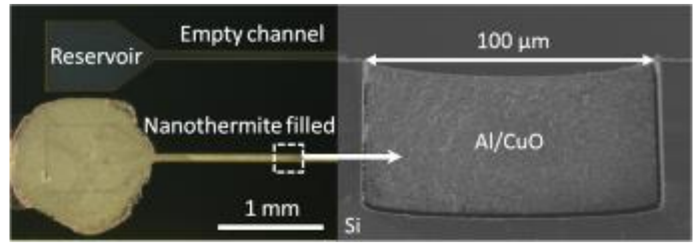



**Figure 2:** *LEFT: Empty, and Al/CuO nanothermite filled EDA reservoirs. RIGHT:Cross-section SEM of Al-CuO nanothermite filled channel by EDA [5].*

**Future Advances:**

While the two examples above have produced intriguing results, combining similar particle technology advancements with emerging additive manufacture capabilities could prove even more impressive. Much of the additive manufacturing field has close ties with particle technology, and as the two progress together, more will be possible with 3-D printing of energetic materials. Ideally this will allow for easier integration of structure (in 3-D) into nanothermite compositions to tune performance in a similar fashion as was demonstrated above in Figure 1. However, in Figure 1 where tuning is essentially limited to 2-D, the use of a third dimension could provide a plethora of additional tuning options. Figure 3 compares current capabilities with architectural possibilities that could be achieved with improvements to direct-write technology with nanothermites. This also shows that there is no longer a limit to one material or one nanothermite mixture, so different oxidizers or nanothermites could be used at precise locations to optimize pressure or temperature output as desired. The key feature of this capability is that material variations can be made at the nanoscale (particle size, particle mixing), microscale (depending on tool resolution), mesoscale, or macroscale, enabling variations of energy transfer mechanisms within a single device that can be tailored to match any application in ways that have never been possible.

For microscale applications, if we consider the EDA channel filling technique, as we increase the channel length, a larger reservoir is required to provide enough material to fill the channel, but a macroscale reservoir may defeat the purpose of having microscale energetics. Again, the filling occurs as the solvent evaporates and the suspended nanoparticles are then left in the channel. Instead of using a large reservoir to fill a long channel, a small reservoir with a continuous solution source via inkjet (or similar) could serve the same purpose while minimizing the overall device footprint. A channel similar to that of EDA could also be used to simply direct, or contain the flow of printed energetic materials and improve reliability, without the need of a reservoir.

These are specific examples, but represent how particle technology advancements are continuing to positively affect the research of energetic materials. As nanoparticle production changed the energetic materials field over a decade ago, current particle technologies are poised to have a similar impact and change the way that we produce and integrate energetic materials.

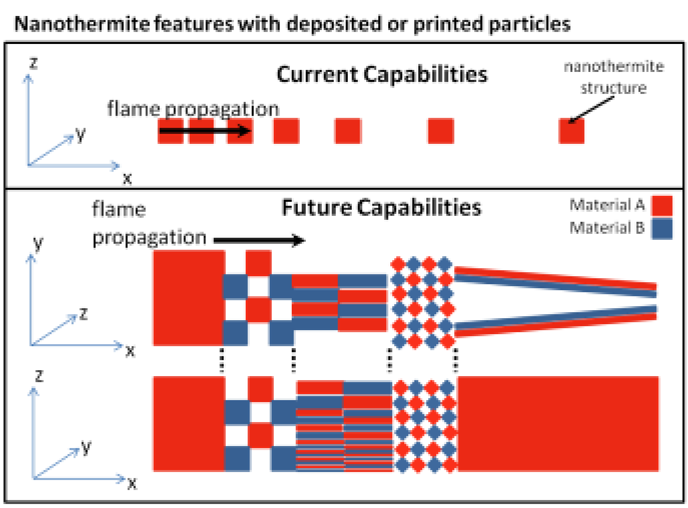



**Figure 3:** *Top: Example of current capabilities to alter performance and energy transfer mechanisms using additive manufacturing. Limited capability demonstrated for expanding in the z-direction (off of the substrate surface) and often limited to one material composition. Bottom: Example of the types of nanothermite 3-D structures that could be made with advances to current printing technologies. Multiple materials could be applied, and structural changes can be made at the micro, meso, or macroscale to tune energy transfer.*

*The entire nanothermite reaction process is very complex and can last for a relatively long time (milliseconds), but the initial reactions are often rapid thanks to the use of nanoparticles.

**References:**

[1] K. T. Sullivan, C. Zhu, E. B. Duoss, A. E. Gash, D. B. Kolesky, J. D. Kuntz, J. A. Lewis, and C. M. Spadaccini, "Controlling material reactivity using architecture," *Advanced Materials*, vol. 28, no. 10, pp. 1934–1939, 2016.

[2] V. S. Parimi, S. A. Tadigadapa, and R. A. Yetter, "Control of nanoenergetics through organized microstructures," *J. Micromech. Microeng.*, vol. 22, no. 5, p. 055011, 2012.

[3] N. W. Piekiel, C. J. Morris, L. J. Currano, D. M. Lunking, B. Isaacson, and W. A. Churaman, "Enhancement of on-chip combustion via nanoporous silicon microchannels," *Combust. Flame*, vol. 161, no. 5, pp. 1417 – 1424, 2014.

[4] S. S. Bedair, C. D. Meyer, and B. Morgan, "Closed core inductor and high-k dielectric capacitor fabrication through evaporation driven nanoparticle assembly in capillaries," *Journal of Applied Physics*, vol. 109, no. 7, pp. –, 2011.

[5] N. Piekiel, C. Morris, and M. Ervin, "Investigating implementation of nanoenergetics for small-scale on-chip applications," *AIChE 2015 Annual Meeting Proceedings*, 2015.

# Profiles in Excellence

## Michael Kraxner

*Professor for Mechanical Process Engineering*
*Head of R&D and Tech Transfer*
*MCI – The Entrepreneurial University, Innsbruck - Austria*
*michael.kraxner@mci.edu*

**Dr. Michael Kraxner** is the Head of R&D and Technology Transfer at MCI - The Entrepreneurial University. Under his leadership, his department is driving solution oriented research activities on dispersed phases in collaboration with the process industry. His research group on 'Fluids & Mechanics' focuses on complex multiphase fluid dynamics, whereby phase characterizations with various non-invasive laser-measurement techniques serve as the basis for real-time flow and phase analysis as a CFD-validation tool. His research work on cyclone separator systems and multiphase transport has been implemented for optimizing industrial systems. The use of high-end prototyping techniques to ensure transfer functions to industrial scales and the operating conditions is one of his key specialties.

The goal of his research work is to create expertise in complex multiphase flows, especially particle/droplet transport and separation within industrial applications. In particular, he focuses on geometrical design studies for optimized fluid-particle/droplet behavior within gaseous and liquid disperse fluid flows, to define process correlation parameters for highest efficiency.

He was given the best presentation award on Gas-Solid Transport and Separation **(Group 3c)** at the AIChE Annual Meeting in 2012. He serves on advisory councils for five independent research-centers within the central European region, and was nominated to the National Commission for FEANI (European Federation of National Engineering Associations) in 2016. He has 60 publications and 5 patents to his credit.



## Nicholas Piekiel

*Team Lead*
*On-Chip Energetic Materials Team*
*Army Research Laboratory (ARL), Adelphi, MD*
*nicholas.piekiel.civ@mail.mil*

**Dr. Nicholas Piekiel's** research efforts focus on the use of energetic materials for on-chip applications; chip-scale integration of energetics with electronics, and utilization of energetics to achieve actuation, phase change, or fuzing effects that cannot be obtained with traditional electronics. This includes novel integration, material development, and varying nano or microstructure to tune energetic material performance.

Much of his previous research has revolved around the use of porous silicon as an energetic material. Along with his colleagues at the Army Research Laboratory, Nick has utilized the tunable structure of porous silicon, along with its electronics friendly fabrication processes to integrate energetic materials and basic electronics features on-chip. Their work in this area continues as they explore the limits of combustion at the microscale, investigate the mechanism for combustion at extreme propagation speeds, and improve uniformity of patterned porous silicon substrates.

Current research interests include novel methods for application of other energetic materials including nanothermites and porous silicon particles at scales ranging from the wafer-scale to the microscale. They have recently utilized an evaporation driven assembly method to deposit highly dense nanothermite films within microscale silicon channels. These could be applied on-chip using a similar evaporation driven assembly method or with other additive manufacturing techniques.

Nick has been at the Army Research Laboratory in Adelphi, MD for 4 years and was recently named the acting Team Lead for the On-Chip Energetic Materials Team. He is an active member within the energetic materials community with ongoing collaborations with industry, academia, and DOD/DOE laboratories. He is also a DOD/DOE Integrated Product Team (IPT) and Technical Coordinating Group (TCG) member for energetic materials related research, and reviewer for various journals and Army related proposals. Nick is the Treasurer for the **Group 3e Energetics** session at the upcoming AIChE annual meeting.

# Annual Meeting - San Francisco, 2016

## Programming Highlights

⇒ PTF has a total of 48 Sessions out of which 7 is cosponsored. Participants, session organizers and area chairs are encouraged to check the preliminary program at https://aiche.confex.com/aiche/2016/webprogram/ataglance.html

⇒ The PTF program starts on Sunday late afternoon and ends on Thursday. Friday has two co-sponsored sessions with area 15b or Pharmaceuticals; Our academic members will be interested in attending “The "Meet-the-Faculty Candidate" poster session which provides a great opportunity for faculty, recruiters, and Department Chairs to speak directly with current graduate students and postdoctoral researchers who are seeking faculty positions

⇒ On Sunday Shrikant Dhodapkar and George Klinzing are offering a tutorial session entitled “Solids Handling and Processing in the Chemical Industry: What They Don’t Teach You at School”. This seminar targets the practicing engineers, new graduates as well as students.

⇒ We are honoring two of our esteemed colleagues, Professors Sankaran Sundaresan and Masayuki Horio for their career long accomplishments with two sessions dedicated to them.

⇒ The Poster Session is scheduled on November 15th at 6pm.

⇒ The Particle Technology Award Lectures are scheduled on Wednesday, November 16th at 12:30 pm.

⇒ Please inform your session chair at the earliest if you are unable to present your paper or attend the meeting.

***Manuk Colakyan, PTF Programming Coordinator***
*Renmatix*

## PTF Dinner

PTF Awards Dinner is on November 16th, 6:30 pm – 9:30 pm, at the Rotunda by Neiman Marcus, at Union Square, San Francisco. The dinner tickets are $85 per person, inclusive of unlimited beer and wine. Please reserve your tickets soon because we will not be able to sell tickets at the door!

Please contact Raj Dave if you have any questions.

## Key Meetings

| Meeting | Date/Time |
|---|---|
| Particle Technology Forum Executive Committee Meeting | Sunday, November 13, 6:00 PM-7:30 PM |
| Particle Technology Forum General Business Meeting | Monday, November 14, 6:00 PM-7:00 PM |
| Particle Technology Forum Area 3A Meeting | Wednesday, November 16, 5:50 PM-6:30 PM |
| Particle Technology Forum Area 3B Meeting | Wednesday, November 16, 5:50 PM-6:30 PM |
| Particle Technology Forum Area 3C Meeting | Wednesday, November 16, 5:50 PM-6:30 PM |
| Particle Technology Forum Area 3D Meeting | Wednesday, November 16, 5:50 PM-6:30 PM |
| Particle Technology Forum Area 3E Meeting | Wednesday, November 16, 5:50 PM-6:30 PM |

## Sponsors of PTF Awards Dinner



# HISTORY OF PARTICLE TECHNOLOGY

## Evolution of Particle Technology as a Discipline in the UK

**Lyn Bates**
Ajax Equipment, UK

In a series of 12 lectures at the Manchester Technical School in 1867, George E. Davis proposed that Chemical Processing be a unified topic of study, a concept that was taken up by a number of U.S Universities. His 1904 'Handbook of Chemical Engineering' becoming a classical text book on the subject. At this stage, the topic was then taken up by various US universities, rather than in UK.

Early work in the science of bulk solids was centred around soils, the interest mainly being on the stability of soils in civil engineering, rather than failure as required for flow and discharge from storage of particulate solids. Nevertheless, the concepts of the Hvorslev diagram and the critical state line, Figure 1, became key features of bulk solids flow.

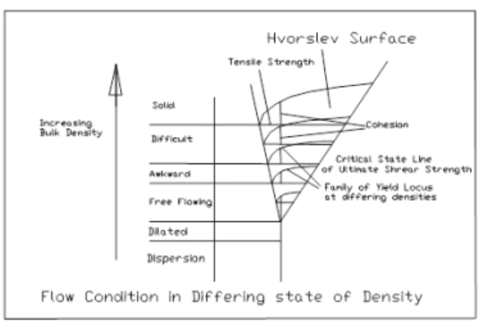



*Figure 1. Hvorslev Diagram*

There is no doubt that Andrew Jenike in the 1960's initiated the application of science to bulk materials and the practice of solids storage based on earlier work on soil mechanics, but, as Enriquo Ortuga Rivas states in the introduction to his book - 'Unit operations of particulate solids, Theory and Practice', the unmistakable pivotal role in establishing powder technology as a distinct technical discipline rests with John Williams, who formed the School of Powder Technology in 1967 at the University of Bradford. He assembled an expert team with Derek Geldart, on fluidisation, Naylor Stanley Woods, on particle sizing, Terry Allen on powder characterisation, Norman Harnby on mixing who were later joined by Lado Svarovsky and Martin Rhodes.

Williams was also instrumental in Elsevier publishing 'Powder Technology' and was the founding Editor, a position later held by Jonathon Saville, of Birmingham University where much work was carried out on particle tracking. Bridgewater, and Ghadiri at Surrey University, developed an annular attrition cell. Michael Rotter, of Edinburgh University, played a leading role in the formulation of standards in hopper design and developed a uniaxial cell.

Jenike's visit the CEGB in 1967 drove Walker to develop the annular shear cell, Figure 2, cell and the commercial benefits offered by the science encouraged Brown and Richards, of The British Coal Utilisation Association, BCURA, and Herbert Wilkinson and Harold Wright of British Steel Research, to study the subject.

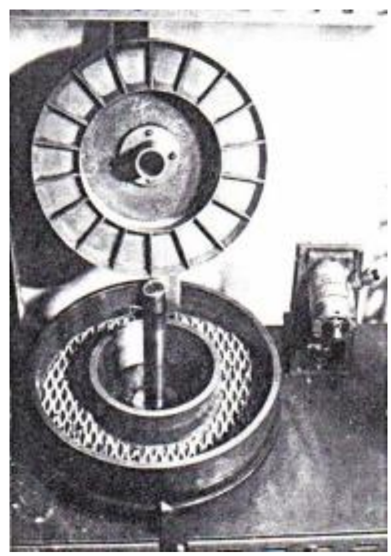


*Figure 2 . Walker Annular Shear Cell*

The academic respectability and promise of the subject lead to Brian Scarlet forming a School of Particle Technology at Loughborough University, and Greenwich University created a Bulk Solids Centre under Stan Mason that developed into a leading consulting and research establishment.

Stan was later enticed to Glasgow Caledonian University, with David Mills and Chris Woodford, to head a solids research section, whilst Greenwich set up the Wolfson Centre for Bulk solids Technology under Alan Reed, later taken over by Mike Bradley.

# HISTORY OF PARTICLE TECHNOLOGY

Surrey, Cambridge and Birmingham Universities also pursued the subject and Leeds created a team to specialise in particle technology within their School of Chemical Engineering and Processing.

The credit for coalescing commercial interest in this field must go to Abraham Goldberg, who organised the first POWTECH Exhibition at Harrogate that became an annual event and spread internationally, with various copies. He also organised various seminars and formed The Powder Advisory Centre and the publication of its magazine, later followed by a number of national publications focusing on the subject.

This flurry of activity and technical promise inspired the Prime Minister, Harold Wilson, to talk of 'The White Heat of Technologies' and institute a research organisation at Warren Spring Laboratories, Stevenage, with a key section under Fred Valentine, with Miles and Scofield, doing sterling development work on a host of topics, including continuous belt weighing, fundamental powder testers, aerated powders, mixing and dust explosions.

The Government formed the British Materials Handling board in 1987 to coordinate research in bulk handling and it sponsored research on flow in silos, organised group development projects with non-competing companies and publishes a range of User Guides and technical books. A trade organisation, Solids Handling and Processing Association, SHAPA, was formed for companies that manufacturing equipment for this sector to organise seminars and publish technical articles. The Institution of Mechanical engineers formed a Solids Handling Committee in their processing division and the Institution of Chemical Engineers created a particulate solids subject group, both institutions organising conferences and seminars on the subject.

The current position is that a number of UK Universities have special powder technology sections. The Wolfson Centre, based on Woolwich University, is a research and consulting organisation devoted to bulk technology and recently developed a commercial annular shear cell. Ghadiri joined Leeds, to bring expertise on attrition and Harnby on Mixing. Glasgow Caledonian specialises in pneumatic conveying. Cambridge, Edinburgh, Surrey, Bradford, Bath and Birmingham also have very active sections. The I.Chem.E and I.Mech.E have specialised Committees on the subject and the trade organisations representing solids handling, S.H.A.P.A and M.H.E.A, organise seminars and publish guide documents on the technology and best practice. The only gap is the lack of coordination by users of bulk materials in differing industries, an omission currently being addressed by the BMHB by forming a User Group of companies that have a common interest in the handling of bulk materials. The recent decision by UK to leave the European Union will not affect technical co-operation and participation in the E.Chem.E. Working Party for Mechanics of Particulate Solids. Meanwhile, University/Industrial co-operative developments, such as the 'Chariot project' between P & G and a number of specialised manufacturing companies, are undertaking joint research in areas such as continuous mixing.

## PTF Bylaws Update

To improve operations of our organization and keep up with the current requirements, it is important to review the bylaws and make any necessary changes. This was completed last year and is ready for voting by the members. Below is a summary of the changes proposed by the executive committee:

- Remove the limitation that executive committee members be elected by their respective section (academia members electing academic liaisons and industrial members electing industrial liaisons).
- EC members should be a PTF member.
- EC candidates shall be reviewed by current EC members prior to voting by general membership.
- Vice-chair qualification is clarified. Any EC members during any of the last six calendar years can be nominated and is elected by the EC.
- Biennial meeting and related parts are omitted.
- Technical areas are added.

The complete bylaws and the voting will be communicated to all during the next few months. If you have any comments or questions, please feel free to contact any of the EC members.

***Raj Dave***

NJIT

# Particle Technology Forum: Organization and Roles

**Reza Mostofi**

UOP, A Honeywell Co.

As we are getting ready for PTF elections, it seems appropriate to highlight some of the aspects of PTF day to day business. This is not a complete list and is only compiled to provide some understanding of the executive team especially for the members who would like to serve the forum.

**Awards and Banquet Dinner**

⇒ Form award committees while avoiding conflicts

⇒ Collect and redistribute completed nomination packets

⇒ Notify all parties of the outcome

⇒ Collect winner information, request plaques & checks

⇒ Present awards at the banquet and arrange for awards talk

⇒ Search for nearby restaurants

⇒ Negotiate options and select the most appropriate one

**Finance**

⇒ Maintain financial records

⇒ Send invoices and collect funds from sponsors and advertisers

⇒ Provide PTF budget and cooperate with AIChE accounting

⇒ Request or issue awards checks and pay other expenses

**Secretary**

⇒ Take notes for various meetings

⇒ Communicate with members about EC and PTF news

⇒ Prepare ballots and report the votes

⇒ Assure compliance with the PTF bylaws

⇒ Review the procedures and revise if necessary

**Communications: Newsletter/Website**

⇒ Request and collect information for newsletter and website

⇒ Update website as the main communication front with members

⇒ Issue newsletter several times a year with most up to date information

**Programming**

⇒ Communicate and guide programing chairs for PTF related sessions

⇒ Work with AIChE planning to assure the PTF members needs are met and resolve possible issues

⇒ Ensure sound and creative program planning and area chairs leadership quality and succession

**One-time Tasks**

⇒ Ongoing: review awards process and update as necessary

⇒ Ongoing: review PTF bylaws and revise

⇒ Recently: revised poster session and judging process

⇒ Ongoing: review membership needs and develop plans on attracting more members

**Executive Committee Members**

⇒ Participate in EC meetings by phone or in person

⇒ Actively looking and suggesting ways to improve PTF related activities

⇒ Help with poster judging at the annual meeting

⇒ Act as a liaison to the PTF and their respective workplace and vice versa. This can include recruiting new members/officers and advertising for PTF related activities

⇒ Help in nominating new EC members

⇒ Help in other PTF standing committees

One last note is that becoming a PTF EC member would require on average somewhere between 1-7 hours per month of your time with some peak months and some months with no activity. In summary, I can assure you that there are lots of interesting works which help PTF grow, offer a great platform for your social connection, help you grow as a leader and learn something new.

# Conferences in Perspective

**90th Annual ACS Colloid and Surface Science Meeting** was held at Harvard University June 5-8 of 2016. The meeting covers many aspects of particulate technology from the perspective of research chemists and engineers in academia and industry. ACS Colloids is a medium-sized meeting, with several hundred attendees every year, and is traditionally held at universities with a strong history of colloid science achievement. The sessions this year reflected a nice balance between new topics, applications, and fundamentals. All of the sessions had strong contributions so I focus below on specific examples to demonstrate the level of work presented and to highlight the work of young, early-career researchers whose work is worth following.

An excellent example is the Colloidal Gels and Glasses session organized by Roseanna Zia (Cornell) and Marco Caggioni (P&G). The topic examines the behavior of suspended particles at high concentrations, glasses, and at lower concentrations when particles have strong attractive interactions and flocculate together. This is an area with strong applications in water/wastewater treatment, advanced materials processing, consumer and pharmaceutical products, and slurry handling to name a few. Strong contributions by new faculty in this area are noted from the simulation work of Emauela del Gado at Georgetown University and Jim Swann at MIT, both of whom simulate colloidal structures and the long-term flow behavior they exhibit.

In other areas, Matt Helgeson of UC Santa Barbara presented a nice overview of work on nanoemulsion structure, flow, and applications as part of the Unilever Award lecture. Michelle Personick, Wesleyan University, gave the Victor La Mer Award lecture on controlling shape in synthesis of inorganic particles.

Other sessions included, but are not limited to, Microfluidics, Rheology of Complex Fluids, Surface Science and Catalysis, Emulsions Foams and Dispersions, and Advanced Experimental and Simulation Techniques.

More information on the program and the organizers can be found here: http://colloids2016.seas.harvard.edu/

***- Pat Spicer, Univ. NSW, Australia***

**Frontiers in Particle Science and Technology (FPST)** Conference at Houston, TX in April was focused on "Mitigation and Application of Particle Attrition." There were 24 speakers in total with 9 from industry, 7 from academia, 7 from product or consulting groups, and 1 government lab. The academic keynote was given by Prof. Stefan Heinrich, where he gave a fascinating talk showing work conducted in his group at TUHH spanning particle, meso, and full process macro scales. John Carson, president of Jenike and Johanson, Inc. gave the industrial keynote, outlining the host of problems unintended particle attrition can cause on industrial processes. From outside our normal particle technology community, Prof. Khalid Alshibli presented mesmerizing imagines of single sand grains fracturing via 3D synchrotron computed tomography. The images showed that when individual grains begin to fracture their load is not instantly distributed elsewhere, they in fact continue fracture further. It was also interesting to see multiple researchers converging on common themes. For example, Prof. Heinrich, Prof. Wassgren (Purdue University), Dr. Potopov (Rock DEM), and Dr. Remy (Bristol Myers Squibb) all showed specific energy as useful parameter in determining size reduction extent in validated simulations.

***- Ben Freirich, Dow Chemical Company, USA***

**The Fluidization XV Conference,** an ECI Conference Series, held at Fairmont Le Chateau, Montebello, Quebec, Canada, from May 22-26, 2016, hosted over 200 participants from academia, industry and national labs across the globe. Around 200 presentations, including 8 plenary lectures, delivered in 3 parallel sessions, covered theoretical, computational, experimental, and commercial aspects of particle technology. The presenters and audience received additional opportunities to discuss interesting research on a one-on-one basis during evening poster sessions. The presentations were classified in various key areas, such as fundamentals, chemical looping combustion, thermal and catalytic cracking, clean energy processes, lignin and wood products, polymerization processes, coating technologies and fluidized nanoparticles, biomass to chemicals, fluidization of irregular shape particles, micro-fluidized bed reactors, encapsulation, biomaterials and fibers, and composites. A special issue of the *Fluidization XV Proceedings* will be published in *Powder Technology*, including approximately 80 peer-reviewed high-quality papers.

***- Mayank Kashyap, SABIC, USA***

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## Creating Prestigious Poster Sessions

One of the most common comments that the EBPC Poster Improvement Taskforce receives is that posters are treated as "second-class" to the oral sessions. This is unfortunate, as the poster sessions enable collaboration through a one-on-one discussion in a way that oral sessions do not. Poster sessions are an opportunity for collaboration, while oral sessions are an opportunity for lecture. Treating both in high regard is necessary to deliver a world-class conference.

Outcome measures based on participant feedback show that the poster sessions are well attended, have significant content, and are generally of good quality. Improvement is needed from all divisions and forums that provide content, to strive to treat poster sessions as prestigiously as the oral sessions. It is for this purpose that the EBPC Poster Improvement Taskforce has put together this quick guide to create prestigious poster sessions.

**Tips for Creating Prestigious Poster Sessions:**

- **Tip 1:** Programming chairs should hold their poster sessions in a non-compete time block in the afternoon.
- **Tip 2:** Poster session chairs should organize their posters in a specific order so that similar research topics are grouped together.
    - To learn how to do so in Confex, please review this list of steps:
      Organizing Posters in Confex →
- **Tip 3:** Poster session chairs must develop a content strategy of rapid fire presentations.
- **Tip 4:** Divisions and Forums should not use the poster sessions as a "dumping ground" for oral presentations that do not fit in their oral sessions. Poster presentations should be held to the same standard as oral presentations.
- **Tip 5:** Consider establishing a recognition process for those who submit high quality posters.

**Metrics:**

Metrics are used to determine the effectiveness of the poster sessions based on surveys to determine attendee's impressions of the poster sessions. The following attendees (1500+) were polled: Division/Forum Programming Chair; Poster Session Chairs; Poster Presenters; and the EBPC.

We received over 150 replies to our survey and wanted to share some of the feedback received with the divisions and forums. You'll find some on the next page.

16AIChE
Annual Meeting, San Francisco, CA

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**Results:**

| I learned something at the poster sessions. | | | | | |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Neither | Disagree | Strongly Disagree | N/A |
| 32.4% | 54.1% | 8.1% | 4.1% | 0.7% | 0.7% |

| I found something that I can use in my profession during the poster sessions. | | | | | |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Neither | Disagree | Strongly Disagree | N/A |
| 26.4% | 42.6% | 19.6% | 8.8% | 0.7% | 0.7% |

| Ease of Locating Specific Posters | | | | | |
|---|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor | N/A |
| 20.9% | 31.8% | 23.0% | 12.8% | 4.7% | 6.8% |

| Quality of Poster Presentations | | | | | |
|---|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor | N/A |
| 20.9% | 38.5% | 27.0% | 2.7% | 2.0% | 8.8% |

| Quality of Rapid Fire Presentations | | | | | |
|---|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor | N/A |
| 20.4% | 25.9% | 25.9% | 14.8% | 13.0% | 0.0% |

| I liked the poster sessions. | | | | | |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Neither | Disagree | Strongly Disagree | N/A |
| 30.4% | 52.7% | 9.5% | 3.4% | 3.4% | 0.7% |

**Selected Feedback Received:**

- "Having prime-time poster sessions is absolutely great! That way, they are truly part of the conference. Evening poster sessions always competed with the hospitality suites (or with getting ready for those events) and poster sessions usually lose that battle. More 3:15pm poster sessions is a major improvement!"
- "I found that the evening poster session was a little bit "slow in motion" due to people being a little bit tired after a whole day. I usually find poster sessions as being much more efficient at lunch time… for having more interactive talks."
- "Give feedback to the poster presenters." – Session chairs, poster presenters, and judges should be more engaged with their session.

16AIChE
Annual Meeting, San Francisco, CA

WCPT8 *Expanding Boundaries*

# 8th World Congress on Particle Technology

## Expanding Boundaries

**April 22 - 26, 2018 • Orlando World Center Marriott • Orlando, FL**

## Save the Date!

The 8th World Congress on Particle Technology (WCPT8) will be held in conjunction with the 2018 AIChE Spring Meeting & 14th Global Congress on Process Safety.

On behalf of AIChE and the Particle Technology Forum (PTF), we invite you to participate, learn, teach and collaborate.

The WCPT8 conference will focus on all aspects of particle technology from fundamental research to applied successes in areas including:

- Particle Processing Technologies
- Particulate Product Engineering
- Specialty Particle Research
- Characterization & Measurement Techniques for Particles & Particulate Systems
- Modeling & Simulation of Particle Hydrodynamics & Interactions

**The Call for Abstracts for the WCPT8 will open in the Spring of 2017.**

**For more information on programming areas, important dates, and the organizing committee, visit:**
**www.aiche.org/wcpt8**

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## GROUP 3B: FLUIDIZATION & FLUID-PARTICLE SYSTEMS

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## GROUP 3C: SOLIDS FLOW, HANDLING AND PROCESSING

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## GROUP 3D: NANOPARTICLES

Chair: Dr. Steven Saunders
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Vice Chair: Dr. Satish Nune
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## GROUP 3E: ENERGETICS

Chair: Dr. Lori Groven
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**Have an idea for an article or suggestions for the PTF Newsletter or Website?**

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