The PTF Newsletter

A New Direction ….

It has been 20 years since the first edition of our newsletter was published. During these years, it has been a conduit of technical information and current events, and has helped us archive past events which would otherwise be distant memories. Thanks to the dedication of the past editors and contributors, the flame has continue to burn strongly. In the last PTF Executive Committee meeting in Atlanta, we proposed a new direction for the future. ***We envision to enrich the technical content through contributions from our diverse technical community which will serve to educate new entrants to the field and provide a platform for members to highlight their research interests***.

Key elements of our proposal are:

- Maintain current content
- 3 issues per year: Spring, Summer and Fall
  - ⇒ ***Spring Issue:*** PTF dinner highlights, programming deadlines, write-up by award winners, annual meeting wrap-up
  - ⇒ ***Summer Issue:*** Focus on technical content and contributions from PTF membership
  - ⇒ ***Fall Issue:*** Annual Meeting highlights / sessions, announcement of award winners, technical content
- New technical content
  - ⇒ Teaching: Back to Basics, fundamental concepts in a nutshell
  - ⇒ Advances: What's new or research frontiers – contributed by members
- Historical perspective – short notes on evolution of particle technology
- Solicit contributions from all PTF members for the technical section of the newsletter.
- Increase exposure of new faculty and upcoming industrial members (< 10 years).
- Sell advertisement in the newsletter. This money will be utilized for various educational activities.

We are excited about the new direction of our newsletter with the hope that it will bring greater value to our collective membership. We are looking forward to this collaborative effort, and expect us to be knocking on your doors for technical contributions!

Shrikant Dhodapkar, The Dow Chemical Company

Ray Cocco, PSRI

In this issue…

2015 AIChE Annual Meeting

November 8-13, 2015, Salt Lake City, Utah

Call for Abstracts Open

New submissions may be entered until

Monday, May 11, 2015

https://aiche.confex.com/aiche/2015/cfp.cgi

Letter from The Chair

Welcome to another year of PTF! I am so honored to serve as the chair of our vibrant group. I realize that the road is well built by my predecessors and we are only to stay in track. During the life of PTF the road has widened and improved and my hope is to do the same.

Before I begin, I would like to thank the two prior chairpersons, Dr. Cocco and Prof. Curtis who have helped me during the past years. They were always available to answer my many questions and guide me when needed. I am sure that continues to be the case in the upcoming years. There are many details in the day-to-day business of PTF and is not a one-person job by any means. We had our executive board election last year and added some new board members. I would like to congratulate the new elected officers and I am looking forward to working with all of the board members during the next two years. A big thank you to all the volunteers who take care of all the aspects of our group and also to the AIChE staff who support our activities in many ways.

There are some mini-projects that we are working on and will report on as we make some progress. Please make sure all your contact information is up to date and if in doubt drop us an email. Staying in touch with you is very crucial.

When I was getting ready to write the chair corner, Dr. Cocco mentioned that I get to choose my chair that goes with the text. He is right; all the chair corners from prior years have different chairs. I was luck since my son just showed me a picture of this chair called Emperor LX and I liked it; so there you are.

Reviewing the past chair letters also gave me the opportunity to realize many visions from the past can be used to guide us for the future. I do not claim that I read all the past newsletters line by line but I surely read all the chair letters. Mostly all of them, in one way or another, point out to the need for more industry academia interaction and students involvement. One particular article from Fall 2012 issue, titled "Our Demographics" is an analysis written by Dr. Cocco, which summarized the data and the need to diversify our membership. That article is even more relevant today as AIChE is making a lot of effort to become the global home of the chemical engineers and diversity is one of our main goals. While I am not sure what the data look like in 2015, I can guess it is not much different.

The question remains the same: what new and innovative actions should be taken to make PTF a diverse group of professionals that includes and serves different individuals.

We are not a very large forum and that is both positive and somewhat negative. A small group means we all know each other (at least most of us) and with that comes the familiarity and friendship. This is obviously priceless. On the other hand, a small group has limited resources, which translates to unfinished projects and tasks due to both time and money limitations. Can we come up with new ideas to help us achieve the goals? Can we somehow create an environment at PTF so that whoever is involved with particle technology defines it as their home? For now, the first attempt is to involve students and make sure when they think about a particle related technology, PTF is the first in their mind. This does not means starting from scratch, as we have many programs geared toward students that are well received and should be continued.

One last thing to mention is that through the efforts of Prof. Curtis, PTF started offering lifetime membership for $150. If you have become a lifetime member, please check your AIChE statement and make sure you are considered as one. AIChE customer service can also answer any questions you might have about this.

Please feel free to contact any one of the PTF officers if there is anything you want to discuss, we are after all "the home of everything particle technology".

Reza Mostofi

UOP, A Honeywell Co.

2014 PTF Award Winner:

Musings and Thoughts On

Particle Technology

Since the PTF Award honoree traditionally does not speak at the PTF Award session, Shrikant and Ray have asked me write a few thoughts about the PTF Award and, perhaps more broadly, my views on the future of particle technology. I am truly honored to have been recognized with the PTF Award. Most importantly, it is particularly heartwarming to have been selected by you, my peers and colleagues. Hats off to my nominators, Tim Frank and Ben Freireich of Dow, for their hard work, and to those of you who wrote letters in support of the nomination, I truly appreciate it.

So my first words to my boss after telling him about the PTF Award were, "No Jim, I am not retiring." While many in industry would view a 33 year career as plenty long enough, my view is that we still have a lot of work to do in the field. Today I am as excited as ever about the particle technology discipline and the world-wide particle technology community. Let's put this in perspective. When Al Weimer got me hooked on particles (and it was very easy to get hooked working with Al and his infectious enthusiasm for the field, thanks Al!), the particle technology of AIChE primarily focused on Group 3b – Fluidization and Fluid Particle Systems. The PTF has blossomed into much, much more, with focus across a broad range of processes and products. We programmed 40 sessions in Atlanta this past fall ranging from energetic materials to nanoparticles to segregation to particle formation, etc. It has been great to see this type of growth in the field. We have decades of job security because there are still LOTS of unsolved problems – I see the cup as more than half full! Even on "solved" or "old" problems, researchers are still innovating and bringing new solutions to the table. Take for example shear testing. Andrew Jenike developed the translational shear tester in the late 1950s. Yet 60+ years later, we continue to have people thinking about new ways to test powders faster, more accurately, etc. This is healthy for our community.

Easily the most important aspect about my career in particle technology is the people. Most broadly, I find that the global particle technology community is, for the most part, very friendly where academics and industrial folks can freely exchange ideas (this is strongly underscored by the significant industrial presence in the PTF). I don't know exactly why this is. My theory is that the problems we work on are very hard and each one of us knows that the free exchange of ideas is both healthy and useful – we're less interested in the specifics of a given material but rather on the fundamental concepts of particle technology. This is underscored by the number of times either I personally or have witnessed visits by industry to other industrial concerns, industry/academic and academic/academic collaboration, etc. I have been very fortunate to have the support of many in the community over the last three decades, and most importantly, my Dow colleagues. One of the greatest joys has been to witness the growth in the Dow solids processing folks over the last quarter of a century. While many of my academic friends have students for 4 -5 years, I feel I am very lucky to have long lasting relationships with my Dow colleagues. And, of course, without the tremendous support of my family, my wife, Sue, and children, Derek and Emma, none of this happens. Their extraordinary patience over the dinner table listening to the talk of bulk solids excitement in the lab, visits to stone piles and quarries, wheat fields, railcars full of plastic granules, etc. has been exemplary.

Ray asked me to address the subject of the longevity of the Dow Solids Processing Lab. In the early 90s shortly after the lab was formed, an expert noted during a visit to our lab that the average life of an industrial particle technology lab was only 10 years. In January 2015, we've celebrated our 26th year. While I don't think there is a secret formula for longevity, there are few things that I feel are essential for success which I will enumerate here. 1) Solve problems that make money. OK, seems obvious. But, for example, insuring flow out of bin by measuring flow properties to keep a process operating is far more important than a model of said process. For those considering starting labs now, I suspect that there is a considerable backlog of problems in your company now that will generate revenue now. There will always be the tug between fixing the plant today (generate revenue now) vs. doing new product development (future revenue generation). 2) Don't try to be everything to everybody immediately. While it is important to have broad expertise across all of solids processing, most company labs do not need deep expertise in ALL areas. 3) Understand the capabilities of your team – there will be some areas which a lab cannot maintain even minimal expertise due to the lack of skilled personnel in the area. 4) Management support is essential. With the general lack of particle technology expertise, the utility of a solids processing should be obvious. In the early days of the Dow lab, we had support from my immediate supervisor up to the vice-president level, all of whom had spent time in Dow production plants struggling with solids problems.

So where are we headed as a community? As I indicated earlier, I am very optimistic about the future of particle technology. Education remains the key. The number of institutions now teaching an elective course or sequence of courses in the field has increased significantly, but we still need more as shown during a session in San Francisco in 2013 which examined industrial needs in undergraduate education. It is important that industry support these efforts (tours, demonstrations, guest lectures, etc.) as much as possible. Computational tools will continue to play a significant role in our future (especially with the growth of computer power) – it has been great to see the application of tools such as DEM, population balance modeling and other flow modeling codes towards the solution of particle technology problems. Oftentimes, these tools allow us to "look in" on problems that we would otherwise have issues examining experimentally. That said, the onus will be on those researching the fundamental chemical and physical interactions between particle and bulk solids to help define the key inputs into the computer codes, lest we subject ourselves to the age-old computer adage of "garbage in/garbage out". Lastly, we, the PTF, need to continue to generate excellent innovative programming at our conferences to encourage technical growth in particle technology which will be important many years into the future.

Once again, thanks to all of you for your support over the last 30+ years!

Karl Jacob

The Dow Chemical Company

Have an idea for an article or suggestions for the PTF Newsletter ?

Please let us know:

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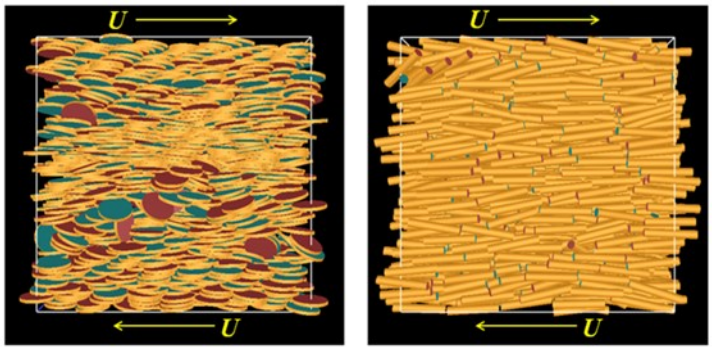
Ray Cocco Ray.Cocco@psrichicago.com

Thomas Baron Award Lecture

Predicting the Flow and Breakage Behavior of Wet and Dry, Flexible Fibers Using DEM

Our research group has developed discrete element method (DEM) models describing the motion of elongated, rigid fibers and disks (see Figure 1) with varying aspect ratios (AR) in shear flow (Y. Guo and J. Curtis, "Discrete Element Method Simulations for Complex Granular Flows", *Annual Review of Fluid Mechanics* **47**, 21-46 (2015); Y. Guo, C. Wassgren, B. Hancock, W. Ketterhagen, and J. Curtis, "Granular Shear Flows of Flat Disks and Elongated Rods without and with Friction," *Physics of Fluids*, **25**, Article 06334, 25 pages (2013); Y. Guo, C. Wassgren, W. Ketterhagen, B. Hancock, B. James and J. Curtis, "A Numerical Study of Granular Shear Flows of Rod-like Particles Using the Discrete Element Method", *Journal of Fluid Mechanics*, **713**, 1-26 (2012))



(a) Flat disks ($AR = 0.1$) (b) Elongated rods ($AR = 6$)

Figure 1: Rigid disks and rods in shear. The images are visualizations of the microstructure predicted by DEM simulations in which elongated particles tend to align in the direction of flow.

We have recently extended this work to consider ***flexible***, non-spherical particles. A glued-sphere approach is applied to describe the flow behavior of fibrous, elongated particles. The fibers (or any particle shape) are described by collections of connecting and overlapping constituent spheres. The relative movement of constituent spheres in a composite non-spherical particle leads to the deformation of the bonds and also the particle. In return, the bond forces/moments are exerted on the spheres to resist the deformation. We have verified our DEM model by a comprehensive examination of static and dynamic behavior of particle bending, twisting, and stretching (Y. Guo, C. Wassgren, W. Ketterhagen, B. Han-

cock, and J. Curtis, "Validation and Time Step Determination of Discrete Element Modeling of Flexible Fibers," *Powder Technology*, **249**, 386-395 (2013)). In Figure 2, this flexible particle DEM model is illustrated via a collinear collision between two flexible particles that have their major axes perpendicular to each other.

We have also considered ***wet, flexible*** fibers and introduced a liquid-bridge force model for the contacts between constituent spheres. The liquid cohesive force is a function of the surface tension, contact angle, and particle radius. One example validation of the wet, flexible fiber model is an angle of repose test as shown in Figure 3 below

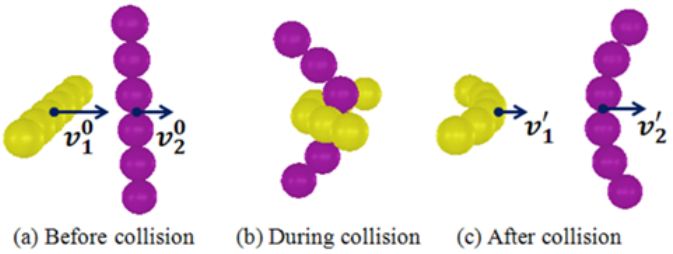


Figure 2: Snapshots of collinear collision between two flexible fibers arranged with two major axes perpendicular to each other.

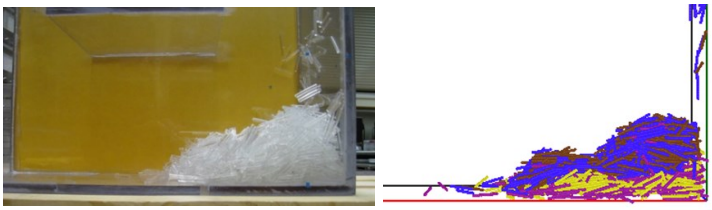


Figure 3. Experimental and simulated pile formation for wet (4% water by volume) fishing wire (2mm x 18mm)

DEM simulations also have been conducted to predict the effective viscosity/stress of both wet and dry fibers and have been compared with experimental measurements in Schulze shear cell tests. The effects of particle size/shape distribution, shear rate, solids content, and liquid composition (type and amount) can be easily explored using DEM. Also, the goal is not only to computationally 'measure' the viscosity/stress, but also to seek scaling relationships which will collapse some of these properties into master relationships. These relationships are particularly useful for the development of constitutive relations needed in continuum-based models used for design of large-scale processes.

In certain solids handling processes, prediction of ***particle breakage*** is critical for achieving a desired particle size distribution (PSD). In our work, the flexible particle model has been extended to simulate the breakage of fiber-shaped particles. As before, the fiber-shaped particle is formed by connecting (linking and overlapping) a number of spheres using elastic bonds. The particle breaks at the bonds where the tensile or shear stresses exceed the corresponding strengths. We have performed combined experimental and simulation studies of particle breakage in order to validate the particle breakage model. The first test is for uniaxial compression of chalk particles (Figure 4). Excellent agreement between simulation and experiment was achieved for the load history and resulting PSD for a given maximum load.

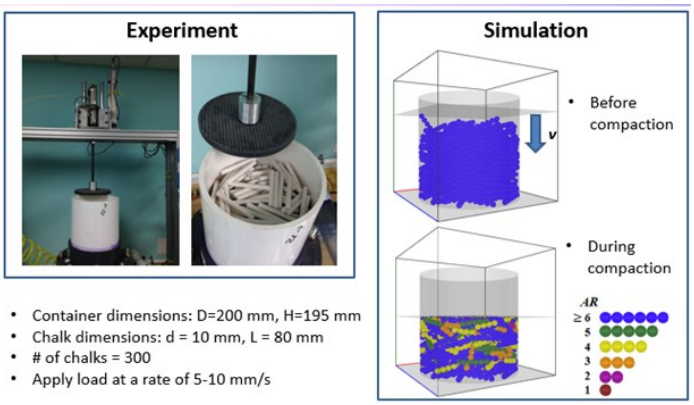


Figure 4. Experimental and numerical set-ups for uniaxial compression

We also applied the particle breakage model to consider particle flow and breakage of fiber-shaped particles in a Freeman FT4 Powder Rheometer, in which the particulate material, compressed by an applied weight from the top, is agitated by rotating blades (see Figure 5). From the DEM simulations, the evolutions of average particle size, PSD, and number and mass fractions of particles with each aspect ratio can be monitored.

Our results show that the particle breakage rate depends on the applied weight on the top of powder bed, the blade rotational speed, the inter-particle friction, and the wall-particle friction. With a small particle-wall friction, the particle bed rotates like a solid body along

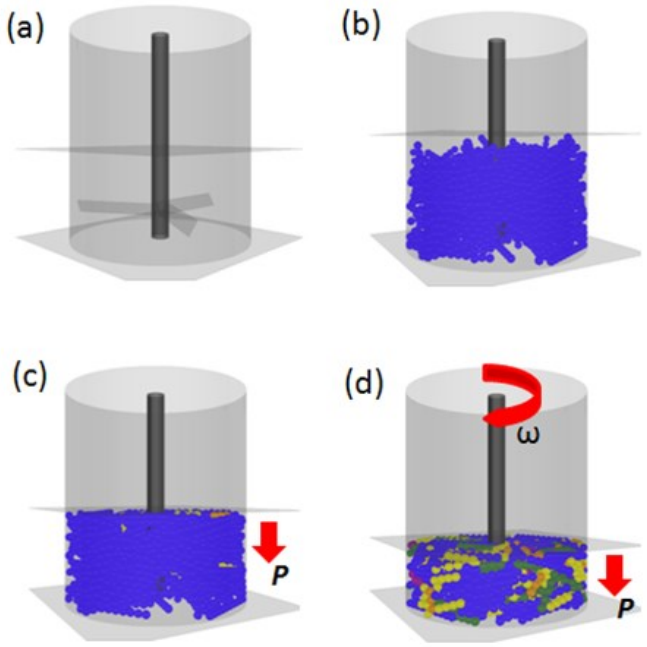


Figure 5. Numerical model of breakage of fiber-shaped particles in the Freeman FT4 Powder Rheometer. A number of elongated particles are generated and deposited in the cylindrical attrition cell with three blades. Before the agitation, the particle bed is compressed by specifying a load to the top wall. When the equilibrium state is reached, the agitation is started by specifying a constant angular speed to the blades. During the agitation, the weight of the top wall remains constant.

with the blades, and particle breakage rarely occurs. While, with large particle-wall friction, retarded flow zones are obtained close to the base and top walls, and the particles are broken due to strong interactions with the blades. As a larger weight is applied to compress the powder bed, the interactions between the particles and walls/blades increase, leading to an increase in breakage rate. The breakage rate increases as the rotational speed of blades increases, due to increased frequency of particle-blade interactions. However, the breakage per blade revolution is independent of rotational speed. It is also found that the attrited weight fraction, increased number of particles, and the average particle size follow power law relationships with the input work done by the blades, which is linearly proportional to the blade rotational speed, elapsed time, and the applied weight (see Figure 6)

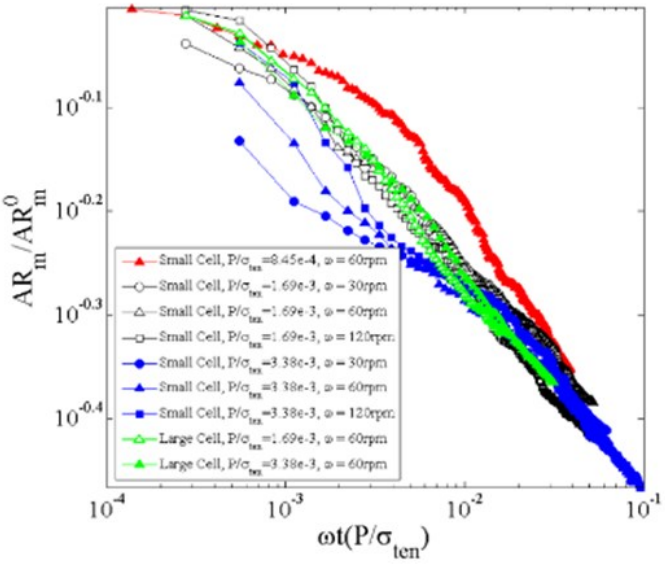


Figure 6. Collapse of particle attrition data (mean particle AR to initial particle AR) for both the small and large cells, various blade angular velocities ω, and various applied pressures P (μ_{pp} = 0.2, μ_{pw} = 0.7)

Jennifer Sinclair Curtis

University of Florida

PTF ELECTION RESULTS

Vice-Chair: Dr. Raj Dave

Executive Committee:

Industrial Liaisons:

- **Dr. Ben Freireich, Dow Chemical**
- **Dr. Reddy Karri, PSRI**

Academic Liaisons:

- **Dr. Ben Glasser, Rutgers University**
- **Dr. Jim Gilchrist, Lehigh University**

Particle Technology Forum Dinner

Sponsor of the PTF Dinner

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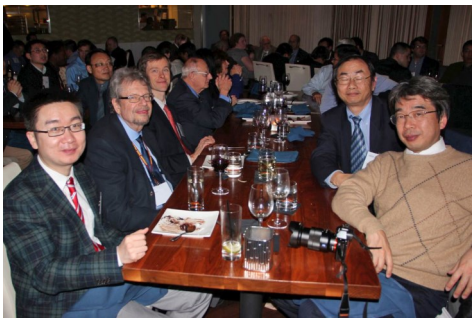
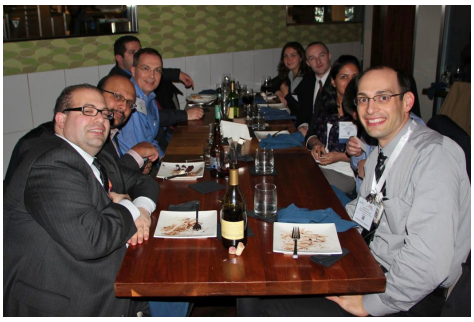
Bulk Solids: Science/Engineering/Design

Particle Technology Forum Dinner









University of Pittsburgh

University of Pittsburgh Alumni

Sponsor of the George Klinzing Best PhD Award

Sponsor of the PTF Dinner

Special Session Honoring Prof. Dimitri Gidaspow

This photograph was taken by Helene Gidaspow right after the two Special Sessions to honor Dimitri Gidaspow on his 80th birthday at the AIChE Annual Meeting in Atlanta, November 18, 2014. With two exceptions, they are all PhD students of Professor Gidaspow at IIT.

Assembled here from left to right are:

1. Vishak Chandra, currently a Masters student of Dimitri's and the first recipient of the Gidaspow Endowed Fellowship. He is the coauthor of the paper presented by Professor Gidaspow.

2. Dr. Jacques X. Bouillard, PhD ChE IIT, 1986. He traveled from France where he is employed by INERIS. He works on nanoparticle safety issues. He presented a paper on his recent research.

3. Dr. Lu Huilin who traveled from China where he is a professor at Harbin Institute of Technology. He worked with Professor Gidaspow as a visiting professor at IIT in the late 1990's on groundbreaking research. Utilizing a two-story circulating fluidized bed designed by him, which still exists at IIT. He presented a paper on his work extending the multiphase computer program developed by Professor Gidaspow and his students over the last 30 plus years.

4. Professor Dimitri Gidaspow, PhD GT IIT, 1962, Distinguished University Professor. He presented a paper with Vishak Chandra as co-author on research relating to computer modeling red blood cell and platelet transport which forms a portion of his MS thesis.

5. Dr. Robert W. Lyczkowski, MS GE IIT, 1966, PhD GT IIT, 1970. He organized and Co-Chaired, together with Dr. Madhava Syamlal, PhD student of Dimitri's, ChE IIT, 1985, not pictured, the two AIChE sessions. Robert spent most of his professional career at Argonne National Laboratory. He worked on projects in the areas of nuclear and fossil energy involving multiphase computer modeling. He retired in 2012.

6. Dr. Mayank Kashyup, PhD ChE IIT, 2010. He received the George Klinzing Best PhD Award from the AIChE Particle Technology Forum. He is presently a lead scientist employed at Saudi Basic Industries Corporation (SABIC) in Houston where he works on particle technology and fluidization.

7. Dr. Isaac Gamwo, PhD ChE IIT, 1992. He is presently employed at the National Energy Technology Laboratory in Pittsburgh. He is a research engineer who has worked on projects including complex fluid properties, coal liquefaction, extreme drilling, and methane hydrates. He presented a paper on his research on modeling and experimental fluid properties..

8. Dr. Reza Mostofi, PhD ChE IIT, 2002. He is presently employed at UOP, LLC in Des Plains where he applies computational fluid dynamics to analyze refinery units.

SABIC Young Professional Award

This award recognizes an individual who has contributed significantly to the field of particle technology within seven years of obtaining the last degree. The awardee must satisfy the following criteria:

1. Outstanding and internationally recognized contributions in particle technology. Metrics will include: (a) technical contribution to the field of particle technology, such as innovation, breakthrough research demonstrated through patents and publications, and (b) service to the particle technology community by way of education, leadership, stewardship and collaboration with other disciplines of engineering and science.
2. Receipt of last degree within the past 7 calendar years
3. Age must be under 40 years at the time of nomination

The awardee is required to:

1. Deliver a presentation during the PTF Award Session at the AIChE Annual Meeting
2. Provide an article for the PTF Newsletter (maximum 2,000 words)

The nomination package must include:

1. A letter of nomination stating all significant contributions made by the nominee to the particle technology community
2. Three to five letters of support, with at least one from industry
3. A résumé of the nominee
4. A short citation for the award

The Young Professional Award will be a part of the American Institute of Chemical Engineers (AIChE) Particle Technology Forum (PTF) Awards, sponsored by the Saudi Basic Industries Corporation (SABIC). The award will include USD1000 honorarium, plaque and two PTF dinner tickets, and it will be given annually at the PTF dinner event.

All nomination packages must be sent to Dr. Reza Mostofi –Ashtiani (Reza.Mostofi@honeywell.com).

Deadline for Submission: June 7, 2015

Upcoming Conferences

The PTF is now sponsoring job searches on the web.
Need a career? Need an engineer?
Go to
http://www.aicheptf.org

PTF Newsletter is now accepting paid advertisement
$250 - Half Page
$500 - Full Page

Job Postings

PURDUE UNIVERSITY

FACULTY POSITION(S)
DESIGNER PARTICULATE PRODUCTS
COLLEGE OF ENGINEERING

The College of Engineering at Purdue University has set a strategic priority to build a world leading pre-eminent team in Designer Particulate Products including foods and feed, consumer goods, specialty chemicals, agricultural chemicals, pharmaceuticals and energetic materials. The team will focus on model-based process design to produce engineered particles and structured particulate products, developing the understanding of process-structure-function relationships for these products, and building capacity through a highly qualified workforce in particulate science and engineering. The College invites applications for any rank (assistant, associate or full Professor for multiple positions). Purdue University seeks to attract exceptional candidates with interests and expertise in:

1. On-line sensing, Process analytical technologies, Process control applied to the manufacture of particulate products; and
2. Modeling multiphase particulate systems related to either (a) manufacturing processes, or (b) product performance in use and the environment.

However, outstanding candidates in other areas of particle technology related to the manufacture of particulate products will also be considered.

Successful candidates must hold a Ph.D. degree in some field of Engineering or a related discipline and demonstrate excellent potential to build an independent research program at the forefront of their field, work well in a larger interdisciplinary team, as well as potential to educate and mentor students. The successful candidates will conduct original research, will advise graduate students, will teach undergraduate and graduate level courses, and will perform service both at the School and University levels. Candidates with experience working with diverse groups of students, faculty, and staff and the ability to contribute to an inclusive climate are particularly encouraged to apply.

The College of Engineering at Purdue University has a strong core of faculty engaged in particulate products research as well as significant interdisciplinary efforts across campus, with other academic institutions, and industry partners. The College of Engineering at Purdue is currently undergoing extensive growth, with over one hundred faculty position openings being projected over the next five years. For a detailed description of research activities see https://engineering.purdue.edu/Engr/AboutUs/StrategicGrowthInitiative/Teams.

Submit applications online at https://engineering.purdue.edu/Engr/AboutUS/Employment/Applications, including curriculum vitae, teaching and research plans, and names of three references. For information/questions regarding applications contact Marion Ragland, Faculty Recruitment Coordinator, College of Engineering, at coeacademicaffairs@purdue.edu. Review of applications will begin on February 1st 2015 and will continue until position is filled. A background check will be required for employment in this position.

Purdue's main campus is located in West Lafayette Indiana, a welcoming and diverse community with a wide variety of cultural activities and events, industries, and excellent schools. Purdue and the College of Engineering have a Concierge Program to assist new faculty and their partners regarding dual career needs and facilitate their relocation.

Purdue University is an EEO/AA employer fully committed to achieving a diverse workforce. All individuals, including minorities, women, individuals with disabilities, LGBTQ, and veterans are encouraged to apply.

Particle Technology Forum Organization

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- Dr. Raj Dave
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- Dr. Marc-Olivier Coppens
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- Dr. Bruce Hook
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- Dr. Mehrdad Kheiripour
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All past PTF newsletters are now archived at the PTF site on the Newsletter section under the menu heading "Activities". http://aicheptf.org/activities/newsletter. Please email any comments, suggestions, or concerns regarding the web site to Pat Spicer p.spicer@unsw.edu.au

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WCPT8 Chair: Dr. Ray Cocco

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Particle Technology Forum Organization

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Vice Chair: Dr. Stephen Conway
(Stephen_conway@merck.com)

GROUP 3B: FLUIDIZATION & FLUID-PARTICLE SYSTEMS

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(reddy.karri@psri.org)

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GROUP 3C: SOLIDS FLOW, HANDLING AND PROCESSING

Chair: Dr. Ben Freireich
(bjfreireich@dow.com)

Vice Chair: Dr. Clive Davies
(C.Davies@massey.ac.nz)

GROUP 3D: NANOPARTICLES

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HISTORY OF PARTICLE TECHNOLOGY

As **Andrew Jenike** approached his mid- to late-30's, he began getting restless. He wanted to do something unique, something that would set himself apart, something that would be worthwhile. He started by reading and collecting articles on every conceivable subject, going to the library every night and every weekend. He put the information he collected into a series of folders arranged by topic. Eventually he had identified about 40 different topics. He constantly poured over these folders, trying to decide which topic would be the right one for him…

Where could he make a significant contribution?

Finally, on his 39th birthday he made his decision. **The topic he chose was the design of bins and hoppers for storage and flow of bulk solids**. Up to that time, design of this equipment was mostly a black art. Most hoppers were either 45 degrees or 60 degrees, because those were the common triangles that all engineers carried around with them. No one gave much thought to the material being stored. After all, it's "just a bin."

Once he made his decision, he promptly went out to the garbage container at the apartment building where he and his wife were living and threw away box after box he had collected on every other topic that he considered. He wanted nothing to interfere with his decision, no looking back.

… and as they say, the rest is history!

- Dr. John Carson