The PTF Newsletter

Particle technology forum is an umbrella that covers a wide range of technologies and interests. While we are generally familiar with various facets of particle technology, the activation barrier to learn new fundamentals and get acquainted with key researchers in non-adjacent areas is quite large. Our vision for the PTF Newsletter is to engage our members from various sub-groups to actively share their expertise and highlight key advances in their respective fields, while we continue to develop it as a useful resource for information related to particle technology worldwide.

For this issue, we have chosen to focus on Groups 3d (Nanoparticles) and Group 3e (Energetics). Profs. Wegner, Driezen and Groven have written concise and eloquent articles on fundamentals related to their respective technologies. With each edition, we will continue to highlight two sub-groups in rotation. Another recurring feature "Profiles In Excellence" is aimed at introducing upcoming PTF members from these groups. Group 3a and 3b will be next.

This is also our first edition with paid advertisements. The money raised from these advertisements will be used to support educational initiatives. Our first "project" is Video Competition for Particle Technology. The details will be shared in the Fall edition of the newsletter.

We have introduced a new feature "Conferences in Retrospective" where we invite our members to share their reviews of recent conferences. It will help our readership plan their conference calendar in an informed manner.

A voluntary organization, such as PTF, can sustain and thrive only through active participation from its membership. The success of our newsletter hinges upon the active contributions and serving the needs of the community. We want to hear your comments and suggestions to make this newsletter more useful and relevant.

Shrikant Dhodapkar, The Dow Chemical Company

Ray Cocco, PSRI

In this issue…

2015 AIChE Annual Meeting

November 8-13, 2015

Salt Lake City, Utah

Technical Program

Register Now & Save

Letter from The Chair

Hello again to all my fellow particle technology fans. Welcome to the summer 2015 issue of the PTF newsletter. This issue is meant to contain articles that are more technical and less concerned with the PTF business. Our newsletter editors have worked very hard and reached out to many experts to identify the most appropriate contributors for this issue.

Let me stop right here and seek out your help. We need your help in letting us know what you would like to see in the newsletter and in PTF; we need your ideas for the PTF website, tutorials, and any other feedback you can provide. A two-way communication guarantees a dynamic and alive community that we have built so far, and for its future growth. As you may know, AIChE is now the global home of chemical engineers and we continue to add many student members from across the globe. In fact, CEOC accepts 2-3 applications every month for student chapters from all over the world. This creates opportunities to grow and at the same time brings challenges that need to be addressed. For example, the small PTF community provides the opportunity to meet face to face at the AIChE annual meeting in November, but now with the many new student members, that may not be the case anymore in a few years as they will become professional members. That is why it is critical to ensure that electronic communication is well established and that we know how to find each other. So please make sure to update your profile at the AIChE website. This will always help us to reach you.

So what are we working on these days at the PTF executive committee? Three main projects are moving along: 1- review bylaws and propose changes if necessary; 2- review awards procedures and create a common set of guidelines for all the awards; 3- review membership data. The day-to-day PTF business of programming for annual meetings, setting up PTF dinner, managing all of the awards are going on as smooth as possible thanks to all the PTF EC devoted and active members. I hope to report more on these special cases in the future newsletter issues.

For my last section, I would like to bring your attention to different educational tools available to you as AIChE and PTF members. If you are a professional engineer, then you may have already taken advantage of these online webinars offered by AIChE some which are related to particle technology. Your membership entitles you to 6 free presentations per year, which you can add to your account and either attend live or watch later at your convenience. Just head to http://www.aiche.org/academy and log in to your account. Many of the conference presentations can be found there as well. Other great tools available to members is the e-library which contains "Knovel" and "AccessEngineering" tool sets, with a wide range of subjects from technical writing to video instruction on how to use a chart in Perry's handbook. These and many more are available free of charge with your AIChE membership. Once again, if you want to see something that is not there, please let us know. We will communicate back to AIChE and will try to make it happen. Keeping up to date with the technology you are interested in has never been easier and it is something that all of us have to keep in mind.

This is it for now. I will talk to you soon and I hope to hear back from you even before that.

Reza Mostofi

UOP, A Honeywell Co.

PSRI Lectureship Award Winner 2014

Predicting Solids Flows and their Heat Transfer

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Processes involving the flow of solid particles are ubiquitous in nature (landslides, avalanches, planetary rings, etc.) and industry (pharmaceuticals, food products, chemical and petroleum industries), though a predictive understanding of their behavior remains elusive. The focus here is on heat transfer in dense flows of solid particles where conduction dominates, with application to a solar receiver in which solid grains are used as the heat transfer fluid. The advantage of using solids like sand over standard heat transfer fluids like molten salts or steam are twofold: (i) sand is inert at (high) radiative temperatures, allowing for potential improvements in efficiency, and (ii) good thermal storage is critical for the diurnal cycle of solar heating. Nonetheless, much work remains to be done to design and optimize a solar receiver capable of reaching the DOE Sun Shot goal of 6 ӣ/kW-hr for concentrating solar power by 2020. To this end, our group has focused on the development and validation of a first-principles model for the heat transfer in dense solids flows. The three main phases of this work are described below:

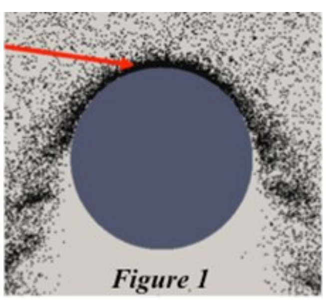

Figure 1

Phase 1: Assessment of Key Heat Transfer Mechanisms

For a gravity-driven flow of solids over an array of heated tubes, conduction at the wall dominates due to enduring, dense contacts; see DEM simulations in Figure 1. As sketched in Figure 2, the conduction is made up of two contributions: (i) particle-wall (direct) conduction across the contact area and (ii) particle-fluid-wall (indirect) conduction across the thin fluid layer between the solid surfaces. To assess which mechanism(s) dominates, DEM simulations were performed. However, one challenge with DEM simulations involving heat transfer is that the use of artificially soft springs leads to non-physical enhancement of heat transfer due to increases in contact area and duration. To overcome this barrier without sacrificing numerical gains, corrections to the contact area and duration are derived based on two approximations: binary contacts and equal, non-dimensional impulses between different collision treatments. The resulting DEM model is validated via the simulation of dense gas-solid flow down an inclined ramp, resulting in very good agreement between the uncorrected (non-softened) and corrected (artificially softened) DEM simulations. The corrected DEM is then applied to the prototype receiver geometry, indicating that particle-fluid-wall conduction dominates over particle-wall conduction. It is worthwhile to note that the opposite (wrong) conclusion would have been reached for artificially-softened DEM simulations *without* the corrections to contact time and duration.

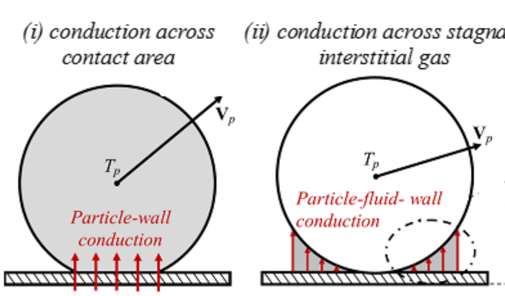

Figure 2

For more details, see "The role of soft-sphere contact models on thermal heat conduction in granular flows" by A. B. Morris, S. Pannala, Z. Ma, and C. M. Hrenya (under review).

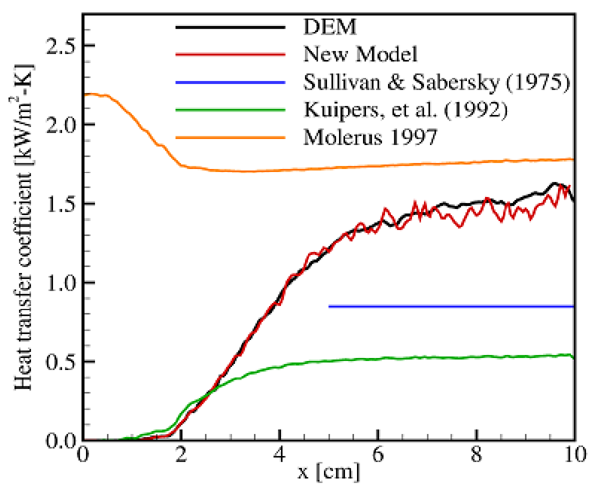

Figure 3

Phase 2: Development of Continuum Model for Particle-Fluid-Wall Conduction

Given this identification of particle-fluid-wall conduction as the dominant mode of heat transfer in the dense flows considered here, attention is now turned to developing a kinetic-theory-based (continuum) description of this mechanism. Previously, two methods have

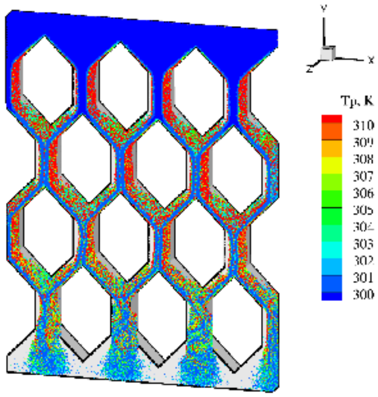

Figure 4

been used for this purpose. First, an "effective" thermal conductivity has been used to describe heat flux at the boundary. The con of this approach is its independence on particle size, which is contrary to experimental and DEM data. The alternative Nusselt-number approach does contain a size dependency though it is independent of concentration, which is also contrary to experiments and DEM simulations. To overcome the limitations of both, here we hypothesize a universal "particle-wall distribution function" that is a function of concentration only. This assumption is reminiscent of the radial distribution function at contact, which appears in kinetic-theory descriptions of multiphase flows. DEM simulations confirm this hypothesis for a wide range of parameters, and the resulting distribution function is incorporated into continuum theory and applied to flow down a ramp. As shown in Figure 3, the new kinetic-theory-based model provides an excellent comparison to DEM data for the local heat transfer coefficient.

For further information, see "A conductive heat transfer model for particle flows over immersed surfaces" by A. B. Morris, S. Pannala, Z. Ma, and C. M. Hrenya (*International Journal of Heat and Mass Transfer* **89**, 1277-1289, 2015).

Phase 3: Simulation of Heat Transfer Tubes in Prototype Solar Receiver

The new heat continuum heat transfer model is now applied to a prototype solar receiver, and compared with DEM simulations. As shown in Figure 4, gravity-driven sand particles flow downward over an array of heated, hexagonal tubes. These DEM simulations of ~12 million particles, which were performed on ORNL's Titan supercomputer, represent the largest MFIX DEM simulations reported in the open literature. When compared to these DEM simulations, the new continuum model accurately predicts the local heat transfer coefficient and <5% average error in the overall heat transfer coefficient, thereby validating the model in a complex geometry. Furthermore, this system also illustrates behavior counter to that observed in a molecular fluid with heat transfer. In particular, an increase in velocity (or Peclet number) leads to increased heat transfer in molecular fluids, but a decrease in heat transfer here due to reduced particle-wall contact at higher velocities.

For more information, see "Simulations of heat transfer to solid particles flowing through an array of heated tubes" by A. B. Morris, S. Pannala, Z. Ma, and C. M. Hrenya (under review).

PTF AWARDS WINNERS

- **PTF Lifetime Achievement Award:**

  Dr. John Carson, Jenike and Johanson

- **George Klinzing Best PhD Award:**

  Dr. Meenesh Singh, UC Berkeley

- **Thomas Baron Award :**

  Prof. Hamid Arastoopour, Illinois Institute of Technology

- **Fluidized Processes Recognition Award:** Charles (Chuck) Hemler, UOP

- **PSRI Lectureship Award in Fluidization:**

  Prof. Rajesh Davé, NJIT

- **SABIC Young Professional Award:**

  Prof. Fanxing Li, NC State University

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

Small Particles at Large Scale

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The past decade has seen intense research on nanoparticle synthesis with a plethora of new materials developed. Several small businesses were established, selling some of these nanoparticles in the form of powders or suspensions. When it comes to industrial nanopowder production however, carbon black, silica and titania are still the prominent examples even though their manufacturing processes were established more than 50 years ago. Clearly, today's challenge is the transfer of the newly developed lab-scale processes for nanoparticle synthesis into an industrial production environment.

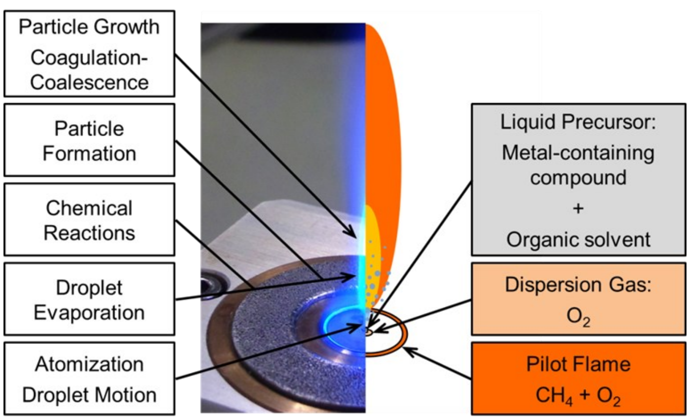

Figure 1: Nanoparticle synthesis by flame spray pyrolysis (FSP).

Flame Spray Pyrolysis (FSP) is an extremely versatile process for nanopowder synthesis, allowing us to transform almost all elements into typically oxide nanoparticles. Some metals, phosphates and other compounds have been made as well (Teoh et al., 2008). It also enables production of multicomponent materials in one step, e.g. in the form of solid solutions, coated or matrix-embedded structures.

The raw material (precursor) for FSP is a metal salt or organometallic compound that is dissolved or diluted with an organic solvent and fed into a spray flame (Figure 1). Atomization typically takes place with the help of an oxidizing dispersion gas, frequently oxygen. The precursor is released during droplet combustion and converted to small product clusters. Research on these early processes is extremely challenging, as they take place within milliseconds in a high temperature environment up to 3000 K (see e.g. Rosebrock et al., 2013). The clusters grow in the flame by coagulation and coalescence and/or surface growth which results in sphere-like nanoparticles. When full coalescence of colliding particles no longer takes place in lower temperature zones of the flame, hard agglomerates or "aggregates" of primary particles are formed. After sintering ceases completely soft agglomerates of these aggregates and/or primary particles result. The size and morphology of primary particles, aggregates and agglomerates thus strongly depends on the temperature, velocity and concentration fields of the flame, which can be influenced by the operating parameters (e.g. type and feed rate of reactants). During scale-up from laboratory to pilot and industrial reactors these fields should be kept similar to yield same product particles.

Gröhn et al. (2014) investigated the scale-up of the FSP process by the example of zirconia nanoparticle production. They integrated the dominant spray and particle formation mechanisms into a 3-dimensional computational fluid dynamics code that was complemented with global expressions for gas-phase oxidation and a monodisperse aerosol dynamics model. This model allowed to extract the high temperature particle residence time that controls primary particle and aggregate growth. Figure 2 shows the temperature-time profile of an average ZrO_2 particle made in flames fed with precursor/dispersion oxygen flow rates in (mL min^{-1})/(L min^{-1}) of 16/80 (dashed line), 16/20 (solid line) and 64/80 (dotted line).

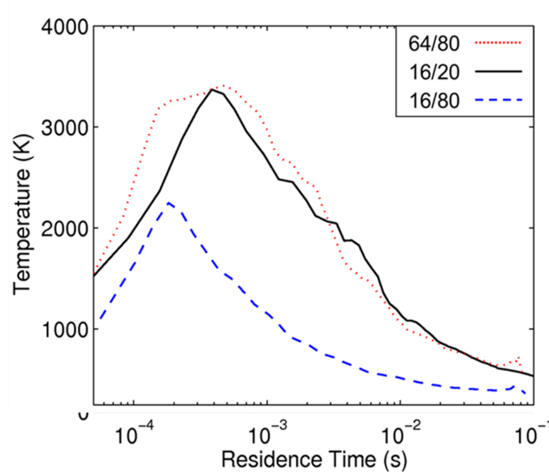

Figure 2: Average temperature –residence time profiles of zirconia nanoparticles made in flames with precursor / dispersion oxygen flows of ([mL min^{-1}]/[L min^{-1}]) 64 /80 (dotted line), 16/20 (solid line) and 16/80 (dashed line). Adapted from Gröhn et al., 2014.

While particles made in the flame with the highest precursor to dispersion gas flow ratio (5 for the 16/80 flame) experience a peak temperature of around 2000K and stay for less than 1 ms above 1500K, those made at a feed ratio of 1.25 stay approximately 5 ms above 1500K and experience a maximum temperature of more than 3000k. Please note that the 16/20 flame and its 64/80 counterpart with flow rates scaled up by four exhibit the same temperature-time profiles!

Figure 3 now shows how the size of product primary particles is kept approximately constant when the production rate is scaled up by maintaining the same ratio of precursor to dispersion gas flow, attributed to the similar high temperature particle residence times. Doubling the precursor concentration from 1 to 2 mol/L Zr slightly increases the primary particle size due to the higher concentration of collision partners in the flame while doubling the production rate. Filled symbols refer to experiments with the lab-scale reactor, which follow the trend of the pilot-scale system and demonstrate that scale-up can be achieved with different but geometrically similar FSP reactors. The primary particle size of the cold and short 16/80 flame was ~8 nm (data not shown), half the size of the products of the hotter flames with precursor/dispersion gas ratio of 1.25. Transmission electron micrographs show that the particle morphology is also maintained during scale-up. Gröhn et al. (2014) even demonstrated that the growth of aggregates and agglomerates proceeds similar for constant ratio scaling.

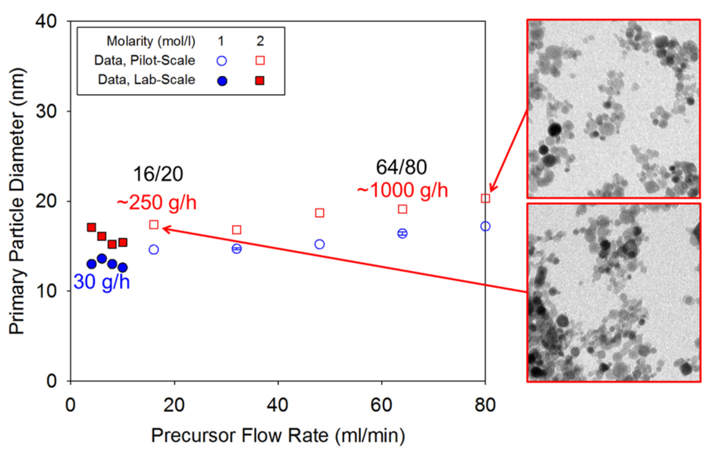

Figure 3: Scale-up of ZrO_2 nanoparticle production by keeping the ratio of precursor and dispersion gas flow constant. Filled and open symbols refer to experiments with lab-scale and pilot-scale reactors, respectively.

While production rates up to 2 kg/h of ZrO_2 have already been achieved with the fully automated pilot-scale FSP system at ETH Zurich, scale-up to 5 kg/h is currently being investigated. A breakdown of estimated production costs for continuous manufacturing (24/7; approx. 40 t/yr ZrO_2) with such a system shows that raw materials costs (precursors, solvents and gases) constitute about 75% of the total costs (Figure 4). Production of ZrO_2 nanopowders at 50 $/kg seems within reach (see also Wegner et al., 2011). This may still be too high for simple oxides like zirconia but can already be attractive for specialties.

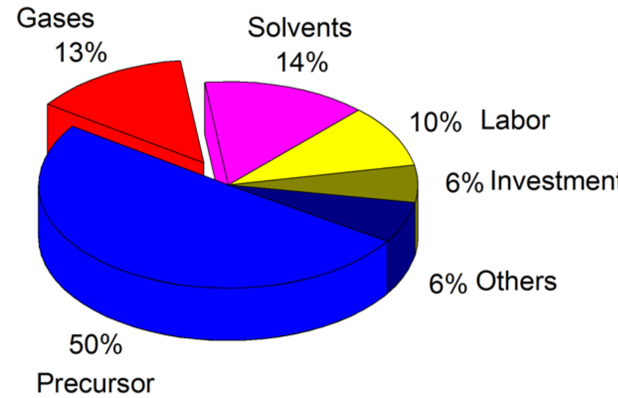

Figure 4: Breakdown of estimated FSP production costs for 40 t/yr of zirconia (24/7 operation).

Apart from optimization of the FSP reactors, more research is required for the development of cheaper precursors, improved filtration and off-gas systems for recovery of nanoparticles as well as heat. Furthermore, many open questions remain regarding the safe handling and processing of large quantities of nanopowders (e.g. fluidization, conveying, dispersion, compaction, agglomeration, dusting behavior). Last but not least, a proof of concept industrial FSP plant would greatly assist the breakthrough of this technology.

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1. Gröhn, A.J., Pratsinis, S.E., Sanchez-Ferrer, A., Mezzenga R., Wegner K. (2014), Scale-up of Nanoparticle Synthesis by Flame Spray Pyrolysis: The High-Temperature Particle Residence Time. *Ind. Eng. Chem. Res.* **53**, 10734.

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Engineering Energetics through Advances in Particle Processing and Technology

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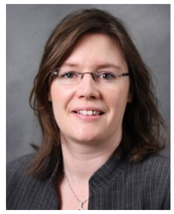

L.J. Groven

South Dakota School of Mines and Technology, Rapid City, SD

One question that we are often asked is what exactly are energetics? Broadly speaking we include explosives (RDX, HMX, etc.), pyrotechnics, propellants and other reactives into this category. What all of these have in common is that they generally contain some type of powder (metals, oxides, diluents, and organics) or are composed of only powder components. These powders take the form of fuels (Al, Mg, Zr, etc.), oxidizers (Bi_2O_3, Fe_2O_3), neat crystalline components (HMX, RDX, Ammonium perchlorate, etc.), fibrous materials (nitrocellulose), and burn rate modifiers (diatomaceous earth). From black powder to the most advanced hybrid propellants - powders are the key.

You might imagine then that understanding the powder characteristics such as particle size distribution, morphology, and surface area is quite important. Not only must we consider their size and morphology in preparation, handling, and processing, but also the added twist that powder characteristics affect the safety and reactivity of the reactive materials. For example, for fine metal particles smaller often means poor handling and processing. On the other hand, smaller particles have greater reactivity that is attractive for some applications, for which accelerated flame propagation, generation of strong pressure or light pulses, and other effects associated with rapidly burning materials are desired.

During the last 15 years or so the focus in terms of energetic materials has shifted on new capabilities for preparing, characterizing, and processing materials which contain nanoscale domains or particles. The production of nanoscale metal powders is a good example. Multiple methods were developed, from exploding electrically heated wires to plasma processing and mechanical milling. One material in particular, nanoscale aluminum, has been at the forefront of energetics research for more than a decade. From propellants to explosives, researchers have been exploring the size effect of aluminum powders. An example of this is when we replace micron sized aluminum with nanoscale aluminum in thermite (Al/metal oxide) systems. Energy is released 2 to 3 times faster from these systems when nanoscale powders are used versus their micron sized counterparts and combustion velocities are increased dramatically (mm/s to hundreds mm/s)[1]. Even with the development and availability of nanoscale aluminum, its incorporation into energetics remains problematic. The very high surface area makes it nearly impossible to include the same metal content in a composite propellant or an energetic material using a binder. Nanopowders are much more electrostatically sensitive in comparison to micron size powders so their dry processing is problematic. In fact, when nanoscale aluminum is included in a thermite system the energy threshold for electrostatic ignition can be as low as < 1 μJ.

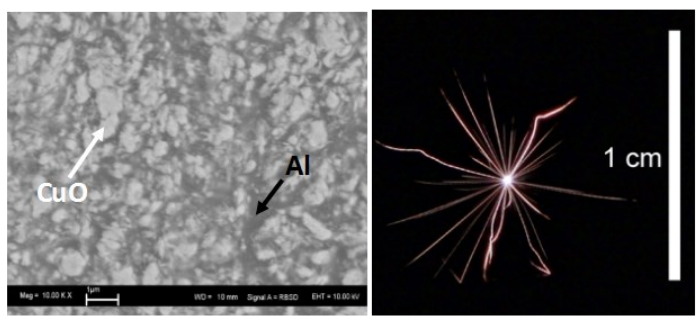

Fig. 1. Left: cross-section of a nanocomposite Al-CuO particle prepared by arrested reactive milling. Brighter CuO inclusions are embedded in a gray Al matrix. Right: nanocomposite Al-CuO particle ignited by a laser beam. Particle explodes producing multiple finer and rapidly burning fragments.

In terms of composites systems, where the reactants are intimately mixed, several methods have recently been explored including bottom up (self-assembly, controlled deposition) and top down (arrested reactive milling) [1,2]. Materials produced via this manner have been of interest for tailoring the reaction front or preparing larger, micron-sized particles but still maintaining high reactivity associated with nanoscale domains. The goal is that at some point we will be able to engineer particles that provide the desired response from various stimuli. Could our particles be gas generators upon combustion? Could they be switched on with acoustic or electromagnetic energy?

For organics there has been little change in processing such powders. Current state-of-the-art is processing both organic and inorganic powders and components with unique technologies such as Resodyn acoustic mixers. Some recent work was aimed at producing nanoscale crystals of explosive powders to enhance safety or processing. Recently, engineered powders again appeared at the forefront of the research community with efforts aimed at co-crystallization of energetic organic molecules [3]. These materials have different properties than either of the individual neat components, including reduced sensitivity to stimuli, better morphology, etc.

So where is the energetics field headed in terms of research directions? The field is broad and there are many significant areas that are ripe for contributions including the following:

- Methods of preparing energetic particulates, while improving their stability and enabling handling with other components of energetics and, at the same time, increasing their combustion heat release and burn rates
- Development of novel composites and alloys with improved reactivity and low-temperature stability
- Development of custom energetics, such as containing biocidal combustion products, capable of emitting a particular light, or generating rapidly decaying pressure pulses
- Development of materials for alternative applications, such as hydrogen generation, batteries, catalysts
- Characterization of reaction mechanisms, with focus on effect of particle or domain size distributions, real-time measurements, detailed kinetic models spanning wide ranges of reaction rates
- Applied work aimed to integrate novel energetic powders and particulates with existing formulations, binders, processing methods

References

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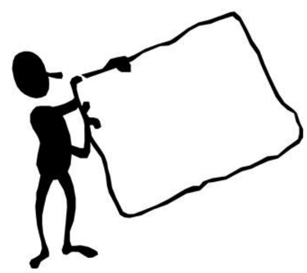
2. Dreizin, E.L., Schoenitz, M., Reactive and Metastable Nanomaterials Prepared by Mechanical Milling. In Metal Nanopowders: Production, Characterization, and Energetic Applications. (Gromov A.A., Teipel U., Editors) Wiley-VCH Verlag GmbH & Co., KGaA, Boschstr. 12, 69469 Weinheim, Germany (ISBN: 978-3-527-33361-5) May 2014, pp. 227-278.
3. Bolton, O., Simke, L. R., Pagoria, P. F., Matzger, A. J. High Power Explosive with Good Sensitivity: A 2:1 Cocrystal of CL-20:HMX, *Cryst. Growth. Des*., 2012, 12:4311-4314

New Poster Session



In an effort to increase attendance and interest, groups that have poster sessions from 6-8 pm on Tuesday night have chosen to move their poster session to 3:15 pm on Tuesday. PTF decided to keep the 6-8 pm time slot due to a large number of consecutive sessions on Tuesday afternoon. To accommodate the posters, AIChE assigned a ballroom to PTF. **This year the posters will be in a smaller venue than the one we are accustomed to.** We hope that this will promote interactions between the poster presenters and attendees, and also increase attendance. Also, new this year, are **short introductory oral presentations by our student poster contestants before they display their posters**. This will facilitate the selection of the best poster by our judges and will give the audience a chance to quickly overview the content of the posters.

Manuk Colakyan

Particle Technology Activities: Global

European Federation Of Chemical Engineering Working Party on the Mechanics of Particulate Solids

Prof. Alvaro Ramirez Gomez

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The Working Party on the Mechanics of Particulate Solids is part of the European Federation of Chemical Engineering. The main aim is the promotion of science and innovation, education, and technology transfer in bulk solids handling and transportation and promoting interaction between industry and academia.

The Working Party was founded in 1969, and currently has 47 members from 15 European countries: 31 members are from academia and 16 members are from industry (18 Delegates, 16 Elected Members, 7 Honorary Members and 6 Guest Members). For most of the time the Working Party on the Mechanics of Particulate Solids has been led by Dr. Jan Novosad of Czechoslovakia (later Czech Republic). In the period 2001 - 2007 it was led by Dr. Hermann Feise, an industrial delegate from Germany, and from 2008 to 2013 by Prof. Massimo Poletto from Italy. Since 2014, the Working Party is headed by Prof. Álvaro Ramírez-Gómez from Spain.

Since it was founded, the Working Party has coordinated numerous technical projects. Its most prominent outcome being the SSTT (Standard Shear Testing Technique for Particulate Solids using the Jenike Shear Cell). This document has become the basis of several standards, most notably those by ASTM on Jenike and Ring Shear Testing.

Current technical projects include:

Flow Properties of Biomass Materials

Because of the irregular shape and the elastic, fibrous, flaky, and stringy nature of biomass materials, flow behaviour of these materials is completely different than those of the particulate solids commonly found in the process industry. Nowadays, the increased use of biomass materials in industries and the handling problems continuously experienced, mainly associated with bottlenecks, are urgently demanding new characterization methods and techniques. WP members have been working on the study of biomass flow since 2011. The initiative started with a demonstration project called *Bio4Flow* (www.bio4flow.com), involving four European countries (Italy, Sweden, United Kingdom and Spain). We continue to aim at creating a European network on biomass handling related activities. Related projects in progress are an ITN-Marie Curie proposal titled "*Efficient, reliable and safe BIOmass HAndling, Pretreatment and Processing for a sustainable EU Bio-based economy*" (BIOHAPPBY) and a COST Action titled "*Towards the Security of Supply of Biomass and Solid Waste Feedstock - Efficiency and Safety for the Bioeconomy (EFFSAF)*".

Contacts: Diego Barletta (U Salerno, IT), Sylvia Larsson (SLU, SE), Robert Berry (U Greenwich, UK), Álvaro Ramírez-Gómez (UPM, SP)

Wall friction project

The wall friction project was initiated due to the considerable scatter found in the results of wall friction tests carried out by various experienced bodies testing bulk materials. This project is being carried out by a considerable number of WP members, involving industrial and academic partners, and continuously aims at increasing the international participation. Since 2009, several rounds of tests have already been carried out carefully selecting the bulk materials to be tested and the wall sample material. The testing procedure followed has received improvements from the experience gained in the different rounds of tests and it will be published in the final report together with the results obtained.

Contact: Eddie Mc Gee (Ajax Equipment, Bolton, UK)

Validation of DEM Simulations

This project was aimed at testing, verifying and validating DEM particle scale simulations of particulate processes and through these activities, to bring the DEM methodologies from academic research towards industrial applications. The envisaged outcome is setting the European/International standards of "best practice" in DEM model development, simulation and implementation in a broad range of industry sectors. Projects developed in this direction have been *PARDEM - PARticle Systems: Training on DEM Simulation for Industrial and Scientific Applications* (www.pardem.eu), an EU Funded Framework 7, Marie Curie Initial Training Network (2009 -2013), and *T-MAPPP - Training in Multiscale Analysis (MA) of multiPhase Particulate Processes and systems (PPP)*, (www.t-mappp.eu), also an Initial Training Network funded by FP7 Marie Curie Actions ITN (2014-2018).

Contacts: Stefan Luding (UTwente, NL), Jin Y. Ooi (U Edinburgh, UK) and U. Tuzun ((U. Oxford, U. Cambridge (Churchill College), UK)

Internal friction project

In order to have a greater consciousness of the scientific meaning and the correctness of some empirical practices often carried out in the measurement procedure using shear testers, a study is being conducted. The starting

point for this study has been to carry out a survey that will first identify the most prevalent testers and their purpose in applications.
Contacts: David Craig (Jenike & Johanson, USA), Timothy A. Bell (Du Pont, USA) and Martin Morgeneyer (UTC)

K/λ Testing
The determination of the lateral pressure ratio K (ratio of horizontal to vertical pressure) of the bulk solid is of significant importance for the prediction of loads in silos. This should be determined at a particle packing density and at a stress level corresponding to the position where the maximum vertical stress occurs after filling (EN 1991-4:2006). An experimental device has been purposely built and tested for fine and cohesive solids.

Experimental campaigns in the project were dedicated:

1) to find reproducible and consistent procedures with different materials;
2) to determine the principal sources of error in the experimental campaign;
3) to improve the design of the cell.

Contact: Massimo Poletto (U Salerno, IT)

The results of these technical projects as well as new initiatives are discussed in annual meetings of the Working Party that usually coincide with conferences on bulk solids handling or in the field of Particle Technology, such as the International Conference for Conveying and Handling of Particulate Solids (CHoPS), the International Congress on Particle Technology (PARTEC), the International Congress of Chemical and Process Engineering (CHISA) or the International Symposium on Reliable Flow of Particulate Solids (RELPOWFLO).

Furthermore, the Working Party is also actively participating in the organization of scientific events such as the series of the International Symposium on Handling and Hazards of Particulate Solids in Industry (HANHAZ).

Further information:http://www.efce.info/wpmps.html

Excellence award in Mechanics of Particulate Solids (2016): http://www.efce.info/ExcellenceAwardMPS.html

CHoPS (Conveying and Handling of Particulate Solids) , an international conference which is organized every three years, was held this year in Tel Aviv (Israel). This was the fifth international conference in the series. Tel Aviv, with its special blend of Mediterranean ambience, seaside resort, modern facade and world renowned night life, justified its moniker of "The City That Never Sleeps". The conference format was a blend of plenary addresses and organized sessions which offered plenty of opportunity for discussion & networking. A number of PTF members were amongst the plenary speakers, namely Karl Jacob, Sotiris Pratsinis, Jennifer Curtis, George Klinzing, Shrikant Dhodapkar and Raj Dave. These plenary talks provided comprehensive and visionary perspectives on various facets of particle technology. The four parallel technical sessions covered a broad range of topics, such as pneumatic & hydraulic conveying, mixing and segregation, attrition, modeling, adhesion, size reduction, characterization, silo flow and solids processing. The conference chairs, Prof. Haim Kalman and Prof. Avi Levy, deserve special accolades for the splendid organization and outstanding hospitality. More details on CHoPS 2015 can be found at http://www.chops2015.org/

Shrikant Dhodapkar, Karl Jacob

The 12th International Conference on Gas–Liquid and Gas–Liquid–Solid Reactor Engineering (GLS-12) was held in New York City from June 28 to July 1, 2015, following the success of the eleven previous conferences which were held in Columbus, OH, USA (1992), Cambridge, UK (1995), Kanazawa, Japan (1997), Delft, The Netherlands (1999), Melbourne, Australia (2001), Vancouver, Canada

(2003), Strasbourg, France (2005), New Delhi, India (2007), Montreal, Canada (2009), Braga, Portugal (2011) and Seoul, South Korea (2013). The GLS conference series focuses on all aspects of fundamentals and engineering of multiphase reactors and processes, which are some of the most important and difficult areas for application and practice in the industries. GLS conferences bring together top class researchers and engineers from diverse fields every two years and have served as an exclusive international platform to exchange state-of-the-art findings and views. GLS-12 particularly emphasized topics related to sustainable energy and water. The conference format was a blend of plenary addresses and organized oral sessions followed by combined poster sessions offering plenty of opportunity for discussion & networking. The plenary speakers were Lynn Gladden at the University of Cambridge in UK, Joseph Powell at Shell in the USA and Ning Yang at the Chinese Academy of Science – Institute of Process Engineering in China. The four parallel technical sessions covered a broad range of topics, such as multiphase computational fluid dynamics, measurements and fluid visualization techniques, and novel multiphase reactors for energy and water applications. The conference chairs were A.-H. Alissa Park from Columbia University, Bing Du from ExxonMobil and L.-S. Fan from Ohio State University. More details on GLS12 can be found at http://www.aiche.org/cei/conferences/international-conference-on-gas-liquid-and-gas-liquid-solid-reactor-engineering/2015.

Ah-Hyung (Alissa) Park

World Congress in Particle Technology VIII (WCPT8): Save the Date

The **WCPT8** will be from **April 22 through 26, 2018** at the Orlando Downtown Marriott in Orlando, Florida. Topics of discussion will include particle and bulk powder characterization, particle interactions, particle design, handling and processing of granular systems, energetic particles, particle surface functionalization, particle classification, fluidization and multiphase flow, sustainable energy and environmental applications, particle systems for separations applications, particle technology for pharmaceutical applications and solids processing unit operations. Questions can be directed to ray.cocco@psri.org.

Ray Cocco

PTF Membership

To continue receiving the PTF newsletters (3 issues per year) and stay current with particle technology events and news, please make sure to renew/start your membership by either:

- Checking Particle Technology Forum when renewing your AIChE membership annually.
- Become a PTF lifetime member so that you don't have to renew membership every year.

Become a PTF only member (annual $15, **lifetime $150**)

Visit website: http://www.aiche.org/community/divisions-forums/ptf

If you don't see the PTF membership in your renewal screen, you can choose "Update Membership Options" and add PTF to your order.

You can also contact AIChE customer service at 800-242-4363 (US); +203-702-7660 (Outside the US); or email customerservice@aiche.org for membership questions and help.

PTF Membership Committee

Sponsors of the PTF Dinner

Profiles in Excellence

Steven R. Saunders

Assistant Professor
Voiland School of Chemical Engineering and Bioengineering, Washington State University, Pullman, WA
Steven.r.saunders@wsu.edu

Research Page

Travis Sippel

Assistant Professor
Mechanical Engineering
Iowa State, Ames
tsippel@iastate.edu

Research Page

Steven R. Saunders and his team are investigating the fundamental thermodynamics of nanomaterials in order to design new, highly active, dispersed nanoparticle catalytic systems using tunable, switchable and sustainable solvents. They are designing new dispersed nanocatalysts which can be easily recovered and reused using Organic-Aqueous Tunable Solvents (OATS). The Saunders Group is able to control dispersability of the nanoparticle into either the organic or aqueous phase after the phase partition by controlling the structure and properties of the stabilizing ligand surrounding the nanoparticles. Essentially all of the nanoparticles can be recovered and reused with the particles still being catalytically active after processing. This technology led to dispersed nanoparticles being more widely used for the production of pharmaceuticals and fine chemicals.

The Saunders Group is also investigating the mechanisms of nanoparticle synthesis using Diffusion Ordered Spectroscopy NMR (NMR-DOSY). NMR-DOSY allows for the measurement of diffusion coefficients of molecular and super-molecular species in solution without having to sample or subjecting the system to transient conditions. Using this technique the group is investigating the Brust-Schiffrin arrested-precipitation technique and morphological changes in the ligand shell due to solvent effects. They are developing new models to describe how nanoparticles disperse in order to ease synthetic and processing requirements leading to more efficient synthetic pathways.

He has been a member of AIChE since 2008, is an annual session chair at the National Meeting and is the Co-Chair of **Group 3d (Nanoparticles)** and 1F (High Pressure). Dr. Saunders is also the AIChE Student Chapter Adviser at WSU.

Travis Sippel's current research interests include development of novel, nanostructured energetic materials for the combustion enhancement of propellants, explosives, and pyrotechnics.

Current efforts are focused on the development of energetic materials containing particulate/inclusion materials that are responsive to an external energy stimulus (e.g. microwave irradiation) in order to establish control over energetic material combustion. The particle doping technique has resulted in the development of solid propellants whose burning rate can be throttled by microwave application. Additionally, diagnostic techniques have been developed enabling exploration of the ignition and subsequent reaction of reactively milled energetic compositions at near detonation speed heating rates.

His prior research work included development of more environmentally friendly nanoscale aluminum and water ice (ALICE) solid propellants for replacement of ammonium perchlorate based propellants (third most read article in *Propellants, Explosives, Pyrotechnics*, during spring, 2015). This work aimed at altering the ignition and combustion characteristics of metal particles through ball milling inclusion of fluorocarbons and hydrocarbons in order to expedite metal combustion rates and combustion efficiency as well as to develop camera photo flash ignitable energetics.

Prof. Sippel's research is funded by the Air Force Office of Scientific Research and Sandia National Laboratories. He is an associate member of AIChE, AIAA, the Combustion Institute, and the International Pyrotechnics Society. He is a committee member of the AIChE Fall Meeting **Group 3e Energetics** materials area and within the AIAA Iowa Chapter, and consults within the state of Iowa on the topic of energetic material safety. He is author or coauthor of over 35 scientific publications. He is a reviewer for numerous international journals.

Job Posting

Full-time Research Assistant Professor: Bulk Solids Innovation Center (BSIC)

The Dean's Office at Kansas State University (KSU) Salina invites applications for a full-time Research Assistant Professor to lead and coordinate research and other KSU related activity at the **Bulk Solids Innovation Center (BSIC)** for the study, development, and understanding of bulk solids materials handling.

Duties and Responsibilities

The successful candidate will serve as a full-time research manager for the center and be responsible for driving research collaboration with KSU faculty as well as business and industry partners while maintaining her/his own active research program at the cutting edge of the bulk solids material handling area. He/she will seek new partnerships and funding leading to interdisciplinary collaborative work that extends the reach and influence of the center over time. Candidate must have a Ph.D. in Chemistry, Chemical Engineering, Grain Science, Mechanical Engineering, or a related field. Research and publication record in one or more of the following areas: solids/particle characterization at the micro scale and macro scale levels; product testing; and/or modeling of solids and products using analytical/numerical techniques. Candidate should also possess experience in one or more of the following technologies: pneumatic transfer, sheer testing, pneumatic/mechanical conveyance, silo design, packaging equipment, gas/solid separation, and discrete element method.

For more information about required and preferred qualifications, and for details of how to apply visit www.salina.k-state.edu/hr/vacancies. Kansas State University is an equal opportunity employer of individuals with disabilities and protected veterans and actively seeks diversity among its employees. Background check required.

Postdoctoral Research Associate Positions at NJIT

Several postdoctoral positions are available in Chemical Engineering at NJIT within the **New Jersey Center for Engineered Particulates (NJCEP).** A Ph.D. in Engineering or Science with research experience and expertise in one or more of the following fields is required: Particle Science and Engineering including Nanotechnology, Pharmaceutical Product Development and Technology, Computational Modeling, and Polymer Science and Engineering. We are looking for self-motivated, hands-on individuals with excellent command of the English language, both written and oral, and having a strong publication record that includes several first-authored journal papers. All positions require ability to work with a diverse group of students, postdocs and faculty working on the research projects involving experimental and modeling of structured organic particulates. The first position concerns with developing a fundamental understanding of the impact of raw materials and processing on the quality attributes of the functionalized and surface modified pharmaceutical powders and their final dosage forms such as tablets and capsule via batch and continuous processing. The second position is in bioavailability enhancement of poorly water soluble drugs, achieved via top-down or bottom-up approaches including both crystalline and amorphous drug forms, as well as their solid dispersions formed via spray drying or hot melt extrusion (HME). Knowledge of formation and stabilization of nano and micro particle and their suspensions and incorporating them in thin films, spray-dried or fluid-bed coated composites is a plus. Advanced characterization and sensing of particulate products using near-IR and/or Raman sensing is another plus. Third position requires an expert in mathematical and computational modeling with familiarity with methods such as the discrete element method, population balance modeling and other dynamical approaches in fluid-particle systems. The person will lead the development, calibration, and validation of mathematical and computational models for various particle processes and their scale up, while incorporating experimental results and carry out sensitivity analysis with simulations and identify critical material–process-scale up parameters. If you are interested and qualified, please send your CV with a list of journal papers, US visa status, the date of availability, and a one-page statement of research interests to both Profs. **Rajesh N. Dave (dave@njit.edu) and Ecevit Bilgili (bilgece@njit.edu).**

Recent Awards and Honors

L. S. Fan is Named AIChE's 67th Institute Lecturer

"Prof. Liang-Shih Fan, Distinguished University Professor and the C. John Easton Professor in the Department of Chemical and Biomolecular Engineering at The Ohio State University, will present AIChE'S 67th Institute Lecture on November 11, 2015, at the organization's Annual Meeting in Salt Lake City, Utah. The Lectureship is awarded to a distinguished AIChE member who has made significant contributions to the chemical engineering sciences in his or her field of specialization.

Fan is being cited for his ground-breaking inventions of next-generation clean carbonaceous chemical looping energy conversion processes for CO_2 emission control and chemicals production; for his invention of the electrical capacitance volume tomography (ECVT) technology used commercially worldwide for multiphase flow imaging; and for major research, education, and service contributions to particle science and technology."

http://www.aiche.org/about/press/releases/03-27-2015/l-s-fan-named-aiches-67th-institute-lecturer

Jennifer S. Curtis is Recipient of 2015 F. J. and Dorothy Van Antwerpen Award

AIChE's Board of Directors has chosen Prof. Jennifer Curtis as the recipient of the 2015 F. J. and Dorothy Van Antwerpen Award for Service to the Institute. This award is sponsored by the Dow Chemical Company, and consists of a plaque and $5,000, plus a $500 travel allowance. Presentation of this award will take place at the Institute's Honors Ceremony, held during AIChE's 2015 Annual Meeting in Salt Lake City, Utah

Upcoming Conferences

Fluidization XV

A ECI Conference Series

May 22-26, 2016
Fairmont Le Chateau Montebello
Quebec, Canada

Abstract submission now open!

The XV Fluidization Conference welcomes delegates from academia, industry and government who share the vocation to meet societal needs, reduce the environmental footprint of our processes, while at the same time forging new business models to meet the needs of the growing global population. To meet these challenges, we bring together experts in fields beyond fluidization and powder technology and include theoreticians in computational fluid dynamics (a transverse application), nano-processing and materials, catalysis, and biopharmaceuticals.

www.engconf.org/16af

Gordon Research Conferences

Granular Matter

July 24-29, 2016

Location: Stonehill College, Easton, MA

Application Deadline: **June 26, 2016**

Upcoming Workshops & Courses

PSRI Fluidization Seminar and Workshop

Particulate Solid Research, Inc. (PSRI) will be giving a four-day seminar and workshop on fluidization concepts in Chicago from Monday, ***September 21 through Thursday, September 24, 2015***. The seminar consists of lectures interspersed with videos, large-scale demonstrations and workshops on the following topics including

- Basic Fluidization Hydrodynamics,
- Gas Distribution Design and Operation,
- Circulating Fluidized Beds and High-Velocity Systems,
- Cyclone Design and Operation,
- Dilute and Dense-Phase Conveying,
- Particle Entrainment,
- Erosion and Particle Attrition, and
- Standpipes and Solids Flow Systems.

The cost is $2,000 USD and registration can be found at https://psri.org/psri-events/seminar/2015-chicago. Note, PTF members get a $100 USD discount by using the discount code PTF2015CHICAGO when registering.

Barracuda User Group Meeting

The first Barracuda Virtual Reactor Users' Conference is being organized during September 30 – October 2, 2015 at the Hyatt Regency Tamaya, Santa Ana Pueblo, New Mexico.The conference is scheduled to include case studies, break-out sessions, new feature / advanced training, one-on-one sessions with CPFD Software staff, and open forum discussions.

- Increase your Barracuda VR product knowledge,
- Keep informed of innovative modeling research,
- Experience hands-on training,
- Interact with the international user community and
- Help shape the future of the technology.

Additional information : http://cpfd-software.com/resources/users-conference

Jenike and Johanson Education &Training Offerings

Fall Schedule: http://jenike.com/education-training/course-calendar/

AIChE Sponsored—Philadelphia

(http://www.aiche.org/resources/education/instructor-led/calendar):

September 16th – 17th Flow of Solids in Bins, Hoppers, Chutes, and Feeder

September 18th Pneumatic Conveying of Bulk Solids

Workshops at Powder Bulk Engineering Show, Atlanta: http://www.pbepowdershow.com/registration/

Workshops at Powder & Bulk Solids – Texas Conference: http://www.canontradeshows.com/expo/ptx_tx13/

19th Bulk Handling Problem Solving and Optimizations (Brisbane and Perth, Australia):

http://www.informa.com.au/training/bulk-materials-handling/bulk-handling-problem-solving

21st Transfer Chute Problem Solving and Optimization: (Perth, Australia):

http://www.informa.com.au/training/bulk-materials-handling/transfer-chute-design-fundamentals-technical-methodologies

Treasurer's Report

AIChE ACCOUNT	Starting	Income	Expenses	Balance
Totals as of 12/2014	$ 1,221.32	$ 22,200.64	$ 18,642.87	**$ 4,779.09**
Dues Income - Divisions (01/2015)		$ 390.00		$ 5,169.09
Dues Income - Divisions (02/2015)		$ 300.00		$ 5,469.09
sponsor check - Univ of Pitt (02/2015)		$ 660.00		$ 6,129.09
Dues Income - Divisions (03/2015)		$ 360.00		$ 6,489.09
sponsor check - DOW Chemical (03/2015)		$ 660.00		$ 7,149.09
Promotion-email (03/2015)			$ 21.32	$ 7,127.77
Dues Income - Divisions (04/2015)		$ 270.00		$ 7,397.77
Promotion-email (04/2015)			$ 10.63	$ 7,387.14
Dues Income - Divisions (05/2015)		$ 135.00		$ 7,522.14
Promotion-email (05/2015)			$ 11.86	$ 7,510.28
Totals as of 06/2015	$ 4,779.09	$ 2,775.00	$ 43.81	**$ 7,510.28**

NY ACCOUNT	Starting	Income	Expenses	Balance
Totals as of 12/2014	$8,435.07	$5,555.00	$8,387.33	**$5,602.74**
sponsor check from ANSYS (02/03/2015)		$1,160.00		$6,762.74
sponsor check from Jenike (02/03/2015)		$2,000.00		$8,762.74
JCurtis - cost for plaques (02/05/2015)			$287.00	$8,475.74
HOSTMYSITE.COM (04/02/2015)			$131.88	$8,343.86
sponsor check - University of Pitt (05/07/2015)		$660.00		$9,003.86
EIG*BLUEDOMINO (06/01/2015)			$107.40	$8,896.46
Shrikant Dhodapkar - MS Publisher (06/2015)			$108.24	$8,788.22
Totals as of 06/2015	$5,602.74	$3,820.00	$634.52	**$8,788.22**

Particle Technology Forum Organization

PTF EXECUTIVE COMMITTEE (ACADEMIC)

- Dr. Benjamin Glasser
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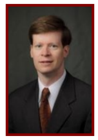

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- Dr. Raj Dave
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- Dr. Marc-Olivier Coppens
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PAST CHAIR
Dr. Jennifer S. Curtis
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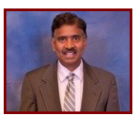

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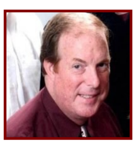

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- Dr. Mehdrad Kheiripour
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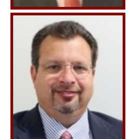

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All past PTF newsletters are now archived at the PTF site on the Newsletter section under the menu heading "Activities".

http://aicheptf.org/activities/newsletter.
Please email any comments, suggestions, or concerns regarding the web site to Pat Spicer p.spicer@unsw.edu.au

CTOC Liaison: Dr.Ray Cocco

SIOC Liaison: Dr. Reza Mostofi

Student Workshop Chair: Dr. Mayank Kashyap

Education Committee: Dr. Shrikant Dhodapkar

WCPT8 Chair: Dr. Ray Cocco

AIChE Staff Liaison: Ms. Darlene Schuster

Particle Technology Forum Organization

PROGRAMMING LEADERSHIP

GROUP 3A: PARTICLE PRODUCTION AND CHARACTERIZATION

Chair: Dr. Raj Dave
(dave@njit.edu)

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

GROUP 3B: FLUIDIZATION & FLUID-PARTICLE SYSTEMS

Chair: Dr. Reddy Karri
(reddy.karri@psri.org)

Vice Chair: Dr. Marc Olivier-Coppens
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GROUP 3C: SOLIDS FLOW, HANDLING AND PROCESSING

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(bjfreireich@dow.com)

Vice Chair: Dr. Clive Davies
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Chair: Dr. Karsten Wegner
(wegner@ptl.mavt.ethz.edu)

Vice Chair: Dr. Steven Saunders
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GROUP 3E: ENERGETICS

Chair: Dr. Lori Groven
(Lori.Groven@sdsmt.edu)

Vice Chair: Dr. Edward L. Dreizin
(dreizin@njit.edu)

HISTORY OF PARTICLE TECHNOLOGY

In the last newsletter, Dr. John Carson shared the pivotal moment in Dr. Andrew Jenike's life which changed the course of particle technology.

The publication of Jenike's work and his visit to United Kingdom in 1967 for a Conference at Bradford stimulated a flurry of activity in the UK. This science formed a part of Harold Wilson's 'White Heat of technology' that was going to transform British industry. His Government set up Warren Spring Laboratories, with a major section under Dr. Fred Valentin devoted to bulk technology development. The exciting days of theory, testing, and development flowed fast and furious. Devices were designed at Warren Spring Laboratories for measuring the tensile and cohesive strength of compacted bulk materials, and they conducted a lot of research into powder and paste behavior, with John Miles researching the use of injected air for controlling the state of powders on a scientific basis. The work broadened into investigating various forms of solids handling equipment, such as factors affecting the accuracy of belt weighing equipment. D. M. Walker, at the South East Electricity Generating Board, Portishead, developed the more user friendly Annular Shear Cell and supporting theory.

Bradford University formed a School of Powder Technology, headed by Dr. John Williams where, with Tony Birks, they introduced the 'Unconfined Failure Tester', surely the ultimate tool for measuring arching potential, and Prof. Brian Scarlet formed a School of Particle Technology at Loughborough University. The work of Roscoe, Schofield and Wroth at Cambridge University on critical state soil mechanics fell into place and industrial applications started to emerge at British Steel, under Herbert Wilkinson and Harold Wright.

It surely was the Golden 60s!

Lyn Bates