



# PTF *Newsletter*

Particle Technology Forum

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## AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

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Vol. 14 No. 1

Fall 2008

The PTF is an international and interdisciplinary forum that promotes information exchange, scholarship, research, and education in the field of particle technology – that branch of science and engineering dealing with the production, handling, modification, and use of a wide variety of particulate materials, both wet or dry, in sizes ranging from nanometers to centimeters. Particle technology spans a range of industries to include chemical, petrochemical, agricultural, food, pharmaceuticals, mineral processing, advanced materials, energy, and the environment. See [www.erpt.org/ptf](http://www.erpt.org/ptf) for more information.

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## LETTER FROM THE CHAIR

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For the past two years, I have had the honor and privilege to serve as the chair of the Particle Technology Forum. As we meet again during the upcoming annual meeting, we can proudly look back and appreciate the growth and diversification of the forum.

The recent survey of PTF membership suggests that about 40% of our membership has worked in particle technology for less than 10 years. I consider it an indicator of growth and renewal. We need to continue to attract new members and nurture their participation in forum activities. We also found that there is a need to attract people working in the particle technology earlier.

To bring awareness amongst young engineers, we are participating in the AIChE Career Fair Workshop. Ray Cocco, Jennifer Curtis, Barry Tarmy and I would be conducting a workshop titled “Challenges and Opportunities in Particle Technology for Industry and Academia.”

Last year, we instituted new awards to recognize best papers presented during the annual meeting for each of the five groups. While the evaluation process is difficult and onerous, I am confident that it will encourage better presentations and more submission to the conference proceedings.

I am personally grateful to the members of the executive committee and the group chairs for their support, enthusiasm and participation in making PTF successful. I would specifically like to acknowledge Manuk Colakyan for his dedication and efforts as the Program Coordinator, and for ensuring outstanding programming each year. Thanks to Christine Hrenya for continuing to issue excellent newsletters and to Patrick Spicer for his efforts in maintaining the PTF website.

Prof. Hugo Caram, current vice-chair, will be taking over as the chair next year. He has been an excellent partner during the past two years. With him at the helm, I am certain that PTF will continue to flourish.



**Shrikant Dhodapkar**  
Chair – Particle Technology Forum

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## 2008 AIChE Annual Meeting

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**November 16-21, 2008**  
**Philadelphia Marriott & Pennsylvania**  
**Convention Center**  
**Philadelphia, PA**

URL: <http://www.aiche.org/Conferences/AnnualMeeting/index.aspx>



| Day of Week | Start Time | Session Title   | Location  |
|-------------|------------|---|---|
| Monday      | 8:30 AM    | Dynamics and Modeling of Particles, Crystals and Agglomerate Formation (03A05)              | Washington B Room (Loews Philadelphia Hotel)    |
| Monday      | 8:30 AM    | Dynamics and Modeling of Particulate Systems I (03C00)                                      | Congress C Room (Loews Philadelphia Hotel)      |
| Monday      | 12:30 PM   | Characterization and Measurement in Powder Processing (03A11)                               | Washington B Room (Loews Philadelphia Hotel)    |
| Monday      | 12:30 PM   | Dynamics and Modeling of Particulate Systems II (03C00)                                     | Congress C Room (Loews Philadelphia Hotel)      |
| Monday      | 12:30 PM   | Fundamentals of Fluidization (03B01)  | Congress B Room (Loews Philadelphia Hotel)      |
| Monday      | 12:30 PM   | Gas Phase Synthesis of Nanoparticles (03D04)  | Washington A Room (Loews Philadelphia Hotel)    |
| Monday      | 3:15 PM    | Characterization of Engineered Particles and Nano-Structured Particles (03A04)              | Washington B Room (Loews Philadelphia Hotel)    |
| Monday      | 3:15 PM    | Fundamentals of Fluidization II (03B02)   | Congress B Room (Loews Philadelphia Hotel)      |
| Monday      | 3:15 PM    | Mixing and Segregation of Particulates (03C03)  | Congress C Room (Loews Philadelphia Hotel)      |
| Monday      | 3:15 PM    | Modeling and Scaleup of Nanoparticle Processes (03D02)                                      | Washington A Room (Loews Philadelphia Hotel)    |
| Monday      | 6:00 PM    | Poster Session: Particle Technology Forum (03001)   | Exhibit Hall A (Pennsylvania Convention Center) |
| Tuesday     | 8:30 AM    | Functional Nanoparticles and Nanocoatings on Particles (03D03)                              | Washington A Room (Loews Philadelphia Hotel)    |
| Tuesday     | 8:30 AM    | Industrial Application of Computational and Numerical Approaches to Particle Flow I (03B07) | Franklin 2 (Marriott Philadelphia Downtown)     |
| Tuesday     | 8:30 AM    | Session in Honor of George Klinzing's 70th Birthday (03C04)                                 | Congress C Room (Loews Philadelphia Hotel)      |
| Tuesday     | 12:30 PM   | Applications of Engineered Structured Particulates (03A03)                                  | Washington B Room (Loews Philadelphia Hotel)    |

## News and Announcements

|           |          |  |   |
|-----------|----------|--|---|
| Tuesday   | 12:30 PM | Functional Nanoparticles and Nanocoatings on Particles II (03D00)  | Washington A Room (Loews Philadelphia Hotel)  |
| Tuesday   | 12:30 PM | Industrial Applications to Computational and Numerical Approaches to Particle Flow II (03B00)                      | Congress B Room (Loews Philadelphia Hotel)    |
| Tuesday   | 12:30 PM | Material Parameters for Particle Simulations (03C05)   | Congress C Room (Loews Philadelphia Hotel)    |
| Tuesday   | 3:15 PM  | Nanoparticles for Functional Coatings (03D08)  | Washington A Room (Loews Philadelphia Hotel)  |
| Tuesday   | 3:15 PM  | Particle Technology Forum Awards Lectures (03002)  | Room 204-B (Pennsylvania Convention Center)   |
| Wednesday | 8:30 AM  | Circulating Fluidized Beds (03B04)   | Congress B Room (Loews Philadelphia Hotel)    |
| Wednesday | 8:30 AM  | Comminution - Experiments, Theory and Modeling (03A07)   | Commonwealth A1/A2 (Loews Philadelphia Hotel) |
| Wednesday | 8:30 AM  | Nanoparticles by Mechanical Breakage and Size Reduction (03D06)  | Commonwealth B (Loews Philadelphia Hotel)     |
| Wednesday | 8:30 AM  | Solids Handling and Processing (03C02)   | Congress C Room (Loews Philadelphia Hotel)    |
| Wednesday | 12:30 PM | Computational and Numerical Approaches to Particle Flow (03B06)  | Commonwealth B (Loews Philadelphia Hotel)     |
| Wednesday | 12:30 PM | Measurement, Monitoring and Characterization Methods for Particulate Systems (03C06)                               | Commonwealth C (Loews Philadelphia Hotel)     |
| Wednesday | 12:30 PM | Nano-Energetic Materials (03E01)   | Congress C Room (Loews Philadelphia Hotel)    |
| Wednesday | 12:30 PM | Particle Formation Processes from Liquids and Gases (03A12)  | Commonwealth A2 (Loews Philadelphia Hotel)    |
| Wednesday | 3:15 PM  | Applications of Fluidization (03B03)   | Congress B Room (Loews Philadelphia Hotel)    |
| Wednesday | 3:15 PM  | Nano-Energetic Materials II (03E00)  | Congress C Room (Loews Philadelphia Hotel)    |
| Thursday  | 8:30 AM  | Energetics Environmental and Lifecycle (03E03)   | Congress C Room (Loews Philadelphia Hotel)    |
| Thursday  | 8:30 AM  | Gas/solid Mixing and Heat/mass Transfer In Fluidized Beds (03B05)  | Washington B Room (Loews Philadelphia Hotel)  |
| Thursday  | 12:30 PM | Particle Formation in Supercritical Fluids for Food and Pharmaceuticals (03A06)                                    | Washington B Room (Loews Philadelphia Hotel)  |
| Thursday  | 12:30 PM | Processing and Safety (03E02)  | Congress C Room (Loews Philadelphia Hotel)    |
| Thursday  | 3:15 PM  | Thermophysical Properties of Energetic Materials – Predictions and Experimental Measurements (03E04)               | Room 105-B (Pennsylvania Convention Center)   |
| Friday    | 8:00 AM  | Population Balance Modeling for Particle Formation Processes: Nucleation, Aggregation and Breakage Kernels (03A01) | Congress A Room (Loews Philadelphia Hotel)    |
| Friday    | 10:45 AM | Aggregate and Agglomerate Formation Dynamics (03D07)   | Congress A Room (Loews Philadelphia Hotel)    |
| Friday    | 10:45 AM | Liquid-Phase Synthesis of Nanomaterials and Particles (03D01)  | Room 105-B (Pennsylvania Convention Center)   |

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## **2008 AIChE PTF Meetings in Philadelphia**

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### **Particle Technology Forum Executive Committee Meeting**

Sunday, November 16, 2008

**Time:** 5:30 PM-7:30 PM

Location: Jefferson Boardroom (3rd Floor), Loews Philadelphia Hotel

### **Particle Technology Forum - General Body Meeting**

Monday, November 17, 2008

**Time:** 6:00 PM-7:00 PM

Location: 103-A Meeting Room (Street Level), Pennsylvania Convention Center

### **PTF- Group 3 a (Particle Production & Characterization) – Programming Meeting**

Monday, November 17, 2008

**Time:** 11:00 AM-12:00 PM

Location: Congress C Room (4th Floor), Loews Philadelphia Hotel

### **PTF- Group 3 b (Fluidization & Fluid-Particle Systems) – Programming Meeting**

Monday, November 17, 2008

**Time:** 11:00 AM-12:00 PM

Location: Washington B Room (3rd Floor), Loews Philadelphia Hotel

### **PTF - Group 3 c (Solids Flow, Handling, and Processing) – Programming Meeting**

Tuesday, November 18, 2008

**Time:** 11:00 AM-2:00 PM

Location: Franklin 2 (4th Floor), Marriott Philadelphia Downtown

### **PTF - Group 3 d (Nanoparticles) – Programming Meeting**

Tuesday, November 18, 2008

**Time:** 11:00 AM-12:00 PM

Location: Congress C Room (4th Floor), Loews Philadelphia Hotel

### **PTF - Group 3 e (Energetic Materials) – Programming Meeting**

Wednesday, November 19, 2008

**Time:** 11:00 AM-12:00 PM

Location: Congress C Room (4th Floor), Loews Philadelphia Hotel

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## PTF Awards

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### Particle Technology Forum Award

*(Sponsored by DuPont)*

**Dr. L. S. Fan**

**Contact Details:**

Department of Chemical Engineering  
Ohio State University

**Award Description:**

*Recognizes outstanding contributions in the field of particle technology, teaching of particle technology (as evidenced by the aggregate contributions of the nominee's PhD students to the field) and the advocacy of particle technology within industry, academia, and government.*



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### Thomas Baron Award in Fluid-Particle Systems

*(Sponsored by Shell Global Solutions)*

**Dr. Dilhan M. Malyon**

**Contact Details:**

Department of Chemical Engineering and Materials Science  
Stevens Institute of Technology

**Award Description:**

*Recognizes an individual's outstanding scientific/technical accomplishment which has made a significant impact in the field of fluid-particle systems or in a related field with potential for cross-fertilization.*





**Lectureship Award in Fluidization**

*(Sponsored by Particulate Solid Research, Inc.)*

**Dr. Robert Pfeffer**

Department of Chemical Engineering  
Arizona State University

**Award Description:**

*Recognizes an individual's outstanding scientific/technical research contributions with impact in the field of fluidization and fluid-particle flow systems.*



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**Best Ph.D in Particle Technology**

*(Sponsored by Procter & Gamble)*

**Janine Galvin**

Department of Chemical and Biological Engineering  
University of Colorado

**Award Description:**

*Recognizes an outstanding original dissertation in particle science and engineering.*



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## PTF Award Lectures

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Tuesday, November 18, 2008

3:15 PM-5:45 PM

Room 204-B (Pennsylvania Convention Center)

***“Fluidization of Nanopowders”***

Professor Robert Pfeffer, Department of Chemical Engineering,  
Arizona State University

*Recipient of Lectureship Award in Fluidization*

***“Rheology and Processing of Particle-Loaded Complex Fluids at Partial Concentrations that Approach the Maximum Packing Fraction”***

Professor Dilhan M. Kalyon, Department of Chemical Engineering and Materials Science,  
Stevens Institute of Technology

*Recipient of Thomas Baron Award in Fluid-Particle Systems*

***“Role of Particle Technology in Energy Initiative”***

Professor John Chen, Department of Chemical Engineering, Lehigh University

*Invited Lecture*



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## PTF Banquet Dinner

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**2008 Particle Technology Forum Dinner and Award  
Presentation on Wednesday, November 19 at the Ristorante  
Panorama in Old City Philadelphia.**

White wine flight - 'World-Class Whites'

Please join us for a night with good friends, good food and good wine during our annual dinner celebration. Ristorante Panorama is an authentic Italian, trattoria-style, "upscale casual" restaurant that offers contemporary, authentic Italian with influence that leans toward the Northern Italian region and features homemade pastas, authentic veal dishes, and fresh seafood specialties. Lavish murals and decor provide a dramatic modern setting with traditional accents. The central focus is on the unique wine bar, with its custom-built, 120-bottle wine keeper. The restaurant has been awarded Wine Spectator's "Best of Award of Excellence," Philadelphia Magazine's "Best of Philly" & Sante' Magazine's "Wine Hospitality Award For Fine Dining."

We recognize the partial support provided by Jenike and Johanson, Inc for the cocktail hour and CPFD software for dinner wine.





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## **Brian Scarlett Scholarship Fund**

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For over 40 years Professor Brian Scarlett made a major contribution to the particulate sciences, during this period many hundreds of students of many nationalities have gained from Brian's tutoring and lively stimulation of debate in Europe, Australasia and the USA. Over the years, Brian made a habit of taking with him on conference and overseas visits as many of his students as the budget would permit, and sometimes more! He reasoned that exposure to new people with other stimulating ideas would build the students' character, broaden their understanding and improve their confidence. Looking at former students of Brian it is evident that this policy has had a remarkable impact and that the philosophy was well-founded.



The Brian Scarlett Scholarship Fund was set up to mark Brian's contribution to society and the discipline of particle science and engineering. A ring-fence fund was developed that is devoted to supporting students in this specific area. The Fund is administered by the Particle Characterisation Interest Group of the Royal Society of Chemistry which is an experienced charity working in this area.

Further information on how to apply for funding can be found at the Scholarship Website <http://brianscarlettsf.co.uk/>. In addition, new contributions to the Fund are warmly welcomed since it is of a finite size and individuals or organisations who would wish to contribute should contact Professor R A Williams at the University of Leeds ([r.a.williams@leeds.ac.uk](mailto:r.a.williams@leeds.ac.uk)) for further information.

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## **PTF Election Results**

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The two newly elected academic members of the PTF executive committee are:

**Professor Hamid Arastoopour**

Department of Chemical and Biological Engineering, Illinois Institute of Technology



**Professor Ah-Hyung Alissa Park**

Department of Earth and Environmental Engineering, Columbia University



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## PTF Survey Results

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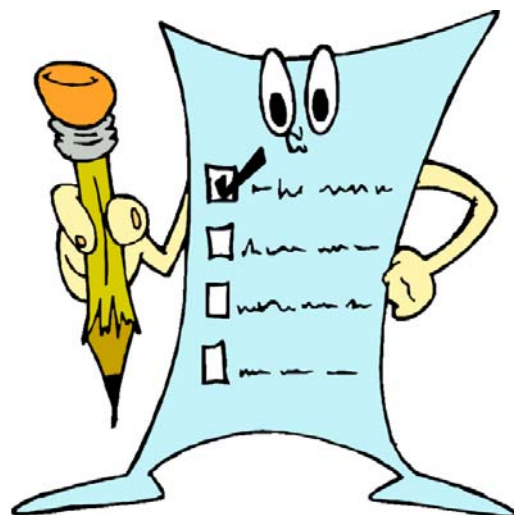
### Particle Technology Forum Survey – April 2008

A web based survey of PTF members was conducted in April 2008. *The objective of the survey was to get feedback from our membership regarding their interests, current programming and ongoing activities.*

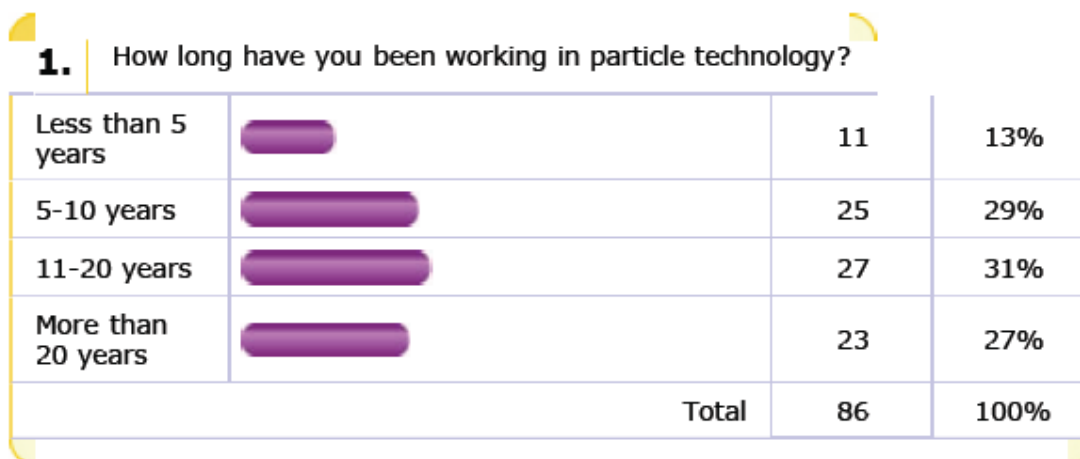
Some salient observations:

- 42% of our membership has worked in particle technology for less than 10 years.
- While 58% of members have worked in particle technology for more than 11 years, only 19% of them have been members of PTF for same duration. This means, we need to do a better job of attracting people working in the particle technology earlier.
- We have seen considerable increase in membership's interests in Particle Formation, Solids Processing and Nanoparticles bringing them at par with Fluidization group. The session allocations reflect it.
- A significant number of members are interested in two or more groups.
- PTF newsletter is serving its purpose as a vehicle for information dissemination.
- Some excellent suggestions were received regarding under-represented technical areas. This could be food for thought during programming meetings.






I encourage you to further reflect on this survey. Let us use this feedback to make PTF more vibrant and stronger.








**Shrikant Dhodapkar**  
**Chair – Particle Technology Forum**



**2.** How long have you been a member of the Particle Technology Forum?

|                  |   |    |      |
|------------------|---|----|------|
| 1 year           |  | 17 | 20%  |
| 2-3 years        |  | 20 | 23%  |
| 4-7 years        |  | 20 | 23%  |
| 7-10 years       |  | 13 | 15%  |
| 11 or more years |  | 16 | 19%  |
| Total            |   | 86 | 100% |

**3.** Which of the following subject areas best represents your current interests ? (You may choose more than one.)

|   |   |    |     |
|---|---|----|-----|
| 3a Particle formation and engineering       |  | 46 | 53% |
| 3b Fluidization and fluidized bed processes |  | 34 | 40% |
| 3c Solids handling, flow and processing     |  | 47 | 55% |
| 3d Nanoparticles                            |  | 38 | 44% |
| 3e Energetics                               |  | 10 | 12% |

4.

Please rate the following features of the Particle Technology Forum newsletter on a scale from 1 to 5, where 1 represents Not Useful and 5 represents Very Useful.

| Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option. | Not Useful | 2         | 3         | 4         | Very Useful |
|---|------------|-----------|-----------|-----------|-------------|
| Information on upcoming conferences and events  | 0<br>0%    | 5<br>6%   | 14<br>17% | 31<br>37% | 33<br>40%   |
| Knoe Flow's Korner  | 3<br>4%    | 16<br>20% | 33<br>40% | 23<br>28% | 7<br>9%     |
| Information on sessions for next meeting  | 0<br>0%    | 8<br>10%  | 20<br>24% | 30<br>37% | 24<br>29%   |
| Contact information for various committee members and office holders  | 1<br>1%    | 15<br>19% | 23<br>28% | 25<br>31% | 17<br>21%   |

| Question 5: Are there any areas of particle technology that you believe are OVER-REPRESENTED by the recent sessions at the AIChE conference ? | Question 6: Are there any areas of particle technology that you believe are UNDER-REPRESENTED by the recent sessions at the AIChE conference ?   |
|---|--|
| Nanoparticles   | Applied concepts towards commercial application  |
| Fluidization, Kinetic theory  | Separation methods applied to particle systems.  |
| Nanoparticle Technology   | system Engineerign concept and energy and envrinmental applications  |
| Too many parrallel sessions that directly clashed eg. in crystallization  | More on colloidal/submicron particle formation/processing specifically addressed towards nanoparticles, composite particles for catalysis and functional/structural applications such as bio-separation, advanced drug delivery etc. Though, presently, some of these areas are reprinted in PTF, more will be useful.   |
| Fluidization modelling  | Basic physics and mechanics  |
| Nano technology   | Surface characterization   |
| Fluidization  | Reactions with particles as reagents or catalysts.   |
| Single particle effects   | Experimental work  |
| Characterisation of microscopic and macroscopic properties of particle systems  | Pharmaceutical applications  |
| Nanoparticles   | Fundamentals of size reduction (grinding and milling)  |
| blending and flow   | Industrial applications... (Always a problem.)   |
|   | Bio technology   |
|   | Drug Delivery  |
|   | Caking   |
|   | 1. More Technical applications and industrial plant experience would give students a mopre realistic view of engineering life in industry.<br>2. With the groups and attendance being too small, there is no discussion and real exchange of information & opinion. Fewer parallel groups, selected/invited papers would be more important, but thisis in contrast to AIChE's financial requirements |
|   | Materials in process dynamic modelling<br>Materials in process on-line dynamic imaging and sampling  |
|   | Properties and rheology of fluids with particles, such as paints, pastes   |
|   | Energy systems such as fluid cokers, gasifiers, combustors, etc.. Gas cleaning technology such as cyclones and sorbents.   |
|   | Dust explosions and other safety issues in particle handling.  |
|   | Energy   |
|   | Phamarceutical applications  |
|   | Solid liquid systems.  |
|   | Particle characterization  |
|   | Material characterization  |
|   | Industry case studies  |
|   | Aerosols and general particle materials characterization   |



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## Industrial Position

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ExxonMobil Research and Engineering employs a large number of PhDs in our Fairfax, VA headquarters. We are currently looking for experts in fluid-solids with a PhD in chemical or mechanical engineering. The ideal candidate should have a strong practical knowledge of two-phase gas-solid fluidization particularly as it refers to refinery FCC processes. Specifically, we are interested in someone whose research contains a significant experimental focus in one or more of the following areas: hydrodynamics, scale up, reaction engineering, and heat and mass transfer issues related to fluidized particle systems. Responsibilities include a blend of research & development activities and real life plant support. In addition to lab or plant experience, strong skills in cold flow modeling, analytical modeling, data analysis, computation fluid dynamics and computer programming are essential. If you meet these criteria, please email your resume to [chris.s.gurciullo@exxonmobil.com](mailto:chris.s.gurciullo@exxonmobil.com).

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## Postdoctoral Position

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A postdoctoral position is available with Professor Christine Hrenya in the Department of Chemical and Biological Engineering at the University of Colorado, Boulder. The NASA-supported research, which is in collaboration with Dr. Phil Metzger of Kennedy Space Center, is targeted at the prediction of trajectories of lunar soil particulates caused by exhaust plumes during rocket landings, with a special emphasis on polydispersity. The overall effort involves computational, theoretical, and experimental aspects. The postdoctoral researcher will focus primarily on DEM modeling alongside a newly developed continuum theory, and will work closely with experimentalists at the Kennedy Space Center on other aspects. More information is available upon request. Appointment will be 1-2 years, and start date is flexible. If interested, email CV, phone numbers and email addresses for three references, and representative publications to Prof. Christine Hrenya at [hrenya@colorado.edu](mailto:hrenya@colorado.edu). Applicants are encouraged to apply by November 15, 2008, though later applications will be accepted if the position is not filled. The University of Colorado at Boulder is committed to diversity and equality in education and employment.

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## IMA Conference on Dense Granular Flows

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5 - 9 January 2009

Isaac Newton Institute, Cambridge

Abstract Deadline: 31 October 2008

Flows involving solid particulates are ubiquitous in nature and industry alike. Such flows are found in pharmaceutical production, the chemical industry, the food and agricultural industries, energy production and the environment. Many unsolved problems remain, however. For example, the rejection rate by US pharmaceutical manufacturers is around 5% with the cost of losing a single batch of medication ranging from £50,000 to £500,000. In order to be able to solve such problems, granular flows need to be understood so that their behaviour can be controlled and predicted.

To date, we are able to describe rapid granular flows, where the particles are highly agitated and there has been some success describing static systems. The intermediate regime, where these two phases meet and coexist, is not as well understood and yet is the most commonly observed behaviour of granular flow. The objective of this meeting will be to interface the two ends of the particulate flow spectrum - those working to understand the fundamentals of granular flows and those attempting to control particulate flows in an industrial setting - to develop solutions to the complex problems presented by dense granular flows.

### Invited speakers include:

Professor Jim Jenkins, Cornell USA; Professor Raffaella Ocone, Heriot-Watt UK; Professor Robert Behringer, Duke University USA; Dr. Thomas Halsey, Exxon USA; Dr. Philippe Rogueda, Novartis UK; Professor Johnathan Seville, School of Engineering, University of Warwick

### Instructions for Contributors:

Contributed papers are invited on all aspects of dense granular flows and will be accepted on the basis of an abstract, max. 1 side of A4, which should be submitted by 31 October 2008 online at <http://online.ima.org.uk/> <<http://online.ima.org.uk/>> or by e-mail to Amy Marsh, Conference Officer, IMA ([amy.marsh@ima.org.uk](mailto:amy.marsh@ima.org.uk)).

Contributors may submit a talk or a poster. Contributed talks are welcomed by postgraduate students. Themes will include dense granular flow, multiphase flow, and geological flows, exploring new developments in theoretical analysis and experimental techniques.

Registration for the conference is now open at <http://online.ima.org.uk/http://online.ima.org.uk/>

The conference is organised by: Dr. Ricky Wildman, Loughborough, Workshop Chair; Professor Christine Hrenya, Colorado; Dr. Jim McElwaine, Cambridge; Professor Nico Gray, Manchester; Professor Jon Huntley, Loughborough

[http://www.ima.org.uk/Conferences/dense\\_granular\\_flows.html](http://www.ima.org.uk/Conferences/dense_granular_flows.html)



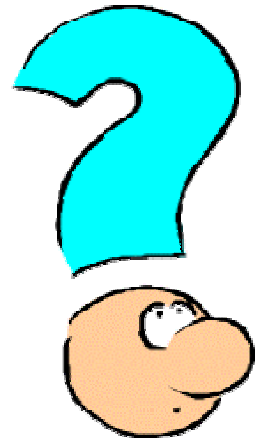
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## “Know Floe’s Korner”

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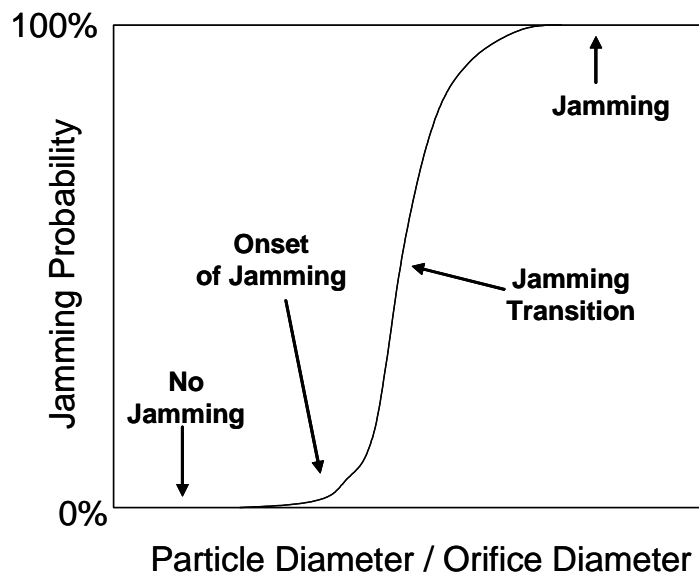


### Guidelines to Prevent Particle Jamming or Structural Blockages

Lyn Bates, Ajax Equipment Co., USA  
Shrikant Dhodapkar, The Dow Chemical Company, TX, USA  
George Klinzing, University of Pittsburgh, PA, USA

With this article, we would like to draw your attention towards an important yet often ignored concept of mechanical jamming of particles. We hope that this article will pique the interest of the research community; thereby leading to further fundamental research.

- 1 Flow blockages can occur for cohesionless bulk solids when the ratio of particle diameter to discharge orifice diameter exceeds a critical value. When the particles in the flow stream converge towards the discharge outlet, **jamming** can occur if the size of the particles is large enough to sustain a stable interlocking arch. Jamming phenomenon or structural blockage can not be predicted from current theories (Jenike and others) for cohesive materials.
- 2 Jamming is statistical in nature. The probability of jamming to occur at the outlet depends on the random nature of packing as the particles move towards the discharge outlet. The jamming probability increases with particle size. The problem is further complicated if the bulk material has a wide particle size distribution or multi-modal size distribution and the particles are non-spherical. Various definitions and explanations of onset of jamming and jamming transitions can be found in the literature.



- 3 Designers of bulk solids equipment have used an **experience based approach** (rules of thumb) since experimental data tends to be scattered, and there are no usable theoretical models. The following guidelines provide a good starting point for design purposes. These suggested figures do not apply to soft, sticky, elastic or plastically deformable particles, for which special investigations should be performed. Also, note that rounded particles are less likely to adopt a stable contact relationship than those that have flat surfaces or are of elongated form.

### Orifice dimension as multiple of maximum particle size

#### Form of flow channel

|  | <i>Particle shape</i> |                  |
|--|-----------------------|------------------|
|  | <i>Round</i>          | <i>Irregular</i> |
| Radial non-mass flow pattern, (from static condition)  | 7                     | 9                |
| Plane non-mass flow pattern, (from static condition)   | 5                     | 7                |
| Radial mass flow pattern, (from static condition)      | 5                     | 7                |
| Plane mass flow pattern, (from static condition)       | 4                     | 6                |
| Radial non-mass flow pattern, (from dynamic condition) | 6                     | 7                |
| Plane non-mass flow pattern, (from dynamic condition)  | 4                     | 5                |
| Radial mass flow pattern, (from dynamic condition)     | 5                     | 6                |
| Plane mass flow pattern, (from dynamic condition)      | 3                     | 4                |

**If it is important that flow stoppages do not take place, then make very generous allowances on the above guidelines, or verify the flow behaviour in representative trials.**

- 4 Select a design for mass flow in the outlet region. If the hopper is not of mass flow design, there is a static bed of product around the discharge orifice. Invariably, some particles will overlap the opening to reduce its effective size and flow has to pass through the rough boundary surface of a static bed of particles. By contrast, mass flow takes place with slip on a smooth boundary that offers very poor support for a stable, structural arch to form. The following link to the video demonstrates reduced jamming tendency in mass flow configuration versus non-mass flow.

<http://www.ajax.co.uk/model1.htm>

- 5 Experience suggests that a slot outlet with plane flow is less prone to jamming than circular outlet with three-dimensional convergence. If the outlet is square or circular, the preceding shape can still converge in one direction only to secure the benefits of a plane flow channel.
- 6 Avoid use of a butterfly valve if possible, as the central blade reduces the flow cross section to two semicircles that are approximately equivalent to openings half the diameter of the valve.
- 7 Minimize segregation, as the accumulation of larger fractions increases the prospect of jamming. Segregation most commonly occurs during the filling of a container at a single point. Dispersing the feed stream by way of spreading the feed over an area or diverting to a multipoint feed is effective in reducing segregation.
- 8 Do not restrict the hopper discharge as a slow moving bed of material has less inertia to disturb an instantaneous blockage. The bulk is also in a denser state when flow is restricted because a flow stream is more dilated when moving at higher flow velocities, therefore, there is less room for slow moving particles to escape from a structural load path forming and arch as they touch in a dynamic state.
- 9 Mechanical vibration can be used as an effective discharge aid to prevent particle jamming or structural blockage. Optimal location for application of vibration, specific energy input, amplitude and frequency will depend on the bulk material and system configuration. The effect of vibrations on jamming probability is an open area for further research.
- 10 Whilst research is handicapped by the numerous factors that influence particle jamming, it would be useful to fit individual contributions into a framework that distinguishes Plane Flow from Radial Flow, Mass Flow from Non-Mass Flow, Dynamic Flow from Incipient Flow, rounded particles from angular particles & so on, and include polydispersity.

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# ***Upcoming Conference Calendar***

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2008

**Annual AIChE Meeting**

November 16-21, 2008, Philadelphia Marriott & Pennsylvania Convention Center,  
Philadelphia, PA

Website: <http://www.aiche.org/Conferences/Calendar/2008.aspx>

2009

**Institute of Mathematics and its Applications (IMA) Workshop on Dense,  
Granular Flows**

January 5-9, 2009, Cambridge, UK

Abstract Deadline: October 31, 2008

Website: [http://www.ima.org/uk/Confrences/dense\\_granular\\_flows.html](http://www.ima.org/uk/Confrences/dense_granular_flows.html)

**Powders & Grains 2009**

July 13-17, 2009, Golden, Colorado

Website: <http://PandG2009.mines.edu>

**2009 Annual AIChE Meeting**

November 8-13, 2009, Nashville, TN

2010

**Sixth World Congress in Particle Technology**

April 26-29, 2010, Nuremberg, Germany

Abstract: starting Spring 2009

**FLUIDIZATION XIII**

May 16-19, 2010, Korea

Website for Mailing List: <http://www.engconfintl.org/10af.html>



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## Officer and Committee Listing

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### Officers:

Chair 2006-2008 Dr. Shrikant Dhodapkar, [sdhodapkar@dow.com](mailto:sdhodapkar@dow.com), 979-238-7940  
Vice-Chair 2006-2008: Professor Hugo S. Caram, [hsc0@lehigh.edu](mailto:hsc0@lehigh.edu), 610-758-4259  
Immediate Past Chair 2004-2006: Professor Alan Weimer, [weimera@colorado.edu](mailto:weimera@colorado.edu), 303-492-3759  
Secretary 2006-2008: Dr. Patrick Spicer, [spicer.pt@pg.com](mailto:spicer.pt@pg.com), 513-634-9628  
Treasurer 2006-2008: Professor Joseph McCarthy, [mccarthy@engr.pitt.edu](mailto:mccarthy@engr.pitt.edu), 412-624-7362

### Liaisons:

Academic 2008-2012: Professor Hamid Arastoopour, [hamid.arastoopour@lit.edu](mailto:hamid.arastoopour@lit.edu), 312-567-3038  
Academic 2008-2012: Professor Ah-Hyung Alissa Park, Columbia University, [ap2622@columbia.edu](mailto:ap2622@columbia.edu), 212 854 8989  
Academic 2006-2010: Professor Jennifer Sinclair Curtis, [jcurtis@che.ufl.edu](mailto:jcurtis@che.ufl.edu), 352-392-0882  
Academic 2006-2010: Professor Joseph McCarthy, [mccarthy@engr.pitt.edu](mailto:mccarthy@engr.pitt.edu), 412-624-7362  
Industry 2008-2012: Dr. Stephen Conway  
Industry 2008-2012: Dr. Greg Mehos  
Industry 2006-2010: Dr. Ecevit Bilgili, [ecevit\\_bilgili@merck.com](mailto:ecevit_bilgili@merck.com), 215-652-2821  
Industry 2006-2010: George Fotou, [george\\_fotou@cabot-corp.com](mailto:george_fotou@cabot-corp.com), 505-563-4275  
AIChE-CTOC: Dr. Joseph Cramer, [josec@aiche.org](mailto:josec@aiche.org), 313-577-3767  
AIChE Staff Associate: Mr. Simon Spitalny, [simos@aiche.org](mailto:simos@aiche.org), 212-591-7478

### Standing Committees (Chairs):

Awards Committee 2006-2008: Professor Hugo S. Caram, [hsc0@lehigh.edu](mailto:hsc0@lehigh.edu), 610-758-4259  
Education: Dr. Ralph D. Nelson, [erptmged@aol.com](mailto:erptmged@aol.com), 302-239-0409  
Membership: Mark Bumiller/Hugo Caram, [mark.bumiller@malvernusa.com](mailto:mark.bumiller@malvernusa.com), 508-480-0200, ext. 222/[hsc0@lehigh.edu](mailto:hsc0@lehigh.edu), 610-758-4259  
Newsletter Editor: Professor Christine Hrenya, [hrenya@colorado.edu](mailto:hrenya@colorado.edu), 303-492-7689  
Nominations: Professor Alan Weimer, [weimera@colorado.edu](mailto:weimera@colorado.edu), 303-492-3759  
Recognition: Professor Sotiris Pratsinis, [pratsinis@ivuk.mavt.ethz.ch](mailto:pratsinis@ivuk.mavt.ethz.ch), 41-1-632-3180

## **Technical Programming Area Liaison and Group Chairs**

The main focus of the PTF has been arranging for the extensive technical programs at the annual AIChE meeting in November. A lot of hard work goes into developing session themes, negotiating for sufficient time and reasonable scheduling of the sessions, attracting and screening papers, finding and training new session chairs, and making sure the whole process flows smoothly. Shrikant Dhodapkar, our Area 3 Liaison, attends an all-day session each January to plan the technical sessions at the Annual Congress and to arrange for co-sponsored sessions with other Divisions and Forums. Participation in this process is excellent training in and proof of management capabilities. The leaders selected this fall were

| <u>Position</u>  | <u>Person</u>                     | <u>Affiliation</u>           |
|--|-----------------------------------|------------------------------|
| Area 3 Liaison   | <b>Dr. Manuk Colakyan</b>         | The Dow Chemical Co.         |
| Area 3 Vice Liaison  | <b>Dr. Shrikant Dhodapkar</b>     | The Dow Chemical Co.         |
| <i>Group 3a – Particle Production and Characterization</i> |                                   |                              |
| Chair  | <b>Dr. Patrick Spicer</b>         | Procter & Gamble Co. CETL    |
| Vice-Chair   | <b>Prof. M. Silvina Tomassone</b> | Rutgers University           |
| <i>Group 3b – Fluidization and Fluid-Particle Systems</i>  |                                   |                              |
| Chair  | <b>Dr. Jesse Zhu</b>              | Univ. of Western Ontario     |
| Vice Chair   | <b>Reza Mostofi</b>               | UOP                          |
| <i>Group 3c – Solids Flow, Handling, and Processing</i>    |                                   |                              |
| Chair  | <b>Prof. Benjamin Glasser</b>     | Rutgers University           |
| Vice Chair   | <b>Dr. Bruce Hook</b>             | Dow Chemical                 |
| <i>Group 3d - Nanoparticles</i>                            |                                   |                              |
| Chair  | <b>Professor Yangchuan Xing</b>   | University of Missouri-Rolla |
| Vice Chair   | <b>Gary Liu</b>                   | DuPont                       |
| <i>Group 3e – Energetic Materials</i>                      |                                   |                              |
| Chair  | <b>Charles R. Painter</b>         | Department of the Navy       |
| Vice Chair   | <b>Jerry S. Salan</b>             | Naval Surface Warfare Center |

## Report from the Treasurer

Here is the state of the accounts from the beginning of 2008 through then end of July 2008. Invoices for this year's award support money have been sent.



| <b>AICHe Account</b>            | <b>Starting</b>    | <b>Income</b>     | <b>Expenses</b> | <b>Balance</b>     |
|---------------------------------|--------------------|-------------------|-----------------|--------------------|
| As of 1/1/2008                  | \$19,510.30        |                   |                 |                    |
| Investment Income (Apr)         |                    | \$280.06          |                 |                    |
| Investment Income (Jun)         |                    | \$573.14          |                 |                    |
| Investment Income YTD           |                    |                   |                 | \$853.20           |
| Dues Income – Divisions (Jan)   |                    | \$345.00          |                 |                    |
| Dues Income – Divisions (Feb)   |                    | \$302.84          |                 |                    |
| Dues Income – Divisions (Mar)   |                    | \$210.00          |                 |                    |
| Dues Income – Divisions (Apr)   |                    | \$105.00          |                 |                    |
| Dues Income – Divisions (May)   |                    | \$43.08           |                 |                    |
| Dues Income – Divisions (Jun)   |                    | \$45.00           |                 |                    |
| Dues Income – Divisions (Jul)   |                    | \$30.00           |                 |                    |
| Total Dues YTD                  |                    |                   |                 | \$1,080.92         |
| <b>Totals as of 11/01/2007</b>  | <b>\$19,510.30</b> | <b>\$1,934.12</b> | <b>\$0.00</b>   | <b>\$21,444.42</b> |
| <b>Pitt Account</b>             | <b>Starting</b>    | <b>Income</b>     | <b>Expenses</b> | <b>Balance</b>     |
| As of 01/24/2007                | \$1,432.68         |                   |                 |                    |
| Miscellaneous Exp (bank fee)    |                    |                   | \$22.39         |                    |
| Web Hosting                     |                    |                   | \$119.70        |                    |
| Contributions – PSRI (07-10)    |                    | \$1,000.00        |                 |                    |
| Miscellaneous Exp (check order) |                    |                   | \$20.13         |                    |
| Web Hosting (Nov)               |                    |                   | \$19.95         |                    |
| Web Hosting (thru Sept)         |                    |                   | \$159.60        |                    |
| Conference Restaurant – Payment |                    |                   | \$469.89        |                    |
|                                 |                    |                   | \$19.95         |                    |
|                                 |                    |                   | \$154.35        |                    |
| <b>Totals as of 11/01/2007</b>  | <b>\$1,432.68</b>  | <b>\$1,000.00</b> | <b>\$985.96</b> | <b>\$1,446.72</b>  |

Joe McCarthy, PTF Treasurer

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## From the Editor's Desk

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The *PTF Newsletter* is published twice a year as a vehicle for communication for all PTF members. PTF members are encouraged to send in news and information of general interest to PTF members. Please address your communication to

**Professor Christine M. Hrenya**  
**Department of Chemical and Biological Engineering**  
**University of Colorado**  
**Boulder, CO 80309-0424**  
**Tel: (303) 492-7689; Fax: (303) 492-4341**  
**email: [hrenya@colorado.edu](mailto:hrenya@colorado.edu)**

If you would prefer to continue receiving a hard copy of the newsletter instead of the electronic version, please send a note to this effect to the editor at the above address.

Advertisements may also be placed in the newsletter. The rates on a per issue basis are:

1/4 page \$40

1/2 page \$60

Full page \$110

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## Moving? New E-mail?

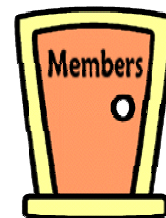
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Help us get PTF news to your new address by filling in and e-mailing a change of address form. See the PTF web page at

<http://www.erpt.org/ptf/addrchng.txt>



## Membership Information

### Membership Application for the Particle Technology Forum, AIChE

#### CONTACT INFORMATION (print or type):

Name: \_\_\_\_\_ Title: \_\_\_\_\_

Category (check only one): AIChE Member ☐ [# if you are a member = \_\_\_\_\_]

Not an AIChE member ☐

Company or University: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_ Country: \_\_\_\_\_

Work Phone: \_\_\_\_\_ FAX: \_\_\_\_\_

Email: \_\_\_\_\_

#### MEMBERSHIP DUES (check only one line below) [Note that dues are for a calendar year]:

☐ 15.00 \$US for one year. Anyone use this option. For AIChE members dues will be listed on your AIChE dues invoice after your first year in PTF. Nonmembers don't receive a dues notice.

☐ 75.00 \$US for five years dues. **Only** nonmembers of AIChE are eligible for this option, which is provided as a courtesy so that non-members won't have to send in five small checks.

#### METHOD OF PAYMENT (check and fill-in only one line below):

☐ check (must be in \$US on a U.S. bank or on a foreign bank with a New York City branch.)

Make payable to **Am. Inst. of Chem. Engineers**. Mail with form to the address below.

☐ money order (an international money order in \$US is acceptable)

Make payable to **Am. Inst. of Chem. Engineers**. Mail with form to the address below.

☐ credit card (only VISA or MasterCard are accepted)

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according to the merchant agreement through my ☐ VISA or my ☐ MasterCard

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Cardholder's Signature \_\_\_\_\_ Date: \_\_\_\_\_

Cardholder's Daytime Telephone Number: \_\_\_\_\_

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