ILASS – Americas

The Institute for Liquid Atomization and Spray Systems

Newsletter #29 August 2006

Mark Your Calendar

ILASS 2007
May 15 – 18, 2007; Chicago

It's not too early to plan ahead to ensure you can attend the upcoming 20th anniversary meeting. In addition to the high quality presentations, meetings and networking opportunities you expect at annual conferences, ILASS 2007 will offer more. It will be a commemoration of ILASS-Americas with special displays and activities blended with a focus on the future to ensure on-going success and growth.

The meeting will be in Chicago, IL and specific details on the hotel will follow in the months ahead. Traveling to Chicago is easy and you will find it an easy city to navigate once you arrive. Many unique attractions

such as museums, theater, music, Lake Michigan and some of the country's finest shopping and dining are within walking distance of the hotel. The weather in May is usually warm and sunny – not hot – and of course, windy!

ILASS-Americas 2006 — Meeting Summary

By Will Bachalo

Our recent conference in Toronto was another memorable meeting featuring many interesting presentations and a chance to converse with new and old friends regarding our work and plans for the future. Although I was quite busy attending to various issues associated with the meeting, the sessions I could attend were interesting and at a standard I believe on par or better than what I encounter at other professional meetings. I was especially pleased with the student presenters who were well-prepared, knew their material and presented their work with confidence. The field of atomization and sprays remains an important front in our struggle to cope with limited energy resources and unfortunately, excessive rates of consumption in our area of the world. Knowing that bright young people are working hard in this area provides us with a degree of confidence that the upcoming challenges will be appropriately addressed.

Thank you to Nasser Ashgriz, Local Arrangements Chair, and his staff for their hard work and attention to detail in planning and arranging a successful meeting.

Organizing a conference requires significant effort and time to make it a success. Shankar Subramaniam, Program Chair, organized an excellent program with an above average number of high quality papers. He was able to cope with many difficulties such as late submissions/requests and produced a program that met all expectations.

The Tuesday evening Workshop, *Spray Diagnostics and Modeling* presented by panel members Vince McDonell, David Schmidt and Chuck Lipp and chaired by Mario Trujillo, was informative and inspired a good amount of lively discussion/debate. Finally, Hart Hall was an excellent setting for our banquet leading to a very enjoyable evening including Norman Chigier's rousing sing-along.

Since we had a number of rookies this year, including myself, there were some minor missteps. We have documented the areas where we need to make improvements and will adjust our procedures for future meetings. We have also committed to developing a Conference Handbook to assist us and our successors in continuing the

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In This Issue:

Our Sponsors:

Edited by David P. Schmidt, University of Massachusetts Amherst

Produced by Rudi Schick, Spraying Systems Co.

Toronto, Canada, was the site of the 2006 ILASS-Americas' conference

ILASS-Americas — Meeting Summary (continued)

organization into the future. We welcome any comments, suggestions and criticisms from the membership. We would also like to hear any suggestions you may have for the evening workshop which has been a popular component of our meetings. We are looking into adjusting the meeting schedules a bit to provide more time for discussions with colleagues working in atomization and spray research. In my opinion, an important part of attending these conferences is the opportunity to have one-on-one discussion with people working in similar areas.

Following my comments from last year, I will again address the issue of technology transfer to the newer members in the atomization and spray community. An important component of our raison d'etre is to develop the science and knowledge on atomization and sprays to enable the solution of problems affecting our well-being and to store/transmit this information to the community. If we accept this premise, the next task is to determine how we can improve our means of storing the information gained over years of research and development and to allow those who are entering the field to easily avail themselves to this information. Currently, we depend on our journal, *Atomization and Sprays,* for archiving our work. As I noted last year, the details of the knowledge, methods and thought processes involved in solving problems cannot all be documented in technical papers and presentations. Thus, a comprehensive handbook that can be continuously updated and contributed to as new information is available would be a valuable contribution. The Board has discussed this possibility over the past years and we believe we are converging on some ideas that will result in the best medium. As with most volunteer organizations, the questions of who will take charge of the tasks and who will contribute the significant efforts needed in collecting/organizing the material are issues to be considered carefully before undertaking the project.

Our International Conference on Liquid Atomization and Spray Systems (ICLASS) will be held in Kyoto, Japan on August 27 to September 1, 2006. Many of us plan to attend and present papers. For those of you who can arrange international travel, this is an excellent opportunity to learn about what is going on in ILASS-Europe and ILASS-Asia and to interact with colleagues working in these geographic locations. Approximately 250 papers will be presented on a range of spray related topics. I hope to see many of you there. For more information, visit http://comb.doshisha.ac.jp/iclass2006/.

Finally, next year is the 20th anniversary of ILASS-Americas and we are planning a special meeting in Chicago. Rudi Schick will act as the Local Arrangements Chair and Shankar Subramaniam will continue as Program Chair. Rudi's company, Spraying Systems Co., is being very generous in supporting the development of this special occasion and we can expect this to be an exceptional event. We look forward to seeing all of you next year.

ILASS-Americas 2006 — Conference Statistics

The 19th annual ILASS-Americas' conference was held May 23 through May 26 in Toronto, Ontario. The conference was well attended with 130 registrants, approximately 70 technical papers, five posters, 11 exhibitors and 11 sponsors. 20 students attended, 18 of who made presentations. Each presenting student received a $100 honorarium.

Invited presentations were given by Professor Cameron Tropea from Technischen Universität Darmstadt and Professor Warren Finlay of University of Alberta. Professor Tropea reported on advanced optical diagnostics and the underlying physics. Professor Finlay discussed experiments and modeling to understand drug inhalation. The conference also included a panel session on spray device design that discussed industry needs, modeling and diagnostics.

Program Chair was Shankar Subramaniam and local arrangements were handled by Nasser Ashgriz. Data courtesy of Will Bachalo.

The Breadth Column

The Correlation Between Pointillism and Sprays

By David Schmidt; University of Massachusetts

This is a new column, devoted to subjects tangentially related to sprays. The editor welcomes short submissions on as broad a subject matter as possible.

Pointillism is a painting technique whereby the artist composes his image from innumerable tiny points. By repeatedly creating these points with the tip of his brush or pen, he can gradually compose an image that, from a distance, appears smooth. Though labor-intensive, the pointillist method gives a painting a sort of texture. A particularly nice example is *A Sunday Afternoon on the Island of La Grande Jatte* by Georges Seurat. If the viewer is sufficiently far away or has a slightly blurred reproduction of the picture, the points disappear and only the smooth image is evident. The viewer is looking at discrete points, but only sees people, structures and grass.

Pointillism is the artistic analogue of stochastic Lagrangian particle tracking of sprays. Mathematically, we have an underlying probability density function (PDF) of liquid-phase quantities that corresponds to the smooth image in the artists' mind. Like the artistic rendering described above, the modeler chooses a finite number of points with which to represent the spray PDF. The number of points is sufficient when the rendering appears continuous.

For a painting to appear smooth as the eye comes closer to the canvas, a greater number of points is required. Similarly, as a modeler refines his computational mesh, a greater number of computational points is needed. When the effects of computational points are agglomerated onto the gas phase mesh, this is like blurring the painted points by a coarse reproduction.

This comparison serves to remind us that, even though sprays themselves are not smooth, our mathematical representations in CFD can represent a continuous PDF. Like the pointillist, we render the smooth underlying quantities as discrete points. And, like the painter, our result can appear more or less smooth. Instead of the human eye, the gas phase is the viewer who can only distinguish features at the grid scale and above.

For a mathematical treatment of the blurring of Lagrangian points onto the gas phase mesh, see Schmidt, D.P., *Int. J. of Num. Methods in Fluids,* 2006.

A Sunday Afternoon on the Island of La Grande Jatte
by Georges Seurat, 1886

Investigating Effects of Neighbor Droplets on Heat Transfer Using an Assumed Point Field Formalism

By Madhusudan Pai, Rahul Garg and Shankar Subramaniam;
Department of Mechanical Engineering, Iowa State University

In typical spray applications, single-droplet heat transfer is affected by the presence of neighboring droplets. Systems with the same number density can have different spatial arrangement of droplets, and hence can exhibit different heat transfer characteristics. In this work, the effect of droplet-droplet heat transfer is investigated using direct numerical simulations of steady laminar flow with a passive scalar (temperature) past stationary spherical droplets. The DNS methodology is based on the Immersed Boundary method (IBM) developed by Mohd. Yusof[1] wherein the appropriate governing equations are solved with an additional forcing term that arises from imposing exact boundary conditions on velocity and scalar fields at each droplets surface. These boundary conditions for momentum transfer are zero slip and no penetration at the droplet surface. For scalar transport, they are constant surface value or surface flux depending on the choice of Dirichlet or Neumann boundary conditions.

Single-point Lagrangian-Eulerian (LE) closures based on the droplet distribution function and number density do not contain information at the two-point level, and therefore cannot characterize the effects of spatial locations of neighboring droplets. In other words, second-order effects cannot be characterized by first-order statistics. We are currently exploring the role of second-order effects on droplet-droplet heat transfer. A second-order statistic that can be used to characterize spatial positioning of droplets is the pair correlation function,

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Footnotes

[1]J. Mohd. Yusof. Interaction of Massive Particles with Turbulence. PhD thesis, Cornell University, 1996.

Investigating Effects of Neighbor Droplets on Heat Transfer (continued)

which represents the relative frequency of occurrence of all possible values of inter-droplet spacing in a droplet ensemble. A simple model for the spatial arrangement of droplet centers, or an Assumed Point Field (APF) is a homogeneous Poisson point process (HPPP), in which all locations in the field are equally probable. The pair correlation function for a HPPP is unity. However, the drawback in using HPPP for a realistic spray is that the point field allows droplets to overlap, which is clearly unphysical. A Matèrn point process (MPP), on the other hand, is a HPPP in which droplet centers closer than a certain distance called the hard-core distance are removed from the ensemble. This model for the droplet centers is attractive since (1) a field with no overlapping droplets can be constructed and (2) the pair correlation function for this point process is completely specified by the hard-core distance.

One can simulate a MPP with varying hard-core distance while keeping the same number density. Figure 1 shows the Isosurfaces of T = 0.5 from DNS of steady

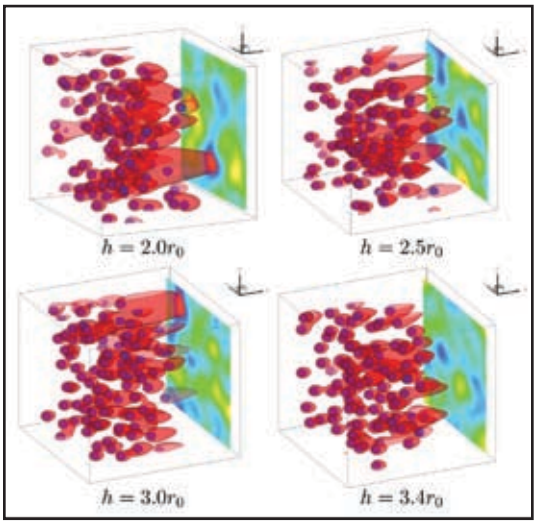

Figure 1

flow past different spatial arrangements of monodispersed spherical droplets initialized using a Matérn point process. All cases are for an average volume fraction of 0.02. As the hard-core distance is increased, the drop-drop interaction effects are less pronounced. Parameters are so chosen such that the system corresponds to a spray of 60 micron diameter droplets vaporizing in air at 1200 K.

The simulations are carried out for different values of volume fraction and the hard core distance is varied for each case. Figure 2 shows the ratio of average surface scalar flux (obtained by averaging over all the spheres in the domain) to the surface scalar

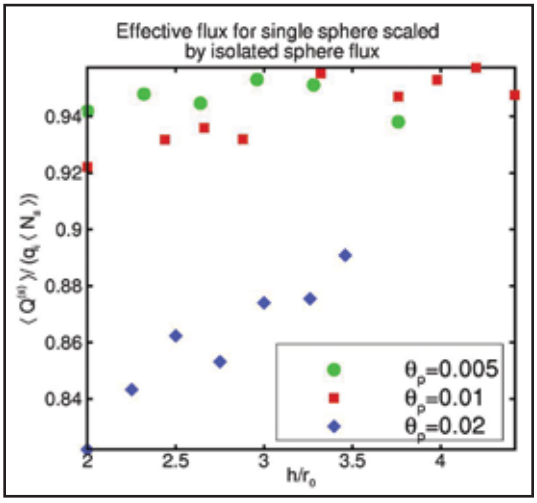

Figure 2

flux for an isolated sphere, with increasing hard-core distance for different values of the volume fraction. It is found that as volume fraction increases, the effect of neighboring droplets increases whereas as the hard-core distance increases, the effect of neighboring droplets decreases. The heat transfer source terms, therefore, do not scale linearly with the number density as is implied by the LE formulation, even for a homogeneous spray at low drop volume fractions of 0.005-0.02. This work motivates the need for including second-order statistics that do influence heat transfer source terms, even at low volume fractions, into existing LE models.

Sprays in Consumer Product Manufacturing

By John Hecht, Procter & Gamble

Many of the products we use every day are manufactured using sprays. These range from cleaning products to snacks. At Procter & Gamble, we use sprays to form particles, coat sheets and particles and print on webs. Our goal is to make the best consumer products in the world. So we need to understand and design processes that operate optimally. Sprays are often buried deep in our processes, but they play major

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Sprays in Consumer Product Manufacturing (continued)

roles. Some examples and key technical issues are listed below:

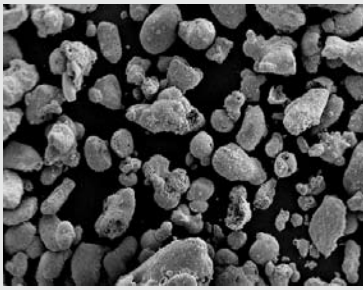
- Atomization of viscous feedstocks for spray drying to make dry laundry granules and instant coffee.
  - *Key issues: Particle-size distribution and morphology.*
- Coating of high-speed moving webs of paper products and other substrates like diapers.
  - *Key issues: Even coverage and low drift.*
- Printing on moving webs, including Pringles crisps.
  - *Key issues: Control over drop trajectory and effects of formula chemistry.*
- Coating of laundry detergent tablets and powders.
  - *Key issues: Proper dosing without overspray.*
- Atomization of dyes, perfumes and liquid binder to dry laundry particles.
  - *Key issues: Proper drop size and spray pattern.*
- Atomization of melts to form aesthetic prills.
  - *Key issue: Particle size distribution.*

Spray research in this business is challenging! We spray liquids having a wide range of fluid properties, many of which are highly viscous and contain a high fraction of solids. We also use many types of atomizers, such as rotary atomizers, pneumatic nozzles, ultrasonic nozzles and pressure nozzles which range in size from bench-scale (g/hr) to full-scale (T/hr). Nozzles in our processes are often not visible and the observable results of the spray often depend on simultaneous phenomena, such as agglomeration and drying.

Our engineering approach is a combination experimentation and modeling. We typically study the spray itself experimentally, and then use modeling to explore the behavior of the drops in the downstream process. We are aware of the current research efforts to define physics and numerical methods needed to predict nozzle performance. Clearly, fundamental models will solve these problems in the future.

The atomization literature is mostly on small nozzles for low-viscosity fluids, like fuel injectors. There is much to learn still if we are to understand how to choose or design the best spraying system for an application involving our difficult fluids. But, fundamental research is occurring in areas of our direct interest. Our involvement with ILASS has enabled us to make important contacts with experts and stay on the front lines of research in this field.

So next time you are using any consumer product, ask yourself a question, "was a spray used to make this?" The answer is probably "Yes."



Spray-dried laundry powder

A Pringles crisp painted with a trivia question

Board Member Profile

Mr. Charles W. Lipp is a charter member of ILASS, attending the first meeting held in Madison, WI in 1987, and has been on the board of directors for two years. Chuck wanted to better understand and apply spray technology in solving industrially important problems and ILASS provided the exposure and opportunity to develop relationships with a broad technical community focused on atomization and sprays. He routinely presents papers highlighting some aspect of his research that relates to spray technology and continues his participation in ILASS because of the diverse application context of spray technology that is presented at the meetings and the opportunities to discuss developing issues with those people with broad expertise.

Chuck earned his BS in Chemical Engineering from Iowa State University in 1973 and has authored several peer reviewed journal articles and holds over 15 U.S. patents. He is currently a member of AIChE and routinely participates in ASME® Fluids Engineering Division technical meetings. He has been involved in developing and scaling-up process technology related to mixing and spray for the past 30 years at The Dow Chemical Company. His technical interests include atomization, spray technology, cavitation and multiphase flows with application to chemical and plastics manufacturing processes.

The Benefits of Membership in ILASS-Americas

Sometimes it is easy to take things for granted — and we all do it from time to time — but we'd like to take just a moment to review the benefits you experience as a member.

- Annual conferences offer the ideal environment for staying on the leading edge of technology and networking.
- Seven technical committees are hard at work developing industry standards, identifying emerging technologies and promoting exchanges of information between the world's leading experts. Be a part of it!
- Do you have a specific problem you'd like to discuss with your peers right now? Log onto the ILASS-Americas' Discussion Board, where you can instantly network with other experts in your field.
- The ILASS newsletter keeps members apprised of upcoming events so you won't miss important educational opportunities and technical articles.
- Our Harold C. Simmons and W.R. Marshall awards recognize and encourage the next generation of industry experts. Can you recommend any worthy candidates?

Encourage someone to join ILASS-Americas

Membership in ILASS-Americas is affordable for all. A one-time $20 membership fee is all it takes to tap into the resources and benefits just noted. Why don't you take just a moment and encourage your colleagues and associates to consider joining? You'll be ensuring the continued growth and longevity of our professional association.

To become a member of ILASS-Americas, complete the application below and mail to:

Professor Scott Samuelsen
Secretariat, ILASS-Americas
UCI Combustion Laboratory
University of California
Irvine, CA 92697-3550

Membership Application Form

I wish to become a member of ILASS-Americas. I enclose a check/money order for $20.00 in U.S. currency payable to "ILASS-Americas." (Please print or type full name, title and mailing address.)

Name (Dr./Prof./Mr./Ms.): _____

Title/Position: _____

Organization/Affiliation: _____

Mailing Address: _____

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Telephone: _____ Fax: _____

E-mail: _____

Signature: _____ Date: _____

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Date Received: _____ Membership Number: _____