

Workshop (Monday, 05 August, optional event)

19may19

10:30 Forum and workshop registration at Purdue's Center for Particulate Products and Processes (CP3)

FLEX building, Purdue West Lafayette campus

11:00 Lab-related short presentations

Carl Wassgren	Purdue University	The continuous manufacturing research conducted at Purdue
Dhananjay Pai	Purdue University	Pilot plant layout, in-line PAT and NIR aspects
Dhananjay Pai & Paul Mort	Purdue University	Multimodal particle size analysis
Hao Shi	MercuryLab	Effect of particle size and cohesion on powder yielding and flow
Matthew Walczel	Alexanderwerk	The power of roller compaction
Sharon Nowak	Coperion K-Tron	Loss-in-weight feeding; importance of feeder accuracy in continuous processes

2:00 Laboratory tours and demonstrations

- **Purdue University's Particle, Powder, and Compact Characterisation Laboratory, with emphasis on:**
 - segregation testing: the SPECTester (demo by Kerry Johanson, Material Flow Solutions)
 - particles characterisation
 - advanced instruments and software
 - microcompression testing (Shimadzu)
 - microtomography demonstration (Brucker)
- **Purdue University's Continuous Tableting Line with emphasis on:**
 - steady-state run, direct compression
 - continuous blending, loss-in-weight feeding
 - in-line PAT aspects
 - advanced control aspects (posters)

5:00 Conclusion: lessons learned by Purdue from the design & implementation of a continuous manufacturing line (pharmaceutical tablets)

6:00 Welcome Reception at Purdue's FLEX building

Scientific Conference (Tuesday/Wednesday, 06-07 August)

Theoretical and numerical aspects:

Jennifer Sinclair Curtis
University of California, Davis

Using DEM to develop constitutive models for CFD simulations of particulate flows

Richard Lueptow
Northwestern University

Predicting particle segregation in industrial granular flows

Carl Wassgren
Purdue University

Contact spreading of liquid between particles in mixed granular systems

Anthony Thornton
University of Twente, Netherlands

Multiscale modelling of industrial granular materials

Yu Liu Dow Chemicals, TX

Modeling granular material segregation using a finite element method and advection-diffusion-segregation equation multi-scale model

Thomas Weinhart MercuryLab, NL

MercuryCG - from discrete particles to continuum fields

William Ketterhagen AbbVie, IL

Application of DEM to understand, predict, and de-risk segregation in the manufacturing of pharmaceutical drug products

Daniel Mateo-Ortiz AbbVie, IL

Continuous powder blending inside a twin screw extruder

Paul Mort Purdue University

Cohesion as a strategy to control segregation and implications for flowability

Siyang Liu Vertex

Connecting segregation to rheology for inherently scalable model development

Ben Freireich PSRI

A review of mixing and segregation in fluidized beds

Zhekai Deng Northwestern University

Continuum modeling of segregation for polydisperse granular materials in hopper discharge flow

Ivan Christov Purdue University

Fundamental aspects of continuum modeling of granular diffusion and dispersion in tumbler flow

Experimental, industrial and peripheral aspects:

John Hecht	Procter & Gamble	What we still need to eradicate powder segregation in industrial processes
Michael Gentzler	Merck, PA	Quantification of segregation potential for polydisperse, cohesive, multi-component powders and prediction of tablet die-filling performance. A methodology for practical testing, re-formulation and process design
Parind Desai	GSK, PA	Evaluation of segregation intensity of pharmaceutical blends using near infrared spectroscopy
Jie Ren	Merck, PA	development of a continuous blending process through mechanistic understanding of the shear effect
Hongyang Cheng	University of Twente Netherlands	Bayesian calibration/validation and uncertainty propagation for discrete particle models of granular materials
Tom Baxter	Jenike & Johanson	Separation anxiety (part 1): experimental segregation test methods and their use from development to commercial scale Separation anxiety (part 2): troubleshooting & solving blend and segregation issues in industrial applications
Rohit Kumar	Alkermes, MA	Effect of different powder charging techniques and blender angle on the powder blending efficiency in an IBC blender
Manogna Adepu	Arizona State University	Particle and wall friction in discharging cylindrical hoppers
Kerry Johanson	Material Flow Solutions	What type of mass flow will prevent or limit segregation of powders? Calculation of custom design curves for a particular powder in preselected process geometry
Wyatt Roth	Eli Lilly and Company	industrial perspectives on mixing in a continuous direct compression manufacturing process
Chen Mao	Genentech/Roche	Assessment of powder flow obstruction using principles of continuum mechanics implications in drug product manufacturing

notes:

1-keynote presentations are highlighted in blue; keynote presentations are 45 minutes in duration and podium presentations are 30 minutes
2-short abstracts and biosketches are posted on the website under the SPEAKERS tab

Symposium (Thursday, 08 August, optional event)

motivation

Rotary tablet presses have existed for about a century and evolved into an ubiquitous, sophisticated pharmaceutical processor. Yet, insufficient scientific basis exists to support their design/behaviour and much remains to be known about the attendant challenge of high-speed die compaction. Similarly, the punches and dies which form the tablets are critical, as they control the production performance of a press.

With the advent of pharmaceutical continuous processing at the end of the last century, operational issues such as punch sticking, lamination and capping have come to the forefront and are to be addressed scientifically if the modern rotary tablet press is to become a truly-continuous processor.

In parallel, material-sparing requirements and rational design approaches have increased the profile of press simulators; significant work is now being dedicated to the development of die compaction models which will lead us to the next level of the material-sparing paradigm.

This 6-hour intense symposium is limited to a small group and gathers presses/compaction experts who attended the Conference and are willing to update the group on their recent research. Critical topics such as punch sticking, compaction models, feeders and PAT aspects will be explored.

8:45 introduction: [scientific aspects of rotary tablet presses: design/operation, PAT and die compaction](#)

9:00 short, casual presentations/discussions focused on rotary tablet presses, including M&S of die compaction (limited to a small group)

- Elisabeth Peeters Pfizer, CT
- Marcial Gonzalez & Carl Wassgren Purdue University
- Anton Kulchitsky & Jerome B. Johnson Coupi, Inc
- Anthony Thornton & Thomas Weinhart MercuryLab
- William Ketterhagen AbbVie
- Martin Bennett Huxley Bertram
- Hao Shi MercuryLab

11:00 presentation and discussion of three die compaction numerical models:

- the modelling challenges of die compaction
- Purdue University
- MercuryLab
- Coupi

1:30 short presentations (continued)

the following topics will be presented during the morning & afternoon short presentations:

- using PAT in a tablet press feed frame to support process understanding
- the effects of production press stiffness on tablet strain rate
- particle size segregation during the die filling process (tentative)
- simulation of load-limiting presses using a compaction simulator
- the discrete nature of punch sticking and how to characterise it
- powder handling/feeding aspects of rotary tablet presses
- effects of particle size on powder compaction and tableting strength

3:00 conclusion of the Symposium and end of Forum