6th International Conference for Conveying and Handling of Particulate Solids 2009 (CHoPS 2009) with the 10th ICBMH and BULKEX 2009

Integrating Scientific and Industry Communities

Queensland, Australia 3-7 August 2009

Editors:

Peter Wypych

ISBN: 978-1-62276-432-7

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2009) by Engineers Australia All rights reserved.

Printed by Curran Associates, Inc. (2012)

For permission requests, please contact Engineers Australia at the address below.

Engineers Australia Engineering House 11 National Circuit Barton ACT 2600

Phone: +61 2 6270 6555 Fax: (02) 6273 1488

memberservices@engineersaustralia.org.au

Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400 Fax: 845-758-2634 Email: curran@proceedings.com Web: www.proceedings.com

TABLE OF CONTENTS

* This Paper has been peer-reviewed by an independent panel of referees.

Opening Address

| Integrating Scientific and Industry Communities | 1 |
|---|---|
| Raper | |

Keynote Presentations

| Recent Advances in Bulk Materials Handling – A UK Perspective | 6 |
|---|----|
| Reed, Bradley | |
| The Environmental Impact of Transport Systems * | 12 |
| Lodewijks, Welink | |
| Are Some Pneumatic Conveying Problems Wicked? * | 19 |
| Klinzing | |
| Implementing a Regime Map Approach to Wet Granulation Design for a | 26 |
| Pharmaceutical Case Study | |
| Kayrak-Talay, Litster | |
| Discrete Element Modelling of Particulate System: from Research to Practice | 32 |
| Ooi | |
| Dust Explosions: A Report on Recent Major Explosions in Argentina & Brazil | 33 |
| Hajnal | |
| Particulate Solids Sensing Techniques | 39 |
| Brasseur, Fuchs | |

1. Computer Simulations & Validations

| Packing of Poly-dispersed Discs into a Rectangular Container * | 45 |
|--|----|
| Belevicius, Kacianauskas, Markauskas, Sesok | |
| A Systematic Approach to DEM Material Model Calibration | 51 |
| Curry, Favier, LaRoche | |
| Simulation of Potash Cake Strength by Discrete Element Method * | 55 |
| Gao, Evitts, Besant | |
| Discrete Element Modelling of Grain Flow in a Planar Silo: Influence of Simulation | 61 |
| Parameters | |
| Gonzalez-Montellano, Ayuga, Ooi | |
| Investigations into Calibration for Discrete Element Modelling of Granular Materials | 69 |
| Grima, Wypych | |
| Discrete Element Modeling of Bulk Solid Active and Passive Stress States on a Belt | 77 |
| Conveyor Test Rig * | |
| Ilic, Donohue, Wheeler | |
| Particle Velocity Profiles and Residence Time Distribution in Mixed-Flow Grain | 83 |
| Dryers * | |
| Iroba, Weigler, Mellmann, Metzger, Tsotsas | |
| Usage of DEM Simulations for the Development of a New Chute Design in | 90 |
| Underground Mining | |
| Katterfeld, Groeger, Hachmann, Becker | |

| Evaluation and Comparison of Process Parameters for a Particle Failure under Different | 96 |
|--|-----|
| Loading Conditions * | |
| Khanal, Tomas | |
| Computer Simulation of the Flow Regimes in Pneumatic Conveying | 102 |
| Kuang, Yu | |
| Simulating Particle-Structure Interaction (PSI) | 105 |
| Lee, Simpson | |
| Numerical Simulation Study on Sensitivity of Pressure Drop predicting in Pneumatic | 106 |
| Transport with Various Settings * | |
| Ma, Williams, Zhou, Jones | |
| DEM Simulations of Rice Grain Flow by Multi-Sphere Particles * | 112 |
| Markauskas, Kacianauskas | |
| Sensitivity Analysis of DEM Software and Design of Validation Model in an Ilmenite | 118 |
| Transfer Chute * | |
| Miles | |
| Numerical Investigation of the Stress Distribution during Die Compaction of Powders | 124 |
| Prigge, Sommer | |
| Stress Inhomogeneity of Solid Flow in Annular Shear Cell * | 130 |
| Wang, Zhu, Yu | |
| DEM Simulation of Granular Flow in a 3D Cuboid Hopper * | 136 |
| Xia, Zhu, Yu, Zulli | |
| Caking Processes in Wetted Potash | 142 |
| Yu, Besant, Evitts | |

2. Design, Production & Processing of Particulates

| Improving Flow Properties of Fine Particles by Mechanical Surface Modification * | 148 |
|---|-----|
| Armstrong, Zhou, Stewart, Morton | |
| Specific Grinding Rate of Raw Material at the Change of Balls' Points of Contact in the | 153 |
| Ball-Mill * | |
| Heim, Olejnik | |
| Size Reduction Toward Nano-scale Thickness on Platelet-like Crystalline Graphite | 158 |
| Kim, Park, Jeon, Jang | |
| Kinetics of Grinding of the Raw Materials Considering of the Compression Strength of | 164 |
| Grains * | |
| Olejnik | |
| Relationship between Mechanical Properties of Pharmaceutical Powder Formulations | 169 |
| and Tablet Quality Parameters | |
| Pandeya, Puri | |
| Uniformity Evaluation of Pressure Distribution in Shallow Dies Filled Using Different | 175 |
| Deposition Methods * | |
| Roudsari, Puri | |
| Modeling of Microorganism Disintegration in Spherical Packing of a Bead Mill * | 181 |
| Solecki | |

3. Environmental Aspects & Dust Hazards

| Industrial Dust Explosion Risk Management | 187 |
|---|-----|
| Brazier | |
| A Coupled Continuum and CFD Model to Investigate the Effects of Dust Generation * | 193 |
| Donohue, Ilic, Roberts, Wheeler, McBride | |
| Dust Control for Hazardous Bulk Solids Packaging | 199 |
| Fabrikanov | |
| Influence of Water Evaporation on Dust Minimisation Efficiency using Enclosed Water | 207 |
| Spraying Systems * | |
| Hoeflinger, Faschingleitner, Mauschitz, Liu, Zhang | |
| Dragline Machine House Dust Control | 213 |
| Manser, Costello | |
| Spillage Measurements during Grab Unloading * | 229 |
| Schott, Rijsenbrij, Lodewijks | |

4. Fluidisation

| Dynamic Behaviour of a Vibrated Fluidized Bed of Cohesive Powders * | 236 |
|---|-----|
| Barletta, Donsi, Ferrari, Russo, Poletto | |
| Particle Distribution in CFB with a new Designed Distributor using DEM Simulation | 242 |
| and ECT * | |
| Zhao, Takei | |

5. Measurement, Control & Instrumentation

| Investigations on the Impact of Different Carrier Frequencies for Capacitance Based | 248 |
|---|-----|
| Moisture Content Determination in Bulk Solids | |
| Fuchs, Moser, Zangl, Bretterklieber | |
| Wireless Monitoring System for a Pneumatic Conveying Rig * | 254 |
| McKenna, Armstrong, Cowell | |
| Non-invasive, Online Capacitive Measurement of Particle Degradation in a Screw | 260 |
| Conveyor * | |
| Moser, Bretterklieber, Fuchs, Zangl | |
| Optical Sorting with the RHEWUM DataSort | 266 |
| Schuetz, Duddek | |

6. Mechanical Conveying & Feeding

| Optimising Belt Conveyor Design using CEMA's Universal Method * | 271 |
|--|-----|
| Ausling, Wheeler | |
| Extending the Outlet Length of Reversible Discharge Screws | 277 |
| Bates | |
| Conveyor Design to Minimise Down Time for Pulley Change | 283 |
| Benson | |
| Profiles of Recent Projects Utilizing "Leading Edge Conveyor Technologies" | 287 |
| Bierie, Marti, Wheatall | |
| Tracking of Flat Belts * | 293 |
| Egger, Hoffmann | |

| Evaluation of Belt Conveyor Trajectories * | 299 |
|---|-----|
| Hastie, Wypych | |
| Reducing the Power Consumption of Troughed Belt Conveyors by Speed Control * | 306 |
| Hiltermann, Lodewijks, Rijsenbrij, Schott, Dekkers, Pang | |
| Investigations on Discharge Screw Conveyors | 315 |
| Hoffmann, Pillichshammer | |
| Start-Up and Running Loads Exerted by Bulk Solid Materials on Extractive Belt | 321 |
| Feeders | |
| Holmes, Berry, Reed, Bradley | |
| Mining Boom Times Lead to Inefficiencies | 327 |
| Law | |
| Safe Transportation of Hazardous, Hot and Abrasive Material | 328 |
| Magaldi, Lalia, Di Domenico | |
| Functional Comparisons of Screw Based Elevators | 332 |
| McBride | |
| Bucket Elevators: Head Pulley Transition Impact on Bucket Discharge | 339 |
| McBride, Sinnott, Cleary | |
| A Comparison of the Stress Distribution in Steel Cable and Fabric Reinforced Conveyor | 347 |
| Belt * | |
| Munzenberger, Wheeler | |
| New Generation Conveyor Skirting | 353 |
| Pratt | |
| Length, Lift, Power and Cost Characterisation of Long and High Lift Troughed Belt | 359 |
| Conveyors * | |
| Spreadborough | |
| Dust Accumulation Resistant Conveyor Structure | 366 |
| Swinderman, Bierie, Wheatall | |
| Experimental Investigations of the Bulk Solid Reaction on Vibratory Conveyors | 372 |
| Uryadov, Katterfeld, Krause | |
| Development of Curved Belt Conveyor in China * | 378 |
| Zhang, Zhou, Yu, Gu, Chen, Guo | |
| Research on Hydroviscous Soft-start Device (HSD) Used in Belt Conveyor * | 385 |
| Zhou, Zhang, Jiang, Yu, Guo, Zhang | |

7. Modelling & Fundamentals

| The Practical Significance Of Fittings Loss In Laminar Flow Design * | 391 |
|---|-----|
| Fester, Slatter | |
| Non-Newtonian Suspension Flow in Open Channels * | 397 |
| Guang, Chryss, Rudman, Bhattacharya, Slatter | |
| Determination of Internal Heat Convection Coefficients within Glass Bead Particle | 403 |
| Beds * | |
| Nie, Besant, Evitts | |
| Hydrodynamic Modelling Of Fine Particle Suspensions * | 409 |
| Slatter | |
| Time Dependence Effects during Conveying of Particulate Material – a Comparison | 415 |
| between Real World Behaviour and Calculation Theory * | |
| Williams, Katterfeld, Roberts | |

8. Particle & Bulk Characterisation

| Interpretation of Stick-Slip Powder Flow-ability Measurements Berry Bradley Ariza | 422 |
|--|-----|
| Wall Flow Function Measurements to Assess Wall Cohesion and Adhesion Berry, Sohel, Bradley, Reed | 428 |
| Evolution of Wall Friction with Realistic Displacements Wall "Conditioning" and the need to Measure Wall Friction Over a Long Distance of Travel <i>Bradley, Berry</i> | 434 |
| Workshop on Wall Friction (A Project of the Mechanics of Particulate Solids Working Party of EFCE) Bradley | 440 |
| Powder Characterisation via Flow Behaviour in a Rotating Drum Instrument Davies | 441 |
| How to Collect a Representative Sample? A Brief Introduction to the Sampling World | 442 |
| Scale-Up Effects in Bulk Characterisation – a Review Dominguez, Wypych | 448 |
| Comparative Study of the Cohesive Properties of Commercial Agricultural Crushed Limestone of New Zealand * <i>Grafton, Davies, Yule, Jones</i> | 454 |
| Measurement of the Anisotropic Consolidation Behaviour Ittershagen, Strege, Zetzener, Schwedes, Kwade | 460 |
| Premixes for Pharmaceutical Powder Mixtures – a Potential Way for Improving Flowability? Leutner, Mueller, Weber, Zimmermann | 466 |
| How to get the Yield Locus of an Adhesive Powder from a Single Numerical Experiment * Luding, Alonso-Marroquin | 472 |
| Development of an Industrial On-line Powder Flowability Tester, Results from Industrial Trials <i>Pillai, Bradley, Berry, Reed</i> | 478 |
| Strength of Particles under Compression Rozenblat, Portnikov, Kalman, Aman, Tomas | 484 |
| Particle Size Distributions measured in a Microscope "Sedimentation Balance" by Means of the Settling Rate Sommer, Dauth | 492 |
| Cubical Triaxial Tester Sample Size Effect on Mechanical Behavior of Powders <i>Yi, Pandeya, Puri</i> | 498 |

9. Particle & Powder Technology

| The Importance of Agglomerate Strength on the Aerosol Performance of | 504 |
|---|-----|
| Pharmaceutical Dry Powders | |
| Adi, Adi, Chan, Yang, Yu, Tong | |
| Surface Energy Contribution of Container Materials to the Triboelectric Charging of | 508 |
| Pharmaceutical Powder for Inhalation | |
| Adi, Wong, Kwok, Traini, Young, Chan | |

| Elastic-Plastic Behaviour of Contacting Layered Spherical Particles * | 511 |
|---|-----|
| Garjonis, Kacianauskas, Stupak | |
| Investigating the Unique Dissolution Behaviour of Nanoparticles | 517 |
| Heng, Ogawa, Cutler, Chan, Raper, Ye, Yun | |
| Protein Nano-Matrices with Controlled Surface Roughness for Inhalation | 526 |
| Kwok, Adi, Chan | |
| Influence of Particle Size and Crystal Habit on the Direct Compression of Ibuprofen * | 529 |
| Liu, Marziano, Bentham, Litster, White, Howes, Rashid | |
| Numerical Study of the Effect of Liquid Surface Tension on the Flow of Wet Particles | 535 |
| in a Rotating Drum * | |
| Liu, Yang, Yu | |
| Coefficients of the Drag Force, Drag Torque, and Magnus Force Acting on Rotating | 541 |
| Spherical Particle * | |
| Lukerchenko, Kvurt, Keita, Chara, Vlasak | |
| End Effect on Permeability of Particulate Bed having Different Internal Structures | 547 |
| Otomo, Harada | |
| Prediction of Aerodynamic Diameter of Particles with Corrugated Surface | 553 |
| Tang, Chan, Raper | |

10. Pneumatic & Hydraulic Conveying

| Implementation of Comminution Functions in DEM Simulation of Dilute-Phase | 559 |
|--|-----|
| Pneumatic Conveying | |
| Brosh, Kalman, Levy | |
| Are Tailing Dams Viable in the Modern Environment? | 565 |
| Bunn, Gilroy, Wheeler, Jones | |
| Design Protocol for Bypass Pneumatic Conveying Systems * | 571 |
| Chen, Jones, Williams, Tan | |
| Experimental Rig for the Investigation of Small Particle Impact Forces * | 577 |
| Cowell, McGlinchey, Pugh, Knight, Kassimkulov | |
| A Probability Approach for Investigation and Determination of Material Slugs/Air Gap | 583 |
| Lengths and their Ratios in Dense-Phase Pneumatic Conveying * | |
| Dresel, Williams, Teipel, Jones | |
| CFD Modeling and Experimental Validation of Pressure Drop and Concentration | 589 |
| Distribution for Bi-Modal Slurry Flow through Horizontal Bend | |
| Kaushal | |
| Investigations into High Pressure Loss in Horizontal Slug-Flow Pneumatic Conveying | 595 |
| Lecreps, Haider, Sommer | |
| Improved Scale-up Procedure for Dense-Phase Pneumatic Conveying of Powders * | 601 |
| Mallick, Wypych | |
| Comparison of Pressure and Force Measurement with Video Images of Dense Phase | 607 |
| Pneumatic Conveying * | |
| Mason, McGlinchey, Pugh | |
| Solids Transport Formula for Pressurized Slurry Pipe with Deposit: New Experiments | 613 |
| Matousek | |
| Modelling of Particle Pneumatic Conveying Using DEM and DPM Methods | 619 |
| Mezhericher, Brosh, Levy | |

| Developments on Pneumatic Conveying of Difficult Bulk Materials in China | 625 |
|---|-----|
| Pan, Gao, Xu | |
| Settling of Coarse Particles in Visco-plastic Fluids during Pipeline Transport * | 626 |
| Pullum | |
| Using Small Pipe Viscometry to Establish the Underlying Rheological Parameters of | 632 |
| Wide Size Distribution, High Concentration Flows * | |
| Pullum, Graham, Chryss | |
| The Saltation Phenomenon in Horizontal Particle-Gas Systems | 638 |
| Rabinovich, Kalman | |
| 9 th Workshop on Pneumatic Conveying of Solids | 644 |
| Rizk | |
| The Influence of Slug Length on Pressure Drop Prediction to Slug Flow Pneumatic | 645 |
| Conveying * | |
| Tan, Williams, Jones | |
| Effect of Particle Size Distribution on Flow Behavior of Concentrated Slurries * | 651 |
| Vlasak, Chara | |
| Special Applications for Rotary Valves | 657 |
| Wilms, Frank | |

11. Segregation & Mixing

| The Influence of the Residence Time Distribution of a Gravity Silo Mixer to smooth | 665 |
|--|-----|
| Periodical Inlet Fluctuations | |
| Dauth, Sommer | |
| Comparison of Available Techniques for Characterising the Air Induced Segregation | 671 |
| Tendencies of Powders | |
| Farnish, Foucart, Kulkarni, Bradley, Reed | |
| Controlling Downstream Particle Segregation with a Twisted Standpipe * | 677 |
| Halford, Kennedy, Arnold | |
| Multi-Size Mixtures for Predicting Percolation Segregation in Continuous | 683 |
| Distributions * | |
| Jha, Puri | |
| A Concept to Predict Particle Segregation Problems in Pharmaceutical Gravity | 689 |
| Discharge Processes | |
| Patel, Bradley, Reed, Davison, Bridle, Batt | |

12. Storage, Flow & Handling

| A Numerical and Experimental Study on Base Pressure Distribution in a Stockpile | 695 |
|---|-----|
| Ai, Chen, Rotter, Ooi | |
| Effect of Anisotropy of Stored Solid on Wall Pressure in a Cylindrical Silo | 701 |
| Ai, Chen, Rotter, Ooi | |
| A Bulk Solids Storage Unit Model for Process Simulation * | 707 |
| Barletta, Del Vecchio, Donsi, Poletto | |
| Finite Element Analysis of Solid Stresses in a Silo with an Inner Tube | 713 |
| Chen, Ooi, Rotter, Batikha, Zhong, Andreasson, Forsmo, Tanno, Horrigmoe | |

| A First Principles Approach to Educating Engineers for the Bulk Materials Handling | 719 |
|--|-----|
| Industry | |
| Dartnall | |
| New Technologies for Safe and Contained Powder Handling in the Bulk | 720 |
| Pharmaceutical Industry | |
| Dietrich | |
| Measurement of Loads Exerted on a Double-Cone Insert with a Large-Scale Axi- | 727 |
| Symmetrical Silo | |
| Ding, Dyroy, Karlsen, Enstad | |
| Industrial Process Design – Utilising Multi Chamber Homogenising Silos for Mixing of | 734 |
| Anode Covering Material * | |
| Dyroy, Karlsen, Hjelle | |
| The Effect of Patch-Load on Stress Components of Corrugated Silo Walls | 740 |
| Gallego, Gonzalez-Montellano, Ramirez, Ayuga | |
| Incidents and Accidents in Aerial Topdressing in New Zealand: Causes and Approaches | 747 |
| to Mitigation * | |
| Grafton, Yule, Davies, Jones | |
| Silo Discharge of an Ultrafine Cohesive Powder by Vibrating Hoppers * | 753 |
| Kache, Poetsch, Haack, Tomas | |
| Best Practice Guide for Handling of Coal/Biomass Blends for Co-Firing in Coal Power | 759 |
| Plants | |
| Khan, Bradley, Berry, Reed | |
| A Simulation Integrated Design Approach for Agribulk Terminal Design | 766 |
| van Schayk, Veeke, Lodewijks | |
| Options in the Design of Bulk Terminals | 773 |
| Velan | |
| Experience with the New DIN 1055 Silo Design Code * | 780 |
| Wilms, Schneider, Kaldenhoff | |

Posters

| New Perspectives for Discrete Element Modeling | 787 |
|--|-----|
| Alonso-Marroquin, Galindo-Torres, Ngan, Azeezullah, Tordesillas, Wang | |
| Flow and Handling of Particulate Materials | 788 |
| Bradley | |
| Combustible Dust Hazards – Top 10 Application Oversights | 789 |
| Brazier | |
| Where Will our Knowledge Take You? | 790 |
| Costello | |
| Strength Characteristics of Steel Pipelines for Waste Transport | 791 |
| Czaban, Sobota, Balawajder | |
| New Perspectives in the Risk Management of a Pharmaceutical Plant | 792 |
| Dietrich | |
| Pipeline Flow of Complex Suspensions | 793 |
| Graham, Pullum, Wu | |
| Tuning Discrete Element Models | 794 |
| Grima | |
| Validated DEM Computer Simulation of Particle Flows and Mechanisms | 795 |
| Hastie, Wypych | |
| Simulation of Normal Impact of Ultrafine Silica Particle | 796 |
| Jasevicius, Tomas, Kacianauskas | |
| Modelling of Fluidised Dense-Phase Pneumatic Conveying of Powders | 802 |
| Mallick, Wypych | |
| Engineered Lactose Carrier Particles with Enhanced Microstructure giving Improved | 803 |
| Inhaler Performance | |
| Morton, Stewart, Das, Lifran, Vu, Sleigh, Hourigan | |
| Vertical Density Profiles in Mixtures Flowing in Industrial and Laboratory Pipelines | 804 |
| Sobota, Czaban | |
| A Multilayer Paint Technique for Erosion Modelling | 805 |
| Wu, Graham, Lester, Wong, Kilpatrick, Nguyen, Bowditch | |
| Powder Flow Monitoring and Measurement Technology | 806 |
| Wypych | |
| Investigating Modification of Fundamental Powder Flow Properties of a Series of Fine | 807 |
| Lactose Powder | |
| Zhou, Armstrong, Morton, Stewart | |