Pharmaceutical Discovery, Development and Manufacturing Forum 2017

Core Programming Area at the 2017 AIChE Annual Meeting

Minneapolis, Minnesota, USA
29 October – 3 November 2017

ISBN: 978-1-5108-5812-1

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© (2017) by AIChE
All rights reserved.

Printed by Curran Associates, Inc. (2018)

For permission requests, please contact AIChE
at the address below.

AIChE
120 Wall Street, FL 23
New York, NY 10005-4020

Phone: (800) 242-4363
Fax: (203) 775-5177

www.aiche.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

(14a) Sustained Supersaturation of Erlotinib Sdd Ternary Amorphous Systems 1
Kimberly B. Shepard, Michael Morgen

(14b) Connecting the Product-Process-Performance Interplay for Improved Understanding in Development of a Spray Dried Dispersion Drug Product 2
Justin D. Moser, Jesse Kuiper

(14c) Strategically-Designed Polymer Synthons As Pharmaceutical Excipients in Oral Drug Delivery 3
Jeffrey Ting, Swapnil Tale, Anatolii Purchel, Seamus D. Jones, Monica Ohnsorg, Soroush Moghadam, Li Guo, Steven Guillaudeu, Ronald G. Larson, Frank S. Bates, Theresa M. Reineke

(14d) Pill Burden Reduction through Engineering the Mechanical Properties of Spray-Dried Amorphous Solid Dispersions 4
Alyssa Ekdahl, Aaron Goodwin, Deanna Mudie

(14e) Reprocessing of Spray Dried Dispersions: Minimizing Resources in Process Development and Dealing with the Possible Failure 5
Tiago Porfirio, Iris Duarte, Rui Ferreira, Bruno Henriques, Joao Vicente, Viriato Semiao

(14f) In silico Development of Amorphous Solid Dispersions for Optimal Performance and Stability 6
Pedro Valente, Iris Duarte, M. Temtem

(26a) Developing Improved Enzymes for Industrial Biocatalysis 7
Iman Farasat

(26b) Technoeconomic Optimisation, Antisolvent Selection and Comparative Environmental EvaluationÂ for Continuous Paracetamol Crystallisation 8
Hikaru G. Jolliffe, Dimitrios I. Gerogiorgis

(26c) Metric-Driven Process Development of a Late Stage Drug Substance 11
Kathleen Lauser, Nathan Domagalski, Michael Fenster, Thomas La Cruz, Max A. Mellmer, Eric M. Saurer, Matthew Winston

(26d) Scalable Continuous Synthesis of Enantiomerically Pure Amine APIs in an Enzyme Membrane Reactor 12
Robert D. Franklin, Bettina Bommarius, Andreas S. Bommarius

(26e) Development of a Biocatalytic Cascade for the Deracimization of a Racemic Alcohol 13
Shane T. Grosser

(26f) Design of New Reactors to Produce Levan Biopolymer through Enzymatic Catalysis: Kinetics and Mass Transfer 15
A. Gonzalez-Garcinuno, Alvaro Sanchez, Sonia Ruiz, Antonio Tabernero, Miguel A. Galan, Montana Elviro, Antonio Monzon, Eva Martin Del Valle

(71a) Automated Systems for Screening, Kinetics, and Optimization of Chemical Synthesis and On Demand Production 16
Klavs F. Jensen

(71b) Can Laboratory Automation Finally Fulfill the Promise of Revolutionizing Pharmaceutical Discovery? 17
Scott Sheehan

(71c) Emerging Technology: A Key Enabler for Modernizing Pharmaceutical Manufacturing and Advancing Product Quality 18
Thomas O'Connor, Celia N. Cruz, Sau Lee

(136a) Accurate and Efficient Representation of Intramolecular Energy in Ab Initio Generation of Crystal Structures 19
Isaac Sugden, Claire S. Adjiman, Costas C. Pantelides, Christina-Anna Gatsiou

(136b) A New Approach in Applying CSP for the Pharmaceutical Industry 20
Alan Jiang, Shuhao Wen

(136c) Capturing the Role of Temperature and the Sensitivity to Energy Function Complexity in Crystal Polymorph Stability Using Molecular Modeling 30
Eric Dybeck, Nathan Abraham, Natalie Schieber, Michael Shirts

(136d) Can Lattice Dynamics with Anisotropic and Isotropic Thermal Expansion Accurately Estimate Thermodynamic Properties of Crystals Pharmaceutics Compared to Molecular Dynamics? 31
Nathan Abraham, Eric Dybeck, Natalie Schieber, Michael Shirts

(136e) Prediction of Phase Transition Thermodynamics for Crystals of Pharmaceutical Compounds 32
Olexandr Isayev, Alexander Golbraikh, Eugene Muratov, Yuriy Abramov, Alexander Tropsha

(136f) Crystal Engineering Applications of COSMO-RS 33
Christoph Loschen, Jens Reinisch, Andreas Klamt

(136g) Enabling Rational Morphology Design and Crystal Engineering with Addict Software for Mechanistic Crystal Growth Models 34
Peng Zhu, Jinjin Li, Carl Tilbury, Yuanyuan Sun, Kevin Girard, Yuriy Abramov, Michael F. Doherty

(152a) Digital Alchemy for Assembly Engineeringc 35
Sharon C. Glotzer

(152b) Improved Algebraic, Numerical, and Graphical Representations in Fluid Mechanics 36
Stuart W. Churchill, James C. Hill

(152c) The Scaling of Turbulence Near the Wall and the Churchill Turbulent Flux Correlation: Insights with Lagrangian Simulations 37
Dimitrios V. Papavassiliou, Quoc T. Nguyen, Chiranth Srinivasan

(152d) Flow Boiling Using a Piranha Pin Fin Heat Sink 38
Cory Woodcock, Xiangfei Yu, Yoav Peles, Joel L. Plawsky

(152e) Transport Problems in the Spirit of Stuart Churchill for Teaching and Research at the University of Michigan 39
Ronald G. Larson, Claudio Vilas Boas Favero

(162a) A Compartmentalized, Numerical Model of Continuous Blending 40
Pongpumin Bunchatheeravate, Joseph W. Bullard, Steven Dale, Greg Connelly, Marcus O'Mahony

(162b) Impact of Raw Material and Blend Properties on the Screw Feeding, Continuous Blending and Tableting Unit Operation of an Integrated Continuous Direct Compression Platform 41
Bernd Van Snick, V. Vanhoorne, Maxim Verstraeten, Jens Dhondt, Giustino Di Pretoro, Thomas De Beer, Chris Vervaet

(162c) Feeder Characterization and Model Development Accounting for Incoming Material Properties 42
M. Sebastian Escotet-Espinoza, Glinka Cathy Pereira, A. D. Roman-Ospino, Fernando Muzzio, Marianthi Ierapetritou

(162d) Disintegration and Dissolution Modeling for Accelerated Drug Product Process Development 43
Pedro Valente, Slavomira Doktorovova, Nuno Enes, Joao Henriques, Paulo Lino, I. Lopes, Nuno Neves, Mafalda Paiva, Tiago Porfirio, Joao Vicente, Marcio Temtem

(162e) Modeling of Flow and Drying of Aqueous Polymer Coatings on Porous Pharmaceutical Tablets 44
Charalampos Christodoulou, Eva Sorensen, Salvador Garcia-Munoz, Luca Mazzei

(162f) Modelling and Simulation Efforts in Scale up and Characterisation of Semi-Solid Dosage Forms 45
Saurav S. Rath, Birendra K. David, Ravichandra Palaparthi

(162g) Dissolution Kinetics Modelling of a BCS Class II Active Pharmaceutical Ingredient 55
Yuan Gao, Brian Glennon, Yunliang He, Guangyang Hou, Philip Donnellan

(176a) Solve this! Fundamental Approach to Problem Solving in Industrial Processes I (Invited Talks) 56
Zdravko Stefanov, Paul Chauvel, Jr., Eldad Herceg, Dana A. Livingston

(203a) Large-Scale Synthesis of Dihydrostreptomycin via Hydrogenation of Streptomycin in a Membrane Dispersion Microreactor 57
Siting Xia, Xifeng Ding, Yujun Wang, Guangsheng Luo

(203c) Direct Comparison Between Batch Bulk Mixing and Continuous Millifluidics in the Synthesis of Amorphous Drug Nanoparticles 58
Kunn Hadinoto, Jia Wei Chew

(203d) Novel Method of Evaluating Liquid Absorption with Intra-Particle Pore of Pharmaceutical Porous Materials Using a Capillary Rise Method 59
Takuma Oba, Yasutomi Kato, Ryoichi Sonoda, Kohei Tahara, Yoshiaki Kawashima, Hirofumi Takeuchi

(203e) Evaluation of Experimental Methods for Solubility Determination of Carbamazepine in Ethanol for Cooling Crystallization Process DesignÂ 60
Wei-Lee Wu, David A. Acevedo, Xiaochuan Yang, Thomas O'Connor, Celia N. Cruz

(203f) Continuous Solvent Exchange Washing of Pharmaceutical Intermediates 61
Manuel Kreimer, Isabella Aigner, Stephan Sacher, Markus Krumme, Thomas Mannschott, Peter Van Der Wel, Albert Kaptein, Johannes G. Khinast

(203g) Design and Characterization of Fast-Release Clofazimine Nanoparticles to Improve Bioavailability 62
Yingyue Zhang, Jie Feng, Simon A. McManus, Hoang D. Lu, Kurt D. Ristroph, Robert K. Prude'Homme

(203h) Design of Efficient Metal Nanocatalysts for Continuous Synthesis of Drug Substances Via Cross Coupling Reactions 63
Andishaeh Dadgar, Farshid Mohammadparast, Marimuthu Andiappan

(203i) Downstream Processing of Extrudates: Polymer Platform Development for Hot-Melt Extrusion/Tableting Via in-Line Monitoring of Compaction Properties 64
Wouter Grymonpre, Valerie Vanhoorne, Thomas De Beer, Jean Paul Remon, Chris Vervaet

(203j) Virtual High-Throughput Screening Pipeline: Size and Classification Distribution Effects on Experimentally Validated Hit-Rates 67
Jonathan J. Chen, Donald P. Visco Jr., Lyndsey Schmucker

(203l) PAT on Oscillatory Systems: Monitor and Control Continuous Crystallization with Fourier Transform Infrared (FTIR) Spectrometer 68
Claire Yiqing Liu, Jonathon Speed, Dan Wood, Alastair Barton, Paul Firth, Zoltan K. Nagy

(203m) Continuous Manufacturing of Oral Disintegrating Films: A Quality By Design Approach 69
Sonal Mazumder, Xiaoming Xu, Cassandra Taylor, Nima Yazdanpanah, Thomas O'Connor, Ashraf Muhammad, Celia N. Cruz, Naresh Pavurala

(203n) Controlled Delivery of Fluorophores from 3D Two-Photon Photolithographic Printed Poly(Ethylene Glycol) Methacrylate Scaffolds 70
Anh-Vu Do, Kristan S. Worthington, Budd A. Tucker, Aliasger K. Salem

(203o) Controlled and Sequential Delivery of Fluorophores from 3D Printed Alginate-PLGA Tubes 71
Anh-Vu Do, Adil Akkouch, Brian J. Green, Ibrahim Ozbolat, Aliasger K. Salem

(203p) The Pressurized-Synthetic Methodology for Solubility Determination at Elevated Temperatures, with Application to Paracetamol in Pure Solvents 72
Brian De Souza, Leila Keshavarz, Patrick Frawley

(274a) How Raw Material Attributes and Process Parameters Affect the Global Residence Time Distribution Behavior in Continuous Direct Compression 84
Samantha Hurley, Robert F. Meyer, Brendon G. Ricart, Matthew H. Flamm, Frank D. Witulski

(274b) Development of a Continuous Blending System 85
Daniel Borginis

(274c) Investigating Continuous Powder Blending at Different Scales Using Residence Time Distribution Studies 86
Marcus O'Mahony, Steven Dale, Greg Connelly, Joseph W. Bullard, Pongpumin Bunchatheeravate

(274d) Leveraging Raw Material and Blend Properties with the Die Filling Step of the Tableting Process 87
Valerie Vanhoorne, Bernd Van Snick, Jens Dhondt, Celine Segers, Kato Van Vooren, Thomas Eerdekens, Giustino Di Pretoro, Thomas De Beer, Chris Vervaet

(274e) Modelling of Pharmaceutical HME Processes 88
Josip Matia, Milica Stankoviä‡-Brandl, Amrit Paudel, Johannes G. Khinast, Christophe Herkenne, Jessica Lovey Martinetti, Sophie Martel

(274f) In-Depth Experimental Analysis of Pharmaceutical Twin-Screw Wet Granulation in View of Detailed Process Understanding 89
Maxim Verstraeten, Daan Van Hauwermeiren, Kai Lee, Neil Turnbull, Pankaj Doshi, Mary T. Am Ende, Ingmar Nopens, Thomas De Beer

(274g) Understanding the Impact of Feedframe Design and Process Parameters on the Die-Filling Step of the Tableting Process 90
Wouter Grymonpre, Valerie Vanhoorne, Bernd Van Snick, Thomas De Beer, Jean Paul Remon, Chris Vervaet

(299a) Intensification of a Continuous Process Guided By Mechanistic Modeling 91
Rudi Oliveira, Ana Cruz, Filipe Ataide, Nuno Matos

(299b) Simultaneous Estimation of Kinetic Parameters and Curve Resolution of Spectral Data - Applications and Extensions 104
Salvador Garcia-Munoz, Lorenz T. Biegler, Weifeng Chen

(299c) Modeling and Monitoring of a Continuous Silylation Reaction 105
Edward Conder, Carla Luciani, Jonas Y. Buser, Jeffrey Tan, Adam D. McFarland, Matthew C. Embry, Scott A. May, Mark S. Kerr, Luke Webster

(299d) Estimability Analysis for Improved Parameter Estimation in Deterministic Models: Pharmaceutical Case Studies 106
Maitraye Sen, Salvador Garcia-Munoz, Nil Tandogan, Indrakant V. Borkar, Stanley P. Kolis, Thomas M. Wilson, Jonas Y. Buser, Charles A. Alt

(299e) Solubility Data Mining and Predictive Modeling: AI+ChE 107
Jacob Albrecht, Jun Qiu

(299f) Toward Efficient Development and Reliable Scale-up of Agitated Filter Drying Protocol through DEM Modeling and Simulation 108
Kushal Sinha, Nandkishor Nere, John G. Gaertner, Laurie Mlinar, Raimundo Ho, Alessandra Mattei, Haojuan Wei, Samrat Mukherjee, Ahmad Sheikh, Shailendra Bordawekar

(310a) A Novel Microfluidic Platform for Screening of Pharmaceutical Polymorphs Under Hydrodynamically-Controlled Crystallization Conditions 109
Paria Coliaie, Meenesh R. Singh

(310b) Polymorphism in Drug Compounds By Controlling Fluid Dynamics during Crystallization 110
Stephanie Guthrie, Gaurav Giri

(310g) Mechanism of Selective Co-Crystallization of Cresol Isomers with Urea 124
Na Wang, Hongxun Hao, Qiuxiang Yin, Baohong Hou, Meijing Zhang

(310d) Continuous Cocrystallization of Benzoic Acid and Isonicotinamide By Mixing-Induced Supersaturation: Exploring Opportunities between Reactive and Antisolvent Crystallization Concepts 125
Vaclav Svoboda, Pol Macfhionnghaile, John McGinty, Lauren E. Connor, Iain D. H. Oswald, Jan Sefcik

(310e) A Multiscale Computational Method for Prediction of Polymorphs 138
Anish V. Dighe, Meenesh R. Singh

(310f) Polymorph Selection By Continuous Precipitation 139
Thomas Farmer, Sina Schiebel, Bradley F. Chmelka, Michael F. Doherty

(344a) Assessing the Adequacy of a Sampling Frequency in the Application of PAT to a Continuous Manufacturing Process for Drug Product 140
Salvador Garcia-Munoz, Lukas Barnes, Evan Hetrick, Ian Leavesley, Zhenqi Shi

(344b) Continuous Production Technology for Pharmaceutical Semi-Solid and Liquid Formulations: Processability and Influence of Process Parameters on the Product Quality 141
Nils Bostijn, Thomas De Beer, Willem Dhondt, Jeroen Van Renterghem, Chris Vervaet

(344c) Modeling of Residence Time Distribution of a Continuous Dry Granulation Tableting Line 142
Michael C. Martinetz, Anssi-Pekka Karttunen, Stephan Sacher, Patrick R. Wahl, Ossi Korhonen, Johannes G. Khinast

(344d) Robust State Estimation of Feeder and Blender Systems in Continuous Pharmaceutical Manufacturing Systems 143
Jianfeng Liu, Qinglin Su, Mariana Moreno, Carl Laird, Zoltan K. Nagy, Gintaras V. Reklaitis

(344e) Large-Scale Experimental Comparison of Batch and Continuous Technologies for Pharmaceutical Tablet Manufacturing 144
Kensaku Matsunami, Takuya Nagato, Koji Hasegawa, Masahiko Hirao, Hirokazu Sugiyama

(344f) A Cost-Benefit Analysis of Continuous Manufacturing Using Discrete Event Simulation 145
Anne Purdy, Amy Greer, Palmerly Tom, Ondrej Slama, Pavlo Minayev, Vaclav Belak

(344g) Real-Time Monitoring and Control of API Concentration in a Tablet Press for Continuous Manufacturing of Tablets 146
Jin Maeda, M. Sebastian Escotet-Espinoza, Ravendra Singh, Marianthi Ierapetritou

(373a) Use of Model Discrimination Method in Drug Substance Process Development 147
Nil Tandogan, Salvador Garcia-Munoz, Maitraye Sen, Thomas M. Wilson, Jonas Y. Buser, Stanley P. Kolis, Indrakant V. Borkar, Charles A. Alt

(373b) Model-Aided Development for a Mixed Anhydride Formation in a Drug Substance Manufacturing Process 148
Derek Starkey, Carla Luciani, Kevin P. Cole, Justin Burt, David Mitchell

(373c) Design of Efficient Metal Nanocatalysts for Cross Coupling Reactions Using Finite Difference Time-Domain Simulations 149
Andishaeh Dadgar, Farshid Mohammadparast, Marimuthu Andiappan

(373d) Nonlinear Optimisation of Continuous Artemisinin Crystallisation with Explicit NRTL Model-Based Solubility Prediction 150
Hikaru G. Jolliffe, Dimitrios I. Gerogiorgis

(373f) Multi-Layered Modelling Techniques for the Development of Continuous Manufacturing Processes 153
Philip Donnellan, Roderick Jones, Phillip Roche, Brian Glennon

(373g) A Refined Non-Random Two-Liquid Segment Activity Coefficient Model for Solubility Modeling 154
Yifan Hao, M. R. Islam, Meng Wang, Chau-Chyun Chen

(418a) Overcoming Challenges for Scale-up of Continuous Pharmaceutical Drug Substance Processes 155
Shujauddin M. Changi, Donal Harrold, Harold Moloney, Martin Johnson, Scott A. May, Timothy M. Braden, Luke Webster, Joel Calvin, Carla Luciani

(418b) Preparation of Hazardous "on-Demand" Reagents Using Continuous Processing 156
Sarah Rothstein, Jerry S. Salan, David Am Ende, Matthew Jorgensen, Trevor Rosensohn

(418c) Model-Aided Development for a Continuous Amide Bond Formation in a Drug Substance Manufacturing Process 157
Derek Starkey, Carla Luciani, Matthew C. Embry, Molly Hess, Justin Burt, David Mitchell

(418d) Effects of Catalyst and Metals Pretreatment for the Continuous Hydrogenation of a Halogenated Aromatic Nitro Compound 158
Christopher Lippelt, Jonas Y. Buser, Bradley M. Campbell, Richard F. Cope, Michael Laurila

(418e) Large Scale Production of Pharmaceutical Intermediates in the Flow Mode 159
Baoquan Sun, Sam Tadayon

(418f) Plasmonic Metal Nanocatalysts As Platform for Continuous Synthesis of Drug Substances 160
Farshid Mohammadparast, Andishaeh Dadgar, Marimuthu Andiappan

(418g) Developing Scale-up Approach for a Fast Reactions in Continuous Flow 161
Plamen Grigorov, Azzedine Lekhal, Marco Armenante, Nicholas Rogus, Glenn Spencer, David A. Thaisrivongs, John R. Naber

(438a) A Method to Reduce Dimensionality of Powder Flow Characterization 162
Yifan Wang, Kushal Dhinoja, Fernando Muzzio, Celia N. Cruz

(438b) Using Mechanistic Modeling of Chromatography to Increasing Process Understanding 163
Tim Fattor, Stephen Hunt, Jonathan Rocher, Robert Todd

(438c) Multivariate Monitoring of a Continuous Manufacturing Process for API Synthesis: Enhancing the Power of Real Time Data 164
Melanie Dumarey, Martin Hermanto

(438d) Global System Analysis of Interconnected Flow Sheet Models for Drug Product Manufacturing to Performance 173
Pankaj Doshi, Marta Moreno Benito, Conrad Davies

(438e) Closed Loop Dynamics of Ribbon Density in a Dry Granulation Process 174
Sudarshan Ganesh, Mariana Moreno, Qinglin Su, Zoltan K. Nagy, G. V. Reklaitis

(438f) Integrated Control and Data Management System for Continuous Pharmaceutical Manufacturing Process 175
Ravendra Singh, Fernando J. Muzzio, Marianthi Ierapetritou, Rohit Ramachandran

(438g) In silico Process Characterization of Drug Product Filling Operations: Predicting Quality Attributes from First Principles 176
Will Johnson, Pablo Rolandi

(472a) Pinducer Analysis for the Design of a Nucleation Subsystem for Continuous Slug-Flow Crystallization 177
Mo Jiang, Chen Gu, Richard D. Braatz

(472b) Understanding Metastable Zone Width without Nucleation Rate 178
Venkateswarlu Bhamidi, Paul J. A. Kenis, Charles F. Zukoski

(472c) Molecular Interactions between Nanocellulose and Crystallizing Pharmaceuticals 179
Manali Banerjee, Blair Kathryn Brettmann

(472d) A New Model for Solubility Prediction to Guide Solvent Selection for Process Development 180
Michael Lovette

(472e) Heterogeneous Nucleation of Small Molecule Crystals in the Presence of Nanoparticles 181
Lucrece Nicoud, Leia Dwyer, Allan S. Myerson

(472f) The Influence of Solution Conditions on the Self-Assembly of Pre-Nucleation Clusters 189
Eftychios Hadjittofis, Mark A. Isbell, Geoff G. Z. Zhang, Jerry Heng

(472g) Simulations and Experiments Validation on the Membrane Based Response Technology for Nucleation Detection and Crystallization Control 190
Xiaobin Jiang, Wu Xiao, Dapeng Lu, Rui Zhao, Gaohong He

(500a) Niimbl: The National Institute for Innovation in Manufacturing Biopharmaceuticals 191
Kelvin H. Lee

(500b) The Transcelerate Comparator Network: Transforming the Supply Chain for Clinical Comparator Medicines 192
Nishchal Chudasama

(500c) Accelerating Pharmaceutical Development through Precompetitive Collaboration: The Enabling Technologies Consortium 193
Srinivas Tummala, Joshua D. Engstrom, Jean W. Tom, Margaret Faul

(500d) Cmac: A Partnership Approach to Precompetitive Collaboration for Pharmaceutical Manufacturing Research 194
Alastair J. Florence

(500e) A Perspective on a Pre-Competitive NSF Engineering Research Center Focused on Pharmaceutical Manufacturing: C-Sops 195
Douglas Hausner

(500f) The Development of an Interactive Knowlege Epicenter for the Advancement of Continuous Manufacturing 196
Philip Donnellan, Lawrence De Belder

(502a) Scale-up Modelling and Analysis of a Pharmaceutical Crystallization Process 197
Merve Oner, Getachew S. Molla, Michael Frederick Freitag, Stuart Michael Stocks, Jens Abildskov, G. Sin

(502b) Removal of Impurity from API and Reduction of Agglomeration during Drying 198
Onkar Manjrekar, Howard E. Morton, Jie Chen, Lijie Cui, David Barnes, Jose Napolitano, Jeff Hartnell, Jeff Bien, Elie Chaaya, Subramanya Nayak, Shailendra Bordawekar

(502d) Viscoelastic Properties and Dissolution Kinetics of Amorphous Drug Dispersion Films, Utilizing the Quartz Crystal Microbalance 199
Mark A. Isbell, Geoff G. Z. Zhang, J. Y. Y. Heng

(502e) Improving the Dissolution of Ibuprofen By Co-Milling of Ibuprofen and MCC Mixture in a Ball Mill 200
Sophia Varghese, Chinmay Ghoroi

(539a) Scientific Considerations on Continuous Crystallization and Its PAT Method Validation 201
Xiaochuan Yang, David A. Acevedo, Adil Mohammad, Naresh Pavurala, Wei-Lee Wu, Thomas O'Connor, Sau Lee, Patrick J. Faustino, Zoltan K. Nagy, Celia N. Cruz

(539b) An Engineering Approach to Concentration of Temperature-Sensitive Pharmaceutical Process Streams for Continuous Crystallization of an API 202
Phillip Roche, Gladys Kate Pascual, Roderick Jones, Philip Donnellan, Brian Glennon

(539c) The Effect of Axial Dispersion on Crystal Size Distribution in a Meso-Scale Continuous Oscillatory Baffled Crystallizer 203
Iyke Onyemelukwe, Qinglin Su, Zoltan K. Nagy, Chris Rielly

(539d) Continuous Heterogeneous Crystallization and the New Method of Making Tablets 204
Nima Yazdanpanah, Jelena Stojakovic, Keith Jensen, Allan S. Myerson, Bernhardt L. Trout

(539e) A Comparative Study of Continuous Crystallization in an Oscillatory Baffled Crystallizer and a Mixed-Suspension-Mixed-Product-Removal Crystallizer 205
Claire Yiqing Liu, Alastair Barton, Paul Firth, Jonathon Speed, Dan Wood, Zoltan K. Nagy

(539f) Continuous Drying of Pharmaceuticals 206
Manuel Kreimer, Isabella Aigner, Stephan Sacher, Markus Krumme, Thomas Mannschott, Peter Van Der Wel, Albert Kaptein, Johannes G. Khinast

(539g) Continuous Fluidized Bed Drying of Pharmaceutical Materials 207
Hao Chen, Fernando Muzzio, Benjamin Glasser

(541a) Protein and Gold Nanoparticle Based Radiation Sensor 208
Amar Thaker, Karthik Pushpavanam, Kaushal Rege, Brent L. Nannenga

(541b) Direct Detection of Nucleic Acids without Amplification 209
Zachary McGee, Savannah Dewberry, Carter Wright, Paula Koelle, Peggy Sammon, Krishnan Chittur

(541c) Photoacoustic Imaging to Simultaneously Detect the Accumulation of Multiple Contrast Agents within Tumors 210
Leon Z. Wang, Hoang D. Lu, Tristan L. Lim, Brian K. Wilson, Andrew Heinmiller, Robert K. Prud'Homme

(541d) DNA Methylation Detection with an Engineered Protein That Binds Hemi-Methylated DNA 211
Brooke E. Tam, Ki-Joo Sung, Yining Hao, Dana B. Dabbousi, Hadley D. Sikes

(541e) Effective Physiological and Anatomical Parameters on Fractional Fluid Reserve (FFR) of Coronary Artery Stenosis 212
Javad Hashemi, R. Eric Berson, Shahab Ghafghazi

(541f) Analysis of Carbonyl Compounds in Exhaled Breath for Identificationf of LUNG Cancer Biomarkers 213
Qi Li, Mingxiao Li, Michael H. Nantz, Xiao-An Fu

(565a) Residence Time Distribution and Segregation Studies Trough Real Time Measurements By Near Infrared Spectroscopy 214
Andres D. Roman-Ospino, Sarang Oka, Sara Moghtadernejad, M. Sebastian Escotet-Espinoza, Ravendra Singh, Rohit Ramachandran, Marianthi Ierapetritou, Fernando Muzzio

(565b) Use of Process Analytical Technology (PAT) in Advanced Manufacturing Process Monitoring and Control: Scientific Considerations and Regulatory Challenges 215
Huiquan Wu

(565c) 3D Raman Imaging: A Method to Study the Effects of Lubrication on the Microstructure of Tablets 216
Shashwat Gupta, Savitha Panikar, Fernando J. Muzzio

(565d) Development and Validation of an in-Line NIR Spectroscopic Method for Continuous Blend Potency Determination in the Feed Frame of a Tablet Press 217
Fien De Leersnyder, Elisabeth Peeters, Djalabi Hasna, Valerie Vanhoorne, Bernd Van Snick, Ke Hong, Steve Hammond, Chris Vervaet, Thomas De Beer

(565e) Identification of Key/Non-Key Process and Model Parameters of Polishing Chromatography, Primary Containers and Autoinjectors Using Mechanistic Models 220
Pablo A. Rolandi, Fabrice Schlegel

(565f) In-Situ Agglomeration Measurement during Kdp Crystallization Based on Double-View Image Analysis 221
Yan Huo, Tao Liu, Cai Y. Ma, Xue Z. Wang

(565g) Progress in Industrial Implementation of Optical Coherence Tomography (OCT) for Real-Time Evaluation of Pharmaceutical Coating Processes 233
Patrick R. Wahl, Matthias Wolfgang, Anna Peter, Andrea V. Raffa, Phillip Clarke, Stephan Sacher, Johannes G. Khinast

(594a) Advanced Control Strategy Approaches for Continuous Pharmaceutical Manufacturing: The Regulatory Landscape 234
Thomas O'Connor

(594b) Pharmacy-on-Demand: A Continuous Revolution in Pharmaceutical Manufacturing? 235
Luke Rogers, Ramona Achermann, Andrea Adamo, Mohsen Behnam, Rachel Beingessner, Dave Brancazio, Naomi Briggs, Jie Chen, Gregory Hammersmith, Timothy Jamison, Klavs F. Jensen, Guahua Liang, Hongkun Lin, Allan S. Myerson, Clemence Neurohr, Carter Salz, Ridade Sayin, David Snead, Dale Thomas, Nopphon Weeranoppanant, Lukas Weimann, Shin Yee Wong, Ping Zhang

(594c) Platforms for Integrated Continuous Drug Subtance Design and Manufacture 236
Anna Przybyl, Gary Morris, Richard Wareham, Brian Glennon, Mark Barrett

(594d) Residence Time Distribution and Material Traceability for Continuous Drug Substance Processes 237
Christopher S. Polster, Venkata Ramana Reddy, Carla Luciani, Stephen B. Jeffery, Martin Johnson, Kevin Chinn, Hod Finkelstein

(594e) A Miniature CSTR Platform for Continuous Processing of Multiphase Systems 238
Yiming Mo, Klavs F. Jensen

(594f) From Grams of Drug Substance to Commercial Scale Clinical Supply Manufacture in Less Than a Year 239
Carl Hartmann III

(594g) A Continuous and Controlled Pharmaceutical Freeze-Drying Technology for Unit Doses 248
Thomas De Beer

(596a) Engineering Considerations for Dissolved Oxygen Sensor Response Across Silicone Membranes in 3-L Single Use Bioreactors 249
William Tran, John Bowers, T. Craig Seamans

(596b) Process Development Tool to Rapidly Predict the Stability of Biopharmaceuticals 250
Sarah Hedberg, Yolanda Hutabarat, Jerry Heng, Jonathan Haigh, Daryl Williams

(596c) Model-Based Process Optimization for Upstream Bioreactor Productionâ€“Downstream Chromatographic Separation of CHO Cell Monoclonal Antibodies (mAb) 251
Uros Novak, Drejc Kopac, Mojca Cajnko, Andrej Pohar, Matic Grom, Blaz Likozar

(596d) Exploring the Multi-Minima Behavior of Organic Crystal Polymorphs at Finite-Temperature 259
Eric Dybeck, Michael Shirts

(596e) Iterative Synthesis of Heteropolymers Using Organic Solvent Nanofiltration 260
Ruiyi Liu, Piers Gaffney, Patrizia Marchetti, Marc Schaepertoens, Ruijiao Dong, Andrew G. Livingston

(596f) Challenges in Process Development of Antibody Drug Conjugates (ADCs) 261
Vimalkumar Patel

(596g) Improved Manufacturing Process for Semi-Synthetic Calicheamicin Linker-Payload En Route to Antibody-Drug Conjugates 262
Leo J. Letendre, Frank W. Kotch, Amarnauth Prashad, Vimalkumar Patel, Wesley Swanson, Xi Hu, Lawrence Chen, April Xu, Sen Zhang, Stephen Freese, Eric Bortell

(623a) Technoeconomic Evaluation of Cyclosporine Crystallisation Intensification Using a Cascade of M.S.M.P.R. Crystallisers 263
Samir Diab, Dimitrios I. Gerogiorgis

(623b) Application of Advanced Process Control Tools in Continuous Processing 265
Stephan Sacher, Jakob Rehrl, Julia Kruisz, Otto Scheibelhofer, Isabella Aigner, Michael Martinetz, Patrick R. Wahl, Johannes G. Khinast

(623c) Nonlinear First-Principle Model-Based Control of a Continuous Pharmaceutical Manufacturing Process 266
Nima Yazdanpanah, Thomas O'Connor, Naresh Pavurala, Sonal Mazumder, Muhammad Ashraf, Celia N. Cruz, Cassandra Taylor, Xiaoming Xu

(623d) A Fault-Tolerant Control Design for Real-Time Release in Continuous Manufacturing of Solid Dose Using Direct Compaction 267
Qinglin Su, Mariana Moreno, Jianfeng Liu, Sudarshan Ganesh, Yasasvi Bommiready, Marcial Gonzalez, Gintaras V. Reklaitis, Zoltan K. Nagy, Thomas O'Connor, Geng Tian

(623e) Intensified Crystallization of Sulfathiazole and Sulfanilamide By Direct Co-Crystal Assembly 268
Kuan-Lin Yeh, Tu Lee

(623f) Direct Co-Crystal Assembly from Synthesis to Co-Crystallization 269
Ya-Chi Fan, Hung-Lin Lee, Tu Lee

(623g) Continuous Preparation of 1:1 Haloperidol-Maleic Acid Salt By a Novel Solvent-Free Method Using a Twin Screw Melt Extruder 270
Tu Lee, Hung-Lin Lee, Jaydip M. Vasoya, Marilia De Lima Cirqueira, Kuan-Lin Yeh, Abu T. M. Serajuddin

(657a) Prediction of Tablet Dissolution By Process Parameters in Continuous Manufacturing 271
Golshid Keyvan, Yifan Wang, Fernando Muzzio

(657b) Integrating Sensors for Monitoring Blend Content in a Pharmaceutical Continuous Manufacturing Plant 272
Savitha Panikar, Jingzhe Li, Varsha Rane, Sean Gilliam, Gerardo Callegari, Bogdan Kurtyka, Sau Lee, Fernando J. Muzzio

(657c) Scientific and Regulatory Considerations for Developing the Control Strategy of a Continuous Manufacturing Process 273
Ying Zhang

(657d) Uncertainty Quantification and Global Sensitivity Analysis of Drug Delivery Primary Containers to Understand Process Capability and Key Risk Factors 274
Fabrice Schlegel, Pablo A. Rolandi

(657e) Nucleation Behavior of Eszopiclone - Butyl Acetate Solutions from Metastable Zone Widths 275
Junbo Gong, Jingkang Wang, Shijie Xu

(657f) Development, Implementation, and Use of an On-line Laser Diffraction Particle Size Method in a Spray Drying Manufacturing Process 276
Martin Warman, Alon Vaisman

(665a) Impurity Rejection in Crystallization â€“Quantification and Mechanisms 287
Fredrik Nordstrom

(665b) Bi-Directional Control of Glycosylation of Antibodies 288
Madiha Khurshid, Tony Wang, Erin Franco, Nelson Chavez, Eleanor Le, Richard Wu, Randy Schweickart, Jack Chung-Jr Huang

(665c) Bioprocess Optimization for Production of Recombinant Proteins in Chinese Hamster Ovary Cells in Consideration of Metabolic Shifts By Shear Stress 289
Keisuke Shibuya, Kenichiro Oka

(665d) Using Machine Learning Tools in Bioprocess Scale up When the Number of Batches Is Small 290
Viktor Konakovsky, Graham McCreath, Jarka Glassey

(665e) A Workflow-Based Framework for Managing Product Analytical Data and Statistical Results for Lot Release 305
Girish Joglekar, Qing Cai, Poching Delaurentis, Linas Mockus, Kenneth Morris, Gintaras V. Reklaitis

(665f) Evaluation of Recovery Pathways for Improved Bioavailability of Clofazimine Nanoparticles 314
Jie Feng, Yingyue Zhang, Hoang Lu, Simon A. McManus, Robert K. Prud'Homme

(665g) Assessment of the Impact of Interfacial and Shear Stress on Biologics Drug Product Via Mini-Piloting Tools 315
Maria Olu Ogunyankin, Smeet Deshmukh, Masano Huang, Thiago Carvalho, Mary Krause, Brenda Remy, Mehrnaz Khossravi

(671a) Suitable Raw Material Attributes for Continuous Manufacturing of a Drug Product Via Direct Compression 316
Brendon G. Ricart

(671c) Wettability of Pharmaceutical Powders of Different Particle Size By Droplet Penetration Technique 317
Yu Han, Zhanjie Liu, Sara Moghtadernejad, Fernando Muzzio, Gerardo Callegari, German Drazer

(671d) Investigation of Microsphere Strength for Spray Drying Applications By Means of Acoustic Levitation 318
Manuel Kreimer, Isabella Aigner, Stephan Sacher, Markus Krumme, Thomas Mannschott, Peter Van Der Wel, Albert Kaptein, Hartmuth Schrottner, G. Brenn, Johannes G. Khinast

(671e) Nanostructural Interfaces of Additives on the API Surfaces Influencing Process Performance 319
Sajan K. Chatarla, Tijana Rajh, Elena Rozhkova, Kalyana Pingali

(671f) Rational Strategies for Physical Characterization of Amorphous Solid Dispersions during Drug Product Development and Manufacture 320
Stephen L. Conway, Kenneth Rosenberg, Itzia Arroyo, Andrew Gmitter, Julianne Farabaugh, Cindy Starbuck

(671g) Investigation of Compression Induced Amorphization of Crystalline API 321
Lei Zhu, Chengbin Huang, Gerard Klinzing, Adam Procopio, Fengyuan Yang, Jie Ren, Rubi Burlage, Anthony Leone, Lawrence Rosen, Yongchao Su

(705a) Routine Process Monitoring for Automated Clean-in-Place Systems 322
Juan C. Silva-Martinez

(705b) Scientific Considerations and Regulatory Challenges for Low Dose Drug Manufacturing Process Monitoring and Control 323
Huiquan Wu, Suyang Wu, Koushik Sowrirajan, Celia N. Cruz

(705c) Frontiers of Industrial Crystallization Science and Technology 324
Junbo Gong, Jingkang Wang

(705d) Models for Comparative Characterization of Complex Mixture and Biological Drug Products 325
Adam Fisher

(705e) Self-Aggregation of Gabapentin Under Confinement of Primary Particle By Smpt 326
Songgu Wu, Junbo Gong

(705f) Feasibility of NIR Spectroscopy for Monitoring Enzymic Digestion Process of Proinsulin Producing Insulin Glargine 327
Xu Yan, Lei Nie, Sheng Zhang, Weiming Wang, Haibin Wang, Wenlong Li, Haibin Qu

(705g) The Benefit of Advance Process Control in Osd Continuous Manufacturing 328
Pamela Docherty

(717a) Oral Formulations: Perspectives from Additive Manufacturing 337
Andrew J. Radcliffe, Zoltan K. Nagy, Gintaras V. Reklaitis

(717b) Predicting the Free Energy of Solvation: A Hybrid QSPR Model for Organic Solute/Solvent Pairs 338
Tohid Borhani, Salvador Garcia-Munoz, Carla Luciani, Amparo Galindo, Claire S. Adjiman

(717c) In silico Prediction of Absolute Rates of Crystal Growth from Solution 339
Mark Joswiak, Baron Peters, Michael F. Doherty

(717d) Mathematical Modeling and Simulation of Magnetophoresis. Application to Drug Delivery Using Magnetic-Field 340
Meenesh R. Singh, Andreas Linninger

(717f) Polyalkoxylated Alcohols As Excipients for Poorly Soluble Drugs 341
Jin Zhao, Tom Kalantar, Mladen Ladika, Keith Harris, Christopher Tucker, Michael Tulchinsky, Tc Kuo, Joe Kiefer, Xiaoyun Chen, Robert Krystosek

(717g) 2D Printed Product Design of Patient Centric Dosage Forms for Adaptive Clinical Trials 342
Diogo G. Lopes, Wen-Kai Hsiao, Miriam Wimmer-Teubenbacher, Thomas Wutscher, Amrit Paudel, Massimo Bresciani, Patrizia Ghiotti, Frederic Eeckman, Johannes G. Khinast

(720g) How Crystal Specifications Influence Pharmaceutical Tablets? 343
Nastaran Ghazi, Zhanjie Liu, Zhiwei Cao, Chinmay Bhat, San Kiang, Alberto Cuitino

(720a) Using a Focused Beam Reflectance Measurement (FBRM) Probe to Characterize Tablet Disintegration Behavior As a Function of Drug Product Processing Conditions 344
Catherine Metzler, Michael Waldo, Joseph W. Bullard, Katie McCarty, Martha Do

(720b) Finding a Surrogate Material to an Expensive API By Applying a Multivariate Analysis on a Material Database 345
M. Sebastian Escotet-Espinoza, Gerardo Callegari, Marianthi Ierapetritou, Fernando Muzzio

(720c) Statistical Evaluation of Modeling Approaches of Drug Release Profiles for HPMC Matrix Tablets 346
Wenzhao Yang, Jin Zhao, Jaime Curtis-Fisk, Karen Balwinski, True Rogers, Shrikant Khot

(720d) Multivariate Data Analysis of Raw Material Properties from Pharmaceutical Powders for Predicting Compaction Behavior Using Finite Element Method 347
Jens Dhondt, Ashish Kumar, Bernd Van Snick, Johny Bertels, Didier Klingeleers, Chris Vervaet, Thomas De Beer

(720e) Simulation of Particle Dissolution Using the Phase Field Approach 367
Dominik Sleziona, David R. Ely, Markus Thommes

(720f) Optimization of a Low-Dose Dosator Capsule Filling Process for Dry Powder Inhalation (DPI) Applications Using in-Line PAT Approaches 370
Sandra Stranzinger, Eva Faulhammer, Otto Scheibelhofer, Vittorio Calzolari, Stefano Biserni, Amrit Paudel, Johannes G. Khinast

(746a) Application of Radiometric Sensor for Inline Mass Flow Rate Monitoring and Control of a Continuous Tablet Manufacturing Line 380
Sudarshan Ganesh, Qinglin Su, Zoltan K. Nagy, G. V. Reklaitis

(746b) Design Space Development for the Dropping Process of a Dripping Pill with Material Attributes Represented As the Scores from Principal Component Analyses of Spectra Data 381
Xingchu Gong, Jichen Shen, Haibin Qu

(746c) Water Proton NMR for Noninvasive Chemical and Pharmaceutical Analysis 382
Bruce Yu, Marc Taraban, Yue Feng, Katharine Briggs

(746d) Monitoring the Whole Blending End-Point of an-Gong-Niu-Huang Wan Using the QbD Concept 383
Xiaona Liu, Qiusheng Zheng, Xiaoqing Che, Zhisheng Wu, Yanjiang Qiao

(746e) Steady-State Data Reconciliation of a Direct Compression Tableting Line 384
Mariana Moreno, Jianfeng Liu, Sudarshan Ganesh, Qinglin Su, Nima Yazdanpanah, Thomas O'Connor, Carl Laird, Zoltan K. Nagy, Gintaras Reklaitis

(746f) Considerations for Control of Manufacturing Processes for Transdermal Systems FDA Perspective 385
James Norman, Yubing Tang, Sharmista Chatterjee

(746g) Real Time Release Testing Using a Quality Data Management Software - Sipat 386
Pamela Docherty

(762a) Use of a Trickled Bed Reactor to Improve the Commercial Feasibility of the Hydrogenation of a Nitro-Compound 391
Carla Luciani, Jonas Y. Buser, Michael Laurila, Richard Cope, Kevin P. Cole, Bradley M. Campbell, Justin Burt, Martin Johnson, Joseph Martinelli, David Mitchell

(762b) Use of Process Analytical Technology to Gain Mechanistic Insights into Spherical Agglomeration of Active Pharmaceutical Ingredients 392
Kanjakha Pal, Ramon Pena, Daniel Jarmer, Christopher L. Burcham, Zoltan K. Nagy

(762c) Process Dynamics of Continuous Cooling Crystallization of Carbamazepine in a Mixed Suspension Mixed Product Removal (MSMPR) System 393
David A. Acevedo, Xiaochuan Yang, Adil Mohammad, Naresh Pavurala, Wei-Lee Wu, Thomas O'Connor, Sau Lee, Patrick J. Faustino, Zoltan K. Nagy, Celia N. Cruz

(762d) Monte Carlo Stepwise Regression for More Accurate Selection of Critical Process Parameters during Process Characterization 394
Cary F. Opel, Cerintha J. Hui, Patrick Y. Yang, Daniel J. Tien

(762e) Delivering a Design Space for a Continuous Drug Substance Manufacturing Process Using Simulation 395
Neil Hodnett

(762f) Estimating NRTL-SAC Conceptual Segments of Molecules Using Sigma Profile 407
Yifan Hao, M. R. Islam, Meng Wang, Chau-Chyun Chen

(776g) Discrete Element Modeling to Predict Pharmaceutical Powder Flow at Different Humidity Conditions 408
Raj Mukherjee, Sayantan Chattoraj, Chen Mao, Bodhisattwa Chaudhuri

(776a) Long-Term Coating Predictions for in a Wurster Fluidized-Bed Coater with Using a Combined CFD-DEM and Markov-Chain Monte Carlo Approach 409
Peter Toson, Peter Bohling, Maximilian Besenhard, Dalibor Jajcevic, Alan Carmody, Conrad Davies, Pankaj Doshi, Mary T. Am Ende, Avik Sarkar

(776b) Microfluidization as an Enabling Technology for Solubility Enhancement 410
Iris Duarte, Clara Sa Couto, Tiago Porfirio, Joao Vicente, Marcio Temtem

(776c) Droplet-Templated Anti-Solvent Spherical Crystallization of Hydrophilic and Hydrophobic Drugs with an in situÂ Formed Binder 412
Tonghan Gu, Saif A. Khan, T. Alan Hatton

(776d) Study & Control Flow Properties of Ibuprofen from Batch & Continuous Crystallization 413
Yunliang He, Yuan Gao, Brian Glennon, Anne-Marie Healy, Zelalem Worku

(776e) Formation and Dissolution Characteristics of Paracetamol Granules 423
Adetutu Martins, Adewale Lawal, Sheena Reeves

(776f) Size Reduction through Flash Nanoprecipitation to Improve Solubility, Dissolution, and Bioavailability of Clofazimine 424
Yingyue Zhang, Jie Feng, Simon A. McManus, Hoang D. Lu, Kurt D. Ristroph, Robert K. Prud'Homme

(778a) Formulation Strategies for Solid Dispersions Containing Tablets 425
Slavomira Doktorovova, Evelyn Voney, Joao Henriques

(778b) Modeling the Effects of Material Properties on Tablet Compaction a Case Study for Development 426
M. Sebastian Escotet-Espinoza, Shishir Vadodaria, Fernando Muzzio, Marianthi Ierapetritou

(778c) Quality By Design Approaches for Dry Powder Inhalation Products: A Regulatory Perspective 427
Chiaochun J. Wang, Yong Hu, Zhigang Sun

(778d) Effect of Bulk Properties of the Tracer on the Measurement of Residence Time Distributions in Continuous Powder Based Unit Operations 428
Sarang Oka, M. Sebastian Escotet-Espinoza, Andres D. Roman-Ospino, Yifan Wang, Marianthi Ierapetritou, Fernando Muzzio

(778e) Assessing Suspension Homogeneity Using CFD-DEM for Enhanced Content Uniformity of Spray Dried Intermediates 429
Nuno Enes, Luis Eca, Jose Pereira, Ines Matos, Pedro Valente

(778f) Advanced Model Predictive Control of Powder Level in Continuous Pharmaceutical Manufacturing Pilot-Plant 430
Ravendra Singh, Fernando Muzzio, Marianthi Ierapetritou, Rohit Ramachandran

Author Index