

# **North American Mixing Forum 2013**

**Core Programming Area at the 2013 AIChE Annual Meeting:  
Global Challenges for Engineering a Sustainable Future**

**San Francisco, California, USA  
3 – 8 November 2013**

**ISBN: 978-1-63439-048-4**

**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© (2013) by AIChE  
All rights reserved.

Printed by Curran Associates, Inc. (2014)

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

AIChE  
3 Park Avenue  
New York, NY 10016-5991

Phone: (203) 702-7660  
Fax: (203) 775-5177

[www.aiche.org](http://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: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>(70a) Novel High Efficiency Axial Flow Impeller.....</b>   | 1         |
| <i>Robert W. Higbee, Jason J. Giacomelli, Richard K. Grenville</i>  |           |
| <b>(70b) Concentration and Mixing Effects On the Production of Amine Hydrochloride Salts in a Confined Impinging Jet Reactor .....</b>  | <b>2</b>  |
| <i>Navid Ershad, Suzanne Kresta</i>   |           |
| <b>(70c) Characteristics of Fluid Deformation Induced By a Rotationally Reciprocating Impeller.....</b>   | <b>3</b>  |
| <i>Saki Senda, Yoshiyuki Komoda, Hiroshi Takeda, Yushi Hirata, Ruri Hidema, Hiroshi Suzuki</i>  |           |
| <b>(70d) The Netmix Reactor: Heat and Mass Transfer Modeling and Mixing Properties Assessment .....</b>   | <b>6</b>  |
| <i>Carlos M. Fonte, Marcelo F. Costa, Madalena M. Dias, José Carlos B. Lopes</i>  |           |
| <b>(70e) The Simplest Stirred Tank for Laminar Mixing: Mixing in a Vessel Agitated By An Off-Centered and Angled Disc.....</b>  | <b>9</b>  |
| <i>Mario M. Alvarez, David Bulnes-Abundis</i>   |           |
| <b>(70f) Low Power, Baffle-Free Mixing With Contra-Rotating Impellers .....</b>   | <b>10</b> |
| <i>Justin Register, John A. Regalbuto, John R. Regalbuto</i>  |           |
| <b>(70g) New Impeller Type for Significant Mixing Efficiency Improvement and Energy Saving.....</b>   | <b>11</b> |
| <i>Li Wang</i>  |           |
| <b>(132a) An Unusual State During the Production of Solid Stabilized Emulsions in Stirred Tanks: Paste .....</b>  | <b>12</b> |
| <i>Inci Ayrancı, Louis Fradette</i>   |           |
| <b>(132b) Macro-Mixing of the Dispersed Phase in An Immiscible Liquid-Liquid Stirred Reactor .....</b>  | <b>13</b> |
| <i>Chao Yang</i>  |           |
| <b>(132c) The Effect of Particle Shape On the Scale Up of Just Suspended Impeller Speed.....</b>  | <b>14</b> |
| <i>Matthew Dimattesa, Daniel Cendo, Steven Boesch, Arthur W. Etchells, Robert P. Hesketh</i>  |           |
| <b>(132d) Effect of Impeller Submergence, Position, Diameter and Speed On Flow Regime, Surface Air Entrainment and Mixing Effectiveness of Partially Filled Stirred Vessels .....</b> | <b>15</b> |
| <i>Shilan Motamedvaziri, Piero M. Armenante</i>   |           |
| <b>(132e) Drop Breakage By Shear Tip Speed .....</b>  | <b>17</b> |
| <i>Thomas L. Rodgers, Michael Cooke</i>   |           |
| <b>(132f) A Process-Based Analysis On the Generation of Pickering Emulsions .....</b>   | <b>18</b> |
| <i>Emir Tsabet, Louis Fradette</i>  |           |
| <b>(132g) The Taylor Dispersivity of a Passive Tracer in the Pressure-Driven Flow of a Concentrated Suspension of Rigid, Non-Colloidal Spheres .....</b>                              | <b>19</b> |
| <i>Arun Ramachandran</i>  |           |
| <b>(132h) Improving Euler-Granular Models in Multiphase Mixing for Polydispersed Flows .....</b>  | <b>21</b> |
| <i>Brigitte Rosendall</i>   |           |
| <b>(188a) Perspectives On the Use of Simulation and Correlation for Design of Mixed Chemical Reactors.....</b>  | <b>22</b> |
| <i>Gary K. Patterson</i>  |           |
| <b>(248a) Synthesis of Fine Chemicals by Heterogeneous Catalysis: A Critical Approach of the Role of Solvent for Hydrogenation Reactions .....</b>                                    | <b>23</b> |
| <i>Carlos Pesteguía</i>   |           |
| <b>(259a) Laminar Flow Pattern and Heat Transfer in a Vessel With Eccentrically Positioned Multiple Inclined Blade Impellers .....</b>  | <b>24</b> |
| <i>Mathijs Koot, Harry E. A. Van Den Akker</i>  |           |
| <b>(259b) The Effects of a Spatially Variant Velocity Field On Stretching: Intuitive Measures.....</b>  | <b>25</b> |
| <i>David Bigio, Jason Nixon</i>   |           |
| <b>(259c) Measuring Blend Time In Laboratory Agitated Vessels: A Case for the Acid-Base-Indicator Method.....</b>   | <b>26</b> |
| <i>Julian B. Fasano, Kevin J. Myers, Eric E. Janz</i>   |           |
| <b>(259d) The Confined Impeller Stirred Tank: Blend Time.....</b>   | <b>27</b> |
| <i>Marcio Bezerra Machado, Suzanne Kresta</i>   |           |
| <b>(259e) Mixing Time in Partially Filled Stirred Vessels .....</b>   | <b>28</b> |
| <i>Shilan Motamedvaziri, Piero M. Armenante</i>   |           |
| <b>(259f) Impeller Placement Optimization; Mixing Versus Mechanical Shaft Fatigue .....</b>   | <b>29</b> |
| <i>Sang Jin Lee, Robert Higbee, Binxin Wu</i>   |           |
| <b>(259g) Simulations of Mobilization of Bingham Layers in Agitated Tanks .....</b>   | <b>30</b> |
| <i>Jos Derkzen</i>  |           |

|  |    |
|--|----|
| <b>(316a) Formation of Poly(<math>\epsilon</math>-caprolactone) Nanoparticles in Microstructured Mixers Via Solvent Replacement Precipitation: Fundamental Studies and Scale-Up Concepts .....</b> | 31 |
| <i>Andreas Kölbl, Abdul Qayyum, Manfred Kraut, Roland Dittmeyer</i>  |    |
| <b>(316b) Bioreactor Simulation With Cuda .....</b>  | 32 |
| <i>Christian Witz, Tawan Tantikul, Johannes G. Khinast</i>   |    |
| <b>(316c) Characterization of Kla Using Definitive Screening Designs for Fermentation Development and Scale-Up .....</b>   | 34 |
| <i>Dogan Ornek, Rayford Anderson, Michelle Chopra, Wenglong Lin, Philip Ramsey</i>   |    |
| <b>(316d) Scaling Down the Production of Biopharmaceuticals to Continuous Micro-Chips .....</b>  | 35 |
| <i>Mario M. Alvarez, Leydi Maribel Carrillo-Cocom, Lucía D. Garza-García, Eduardo J. Tapia-Mejía, Sergio Camacho-León, Ciro Angel Rodríguez-González, Erika García-López</i>                       |    |
| <b>(316e) Computing Dissolved Oxygen Profiles in Aerobic Fermenters .....</b>  | 36 |
| <i>Gopal Kasat, Damodaran Vedapuri, Gregory Benz</i>   |    |
| <b>(316f) Hydrodynamic Effects of An Arch-Shaped Fiber Optic Probe in a USP Dissolution Testing Apparatus 2 .....</b>  | 37 |
| <i>Yiran Zhang, Gerard Bredael, Piero M. Armenante</i>   |    |
| <b>(371a) Towards the Combination of Modeling Strategies for Solid-Liquid Mixing .....</b>   | 38 |
| <i>Bruno Blais, Francois Bertrand</i>  |    |
| <b>(371b) CFD Modeling of Viscoelastic Droplet Breakup .....</b>   | 40 |
| <i>Laura J. Dietsche, Nilesh Parmar</i>  |    |
| <b>(371c) Hybrid Multiphase CFD Simulation for Interfacial Area Prediction in Liquid-Liquid Extraction .....</b>   | 41 |
| <i>Kent E. Wardle</i>  |    |
| <b>(371d) Determination of Drop Size Distribution in Turbulently Agitated Liquid-Liquid Dispersion Using Numerical Simulations .....</b>   | 42 |
| <i>Alexandra E. Komrakova, Dmitry Eskin, Jos Derkens</i>   |    |
| <b>(371e) CFD Simulation of Integrated Physical and Biological Processes for Anaerobic Digestion .....</b>   | 43 |
| <i>Binxin Wu</i>   |    |
| <b>(371f) Application of a Combination of Statistical Techniques and Mechanistic Modeling to the Mixing Process in Co-Rotating Twin Screw Extruders .....</b>                                      | 44 |
| <i>Osaihe Kennedy Amedu</i>  |    |
| <b>(371g) Computational Study of Solids Mixing in Flotation Cells Using CFD-DEM Simulations .....</b>  | 45 |
| <i>Manjunath Basavarajappa, Sanja Miskovic</i>   |    |
| <b>(371h) Erosion of Granular Beds - Solids Suspension Mechanisms .....</b>  | 46 |
| <i>Jos Derkens</i>   |    |
| <b>(467a) Experimental Investigation of Multiphase Mixing in Annular Centrifugal Contactors Using High-Speed Imaging and Electrical Resistance Tomography (ERT) .....</b>                          | 47 |
| <i>Kent E. Wardle</i>  |    |
| <b>(467b) Mixing Performance of a Bioreactor .....</b>   | 48 |
| <i>Sally Mattar, Marcio Bezerra Machado, Suzanne Kresta, Dominic Sauvageau</i>   |    |
| <b>(467c) Gas Dispersion With Up-Pumping Maxflo W Impellers .....</b>  | 49 |
| <i>Muneeb Ur Rahman Shaik, Kevin J. Myers, Eric E. Janz</i>  |    |
| <b>(467d) The Simulation of Solid Suspension By Using Scaba and A310 .....</b>   | 50 |
| <i>Ruey Chi Hsu, Jer Chang Kang</i>  |    |
| <b>(467e) Improved Mixing and Mass Transfer Scale-Up: Design &amp; Characterization for Cell Culture in Single Use Bioreactors .....</b>   | 51 |
| <i>Nephi Jones, Christopher Brau</i>   |    |
| <b>(467f) Foamless and Bubble Free Dynamic Gas-Liquid Mixing in Cell Culture Bioreactor .....</b>  | 52 |
| <i>Alan Cheng, Ying Zhou</i>   |    |
| <b>(467g) Vortex Generation With Submerged Baffles: Comparison Of Two Scales .....</b>   | 53 |
| <i>Jason J. Giacomelli, Wojciech Wyczalkowski</i>  |    |
| <b>(476a) Computational Fluid Dynamic Simulations of Gas-Liquid and Liquid-Liquid Flow in An Advanced-Flow Reactor (AFR) .....</b>   | 54 |
| <i>Maria Jose Nieves-Remacha</i>   |    |
| <b>(476b) Uncertainty Quantification in Coal Gasifier Simulations For Reliable Predictive Computational Fluid Dynamics Models .....</b>  | 57 |
| <i>Aytekin Gel, Mehrdad Shahnam, Arun K. Subramanyan</i>   |    |
| <b>(476c) Experimental and CFD Study of Methane Steam Reforming in a Catalytic Plate Reactor and Characterization of the Coated Noble Metal Catalyst .....</b>                                     | 59 |
| <i>Mayur Mundhwa, Brant. A. Peppley, Christopher P. Thurgood</i>   |    |

|  |    |
|--|----|
| <b>(476d) Three Dimensional CFD-Based Numerical Study of Chemically Reacting Carbon Particles Within a Randomly Packed Bed.....</b>  | 60 |
| <i>Sebastian Schulze, Petr A. Nikrityuk, Bernd Meyer</i>   |    |
| <b>(476e) Development of a Methodology to Obtain the Kinetic Mechanism of Steam Methane Reforming Compact Reactor Using CFD Coupled With Hybrid Genetic/Surface Response Optimization Model.....</b> | 61 |
| <i>Rodrigo P. M. Moreira, Lucilla Almeida, Raphael David A. Bacchi, Karolline Ropelato, Fabio M. Passarelli, Erick F. A. Quintella Coelho, Antonio Marcos F. Bidart</i>                              |    |
| <b>(476f) Numerical Investigation of Packed Bed Reactors With Non-Spherical Particles.....</b>   | 62 |
| <i>Thomas Eppinger, Nico Jurtz, Matthias Kraume</i>  |    |
| <b>(476g) Computational Fluid Dynamics for the Analysis and Optimization of a Lab-Scale Stirred Tank Reactor With Catalytic Basket .....</b>   | 64 |
| <i>Cláudio P. Fonte, Maria Braga, Léna Brunet-Errard, Isabelle Pitault, Serge Simoëns, Claude De Bellefon, Vania Santos-Moreau, José Carlos B. Lopes</i>   |    |
| <b>(578a) CFD Model of Suspension Polymerization in Mixed Reactors.....</b>  | 65 |
| <i>Michal Vonka, Miroslav Soos, Massimo Morbidelli</i>   |    |
| <b>(578b) Simulation of Mixing in Hot Melt Extruders Using Smoothed Particle Hydrodynamics .....</b>   | 66 |
| <i>Andreas Eitzlmayr, Stefan Radl, Gerold Koscher, Johannes G. Khinast</i>   |    |
| <b>(578c) Investigation of Single and Multiphase Fluid Flow Behavior in Stirred Tanks By Means of CFD and Radioactive Particle Tracking.....</b>   | 68 |
| <i>Hamed Bashiri, Ebrahim Alizadeh, François Bertrand, Jamal Chaouki, Mourad Heniche</i>   |    |
| <b>(578d) Computational Fluid Dynamics Investigation of Mechanical Mixing in Anaerobic Bioreactors .....</b>   | 69 |
| <i>Jia-Jun Wang, Chun-Yan Ge, Xue-Ping Gu, Lian-Fang Feng, Binxin Wu</i>   |    |
| <b>(578e) Validation of Openfoam Solver for Mixing Tank Analysis.....</b>  | 70 |
| <i>Gopal Kasat, Damodaran Vedapuri, Pritam Hule, Yogesh Bapat</i>  |    |
| <b>(578f) Steady State CFD for Determining Just Suspended Speed .....</b>  | 71 |
| <i>David C. Russ, R. Eric Berson</i>   |    |
| <b>(578g) Discrete Tangent Based Sensitivity Analysis Method in Computational Fluid Dynamics (CFD) for Stirred Tank Reactors.....</b>  | 72 |
| <b>Author Index</b>  |    |