

# **Residuals and Biosolids 2017 Conference**

Seattle, Washington, USA  
8 - 11 April 2017

Volume 1 of 2

ISBN: 978-1-5108-6297-5

**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 Water Environment Federation (WEF)  
All rights reserved.

Printed by Curran Associates, Inc. (2018)

For permission requests, please contact Water Environment Federation (WEF)  
at the address below.

Water Environment Federation (WEF)  
601 Wythe Street  
Alexandria, Virginia 22314  
USA

Phone: 1-800-666-0206  
Fax: 1-703-684-1545

[csc@wef.org](mailto:csc@wef.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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## VOLUME 1

### SESSION 1

<b>Understanding the Role of Mixing and Viscosity in Rapid Volume Expansion Due to Gas Holdup in Anaerobic Digesters</b> .....	1
<i>Nick Bartek, Matthew J. Higgins, Sudhir N. Murthy, Steven Beightol, Ahmed Al-Omari</i>	
<b>Quantification of Struvite Content of Biosolids is Necessary to Avoid Bias in the Assessment of Digester and Dewaterability Performance</b> .....	12
<i>Alexandria A. Gagnon, Christopher A. Wilson, Wendell Khunjar, Ron Latimer, Jeff Nicholson, Charles Bott</i>	
<b>Driving Operational Improvement Through the Use of Dashboards: A Regional Biosolids Pelletizing Facility Perspective</b> .....	19
<i>Amber M. Batson, Raymond H. Schauer, Scott Trainor</i>	
<b>The Trials and Tribulations of Commissioning a Large Biosolids Facility; An Operational Perspective</b> .....	35
<i>Kenneth Schnaars, Terry Highsmith</i>	

### SESSION 2

<b>Optimising THP - The Intermediate Thermal Hydrolysis Process</b> .....	42
<i>Ester Rus, Aurelien Perrault, Nick Mills, Achame Shana, Paul J. Nilsen, O Molokwu</i>	
<b>Solubilization of Organics Due to Thermal Hydrolysis Pretreatment Leading to Stable Mesophilic Anaerobic Digestion</b> .....	50
<i>Manisha Berde, Domenec Jolis</i>	
<b>Does Operation At Increased Ammonia Concentration Impact Hydrolysis Rates?</b> .....	60
<i>Baoqiang Li, Adrian Romero, Elizabeth Manning, Matthew Higgins, Ahmed Al-Omari, Sudhir Murthy, Rumana Riffat, Haydée D. Clippeleir</i>	
<b>Are Thermal Hydrolysis Digesters Robust Because of Their Unique Microbial Communities?</b> .....	64
<i>Joshua Mah, John Novak, Kaisen Lin</i>	
<b>Free Nitrous Acid Pretreatment of Thickened Waste Activated Sludge Improves Anaerobic Degradability</b> .....	75
<i>Elsayed Elbeshbishy, Frances Okoye, Dang Ho, Siva Sarathy, Wayne Parker</i>	
<b>Thermal Hydrolysis Reduces Carbon Footprint of Biosolids Treatment</b> .....	85
<i>William Barber</i>	
<b>Batch Vs. Continuous Thermal Hydrolysis: Which Is Right For You?</b> .....	106
<i>Chris Thomson, Rich Dimassimo, Robert Clay, Sudhakar Viswanathan, Jongmin Kim, Nicholas Landes</i>	

### SESSION 3

<b>Pilot-scale Evaluation Of Airprex® For Digestate Treatment</b> .....	119
<i>Blair Wisdom, Brad Van Anderson, Isaac Avila, Troy Gottschalk, Kurt Carson, Liam Cavanaugh</i>	
<b>Enhanced Dewatering with Struvite Recovery: Pilot Testing of AirPrex® Technology at Miami's South District WWTP</b> .....	139
<i>Brian D. Stitt, Terry Goss, Manual Moncholi, Mohammad Abu-Orf, BrianIsmael Diaz</i>	
<b>Construction and Startup Lessons of the Rocky Mountain</b> .....	155
<i>Tom Dingemen, Matt Gough, Sean Cooney, Adam Parmenter</i>	
<b>Roadmap for Setting Up an Optimal Treatment Train Configuration for Nutrient Recovery from (Digested) Residuals</b> .....	166
<i>Céline Vaneekhaute, Evangelina Belia, Erik Meers, Filip Tack, Peter Vanrolleghem</i>	
<b>Utilization Of Municipal Waste And Biosolids As Sources Of Phosphorus For Land Restoration Projects</b> .....	173
<i>Principal Mdolo, Magnús H. Jóhannsson</i>	
<b>Extractive Nutrient Recovery is aViable Nutrient Control Alternative for Water Resource Reclamation Facilities</b> .....	185
<i>Wendell Khunjar, Ronald Latimer, Samuel Jeyanayagam, Chirag Mehta, Damien Batstone</i>	

## **SESSION 4**

<b>Selection of a Thermal Hydrolysis Process for The City of Calgary's Bonnybrook Wastewater Treatment Plant</b> .....	196
<i>Jennifer Peters, Kari MacDonald, Kim Fries, Ryan Roberts</i>	
<b>Reinventing Your Biosolids Management Program and Unlocking Resource Recovery with Thermal Hydrolysis - The City of Raleigh's Journey</b> .....	217
<i>C M. Bullard, Amy Hanna, Greg Knight, Kent Lackey, Brenan Buckley, Perry Schaefer, T. J. Lynch, Aaron Browe</i>	
<b>A Commitment to Improving the Odors of DC Water Biosolids Leads to Improved Acceptance</b> .....	234
<i>Bill Brower, Christopher Peot, Al Razik</i>	
<b>Developing a Large-scale CAMBI Biosolids Marketing and Distribution Program</b> .....	247
<i>Ronald A. Alexander, Chris Peot</i>	

## **SESSION 5**

<b>Business Case Concept Portfolio Supporting a 90 dtpd Biosolids Reuse Program</b> .....	251
<i>Alicia Gilley, Steve Rogowski</i>	
<b>Biosolids on Trial -- Recent Litigation Wins for Land Application</b> .....	264
<i>James B. Slaughter</i>	
<b>Creating Cost-Effective Centralized Solids Management</b> .....	269
<i>Perry L. Schafer, Natalie Sierra, Steve Wilson</i>	
<b>High-Tech Analysis of Low-Cost,Low-Tech Methods for Sustainable Class A Biosolids Production: Set up and Initial Pilot-Scale Data</b> .....	280
<i>Christa L. Meingast, Jennifer Becker, Eric Seagren</i>	
<b>Bay Area Biosolids to Energy (BAB2E) Coalition: The San Francisco Bay Area's Regional Approach to Biosolids Management</b> .....	292
<i>Sarah A. Deslauriers</i>	

## **SESSION 6**

<b>Developing Biosolids Based Bioretention Soils for Green Stormwater Infrastructure</b> .....	297
<i>Julia G. Jay, Sally Brown</i>	
<b>Biosolids Reuse: Continuous Flow-Through Column Testing of Biosolids-Derived Biochar to Sorb Micropollutants</b> .....	302
<i>Lee K. Kimbell, Yiran Tong, Anna Avila, Brooke K. Mayer, Patrick J. McNamara</i>	

## **SESSION 7**

<b>Trace Organic Contaminants in Biosolids: Recent Survey, Risk Analysis and Communication Tools</b> .....	306
<i>Kate Kurtz, Roberta King, Ashley Mühle, Sally Brown, Mark Cullington, Heather Brunelle, Laura Kennedy, Dana Devin-Clarke, Maile Lono-Batura</i>	
<b>PBDEs in Class A Biosolids Produced from Thermal Hydrolysis and Anaerobic Digestion Processes</b> .....	318
<i>Xuanzhao Wang, Natasha A. Andrade, Alba Torrents, Mark Ramirez, Chris Peot</i>	
<b>Hydrothermal Processes For Simultaneous Bioenergy Recovery And Destruction Of Bioactive Microconstituents From Biosolids</b> .....	329
<i>Young Hwan Shin, Lance Schideman, Yuanhui Zhang, Peng Zhang, Michael Plewa, John Scott</i>	

## **SESSION 8**

<b>Can Autocatalytic Pyrolysis of Wastewater Biosolids be Energy Neutral and Generate Value-added Products?</b> .....	360
<i>Zhongzhe Liu, Simcha Singer, Daniel Zitomer, Patrick McNamara</i>	
<b>How the City of Lebanon TN Implemented Gasification for Biosolids Disposal and Power Generation</b> .....	365
<i>Jeff Snyder</i>	
<b>Innovative Technology Reduces Mercury Emissions to Keep Ohio's Sewage Sludge Incinerators Hot and Costs Cool</b> .....	371
<i>Connor Smith, Scott D. Reed, Robin Rupe, Sara Cramer</i>	

<b>Triple Bottom Line Analysis of Energy Recovery from Thermal Oxidation of Wastewater Solids Compared to Coal</b> .....	401
<i>Anna J. Munson, Webster F. Hoener, Robert P. Dominak, James E. Welp</i>	
<b>Sewage Sludge Gasification as an Alternative to Incineration</b> .....	415
<i>Andrew Jones</i>	
<b>Duffin Creek and Cleveland Experience - Two New Fluid Bed Sewage Sludge Incinerators Equipped with State of the Art Equipment</b> .....	428
<i>Euan Ferguson, Brad Dobson, Ky Dangtran, Levent Takmaz</i>	

## **SESSION 9**

<b>Can We Overcome Hydrolysis Limitation by Better Understanding the Impacts of Physics Within Anaerobic Digestion?</b> .....	437
<i>Elizabeth Manning, Adrian Romero, Baoqiang Li, Ahmed Al-Omari, Matthew Higgins, Rumana Riffat, Sudhir Murthy, Haydee De Clippeleir</i>	
<b>A Review of Rapid Volume Expansion Research and Development of Design Methodologies for Mitigation in Full-Scale Digesters</b> .....	444
<i>Steven J. Krugel, Thomas Chapman, William Persich</i>	
<b>Making Room for Energy Neutrality</b> .....	484
<i>Michael Theodoulou, Dorian Harrison, Nicholas Bonkoski</i>	
<b>Application of Rheological Data for Non-Newtonian Sludges; Use of the “Differential Viscosity” for Mixing Simulations and System Friction Calculations</b> .....	496
<i>Marilyn Pine, Kent Keeran, Glenn Dorsch</i>	
<b>Digester Cover Selection and Safety: Balancing Risk and Reward</b> .....	512
<i>John Maley, Benjamin Miller, Matthew J. Williams</i>	
<b>Parameters Influencing Anaerobic Digestion Of Sewage Sludge</b> .....	531
<i>Stefano Giacalone, Peter Winter, Stephen Smith</i>	
<b>Extracting Energy from Sludge in the UK: Recent Experience</b> .....	550
<i>Keith M. Panter, Bill Barber</i>	

## **SESSION 10**

<b>Innovative Biosolids Conditioning Ahead of Belt Filter Presses to Improve Cake Solids Dewatering</b> .....	555
<i>John H. Rickermann, Charles Volk</i>	
<b>A Laboratory Based Method for Predicting Dewaterability</b> .....	566
<i>Zwelani Ngwenya, Matthew Higgins, Steven Beightol, Sudhir Murthy</i>	
<b>Paradigm Shift if Dewatering Operations Moved to the Center of the Plant Universe</b> .....	583
<i>William Wehner, Murthy Kasi, Mario Benisch, Anthony Perriera, James Wodrich</i>	
<b>Dewatering Biosolids with a Volute Press at Two Biological Nutrient Removal Wastewater Treatment Plants in Montana</b> .....	600
<i>Rickey Schultz</i>	
<b>Piloting to Establish Performance Criteria at Miami’s South District WWTP</b> .....	613
<i>Charles T. Goss, Brian Stitt, Manuel Moncholí, Mohammad Abu-Orf, Ismael Diaz</i>	
<b>Reducing Dewatering Costs Through an Optimization Program</b> .....	633
<i>Rashi Gupta, Steve Walker, Mike Brehm, Bryan Stevenson, Ken Tagney, Matthew Verosik</i>	

## **VOLUME 2**

<b>Screw Press Maximum Dewaterability and Energy Consumption</b> .....	642
<i>Edward W. Fritz, Dieter Weinert, Harald Neumann</i>	

## **SESSION 11**

<b>Challenges and Opportunities for Approaching Net Zero Energy and Improving Resiliency of a Unique Solids Handling Facility in California</b> .....	650
<i>Irina Lukicheva, Dan Frost, Nitin Goel, Peter Burrowes, Summer Bundy, Jamie Pigott</i>	
<b>State of the Art Review of Digester Gas Treatment and Upgrading Technologies</b> .....	679
<i>Christine A. Polo, Kevin Jankowski, Cary Solberg, Jay Kemp, Greg Knight, Dave Long</i>	

<b>From Biogas to Boiler Fuel: Cleaning Up Digester Gas Biologically at a Large Scale</b> .....	700
<i>Melissa Woo, Tom Jacobs, Samir Mathur</i>	
<b>To Treat, Or Not To Treat (Post Combustion Exhaust), That Is The Question</b> .....	720
<i>Jason R. Wiser, James Schettler, Don Trueblood, Mike Prinz, Phil Heck</i>	
<b>Evaluation of Biogas-to-Energy Options for Edmonton’s Gold Bar Wastewater Treatment Plant</b> .....	735
<i>Nicholas T. Szoke, Alfredo Suarez</i>	
<b>Stirling Engine Co-Gen: Gas Scrubbing Not Required</b> .....	754
<i>Brian R. Mitchell, Michael Moe, Keith Albretson</i>	

## **SESSION 12**

<b>Update on Biogas Upgrading Project for City Of Portland</b> .....	762
<i>Vu Han, Paul Suto, Jeremy Holland, Muriel Gueissaz-Teufel</i>	
<b>A Greener Future for The City Of Raleigh Turning Biosolids Into Vehicle Fuel</b> .....	780
<i>Greg Knight, Michael Bullard, Kent Lackey, Christine Polo, Jay Kemp, Aaron Brower, TJ Lynch</i>	
<b>What's The Best Use Of Your Digester Gas? Well, It Depends</b> .....	795
<i>Ian McKelvey, Eron Jacobson, Peter Zemke, John Smyth</i>	
<b>Biogas Testing: Critical Techniques To Minimize Capital And Operating Costs</b> .....	817
<i>Jeremy Holland</i>	
<b>Next Generation Resource Recovery: Co-Digestion to Renewable Natural Gas (RNG) Pipeline Injection at the Des Moines WRF</b> .....	827
<i>Dustin L. Craig, Larry Hare, Laurel Schaich</i>	
<b>Converting Biogas into Energy and Vehicle Fuel</b> .....	829
<i>Adam Klaas</i>	
<b>Power or Fuel: Renewable Natural Gas a Feasible Alternative</b> .....	834
<i>Trung Le, Joseph Marino, Trent Montemayor, Jacob Klosinski</i>	

## **SESSION 13**

<b>Using a Chemically Hydrolyzed Biosolids for Co-digestion</b> .....	839
<i>Joshua Registe, Josh Perez, Jeanette Brown, Robert Sharp, George Nakhla, Ajay Singh</i>	
<b>Kenosha’s Energy-Optimized Resource Recovery System</b> .....	850
<i>Joseph Hughes, Andreas Duennebeil</i>	
<b>Reducing Sludge Viscosity and Improving Dewaterability through a Thermochemical Hydrolysis Process</b> .....	862
<i>Peiyu Tan, Zhongtian Li</i>	
<b>The Sludge Ozonation for Different Types of Mixed Liquor Under High and Low pH Conditions by a Plug-flow Reactor</b> .....	872
<i>Xiaoyu Zheng, Eric R. Hall</i>	
<b>A Tale of Two Cities: How Climate, Drivers, and Budget Affect Thermal Hydrolysis Design</b> .....	883
<i>Thomas Nangle, Kristina Warren</i>	

## **SESSION 14**

<b>Planning Your Class A Biosolids Program: Design Considerations And Lessons Learned In Pierce County, Washington</b> .....	905
<i>Melissa Newell</i>	
<b>Beginning a Complete Renewal of San Jose-Santa Clara Regional Wastewater Facility’s Biosolids Processing Facilities</b> .....	911
<i>Adam Ross, Mariana Chavez-Vazquez, Lloyd Slezak, Alicia Alba</i>	
<b>Sustainable and Cost Effective Biosolids Management Planning at OCSO</b> .....	931
<i>Daniel F. Buhrmaster, James H. Clark, Tom Chapman, Natalie Sierra, Sharon Yin, Tom Meregillano</i>	
<b>Comprehensive Biosolids and Bioenergy Planning</b> .....	957
<i>Cameron Clark, Irina Lukicheva, Anna James, Kathy Rosinski, Dave Parry</i>	
<b>Biosolids Trends In Tennessee: A Roadmap For The Future?</b> .....	972
<i>Robert G. Odette</i>	

<b>A Big Picture Approach to Addressing Multiple Improvement Triggers for both Short- and Long-term Multi-Facility Master Planning .....</b>	<b>984</b>
<i>Vera Gouchev, Paul Knowles, Robert Sharp, Emanuel Psaltakis, Thomas Lauro</i>	

### **SESSION 15**

<b>Mechanistically Understanding the Dewatering Fundamentals: Impact of Biological Systems and Thermal Hydrolysis on Cake Total Solids &amp; Polymer Demand .....</b>	<b>997</b>
<i>Mahmudul Hasan, Qi Zhang, Rumana Riffat, Ahmed Al-Omari, Sudhir Murthy, Matthew J. Higgins, Haydee De Clippeleir</i>	
<b>Phosphorus Release and Thermal Hydrolysis Pretreatment Effects on the Dewatering Properties of a Bio-P Biosolid in Anaerobic Digestion .....</b>	<b>1002</b>
<i>Jeffrey D. Nicholson, Steven Beightol, Matthew J. Higgins, Charles B. Bott</i>	
<b>The Role of Soluble P &amp; EPS on Dewatering Performance .....</b>	<b>1007</b>
<i>Ester Rus, Paul Fountain, Nick Mills, Achame Shana, Obinna Molokwu, Manocher Asaadi</i>	

### **SESSION 17**

<b>Development of Kodiak Alaska's Successful Composting Program .....</b>	<b>1025</b>
<i>Todd O. Williams, Bud Alto, Floyd Damron, Mark Kozak, Lori Aldrich</i>	
<b>Using Lime to Beneficially Manage Wastewater Treatment Plant Residuals: A Review and Assessment of the Practice for Producing an Exceptional Quality Product .....</b>	<b>1032</b>
<i>James E. Smith Jr, A. R. Rubin, Harry L. Francis, Robert S. Reimers</i>	
<b>Producing High Value Carbon Products From Municipal Solids Generated From Chemically Enhanced Primary Treatment .....</b>	<b>1052</b>
<i>Wendell Khunjar, Eirene Pavlakis, Kartik Chandran, Christopher Wilson</i>	
<b>Class B Land Application: A Long-term, Highly Successful Public-Private Partnership .....</b>	<b>1056</b>
<i>Jake Finlison, Dave Ruud, Andrew Bary, Maile Lono-Batura</i>	
<b>Biosolids Products for Urban Agriculture .....</b>	<b>1065</b>
<i>Sally Brown, Kristen McIvor, Dan Thomspson</i>	
<b>The Effect of External Substrate (Pure Glycerol), SRT, pH and Mixing Intensity on VFA Production in Bench-Scale Fermenters .....</b>	<b>1070</b>
<i>Marzieh Ghasemi, Andrew A. Randall</i>	
<b>Vermicomposting of Biosolids and Beneficial Reuse - New Zealand Commercial Case Studies from 4 Communities over 8 Years .....</b>	<b>1084</b>
<i>Michael Quintern, Max Morley</i>	

### **SESSION 18**

<b>Know What You Don'T Know - Using Social Media And Market Research To Inform Loop Communication Strategies .....</b>	<b>1099</b>
<i>Ashley Mihle</i>	
<b>Class "A" Part Two. After Achieving Class A Designation, Our Path ToBuilding A Sustainable Class A Program .....</b>	<b>1137</b>
<i>Shannon Ostendorff, Scott Thompson, Tim Truax</i>	
<b>A Strong Network: The Success of Regional Biosolids Groups in North America .....</b>	<b>1148</b>
<i>Maile Lono-Batura, Ned Beecher</i>	
<b>Not All Dryer Products are Created Equal .....</b>	<b>1163</b>
<i>Lisa Boudeman</i>	
<b>Merging Innovation and Resource Recovery into Daily Operations .....</b>	<b>1170</b>
<i>Manon Fisher, Natalie Sierra, Ben Jordan, Karri Ving</i>	

### **SESSION 20**

<b>Anaerobic Codigester Feeding Pattern Drives Long-chain Fatty Acid Bioconversion Kinetics and Syntrophic Community Structure .....</b>	<b>1186</b>
<i>Ryan M. Ziels, David A. Beck, H. David Stensel</i>	
<b>Resource Recovery Cooperative for the Security of Consistent, High Quality Codigestion Feedstock .....</b>	<b>1202</b>
<i>David E. McNeil</i>	

<b>Codigestion Study Helps Turn Industrial Pre-Treatment Problem to Renewable Energy Benefit</b> .....	1209
<i>Scott Hardy, David Ornelas, Edward Keenan, Brandt Miller, Michelle Brown, Chamindra Dassanayake, Spyros Pavalostathis, Mohammad Abu-Orf</i>	
<b>Effects of Biosolids Addition and Alkalinity Sources on High-Solids Anaerobic co-Digestion (HS-AcD) of Food Waste and Green Waste</b> .....	1219
<i>Phillip Dixon, Paula Bittencourt, Eunyong Lee, Meng Wang, Eduardo Jimenez, Qiong Zhang, Sarina Ergas</i>	
<b>Lifting the Fog from FOG Receiving</b> .....	1236
<i>Rashi Gupta, Daniel Meacham, Phil Parkins, Travis A. Peacock, Anthony L. Montoya</i>	
<b>Synergistic Effects of Codigesting Preprocessed Food Waste Slurry</b> .....	1255
<i>Michael P. Keleman, Mingu Kim, Mohammad M. Chowdhury, George Nakhla</i>	

**ADDITIONAL PAPERS**

<b>Cleveland Experience - Three New Fluid Bed Munciple Sludge Incinerators and a Steam Turbine to Generate Power</b> .....	1259
<i>D. Hancock, T. Shively, T. Vasel, K. Dangtran, L. Takmaz</i>	
<b>Detailed Market Analysis Helps Focus Capital Decisions for Orange County Sanitation District</b> .....	1270
<i>Natalie Sierra, Ron Alexander, Steve Wilson, Deirdre Bingman, Tom Meregillano, Sharon Yin, Jeff Mohr, Daniel Buhrmaster</i>	
<b>Author Index</b>	