

Air & Waste Management Association

Power Plant Air Pollutant Control “Mega” Symposium 2006

August 28 – 31, 2006
Baltimore, Maryland, USA

Volume 1 of 3

Printed from e-media with permission by:

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

ISBN: 978-1-60423-719-1

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

Copyright Information

Proceedings of the EPA-DOE-EPRI-A&WMA Power Plant Air Pollutant Control
"Mega" Symposium 2006.
CP-149-CD

Publication Policy

This compact disk contains technical papers presented at the EPA-DOE-EPRI-A&WMA Power Plant Air Pollutant Control "Mega" Symposium, held August 28-31, 2006, in Baltimore, MD. The information and opinions expressed in these papers are solely of the authors and should not be considered as having the endorsement or support of the Association.

Compilation Copyright ©2006 by the Air & Waste Management Association.
Copyright of the individual papers are retained by the authors. Published in August 2006.

Manufactured in the United States of America

Additional copies of this CD-ROM and the proceedings of previous conferences are available through the A&WMA Online Library. To place an order, please visit the Online Library at <http://www.awma.org/OnlineLibrary/> or contact the A&WMA Publications Order Department at onlinelibrary@awma.org or +1-412-232-3444.

For a complete listing of books, CDs, and educational materials offered in the Online Library, visit our Web Site, or contact the Publication Department at onlinelibrary@awma.org or +1-412-232-3444.

Air & Waste Management Association
Power Plant Air Pollutant Control “Mega” Symposium
2006

TABLE OF CONTENTS

Volume 1

U.S. DOE™s Hg Control Technology RD&D Program - Making Great Strides, But More to Be Done . . .	1
<i>Tom Feeley</i>	
Clean Air Mercury Rule: Multipollutant Approach to Power Plant Pollution	11
<i>Jason Burnett</i>	
Status of States Strategies to Address Mercury Emissions from Coal-Fired Power Plants.....	36
<i>Praveen Amar</i>	
Canada Wide Standards Mercury Measurement Methodologies for Coal-fired Power Plants.....	60
<i>Eric Mazzi</i>	
Mercury Control from Power Plants.....	81
<i>Ramsay Chang</i>	
TOXECON™ Clean Coal Demonstration for Mercury and Multi-Pollutant Control at We Energies Presque Isle Power Plant	95
<i>Steven Derenne, Paul Sartorelli, Jean Bustard, Robin Stewart, Richard Schlager, Sharon Sjostrom, Ramsay Chang, Ron Utter, Jeffrey Cummings, Ted McMahon, Fred Sudhoff</i>	
Multi-Pollutant Emissions Control with SDA/FF Technology at Black Hills Power	114
<i>Bryan J. Jankura, Kevin E. Redinger, Scott A. Renninger, Royd Warren, Mark L. Lux</i>	
Field Testing of Activated Carbon Injection Options for Mercury Control at TXU™s Big Brown Station	115
<i>John Pavlish, Jeff Thompson, Chris Martin, Bob Wiemuth, Sara Pletcher</i>	
Enhanced Vapor Phase Mercury Removal Using Activated Carbon Injection Across the Indigo Agglomerator	130
<i>Mark Berry, Theron Furr, Rodney Truce, Bob Crynack, Ralph Altman, Kenneth Cushing, Wallis Harrison, Robert Glesmann</i>	
Mercury Reduction in Coal Fired Power Plants using MinPlus Sorbent through Furnace Sorbent Injection.....	148
<i>Joep J.P. Biermann, Brian Higgins, Peter Hoeflich, Bruce W. Ramme</i>	
New Full-Scale Results from B-PAC Control Trials.....	166
<i>Ronald R. Landreth, Sid Nelson Jr., Xin Liu, Zhong Tang, Jon E. Miller, Peter C. Hoeflich, Gary Moore, Lynn A. Brickett</i>	
Demonstration of Amended Silicates™ for Mercury Control at Miami Fort Station	183
<i>James R. Butz, Thomas E. Broderick, J. Michael Geers</i>	
Field Evaluations of Carbon Sorbents.....	199
<i>Nicholas Pollack, Ward Rogers, David Fair, Trevor Ley</i>	
TOXECON I™ and High-Temperature Reagents or Sorbents for Low-Cost Mercury Removal	210
<i>David Muggli, C. Jean Bustard, Tom Campbell, Richard Schlager, Andrew O™ Palko, Ramsay Chang, Richard Roberts, Mike Kolbus, Mike Rees</i>	

Impact of Coal Blending and SO₃ Flue Gas Conditions on Mercury Removal with Activated Carbon Injection at Mississippi Power™'s Plant Daniel	232
<i>Mark Berry, Richard Semmes, Tom Campbell, Sheila Glesmann, Robert Glesmann</i>	
Mercury Control by EPRI MerCAP™ Process	247
<i>Juliana Kyle, Mark Berry, Mark Strohfus, Greg Archer, Steve Smokey, Ramsay Chang, Tom Machalek, Jennifer Paradis, Carl Richardson, Timothy Ebner, Kevin Fisher, Rick Slye, Pierina Noceti, William Aljoe</i>	
Field Studies of Combustion Modifications on Power Plant Mercury Emissions.....	266
<i>Jennifer Paradis, Tom Machalek, Carl Richardson, Ramsay Chang, Dean Engleman, Sam Krueger, Randy Short, Shana Scheiber, Randy Bermke</i>	
Testing of K-Fuel™ at Coal-Fired Units	282
<i>Ted Venners, Carrie Atiyeh</i>	
Predicting Mercury Retention in Utility Gas Cleaning Systems with SCR/ESP/FGD Combinations or Activated Carbon Injection.....	298
<i>Balaji Krishnakumar, Chitralkumar V. Naik, and Stephen Niksa</i>	
Modeling Tool for Evaluation of Utility Mercury Control Strategies.....	312
<i>Connie Senior, Andrew Fry, Chris Montgomery, Adel Sarofim, Jost Wendt</i>	
Quantitative Prediction of Hg-Capture Enhancement by Calcium	327
<i>Thomas K. Gale, Neelesh S. Bhopatkar, Heng Ban, Bruce W. Lani, George R. Offen</i>	
SCR Catalyst with High Mercury Oxidation and Low SO₂ to SO₃ Conversion.....	348
<i>Keiichiro Kai, Hirofumi Kikkawa, Yasuyoshi Kato, Yoshinori Nagai, William J. Gretta</i>	
A Three-Year Assessment of Mercury Mass Balance from Lambton™'s Coal Fired Boilers Equipped with FGD and SCR.....	361
<i>Yen V. Nguyen, George F. Pessione</i>	
Mercury Oxidation Across SCR Catalyst at LG&E™'s Trimble County Unit 1.....	376
<i>William J. Gretta, Isato Morita, John W. Moffett</i>	
Large-Scale Mercury Control Technology Testing for Lignite-Fired Utilities & Oxidation Systems for Wet FGD.....	388
<i>Donald P. McCollor, Steven A. Benson, Michael J. Holmes, Stuart Libby, Jill M. Mackenzie, Charlene R. Crocker, Lingbu Kong, Kevin C. Galbreath</i>	
Hg Oxidation Compared for Three Different Commercial SCR Catalysts.....	398
<i>Thomas K. Gale, George A. Blankenship, W. Scott Hinton, Jared W. Cannon, Bruce W. Lani</i>	
Pilot Testing of Oxidation Catalysts for Enhanced Mercury Control by Wet FGD.....	412
<i>Gary Blythe, Tom Machalek, Bruce Lani, Richard Rhudy, Bob Wiemuth, Juliana Kyle, D. Steven Bishop</i>	
The Development of a Pilot-scale Slipstream Facility with Multi-function on Evaluation of Mercury Oxidation and Capture at a Coal-fired Utility Boiler	429
<i>Yan CO; Bobby Chen; Chien-Wei Chen; Jiang Wu; Martin G Cohron; John Smith, Wei-Ping Pan</i>	
Study of the Effect of Chlorine Addition on Mercury Oxidation by SCR Catalyst under Simulated Subbituminous Coal Flue Gas	452
<i>Chun W. Lee, Shannon D. Serre, Yongxin Zhao, Thomas W. Hastings</i>	
Mercury Control Evaluation of Furnace Halogen Injection at TXU™'s Monticello Unit 3	465
<i>Katherine Dombrowski, Carl Richardson, Bob Wiemuth, Mike Montgomery, Ramsay Chang, Andrew O™Palko</i>	
Bench-scale Kinetics Study of Mercury Reactions in FGD Liquors.....	484
<i>David W. DeBerry, Sara Pletcher, Richard Rhudy</i>	

Pilot Plant Testing of Elemental Mercury Re-emission from Wet Scrubbers	502
<i>John C.S. Chang, Yongxin Zhao</i>	

Wet FGD Additive for Enhanced Mercury Control	513
<i>Gary M. Blythe, Charles E. Miller, Richard G. Rhudy, Bob Wiemuth, Juliana Kyle, Joe Lally</i>	

Volume 2

Mercury Capture and Fate Using Wet FGD at Coal-Fired Power Plants	533
<i>Charles E. Miller, Thomas J. Feeley, III, William W. Aljoe, Karl T. Schroeder, Candace Kairies, Andrea T. McNemar, Andrew P. Jones, James T. Murphy</i>	

Pilot Scale Test Results on Plasma-Enhanced Electrostatic Precipitation Technology for Mercury Removal	549
<i>Ralph Altman, Mark Berry, Wayne Buckley, Patrick Doonan, James Reynolds, Dan Battleson, Bob Brunette</i>	

Simultaneous Removal of Gaseous Elemental Mercury and Dichlorobenzene from Flue Gas using Reactive Species Produced from Dielectric Barrier Discharge and Short-wavelength UV	559
<i>Juyoung Jeong, Jae-Wook Choi, Dong Jin Suh, Jongsoo Jung</i>	

MHI Mercury Removal System - Combination of HCl Injection System and ORP Control System	N/A
<i>Susumu Okino, Shintaro Honjo, Yoshio Nakayama, Motofumi Itoh</i>	

Role of Sulfides in the Sequestration of Mercury by Wet Scrubbers	571
<i>Behrooz Ghorishi, Bill Downs, and Scott Renninger</i>	

Performance of Activated Carbon Produced from Fort Union Lignite Coal	N/A
<i>C. Crocker, S. Benson, E. Olson, M. Musich, A. S. Rokanuzzaman, M. Hummel</i>	

Slipstream Baghouse Evaluation of Design and Operating Parameters that Affect Mercury Removal	N/A
<i>J. Pavlish, J. Laumb, L. Brickett</i>	

Fundamental Studies of Unburned Carbon and Their Impact on Mercury Adsorption from Power Plant Flue Gases	N/A
<i>M. Rostam-Abadi, Y. Lu, C. Mueller, C. Richardson, J. Paradis, D. Frezel</i>	

Mercury Speciation and Control during Combustion of U.S. Lignites in a 1-MWth Circulating Fluidized Bed Combustor	N/A
<i>M. Jones, C. Crocker, C. Nyberg, D. Hajicek, S. Benson</i>	

Fabric Filter Size Impacts on Mercury Control Using Activated Carbon Injection	586
<i>Robert E. Snyder, P.E. and David M. Novogoratz</i>	

Mercury and NO_x Control for Low-Rank Coals	593
<i>Vitali Lissianski, Peter Maly, and Randy Seeker</i>	

Palladium Sorbents for Mercury, Arsenic & Selenium Capture from Fuel Gas	N/A
<i>E. Granite, H. Pennline, C. Myers, D. Stanko, H. Hamilton, L. Rowsell, S. Poulston, W. Chu</i>	

When East Meets West, New Technology from Romania Reduces Fuel Consumption and Emissions with Virtually No Capital Costs	604
<i>George H. Wagner</i>	

Low NO_x Combustion System Solutions for Wall Fired, T-Fired and Turbo Fired Boilers	N/A
<i>C. Penterson, D. Dorman</i>	

Thomas Hill 3 SCR Retrofit Design Approach Avoids Increases in Draft Requirements	N/A
<i>D. Hellard, D. Pattison, S. Voss, R. Johnson</i>	

A New Approach for Hybrid SNCR/SCR	N/A
<i>T. Wright</i>	
Clean Coal Power Initiative: Reducing Emissions While Improving the Operating Efficiency and Reliability at Dynegy Inc.™s Baldwin Energy Complex	N/A
<i>P. Spinney, J. Naberhaus</i>	
The Use of Mg(OH)₂ as a Replacement for DBA in Limestone Scrubbing	N/A
<i>A. Gibson, P. Schmidtchen, M. Wajer</i>	
Design Considerations for Baghouses Treating Flue Gas From High Sulfur Coal Combustion	612
<i>Paul S. Farber, Matt Usher</i>	
Vertical Integration of FGD Systems - Design, Benefits, & Project Execution of CAIRtech	N/A
<i>M. Gregory</i>	
Economic Implications of Carbon Sequestration on Future Retrofit Costs Coal-Fired Power Plants	623
<i>David Stopek</i>	
PC /IGCC Panel	644
<i>David Foerter</i>	
Environmental Footprints and Costs of Coal-Based IGCC and PC Plants	674
<i>Sikander Khan</i>	
Advanced Coal Cost and Emissions Update	689
<i>Ron Schoff</i>	
The Interactions of SO₂ and SO₃ on a Carbon Sorbent and Their Impact on Mercury Capture	711
<i>Edwin S. Olson, Charlene R. Crocker, Jenny Sun, Katie Hill Brandt, Grant E. Dunham, John H. Pavlish</i>	
Full-Scale Evaluation of Carbon Injection for Mercury Control at a Unit Firing High Sulfur Coal	722
<i>Sharon M. Sjostrom, Cody Wilson, Jean Bustard, Gary Spitznogle, Aimee Toole, Andrew O™Palko, Ramsay Chang</i>	
Results in Scaling Up Concrete-Friendly Sorbents	737
<i>Sid Nelson Jr., Qunhui Zhou, and Yinzi Zhang</i>	
FA100: Mineral Based Mercury Sorbents	750
<i>Pascaline Tran, Xiaolin Yang, Larry Shore, William Hizny</i>	
A Novel Process for On-site Production of Mercury Sorbents	760
<i>Lawrence E. Bool III, David R. Thompson, Chien-Chung Chao</i>	
Sorbent Injection into a Slipstream Baghouse for Mercury Control: Long-Term Test Operations and Results	769
<i>John H. Pavlish, Jeffrey S. Thompson, David Smith, Steve Podwin, Lynn Brickett, Leif Lindau</i>	
Applying Nonlinear Signal Analysis Techniques to Flame Scanner Signals to Improve Staging of Cyclone Boilers for NO_x Control	782
<i>Thomas J. Flynn, Randy Bermke, Ralph T. Bailey, Tim A. Fuller, Charles E. A. Finney, Ken Stuckmeyer, C. Stuart Daw, Jeff Stallings, Rick Himes</i>	
The First 100 GW of SCR in the U.S. - What Have We Learned?	801
<i>J. Ed Cichanowicz, Lawrence J. Muzio, Michael C. Hein</i>	
Selective Catalytic Reduction System Performance and Reliability Review	824
<i>Clayton A. Erickson and James E. Staudt</i>	

Advanced In-situ NO_x Sensor Development	840
<i>Robert W. Burbage, Donna L. Dearmon, Jim Downey, G. M. Chad Starnes</i>	
Steag™'s Long-Term Catalyst Operating Experience and Cost	854
<i>Marilynn Martin, Horst Rhein, Hans Hartenstein, Hans Sobolewski</i>	
NO_x Reduction at Consumers Energy Dan E. Karn Generation Station	859
<i>W. Keslar, M. Tittle, J. Gose, J. Pomaranski, N. Foster</i>	
SCR Catalyst Management: Enhancing Operational Flexibility	871
<i>Scot Pritchard & Chris DiFrancesco</i>	
Large Particle Ash (LPA) Screen Retrofits At Coal-Fired Units In Ohio, Indiana, Pennsylvania, Alabama & Germany	883
<i>Joseph Jancauskas, Michael Harrell, Hans Sobolewski, Hans Hartenstein, Marilyn Martin</i>	
Performance Testing and Modeling of an Advanced SNCR NO_x Control System	892
<i>Gui-su Liu, Brian Higgins, Issa Zarzar</i>	
On-Line Ammonia Slip Process Monitoring in Post-Combustion NO_x Control Equipped Power Generating Stations	909
<i>H. A. Gamble, G. I. Mackay, J. T. Pisano, R Himes</i>	
Expanded Experience with an In-situ Ammonium Bisulfate Fouling Probe	926
<i>Charles A. Lockert, Bernard P. Breen, Robert Schrecengost, Jacob A. Peter</i>	
Sootblowing Optimization for Opacity Control	937
<i>Nenad Sarunac, John W. Sale, Xiadong Bian, Wei Zhang, Michael Cilinski, Thomas Johnson, John Bokowski</i>	
A Review of Sulfuric Acid Formation and Behavior in Coal-Fired Power Plants	948
<i>Nick Irvin; Larry S. Monroe</i>	
A System Approach to SO₃ Mitigation with Trona	963
<i>Douglas P. Ritzenthaler, Albert L Moretti, Ronald J Triscori</i>	
Sulfur Trioxide Reduction Technology Demonstrated at Dominion Energy's Chesterfield Plant	976
<i>E. Bowes, S. Benson, D. McCullor, R. Rhodes, B. Hamel</i>	
Demonstration of SBS Injection™ for SO₃ Control Upstream of a Pilot Baghouse	986
<i>Scott D. Miller, James H. Wilhelm, Kevin M. Fisher</i>	
Use of Magnesium Hydroxide for Reduction of Plume Visibility in Coal-Fired Power Plants	1002
<i>Lewis B. Benson</i>	
Hydrated Lime for SO₃ Removal	1021
<i>Thomas K. Gale, Jared W. Cannon, Paul S. Nolan, Michael R. Brinker, Alain Brasseur, Alain Laudet</i>	
Benefits of Effective SO₃ Removal in Coal-Fired Power Plants: Beyond Opacity Control	1037
<i>Robert E. Moser</i>	

Volume 3

Updating Capital Cost of SO₂ Control Technologies in the Integrated Planning Model and the Coal Utility Environmental Cost Model	1056
<i>James E. Staudt and Sikander R. Khan</i>	
Cost Development of Single Absorber Open Spray Tower Limestone Forced Oxidation FGDs During the Last 20 Years - STEAG™'s Experience	1077
<i>Hans Hartenstein, Horst Rhein, Hermann Brüggendick</i>	

Repair or Replace - What to do with a 20-Year Old Scrubber: East Kentucky Power Cooperative™s Spurlock Unit 2 WFGD Retrofit	1098
<i>Sam Holloway, Larry Shell, Doug Einck, Phil Rader, David Muraskin</i>	
Flue Gas Treatment System Design Considerations for the City of Hamilton Oxygen Firing Demonstration	1128
<i>Paul Williams, Garrett Pavlovicz, Dan Moats</i>	
Computer Modeling to Assist in Evaluation of Multi-Pollutant Control Technologies	1139
<i>Bryan D. Hansen, Douglas Randall</i>	
Boiler Optimization for Multi-Pollutant Control: Mercury and NOx Emissions	1148
<i>Carlos E. Romero, Harun Bilirgen, Edward Levy, Atira Mabin, Melanie McCoy, Robert Serlin, Craig Tylanda</i>	
Multi-Pollutant Control from Pulverized Coal-fired Boiler OP-430	1162
<i>Mieczysław A. Gostomczyk, Renata Krzyzyska</i>	
Multi-Pollutant Control Project at Huntington Unit 2	1177
<i>Jeromy K. Jones</i>	
Advanced Ammonia Scrubbing for SO2 Control.....	1190
<i>Phillip D. Boyle</i>	
A Pilot Scale Evaluation of the Electrocore Technology as a Multi-Pollutant Control Technology	1202
<i>Sergei F. Burlatsky, Eric J. Gottung, Luca Bertuccioli, Bruce H. Easom, Leo Smolensky, Mark S. Berry, Ralph F. Altman, Vadim V. Atrazhev, Dmitrii V. Ivonin</i>	
MHI High Efficiency System - Proven technology for multi pollutant removal	1215
<i>Yoshio Nakayama, Satoshi Nakamura, Yasuhiro Takeuchi, Motofumi Itoh, Susumu Okino, Shintaro Honjo</i>	
Impact of Fabric Filter Media and SDA Operations on Multi-Pollutant Emissions	1226
<i>Michael McMenus, Robert E. Snyder, Kevin E. Redinger,</i>	
Simultaneous Scrubbing of the Full Array of Flue Gas Acid Gases	1236
<i>W. Ellison</i>	
Wet Flue Gas Desulfurization (WFGD) Upgrade at the Trimble County Generating Station Unit 1	1252
<i>Clayton Erickson, Michael Jasinski, Larry VanGansbeke</i>	
Duke Energy-Carolinas™ WFGD Retrofit Program: Site-specific Innovations and their Implementation.....	1267
<i>Jim McCarthy, Jürgen Dopatka, Kelly Barger, Phil Rader, Clark Bussell</i>	
WFGD Case Study - Maximizing SO2 Removal by Retrofit with Dual Tray Technology	1286
<i>James Balbo, Anthony A. Silva, Paul J. Williams</i>	
SO2 Emission Controls for Small Boilers	1296
<i>Jim Dickerman</i>	
The Influence of Nozzle Arrangements in Wet FGD Scrubbers	1304
<i>Markus. Feldkamp, Christian Moser</i>	
Investigations on Aluminum-Induced Limestone Blinding at Wet FGD Plants Producing Gypsum	1324
<i>Prof. Dr. rer. nat. H. Gutberlet, Dipl.-Ing. G. M. Böhm, Dipl.-Ing. S. Neuhaus, Dipl.-Ing. M. Dickamp, M. Kraus, Dipl.-Ing. C. Moser</i>	

EPRI FGDExpert Demonstration Results at Georgia Power™s Plant Yates Unit 1 Chiyoda FGD System	1342
<i>James G. Noblett, Ralph Altman, Nick Irvin, Steve McCarty, Peter Honeycutt</i>	
Utility Boiler Baghouse Update - 2005	1354
<i>Victor H. Belba, W. Theron Grubb, Randy L. Merritt, Kenneth M. Cushing, Ramsay Chang</i>	
Reducing PM 2.5 Emissions Using the Indigo Agglomerator	1372
<i>Rodney Truce, Robert Crynack, Mark Berry, Wallis Harrison</i>	
A New Multi-Stage Collector (MSCTM) Concept	1389
<i>Henry V. Krigmont, Lawrence J. Muzio and Randall A. Smith</i>	
The Effects of Unburned Carbon Properties on Electrostatic Precipitator Performance Modeling	1405
<i>Victor H. Belba, Cameron E. Martin, Kenneth Baldrey, Charles Lindsey, Ralph Altman</i>	
Materials Selection and Optimization for Wet Flue Gas Desulfurization Control Systems	1424
<i>Gary M. Carinci</i>	
Corrosion resistance of duplex and super duplex stainless steels for wet flue gas desulphurization	1435
<i>J. Peultier, F. Barrau, J.-C. Gagnepain, J.-P. Audouard</i>	
Mist Eliminators - Proper Material Selection Can Reduce Maintenance Costs and Improve Reliability in Wet Scrubbers	1449
<i>Bill Looney, Brian Baleno, Greg L. Boles, Jacob Tetlow</i>	
Increasing Capacity of Existing Limestone Grinding Systems While Reducing Grind Size	1467
<i>Gary Harper, Melissa A. Hagan, Paul Dyer, William J. Breuer</i>	
Rotary Drum Vacuum Filters for Production of Wallboard-Grade Gypsum	1483
<i>Kevin Hibbert, Carl Weilert, Thomas O'Leary</i>	
Improvement of Extractive Measurement Methods for Pulverized Coal at the EPRI Coal Flow Loop	1497
<i>Jose C. Sanchez, Robert A. Mudry</i>	
Demonstration of an On-line Elemental Coal Analyzer at TVA™s Cumberland Plant	1513
<i>Stephen Smith, Donna L. Dearmon, Robert W. Burbage, Jose C. Sanchez, Phil C. Womble</i>	
A Novel Process to Beneficiate High Carbon Ash for Concrete	1527
<i>Lawrence E. Bool III, David R. Thompson</i>	
Demonstration of Fly Ash Beneficiation by Ozonation at PPL Montour SES	1535
<i>R. Afonso, R. Hurt, L. LaBuz, R. Patton, R. Altman</i>	
The Impact of Mercury Control Technologies on the Leaching of Hg, Ni, As, Se Cd, and Pb from Coal Utilization Byproducts	1558
<i>Carl E. Hensman, Lynn Brickett</i>	
Author Index	