**David W. Pershing**

**President Emeritus, The University of Utah**

*Distinguished Professor of Chemical Engineering, The University of Utah*

**Education**

B.S., Chemical Engineering, Purdue University, 1970

Ph.D., Chemical Engineering, University of Arizona, 1976

**Honors and Awards**

2014 National Association of Student Personnel Administrators (NASPA) Region V President’s Award

Charter Fellow, National Academy of Inventors (2013)

Honorary Alumnus, S.J. Quinney College of Law (University of Utah, May 2011)

University of Utah Diversity Award (2006)

Professional Achievement Award (University of Arizona, 2004)

2002 Engineering Educator of the Year Award (Utah Engineering Council)

Outstanding Chemical Engineer (Purdue University, 1999)

Distinguished Engineering Alumnus (Purdue University, 1999)

Invited Keynote Speaker at the International Symposium on Incineration Conference, Sheffield, England (July 1997)

Executive of the Year Award (Utah Manufacturers Association, 1997)

Rosenblatt Prize - $30,000 (University of Utah, 1997)

Governor's Medal for Science and Technology (State of Utah, 1995)

Appointed Distinguished Professor of Chemical Engineering (1995)

Distinguished Research Award (University of Utah, 1990)

NSF Young Presidential Investigator Award (1984 -1990)

Distinguished Teaching Award (University of Utah, 1982)

National Science Foundation Fellow (1973-1976)

Outstanding Senior Award (Purdue, 1970)

Phi Eta Sigma National Honor Society

Omega Chi Epsilon (President, 1970)

**Previous Academic Experience**

Visiting Scientist, MIT Laboratory for Energy and the Environment, July – Oct. 2005

Sr. Vice President for Academic Affairs, August 1998 – March 2012

Dean, College of Engineering, University of Utah, October 1987 – July 1998

Associate Dean of the Graduate School, July 1983 – October 1987

Associate Professor, Chemical Engineering, July 1982 – July 1985

Assistant Professor, Chemical Engineering, August 1977 – July 1982

Visiting Assistant Professor, Chemical Engineering, U of AZ, Sept. 1976 – Aug. 1977

**Academic Leadership**

As President, had overall responsibility for 32,000 students, 20,000 employees and an annual budget of $4 billion. Recently concluded a $1.65 billion comprehensive campaign and growing research funding to over $400 million per year. Major presidential initiatives include increased emphasis on excellence in undergraduate education, improving retention and graduation rates, supporting new interdisciplinary research efforts, diversity and sustainability, growth of on-line education and the medical school class and continued expansion of research and academic facilities.

As the Senior Vice President for Academic Affairs (Provost), had overall responsibility for approximately 1,000 faculty and 25,000 students in the 11 colleges of the main campus. Also had responsibility for distance and continuing education, libraries and museums, budget and planning, student affairs, performing arts, and diversity enhancement. Hired 21 new deans, 10 Vice Presidents and supported many other faculty recruitments. Increased ethnic and gender diversity by new, targeted programs. Reorganized the budget model of the university to relate college budgets to student enrollments and quality. Helped create a statewide economic development initiative (USTAR) and have helped attract more than 30 new physicians, scientists and engineers to help grow the high-technology base of the state. Worked collaboratively with Deans and Directors to raise over $600 million in new, public and private funds to support the construction of 14 new buildings.

As the Dean of the College of Engineering, had responsibility for approximately 150 faculty and 2500 students. Help grow the research budget for the College of Engineering from $8 million (1987) to over $30 million (1998) and increased the state budget by 50% due primarily through new, direct legislative appropriations. Reduced faculty resignations to less than 1% per year and dramatically increased the number of women in tenure track positions. Initiated private fundraising program and began planning for new engineering building.

As the Associate Dean of the Graduate School,had campus-wide responsibilities for the review of graduate and undergraduate programs on both the main and medical school campuses. Worked with the President and Dean of the Graduate School on strategic visioning; managed the graduate records office and also the thesis office.

**Research Leadership**

Served as the founding Director of the NSF-Engineering Research Center (ERC) for the University of Utah and led the center for the 12 years of the grant. Helped write the original proposal with BYU and led the combustion research program for the duration. Helped plan the research agenda, organize the research teams, recruit new faculty members and manage the budget. Also participated as an active scientific investigator with normal project responsibilities.

Served as the founding director of the DOE funded Center for the Simulation of Accidental Fires and Explosions (C-SAFE) to develop technology that will help national laboratories, refineries, and other industries predict and prevent devastating fires and explosions. Provided overall leadership for the 13 years of the grant, which included approximately 50 faculty, staff and students from seven departments and two other universities. Helped to write the original proposal, recruit the center faculty, and manage the overall budget. Coordinated annual congressional activities in Washington D.C. with the Utah delegation to ensure appropriate budget increases for the DOE program.

## Serves as co-PI and member of the executive steering committee for the DOE-ASC funded Carbon-Capture Multidisciplinary Simulation Center (CCMSC) to demonstrate exascale computing with verification & validation/uncertainty quantification to more rapidly deploy a new technology for providing low cost, low emission electric power generation to meet the growing energy needs of the U.S. The project uses a hierarchal validation approach to obtain simultaneous consistency between a set of selected experiments at different scales embodying the key physics components (large eddy simulations, multiphase flow, particle combustion and radiation) to predict performance in a 350MWe oxy-fired boiler.

**Teaching Interests**

For more than two decades taught the core, required undergraduate heat transfer course for chemical and mechanical engineering students (juniors.) Have also taught undergraduate fluid mechanics, senior projects laboratories, graduate heat transfer and advanced graduate catalysis and heterogeneous reactions.

**Research/Technical Interests**

Have published extensively on the formation and control of pollutant emissions from fossil fuel combustion and on the incineration of solid waste materials. Activities have been directed toward minimizing NOx emissions from coal and biomass combustion, investigating the control of emissions from process heaters and cement kilns, characterizing hydrocarbon emissions from solid waste combustion, evaluating and modeling the rate controlling processes in rotary kiln incineration, and quantifying the formation of dioxin and furan emissions. Have also worked on the modeling and associated experimental validation of large hydrocarbon pool fires (such as would result from the crash of a large airplane).

Recent activities have focused on national energy policy considerations including sources of CO2 and the impact US control alternatives on global warming trends, considering the increased coal burning in China and India.

**Major Appointments**

Craig H. Neilsen Foundation

Herbert I. and Elsa B. Michael Foundation

Obert C. Tanner Foundation

University of Utah Research Foundation

NCAA Division I Presidential Forum

**Research Grants (as PI except as indicated)**

 “Investigation of Pollutant Control Through Staged Combustion of Pulverized Coal,” with J.O.L.

 Wendt, U.S. ERDA, 4/75 - 3/78 $165,052

“Pollutant Formation During Fixed-Bed and Suspension-Coal Combustion,” U.S. EPA Grant

R-805899, 6/01/78 - 5/31/81 $312,540

“Measurement of Sulfur and Nitrogen Species in Fossil-Fuel Flames,” U.S. EPA subcontract, 11/1/79 – 5/31/80 $24,925

“Combustion of Wood in Spreader Stoker Systems,” Weyerhaeuser Corporation Grant, 3/1/81 –

12/3/83 $106,848

“Analytical Equipment for Fossil-Energy Research,” with A.L. Tyler, University of Utah Institutional Funds, 12/1/78 $23,900

“Bench Scale Combustion Studies of SOx Formation and Control,” U.S. EPA Grant R-809267, 7/26/81 - 7/25/83 $270,050

“Bench Scale Investigations of Sulfur/Sorbent Reactions with Pulverized Coal,” U.S. EPA Cooperative Agreement, 9/15/83 - 9/14/86 $430,725

“Presidential Young Investigators Award (PYI),” NSF, 9/1/84 - 2/28/91 $242,500

“Use of a Rotary Kiln for Zirconium Waste Disposal,” Westinghouse, 1/16/86 - 1/15/87 $15,160

“Bench Scale Investigations in Support of Sorbent Injection Demonstrations,” U.S. EPA, 9/15/86 – 1/14/89 $249,314

“Utilization of Natural Gas for Incineration Processes,” Gas Research Institute, 11/1/86 - 10/31/89

$138,150

“Bench and Pilot Scale Investigations in Support of the Dow Rotary Kiln Incineration Project,”

EPA-LSU, 1/15/87 - 1/4/90 $70,000

“The Development and Evaluation of Natural Gas-Fired Solid Waste Incineration Devices,” Gas

Research Institute (with J.S. Lighty and G.D. Silcox), 11/90 - 11/93 $543,500

Phase II SBIR subcontract, EPA (from REI), 1993-94 $48,000

“Use of Biofuels to Reduce NOx” EPRI/TVA, subcontract from REI (with JoAnn Lighty), 1994 $25,000

“Control of Emissions from Wood Fired Domestic Heating Units,” EPA (SCERP) (with JoAnn Lighty), 1994 $95,000

“Evaluation of Ultra Low NOx Emission Systems,” DOE, subcontract from REI, 1992-1994 $77,500

Combustion 2000 – “Low Emission Boiler Systems,” DOE, subcontract from Riley Stoker Corp. (with JoAnn Lighty), 3/95 - 10/96 $1,397,191 “Waste Incineration for Resource Recovery in

Regenerative Life Support Systems,” NASA/Ames Research Center (with JoAnn Lighty),

1994-1998 $569,000

“Advanced Combustion Engineering Research Center,” NSF, 5/1/86 – 4/30/97, University of Utah

Portion $6,645,945

“Center for the Simulation of Accidental Fires and Explosions” (C-SAFE), DOE, 9/97 - 9/02

$20,000,000

“Southwest Consortium for Environmental Research and Policy (SCERP),” EPA, 1994 – 999

$3,200,000

“Low Emission Burner Systems (LEBS),” DOE, 1997-2001 $1,970,000

“Minimization of NOx Emissions from Multi-burner Coal-Fired Boilers,” DOE, 9/97 - 9/00 $600,000

“Optimization of Fuel Injector Design, PRDA-Phase II,” DOE, 1997 - 99 $333,000

“Control of NOx Emissions in Steel Making,” DOE (with JoAnn Lighty), 10/1/96 - 9/31/99 $384,129

“Center for the Simulation of Accidental Fires and Explosions,” Renewal DOE/ASCI, 12/2002 - 9/20/10 $22,000,000

“Retrofitable CO2 Capture Technologies through Predictivity - CO2 Lifcycle,” NNSA (with Geoff

Silcox), 7/2010 - 9/2012 $115,000

“Macroscale CO2,” DOE, 7/2009 - 9/2013 (with Kerry Kelly) $245,000

“The UQ-Predictive Multidisciplinary Simulation Center for High Efficiency Electric Power Generation with Carbon Capture,” NNSA (03/01/2014 - 02/28/2019), $20,000,000 (co-PI)

“Deployment of Dynamic Neural Network Optimization to Minimize Heat Rate During Ramping for Coal Power Plants,” DOE, 10/2019 – 9/2022, $3,784,781. (co-PI with Kody Powell)

(Total, externally funded research – approximately $80 million)

**Graduate Thesis Students Supervised (Major Professor)**

P.L. Case MS - ME, December 1979

G.P. Starley MS - ChE, August 1980

J.W. Daly ME - ChE, September 1980

J. Stanojevic MS - FE, March 1981

D.H. Tomlinson ME - ChE, June 1981

S.L. Manis MS - ChE, July 1981

R.M. Winter MS - ChE, July 1981

S.P. Purcell PhD - ChE, September 1981

D.M. Slaughter MS - ChE, March, 1982

J.M. Munro PhD - ChE, July 1982

G.P. Starley PhD - ChE, August 1982

F.W. Bradshaw MS - ChE, September 1983

R.M. Winter PhD - ChE, August 1985

G.D. Silcox PhD - ChE, August 1985

D.M. Slaughter PhD - ChE, December 1986

G.H. Newton PhD - ChE, June 1987

P.M. Lemieux PhD - ChE, August 1987

J.S. Lighty PhD - ChE, September 1988

E.R. Lindgren PhD - ChE, November 1988

D.J. Harrison PhD - ChE, November 1988

C.R. Milne PhD - ChE, August 1988

G.E. Parry PhD - ChE, August 1989

W. Owens PhD - ME (with J.S. Lighty), April 1991

K. Rink PhD - ME (with J.S. Lighty), November 1993

Jim Campbell ME - Env. Eng., June 1997

Jennifer Spinti PhD - ChE, June 1997

John Veranth PhD - ChE, December 1998

Roy Vanos PhD - ChE, December 2001

Kerry Kelly PhD - Env. Eng., May 2015

**Undergraduate Thesis Students Supervised**

C.G. Beck, D.M. Hansen, W.M. Parry,

B.D. Beckstrom, T.W. Hansen, S.L. Pessetto,

D. Bolton, D. Hendricks, C.R. Pettersson,

D.R. Brodbeck, D.E. Hugg, R.L. Roundy,

S. Burgin, R.J. Lang, J. Slama,

M. Burkinshaw, C.A. Manning, D.M. Slaughter,

C.S. Carrel, V.H. Mason, G.D. Smith,

J. Clough, C.R. Milne, T.D. Thacher,

D. Gordon, B.J. Overmoe, T.S. Wilde,

S.B. Greene, R.K. Wright

**Other Experience**

*Government*

**U.S. Environmental Protection Agency**, National Environmental Research Center. Project Engineer (RTP, NC), September 1970 - August 1973.

Had technical responsibility for nine contracts totaling over $1,000,000 and direction of an in-house research program to define the sources of NOx formation.

*Industrial Experience*

**Exxon** Production Research, Houston Texas. Research Assistant. June - September, 1969. Conducted an experimental investigation of the friction-reduction properties of six water-soluble polymers.

**International Flame Research Foundation**, Ijmuiden, Holland. May 1972 and May 1973. Measured temperature, velocity, and specie concentrations in large turbulent natural gas and pulverized-coal flames.

*Consulting*

**Reaction Engineering International**, Salt Lake City, Utah, on engineering research and development activities associated with waste incineration and design of low NOx furnaces for coal firing. 1990 - 1998

**Energy and Environmental Research Corporation**, Irvine, California, on the planning, execution, and interpretation of experimental laboratory studies to define the mechanisms of sulfur and

nitrogen oxide formation and control in liquid-fuel and pulverized-coal flames and to evaluate POHC destruction and PIC formation in hazardous and municipal waste incineration. 1974 - 1990

Aerotherm Division, **Acurex Corporation,** Mountain View, CA, on the planning of a research pro-gram on tangential pulverized coal combustion and the analysis of the resulting data. 1974 -1979

**Kennecott Copper Corporation**, Salt Lake City, Utah, on the control of NOx formation in oxygen-blown flames and advanced smelting concepts. 1979 - 1981

**National Bureau of Standards**, Washington, D.C., on the evaluation of energy-related inventions in the stationary source combustion field. 1976 - 1978

Rocketdyne Division, **Rockwell International**, Canoga Park, California, on the planning of a catalytic combustion research program and on the hardware problems associated with retrofitting of catalytic combustors. March 1975 - August 1975

**Patents**

Carver, G.P., M.P. Heap, G.B. Martin, D.W. Pershing, D.P. Rees, T.J. Tyson, and D.M. Zallen, “Low Emissions Process and Burner,” (pulverized coal), U.S. Patent 4,381,718.

Pershing, D.W., G.B. Martin, and J.M. Munro, “Reduction of Pollutant Emissions from a Coal-Fired Spreader-Stoker by Fines Control,” U.S. Patent 6,514,192.

Pershing, D.W., G.B. Martin, and J.M. Munro, “Reducing Pollutant Emissions from a Spreader-Stoker-Fired Furnace by Stoichiometric Control,” U.S. Patent 4,592,289.

Heap, M.P., S.L. Chen, J.M. McCarthy, and D.W. Pershing, “Methods of Removing NOx and SOx Emissions From Combustion Systems,” U.S. Patent 4,861,567.

Heap, M.P., S.L. Chen, J.M. McCarthy, and D.W. Pershing, “Methods of Removing NOx and SOx Emissions From Combustion Systems Using Nitrogen Compounds,” U.S. Patent 4,851,201.

**Publications (Peer Reviewed)**

Pershing, D.W., and E.E. Berkau, “The Chemistry of Nitrogen Oxides Control through Combustion Modifications,” *Pollution Control and Energy Needs*, R.M. Jimeson and R.S. Spindt editors, Advances in Chemistry Series 127, American Chemical Society, Washington, D.C. (1974).

Pershing, D.W., G.B. Martin, and E.E. Berkau, *AIChE Symposium Series,* No. 148, 71 (1975).

Pershing, D.W., and J.O.L. Wendt., “Pulverized Coal Combustion: The Influence of Flame Temperature and Coal Composition on Thermal and Fuel NOx,” *Sixteenth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1977).

Wendt, J.O.L., and D.W. Pershing, “Physical Mechanisms Governing the Oxidation of Volatile Fuel Nitrogen in Pulverized Coal Flames,” *Combustion Science and Technology,* 16, 111 (1977).

Pershing, D.W., and J.O.L. Wendt, “Formation and Abatement of Nitrogen Oxide Emissions from Pulverized Coal Flames,” *Archives of Thermodynamics and Combustion Quarterly* (1979).

Pershing, D.W., and J.O.L. Wendt, “Relative Contributions of Volatile Nitrogen and Char Nitrogen to NOx Emissions from Pulverized Coal Flames,” *I & EC Process Research and Development*, January (1979).

Wendt, J.O.L., D.W. Pershing, J.W. Lee, and J.W. Glass, “Pulverized Coal Combustion: NOx Formation Mechanisms under Fuel-Rich and Staged-Combustion Conditions,” *Seventeenth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1979).

Pershing, D.W., J.E. Cichanowicz, G.C. England, M.P. Heap, and G.B. Martin, “The Influence of Fuel Composition and Flame Temperature on the Formation of Thermal and Fuel NOx in Residual Oil Flames,” *Seventeenth Symposium (International) on Combustion,* The Combustion Institute, Pittsburgh, PA (1979).

Brown, R.A., H.B. Mason, D.W. Pershing, and J.O.L. Wendt, “Investigation of First- and Second-Stage Variables on Control of NOx Emissions Using Staged Combustion in a Pulverized-Coal, Wall-Fired Furnace,” *AIChE Symposium Series* No. 188, 75 (1979).

Heap, M.P., G.C. England, and D.W. Pershing, “Emission Characteristics of Alternate Liquid Fuels,” *Clean Fuel Combustion*, IGT Press (1979).

England, G.C., M.P. Heap, and D.W. Pershing, “Control of NOx Emissions,” *Hydrocarbon Processing*, January (1980).

Pershing, D.W., G.C. England, and M.P. Heap, “Control of NOx Emissions from Liquid-Fired Industrial Boilers,” *AIChE Symposium Series* (1981).

England, G.C., M.P. Heap, D.W. Pershing, R.K. Nikart, and G.B. Martin, “Mechanisms of NOx Formation and Control: Alternative and Petroleum-Derived Liquid Fuels,” *Eighteenth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1981).

Chen, S.L., M.P. Heap, D.W. Pershing, and G.B. Martin, “The Fate of Coal Nitrogen During Combustion,” *Fuel,* 61, 1218 (1982).

Kramlich, J.C., R.K. Nihart, S.L. Chen, D.W. Pershing, and M.P. Heap, “Behavior of N2O in Staged Pulverized Coal Combustion,” *Combustion and Flame* (1982).

Starley, G.P., J.M. Munro, D.M. Slaughter, D.W. Pershing, and G.B. Martin, “Formation and Control of NOx Emissions from Coal-Fired Spreader-Stoker Boilers,” *Nineteenth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1983).

Slaughter, D.M., D.W. Pershing, D.C. Drehmel, and G.B. Martin, “Parameters Influencing the Evolution and Oxidation of Sulfur in Suspension-Phase Coal Combustion,” *Nineteenth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1983).

Chen, S.L., M.P. Heap, D.W. Pershing, and G.B. Martin, “Influence of Coal Composition on the Fate of Volatile and Char Nitrogen During Combustion,” *Nineteenth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1983).

Silcox, G.D., D.M. Slaughter, and D.W. Pershing, “High Temperature Sulfation Studies in an Isothermal Rector: A Comparison of Theory and Experiment,” *Twentieth Symposium (International) on Combustion*, The Combustion Institute, Ann Arbor, Michigan (1984).

Starley, G.P., F.W. Bradshaw, C.S. Carrel, and D.W. Pershing, “Influence of Stoichiometry on NOx Formation in Mass-Burning Stokers,” *Combustion and Flame* (1985).

Silcox, G.D., D.M. Slaughter, and D.W. Pershing, “High Temperature Sulfation Studies in an Isothermal Reactor: A Comparison of Theory and Experiment,” *Twentieth Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1985).

Starley, G.P., F.W. Bradshaw, C.F. Carrel, D.W. Pershing, and G.B. Martin, “Fate of Fuel Nitrogen in Coal-Fired Spreader Stokers,” *Combustion Science and Technology,* 43 (1985).

Chen, S.L., J. M. McCarthy, W.D. Clark, M.P. Heap, W.R. Seeker, and D.W. Pershing, "Bench and Pilot Scale Process Evaluation of Reburning for In-Furnace NOx Reduction,”*Twenty-First Symposium (International) on Combustion*/The Combustion Institute, pp. 1159-1169 (1986).

Starley, G.P., B. Overmoe, and D.W. Pershing, “Influence of Fuel Composition on Nitric Oxide Formation in Mass-Burning Stokers,” *Fuel,* 65 (1986).

Newton, G.H., D.J. Harrison, G.D. Silcox, and D.W. Pershing, “Control of SOx Emissions by In-Furnace Sorbent Injection: Carbonates vs. Hydrates,” *Environmental Progress*, 5, 2 (1986).

Chen, S.L., M.P. Heap, W.R. Seeker, and D.W. Pershing, “Bench and Pilot-Scale Process Evaluation of Reburning for In-Furnace NOx Reduction,” *Twenty-First Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA (1986).

Starley, G.P., D.R. Brodbeck, D.W. Pershing, and G.P. Martin, “Nitric Oxide Destruction in the Fuel Bed Burning Regime of Spreader Stokers,” *I & EC Process Design and Development* (1987).

Munro, J.M., F.W. Bradshaw, and D.W. Pershing, “Control of NOx and Particulate Emissions from Hogged-Wood-Fired Spreader Stokers,” *TAPPI*, 70 (1987).

Lighty, J.S., D.W. Pershing, V.A. Cundy, and D.G. Linz, “Clean-Up of Contaminated Soils by Thermal Desorption,” *Second International Conference on Hazardous Waste Management*, NUS Corporation, Pittsburgh, PA (1987).

Lighty, J.S., D.W. Pershing, V.A. Cundy, and D.G. Linz, “Characterization of Thermal Desorption Phenomena for the Clean-Up of Contaminated Soil,” *Nuclear & Chemical Waste Management,* 8, 225 (1988).

Slaughter, D.M., B.J. Overmoe, and D.W. Pershing, “Inert Pyrolysis of Stoker Coal Fines,” *Fuel,* 67, 4, pp 482-489 (1988).

Chen, S.L., J.A. Cole, M.P. Heap, J.C. Kramlich, J.M. McCarthy, and D.W. Pershing, “Advanced NOx Reduction Processes Using -NH and -CN Compounds in Conjunction with Staged Air Addition,” *Twenty-Second Symposium (International) on Combustion*, 1135, The Combustion Institute, Pittsburgh, (1988).

Silcox, G.D., D.W. Pershing, and J. Kramlich, “A Mathematical Model for the Calcination of Dispersed CaCO3 and Ca(OH)2 Particles,” *I & EC Research*, 28, 2, pp 155-160 (1988).

Heap, M.P., S.L. Chen, J.C. Kramlich, J.M. McCarthy, and D.W. Pershing, “An Advanced Selective Reduction Process for NOx Control,” *Nature* 335, 6191, pp 620-622 (1988).

Slaughter, D.M., et al., “Evolution & Oxidation of Sulfur & Nitrogen in Suspension Phase Coal Combustion,” *Combustion & Flame* (1989).

Lemieux, M.P., and D.W. Pershing, “Design & Construction of a Rotary Kiln Simulator for Use in Studying the Incineration of Hazardous Waste,” *Review of Scientific Instruments*, 60, 8, pp 2768-2777 (1989).

Lemieux, P.M., and D.W. Pershing, “Experimental and Theoretical Studies on The Combustion of Waste Zirconium Sponge in a Rotary Kiln Simulator,” *Waste Management*, 9 (1989).

Lemieux, P.M., and D.W. Pershing, “A Mathematical Model of Zirconium Combustion in a Rotary Kiln,” *Waste Management,* 9, 2 (1989).

Milne, C.R., G.D. Silcox, D.W. Pershing, and D.A. Kirchgessner, “Calcination and Sintering Models for Application to High Temperature Short-Time Sulfation of Calcium Base Sorbents,” *I and EC Research*, 29, 139 (1989).

Cundy, V.A., T.W. Lester, C. Leger, G. Miller, A.N. Montestruc, S. Achara, A.M. Sterling, D.W. Pershing, J.S. Lighty, G. D. Silcox, and W.D. Owens, “Rotary-Kiln Incineration: Combustion Chamber Dynamics,” *Journal of Hazardous Materials*, 22, pp 195-219 (1989).

Chen, S.L., et al., “Advanced NOx Reduction Processes Using -NH and -CN Compounds in Conjunction with Staged Combustion,” *Twenty-Second International Symposium on Combustion*, The Combustion Institute, Pittsburgh, PA (1989).

Lemieux, P.M., P.M. Case, and D.W. Pershing, “The Combustion of Waste Zirconium Sponge in a Rotary Kiln Incinerator,” *J. Minerals, Metals, and Materials Soc.,* 41, 5, pp 55-57 (1989).

Chen, S.L., D.W. Pershing, W.R. Seeker, and J.C. Kramlich, “Optimization of Reburning for Advanced NOx Control on Coal-fired Boilers,” *JAPCA* 39, 10, pp 1375-1379 (1989).

Slaughter, D. M., D. A. Kirchgessner, and D.W. Pershing, “Increased SO2 Removal with the Addition of Alkali Metals and Chromium to Calcium Based Sorbents,” *Twenty-Second International Symposium on Combustion*, The Combustion Institute, Pittsburgh, PA (1989).

Winter, R.M., J. Clough, D.W. Pershing and B.J. Overmoe, “Biomass Combustion: Relationship Between Pollutant Formation and Fuel Composition,” *TAPPI*, 72, 4, pp 139-145 (1989).

Lighty, J.S., R. Britt, D.W. Pershing, W. Owens, and V.A. Cundy, “Rotary Kiln Incineration II. Laboratory-Scale Desorption & Kiln Simulator Studies - Solids,” *JAPCA*, 39, 2, pp 187-193 (1989).

Lighty, J.S., G.D. Silcox, D.W. Pershing, V.A. Cundy, and D.G. Linz, “Fundamental Experiments on Thermal Desorption of Contaminants from Soils,” *Environmental Progress*, 8, 1 (1989).

Cundy, V.A., S. Acharya, T.W. Lester, C.B. Leger, A.N. Montestruc, J.S. Morse, D.W. Pershing, and A.M. Sterling, “Rotary Kiln Injection I. An In-Depth Study – Liquid Injection,” *JAPCA*, 39, 1, pp 63-75 (1989).

Silcox, G.D., J.C. Kramlich, and D.W. Pershing, “A Mathematical Model for the Flash Calcination of Dispersed CaCO3 and CA(OH)2 Particles,” *I & EC Research*, 28, 155 (1989).

Lighty, J.S., G.D. Silcox, D.W. Pershing, V.A. Cundy, and D.G. Linz, “Fundamentals for the Thermal Remediation of Contaminated Soils: Particle and Bed Desorption Models,” *Environmental Science & Technology*, 24, 5, pp 750-757 (1990).

Lighty, J.S., E.G. Eddings, E.R. Lindgren, Deng, Xiao-Xue, D.W. Pershing, R.M. Winter, and W.H. McClennen, “Rate Limiting Processes in the Rotary-Kiln Incineration of Contaminated Solids,” *Combustion Science and Technology*, 74, pp 31-49 (1990).

McClennen, W.H., N.S. Arnold, K.A. Roberts, H.L.C. Meuzelaar, J.S. Lighty, D.W. Pershing, and E.R. Lindgren, “Fast Repetitive GC/MS Analysis of Thermally Desorbed PAHs from Contaminated Soils,” *Combustion Science and Technology,* 74, p. 297 (1990).

Silcox, G.D., G.E. Parry, A.L. Bunge, L.K. Pershing, and D.W. Pershing, “Percutaneous Absorption of Benzoic Acid Across Human Skin II: Prediction of an *in Vivo*, Skin-Flap System Using *in Vitro* Parameters,” *Pharmaceutical Res*., 7, 4, pp 352-358 (1990).

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