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## curriculum vitae

**PHILIP JOHN SMITH**

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volume rendered temperature from computer simulation of a JP8 pool fire



### ADDRESSES

3290 Merrill Engineering Building,  
50 South Central Campus Drive  
The University of Utah  
Salt Lake City, Utah 84112  
Phone: (801)585-3129, Fax: (801)585-1456  
smith@crsim.utah.edu  
<http://www.crsim.utah.edu>

### CURRENT POSITIONS

- Chair, Department of Chemical Engineering,
- Professor, Department of Chemical Engineering,
- Chair, Conflict of Interest Committee, University of Utah
- Adjunct Professor, Department of Mechanical Engineering,

### BIRTHDATE

November 9, 1951.

### CITIZENSHIP

Canada  
U.S. Permanent Resident Visa—Alien Number: A10779710

### EDUCATION

- Ph.D., Chemical Engineering, Brigham Young University, 1979  
Dissertation: Theoretical Modeling of Coal and Gas Fired Turbulent Combustion and Gasification Processes.
- M.S., Chemical Engineering, Brigham Young University, 1976  
Thesis: A Theoretical Model of Great Salt Lake Predicting Upper South Arm Brine Salinity.
- B.S.(Cum Laude), Chemical Engineering. and Physics, Brigham Young University, 1975
- University of Saskatchewan (1969-1971)

### RESEARCH

Computational Simulation and Modeling of Fire, Combustion and Reacting-Flow Systems.

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## EMPLOYMENT HISTORY

- 2000 - present.....Chair, Department of Chemical and Fuels Engineering, The University of Utah, Salt Lake City, Utah.
- 1998 - 2003.....Associate Director, Center for Simulation of Accidental Fires and Explosions, The University of Utah, Salt Lake City, Utah.
- 1990 - present.....Professor (tenured), Department of Chemical and Fuels Engineering, The University of Utah, Salt Lake City, Utah.
- 1990 - 1998.....Co-Founder and Vice-President, Reaction Engineering International, Salt Lake City, Utah.
- 1985 - 1991.....Associate Professor, Dept. of Chem. Eng., and Head, Combustion Computations Laboratory, Brigham Young University, Provo, Utah.
- 1982 - 1983.....Staff member, Energy (Q) Division, Los Alamos National Laboratory, Los Alamos, New Mexico (sabbatical leave from BYU).
- 1979 - 1985.....Assistant Professor, Dept. of Chem. Eng., Brigham Young University.

## ORGANIZATIONAL MANAGEMENT

- 2000 - present.....Chair, Department of Chemical and Fuels Engineering, The University of Utah
- remodelled department offices and laboratories
  - created student computing and teaching laboratory
  - instituted department policy on auxiliary faculty
  - full EC 2000 ABET accreditation (review fall 2003)
  - acquired 3 new tenure track faculty
  - added \$750K in endowments and \$250K in scholarships
- 2002 - present.....Chair, University Conflict of Interest Committee, The University of Utah
- responsible for the creation of a new University policy that identifies, evaluates and manages individual financial conflicts of interest
  - responsible for developing and managing process to adjudicate individual cases of conflicts of interest under this new policy
- 1998 - 2003.....Associate Director, C-SAFE (Center for Simulation of Accidental Fires and Explosions)<sup>1</sup>, a U.S. DOE funded ASAP<sup>2</sup> (Academic Strategic Alliance Partners) Center for ASCI<sup>3</sup> (Advanced Simulation and Computing)
- principal proposal author
  - responsible for defining the mission and integrating the personnel and technology from Chemistry, Computer Science, Chemical Engineering, Mechanical Engineering, and Mathematics to create a product that will be useful to three national laboratories
  - responsible for managing creation and delivery of fire simulation
- 1998 - 1999.....Elected representative to the Executive Committee of the Academic Senate—elected to the Academic Senate by the faculty in the College of Engineering, then elected by the senate to sit on the executive committee of this governing body of The University of Utah.

<sup>1</sup>. see <http://www.csafe.utah.edu>

<sup>2</sup>. see <http://www.llnl.gov/asci-alliances>

<sup>3</sup>. see <http://www.llnl.gov/asci>



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1990 - 2000.....	Department Strategic Planning Committee—responsible for defining and implementing department long term goals and objectives.
1990 - 1998.....	One of three founding partners of Reaction Engineering International (REI)—REI now employs ~35 professionals and provides international consulting services in combustion technology.
1992 - 1993.....	Committee for the Merger of Department of Fuels in the College of Mines with the Department of Chemical Engineering in the College of Engineering.—one of 4 faculty (2 from each dept.) responsible for establish procedures and policies for amicably merging 2 different departments from 2 different colleges.
1985 - 1990.....	Head of Combustion Computations Laboratory for the Advanced Combustion Engineering Research Center (ACERC) at Brigham Young University, a National Science Foundation ERC (Engineering Research Center).—responsible for defining the vision and leading the development of the combustion simulation software.
1982 - 1990.....	Founding member of College of Engineering CAEDM Committee of Brigham Young University—responsible for identifying academic, and research computer needs and seeking funding.

## CREATIVE PRODUCTS<sup>4</sup>

- **ARCHES** (2002 - present)—A general, public-domain, massively parallel, large eddy simulation package for fire.—Aimed at bridging wide ranges of time and space through dynamic mixing and reaction models for turbulent reacting flow.
- **GLACIER** (1994 - present)—A suite of computer algorithms for simulation of three-dimensional, multi-phase combustion and reacting flow systems.—Couples all modes of heat transfer, computational fluid dynamics, homogeneous & heterogeneous chemistry, turbulent micro-mixing, finite-rate chemistry.
- **BANFF** (1993 to present)—A computer software package (including graphical user interface) for simulation of three-dimensional turbulent combustion chambers with gaseous fuels.
- **JASPER** (1992)—An axisymmetric computational fluid dynamics code for turbulent reacting flows and reacting particles.
- **PCCWM** (1988 - 1991)—A computer program for solving combustion and gasification of coal-water slurry systems—Couples axisymmetric computational fluid dynamics with heat transfer for three phase mixture turbulent combustion.
- **PCGC3** (1990)—A computer software package including graphical pre- and post-processing for combustion of gaseous fuels in three-dimensional geometries—Couples computational fluid dynamics with equilibrium chemistry—licensed by Brigham Young University.
- **PCGC2** (1980 - 1989)—A computer program for combustion or gasification of coal in two dimensions—licensed by Brigham Young University.
- **1DICOG** (1980 - 1986)—A computer software program for calculating one dimensional (plug flow with variable but prescribed recirculation rates) combustion of gaseous and coal fuels and for gasification of coal.

<sup>4</sup>. all of these computer programs have been distributed to and used by industrial, governmental and academic users. (User references available upon request)



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## RECENT & SIGNIFICANT RESEARCH GRANTS / CONTRACTS

- 1998 - present •DOE ASCI Center for Simulation of Accidental Fires and Explosions, associate director and one of several PI's—\$45.0 million over 10 years—individual budget: ~\$350,00/year.
- 2000 - present •Sandia National Laboratories and PPG Industries, “Sensor Fusion for Intelligent Process Control,”—contract for developing combustion simulation and process control for NOx formation in glass furnaces—\$450,000.
- 1999 - present •FLUENT Inc.donation—cooperative agreement on combustion modeling in which Fluent has granted a 20 processor license—in-kind donation of \$158,600/year.
- 1994 - 2000 •DOE “Combustion 2000” contract—contract for computational simulation support for designing a new coal-fired power system—UofU PI, \$2.2 million over 6 years.
- 1998 - 2002 •DOW Chemical Company grant—for cfd-based simulation of liquid-liquid reactors—\$125,000.
- 1996 - 1998 •DOE contract—Optimization of Chemical Process Heaters and Combustion Systems—for optimization of ethylene furnace simulations—\$160,000.
- 1993 - 1998 •REI/UofU joint venture—on Development of Reacting Flow algorithms—\$170,000.
- 1992 - 1996 •DOW Chemical Company grant—Coupling PIC Reaction Kinetics with Computational Fluid Dynamics—\$161,000.
- 1990 - 1993 •DOE contract—3-D Turbulent Particle Dispersion Submodel Development—\$189,000.
- 1990 - 1993 •IBM grant—with Michael Pernice (USI), Christopher Sikorski (CS), Frank Stenger (CS), and Gerard Schuster (Geology)—Distributed Computation with Clusters of IBM Workstations for Geophysical Modeling and Combustion Engineering—\$750,000.
- 1990 - 1992 •Three University of Utah internal grants—(1) support of combustion modeling, (2) use of supercomputer and (3) research start-up—\$180,000+supercomputer time.
- 1989 •NSF equipment grant—Networking Equipment to Link Brigham Young University and the University of Utah—\$90,000.
- 1985 -1990 •Directed the Combustion Computations Laboratory at the NSF sponsored Engineering Research Center in Advanced Combustion at BYU with a personal research budget in excess of \$400,000/year.
- 1984 -1988 •Consortium of nine industries and governmental agencies—principal investigator on a research contract at Brigham Young University to develop three dimensional combustion models—\$1.3 million.

## RECENT TEACHING DEVELOPMENT

- Computational Fluid Dynamics Class: developed an introductory CFD class<sup>5</sup> for advanced undergraduates and graduate students in Mechanical and Chemical Engineering. Students write their own Navier-Stokes solver as well as demonstrating proficiency in a commercial CFD software package.

<sup>5</sup>. see <http://www.crsim.utah.edu/~smith/Classes/5353>



- Multicomponent Mass Transfer: developed a graduate course delivered over the internet<sup>6</sup> in conjunction with class room discussions for complex principles of multicomponent mass transfer including on-line video (see <http://opus.utah.edu/~smith/Classes/666>).
- Freshman Computer Literacy Class: developed a new curriculum for teaching freshman engineering students the essentials and tools for engineering computing.
- Course on improving teaching: participant in a course on Integrated Learning Systems for Improving Engineering Education at Brigham Young University. (1989-1990)
- TV courses: pioneered two-way audio and video television transmission and reception between the University of Utah and Brigham Young University for graduate classes in Coal Combustion and Combustion Modeling. (1987-89)
- Digital Process Control: responsible for a 5-year program for implementation of computer control in the Unit Operations Laboratory of the Chemical Engineering Department of Brigham Young University. This included computer hardware and software acquisition, facilities modifications, experimental equipment upgrading, digital control equipment acquisition, and implementation of two new courses in the regular curriculum on digital process control. (1984-1988)

## ACADEMIC HONORS

- rated in top 10% of all College of Engineering faculty teaching graduate courses at the University of Utah for the instruction of Multicomponent Mass Transfer every year taught (1994-2004)
- University-wide Student Choice Award for Excellence in Teaching, University of Utah, 1999
- rated in the top 15% of all Engineering College faculty teaching undergraduate courses at the University of Utah in 1992 & 1994.
- The Outstanding College Faculty Member, College of Engineering and Technology, Brigham Young University, 1988.
- The Outstanding Ph.D. Dissertation (1979) and M.S. Thesis (1977), College of Engineering Science and Technology, Brigham Young.

## CONSULTING

CD Adapco Group, StarCD Software, London, UK, and New York, NY  
 James Hardie Building Products, Sydney Australia  
 Dow Chemical Company, Baytown, TX, and Midland, MI  
 Ray, Quinney & Nebeker, Salt Lake City, UT  
 Monsanto Company, St. Louis, MO, and Soda Springs, ID  
 City of Mesa, Mesa AZ  
 John Zink Company (a Koch Industries company), Tulsa, OK  
 ASARCO Incorporated, El Paso, TX  
 Electric Power Research Institute, Palo Alto, CA  
 ABB, Combustion Engineering, Windsor, CT  
 Stone and Webster Corporation, Dallas, TX  
 Shell Development Corporation, Houston, TX  
 Southern California Edison, Rosemead, CA  
 General Electric Corporation, Schenectady, NY  
 Clemson University, Clemson, SC

<sup>6</sup>. see <http://www.crsim.utah.edu/~smith/classes/6603>



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Department of Energy, Morgantown, WV  
Allison Gas Turbine Operations, GM Corp., Indianapolis, IN  
Babcock and Wilcox Corp., Alliance, OH  
Sterns Roger, Denver, CO  
Jaycor Corporation, Del Mar, CA  
Thiokol, Brigham City, UT  
Eyring Research Corporation, Provo, UT  
Atlantic Research Corporation, Alexandria, VA  
Los Alamos National Laboratory, Los Alamos, NM  
State of Utah, Div. of Water Resources, Salt Lake City, UT  
N.L Industries, Salt Lake City, UT  
Western Refining Company, Salt Lake City, UT  
Redd-Redd Associates, Salt Lake City, UT

## RECENT INVITED LECTURES

- 50th Anniversary Lecture on Computational Combustion (with C. Westbrook, Y. Mizobuchi, T. Poinso, J. Warnatz), Thirtieth International Symposium on Combustion, Chicago, Illinois, Aug. 2004
- 3rd International Conference on CFD in the Minerals & Process Industries, invited session lead paper, Melbourne Australia, Dec. 2003.
- Penn State University, Department of Chemical Engineering, speaker, Sept. 2003.
- Gordon Conference (Hydrocarbon Resources) speaker Jan. 2003.
- briefing at Dept. of Energy, Washington, D.C. on Accelerated Strategic Computing Initiative, June 2003.

## INDUSTRIAL SHORT COURSES

- Spring 2004.....Applied Combustion Technology, Problem Solving for the Utility and Process Industries, March 15 through March 17, 2004<sup>7</sup>  
The University of Utah
- Summer 1990.....Three-Dimensional Combustion Modeling,  
Brigham Young University, Provo, UT
- Summer 1984.....Combustion and Gasification Modeling of Coal  
and Coal-Water Mixtures,  
Brigham Young University, Provo, UT
- Spring 1984.....Fundamentals of Coal Combustion Processes,  
Babcock and Wilcox Corporation, Alliance, OH
- Summer 1983.....Combustion and Gasification Modeling of Coal  
and Coal-Water Mixtures,  
Brigham Young University, Provo, UT

## PROFESSIONAL SERVICE

- Conflict of Interest Committee for the University of Utah (2001 - present), currently the chair of this committee.
- Technical organizing committee for International Symposium on Combustion held in Sapporo, Japan by the Combustion Institute (2002-2003).

<sup>7</sup>. see <http://www.che.utah.edu/combustion> course



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- Member of technical program review of the National Energy Technology Laboratory (NETL) (2002).
  - User Group Advisory Board for the Combustion Research Facility, Sandia National Laboratories, Livermore, CA (2000-2002).
  - Member of Executive Committee of the Academic Senate, University of Utah, (1998-1999).
  - Member of the Ad Hoc Committee for Resolving University Faculty Grievances (1998-1999).
  - Member of University Committee for Technology Enhanced Curriculum (CTEC), committee to oversee policy and practice for web-based instruction at the University of Utah (1997-1999).
  - Member of Academic Senate, University of Utah, (1995-2000).
  - Member of committee to define research objectives in the Chemical Process Industry for the U.S. Dept. of Energy, Office of Industrial Technology (1996-1997).
  - Sponsor & organizer for technical meeting for Western States Section of the Combustion Institute, Salt Lake City, UT (March 21-23, 1993).
  - Member of peer review panel for assessment of combustion related projects in the Office of Energy Research, Basic Energy Sciences Office, Department of Energy, Bethesda, Maryland (Nov 3-5, 1992).
  - Member-at-large to the executive board of the Western States Section of the Combustion Institute (1989 to present).
  - Member of university committee to study the merger of the departments of Chemical and Fuels Engineering, University of Utah, (1992).
  - Member of committee to define a strategic plan for the Dept. of Chemical Engineering, University of Utah (1991-present).
  - Member of review panel for Combustion Research Initiative at University of California, Berkeley (1991).
  - Head of Combustion Computations Laboratory at Brigham Young University—responsible for creating and operating a computer center to support super-computing in combustion and other research throughout the university (1985-1990).
  - Consultant to Morgantown Energy Technology Center (METC) of the Dept. of Energy (DOE) on defining computing needs for them (1989).
  - Executive board member, Western States Section of the Combustion Institute (1987 to 1989).
  - Member of review panel for combustion research (“Flames of the Future”) at the Environmental Protection Agency, Research Triangle Park, NC (1990).
  - Member of review panel for Combustion Research Facility, Phase II at Sandia National Laboratory, Livermore CA., sponsored by DOE, Basic Energy Sciences (1989).
  - Head of committee on redefining graduate programs for the Dept. of Chemical Engineering, Brigham Young University (1989).
  - Member of CAEDM Committee, College of Engineering, Brigham Young University—the committee was responsible for overseeing all computing activities in the College of Engineering (1982-1990).
  - Sponsored and organized technical meeting for Western States Section of the Combustion Institute, Provo, UT (March 20-22, 1988).
  - Organized a session on Combustion for AIChE National Meeting (in cooperation with Prof. Dan Rosner, Yale University), (1988).



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## GRADUATE STUDENTS SUPERVISED (YEAR DEGREE AWARDED)

- currently supervising 9 graduate students and 1 Post Doc
- Wing Yee, Ph.D. Department of Chemical and Fuels Engineering, The University of Utah (2004).
- Stanislav Borodai, Post Doctoral Studies, PhD from University of Illinois, Urbana-Champaign from Prof. Robert D. Moser (2002 - 2004).
- Diem-Phuong Nguyen, Ph.D. Department of Chemical and Fuels Engineering and U.S. Dept. of Energy Computational Science Graduate Fellow, The University of Utah (2003).
- Jennifer Spinti, Post Doctoral Studies, Department of Chemical Engineering, University of Utah (1998-1999).
- Dale Smith, Ph.D. Department of Chemical Engineering, University of Utah (1999).
- Stefan Domino, Ph.D. Department of Chemical Engineering, University of Utah (1999).
- Sheshadri Kumar, Ph.D. Department of Chemical Engineering, University of Utah (1999).
- Chrys Correa, M.S. Department of Chemical Engineering, University of Utah (1998).
- David Swensen, M.S. Department of Mechanical Engineering, University of Utah (1997).
- Rajesh Rawat, Ph.D. Department of Chemical Engineering, University of Utah (1997).
- Sandeep Jain, Ph.D., Department of Chemical Engineering, University of Utah (1997).
- Rahul Shah, M.S., Dept. of Chemical Engineering, University of Utah (1996)
- James Valentine, Post-Doctoral Studies, Dept. of Chemical Eng., University of Utah (1995-1996).
- Seshadri Kumar, M.S., Department of Chemical Engineering, University of Utah (1994).
- Bradley R. Adams, Ph.D., Department of Mechanical Engineering, University of Utah (1994).
- Subrata Sen, Post Doctoral Studies, Dept. of Chemical Engineering, Brigham Young University (1989-1991).
- Joseph D. Smith, Ph.D., Dept. of Chemical Engineering, Brigham Young University (1990).
- Dale A. Smith, M.S., Dept. of Chemical Engineering, Brigham Young University (1989).
- Paul A. Gillis, Ph.D., Dept. of Chemical Engineering, Brigham Young University (1989).
- Robert W. Colson, M.S., Dept. of Chemical Engineering, Brigham Young University (1989).
- Larry L. Baxter, Ph.D., Dept. of Chemical Engineering, Brigham Young University (1989).
- Mohamed Hassan, Post Doctoral Studies, Dept. of Chem. Eng, Brigham Young University (1988-1989).
- Knute R. Christensen, M.S., Dept. of Chemical Engineering, Brigham Young University (1988).
- A.S. Jamaluddin, Post Doctoral Studies, Dept. of Chem. Engineering, Brigham Young University (1986-1988).



- Paul R. Davies, M.S., Dept. of Chemical Engineering, Brigham Young University (1988).
- Daniel L. Meyers, M.S., Dept. of Chemical Engineering, Brigham Young University (1988).
- Mary W. Rasband, M.S., Dept. of Chemical Engineering, Brigham Young University (1988).
- Michael L. Hobbs, M.S., Dept. of Chemical Engineering, Brigham Young University (1985).

## PUBLICATION SUMMARY<sup>8</sup>

### Books

- L.D. Smoot and P.J. Smith, *Coal Combustion and Gasification*, Plenum Publishing Corp., New York, NY, (1985).
- L.D. Smoot and P.J. Smith, "Modeling Pulverized Coal Reaction Processes," and "Modeling One-Dimensional Systems," two chapters in *Coal Combustion and Gasification*, edited by L.D. Smoot and D.T. Pratt, Plenum Publishing Corp., New York, NY, (1979).

### Peer Reviewed Journal Publications

- Charles K. Westbrook, Yasuhiro Mizobuchi, Thierry J. Poinso, Phillip J. Smith, Jürgen Warnatz, "Computational Combustion," *Proceedings of the Combustion Institute*, 2004.
- James C. Sutherland, Philip J. Smith, Jacqueline H. Chen, "Quantification of Differential Diffusion in Nonpremixed Systems," *Combust. Theory Modelling*, submitted 2004.
- Kumar, S., and P.J.Smith, "A Projection Analysis of the SIMPLE family of Algorithms for Steady Incompressible Internal Flows in the Context of a Nonlinear Picard Solver. Part I: Theory," submitted to the *International Journal for Numerical Methods in Fluids*, September 2004.
- Kumar, S., and P.J.Smith, "Optimization of the nonlinear convergence rate of the SIMPLER Picard algorithm for steady incompressible internal flows through enforcement of continuity projections," submitted to the *International Journal for Numerical Methods in Fluids*, September 2004.
- G. Krishnamoorthy, R. Rawat and P.J. Smith, "Parallel Computations of Non Gray Radiative Heat Transfer," *Numer. Heat Transfer B*, submitted for publication 2004.
- Gautham Krishnamoorthy, Rajesh Rawat and Philip J. Smith, "Parallel Computations of Radiative Heat Transfer Using the Discrete Ordinates Method," *Numerical Heat Transfer, Part B: Fundamentals*, accepted for publication, 2004.
- James Sutherland, Philip Smith and Jackie Chen, "A Generalized Method for A Priori Evaluation of Combustion Reaction Models," submitted for publication, 2003.
- James Sutherland, Philip Smith and Jackie Chen, "Quantification of Differential Diffusion in Nonpremixed Systems," submitted for publication, 2003.
- M. Perez-Tello, H. Y. Sohn, K. St. Marie, and A. Jokilaakso, "Experimental Investigation and 3-D Computational Fluid Dynamics Modeling of the Flash Converting Furnace Shaft: Part I. Experimental Observa-

<sup>8</sup>. Not shown: users manuals, contract reports, presentations without full papers, etc.



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tion of Copper Converting Reactions in Terms of Converting Rate, Converting Quality, Changes in Particle Size, Morphology, and Mineralogy," *Metall. Mater. Trans. B*, 32B, 847-868 (2001).

•M. Perez-Tello, H. Y. Sohn, and P. J. Smith, "Experimental Investigation and 3-D Computational Fluid Dynamics Modeling of the Flash Converting Furnace Shaft: Part II. Formulation of 3-D Computational Fluid Dynamics Model Incorporating the Particle Cloud Description," *Metall. Mater. Trans. B*, 32B, 869-886 (2001).

•R. Rawat, S.G. Parker, P.J. Smith, and C.R. Johnson, "Parallelization and Integration of Fire Simulations in the Uintah PSE," *Proc. 10th SIAM Conference on Parallel Processing for Scientific Computing*, Portsmouth, VA, 2001.

•T. Henderson, P. McMurtry, P. Smith, G.Voth, C.Wight, and D.Pershing, "Simulating Accidental Fires and Explosions," *IEEE Comput. Sci. Eng*, vol.7, pp.64-76, 2000.

•Stefan P. Domino and Philip J. Smith, "State Space Sensitivity to a Prescribed Probability Density Function Shape in coal Combustion Systems: Joint  $\beta$ -PDF versus clipped Gaussian PDF," *Proceedings of the Combustion Institute*, Volume 28, pp.2329-2336, (2000).

•M. Pernice, M.J. Bockelie, D. Swensen, P.J. Smith, "Progress, Results, and Experiences in Developing an Adaptive Solver for Steady-State Turbulent Reacting Flows in Industrial Boilers and Furnaces," *IMA Volumes in Mathematics and its Applications*, 1999.

•S.P. Domino, and P.J. Smith, *1999 ASME International Mechanical Engineering Congress and Exposition*, HTD-Vol. 364-2, pp. 395-404, American Society of Mechanical Engineers, New York, 1999.

•C.D. Correa, P.J. Smith, "Optimization of Ethylene Furnace Operations," *AICHE Journal*, submitted Dec. 1998.

•J.R. Valentine, P.J. Smith, "Numerical Predictions of Deposition with a Particle Cloud Tracking Technique," *AICHE Journal*, submitted Oct. 1998.

•V. Mehrotra, G.D. Silcox, P.J. Smith, "Numerical Simulation of Turbulent Particle Dispersion Using a Monte Carlo Approach", *Proceedings of FEDSM 98, ASME Fluids Engineering Division*, 1998.

•J. Brouwer, E.G. Eddings, M.P. Heap, D.W. Pershing, and P.J. Smith, "Effects of Mixing and Thermal Quenching on NO Reduction by Selective Non-Catalytic Reduction in the Presence of CO," *25th Symposium (International) on Combustion*, The Combustion Institute, 1996.

•B.R. Adams, and P.J. Smith, "Modeling Effects of Soot and Turbulence-Radiation Coupling on Radiative Transfer in Turbulent Gaseous Combustion," *Combust. Sci. and Tech.* 109, 121-140, 1995.

•M.A. Cremer, P.J. Smith, R. Rawat, P.C. Fife, "Reduction of a Chemical Mechanism for Natural Gas Combustion (GRI-MECH) based on the Intrinsic Low-Dimensional Manifold Method," *Bull. Amer. Physical Society*, 40 (12), November, 1995.

•K-L. Ma, K. Sikorski, P.J. Smith, and B.R. Adams, "Distributed Combustion Simulations," *Energy and Fuels*, Vol. 7, No.6, pp. 902-905, 1993.

•B.R. Adams and P.J. Smith, "Three-Dimensional Discrete-Ordinates Modeling of Radiative Transfer in a Geometrically Complex Furnace," *Combustion Science and Technology*, 88(5-6):293, 1993.



- J.D. Smith, P.J. Smith and S.C. Hill, "Parametric Sensitivity Study of an Entrained-Flow Pulverized-Fuel Combustion Model," *AICHE Journal*, 1993.
- K-L Ma and P.J. Smith, "Virtual Smoke: An Interactive 3D Flow Visualization Technique," *IEEE Visualization*, to appear, 1992.
- A.S. Jamaluddin and P.J. Smith, "Discrete-Ordinates Solution of Radiative Transfer Equation in Non-Axisymmetric Cylindrical Enclosures," *Journal of Thermophysics and Heat Transfer*, Vol.6, No.2, 242, 1992.
- P.J. Smith, W.A. Sowa, and P.O. Hedman, "Furnace Design Using Comprehensive Combustion Models," *Combustion and Flame*, 79:111, 1990.
- M.L. Hobbs and P.J. Smith, "Algebraic, Multi-Zoned Radiation Model for a Two-Zoned Zero-Dimensional Cylindrical Furnace," *Fuel*, 69:1420-1427, 1990.
- P.A. Gillis and P.J. Smith. "An Evaluation of Three-Dimensional Computational Fluid Dynamics for Industrial Furnace Geometries," *23rd Symposium (International) on Combustion*, The Combustion Institute, 1990.
- J.D. Lindsay, P.O. Hedman, and P.J. Smith., "Laser-Doppler Velocimeter Measurements in Simulated Entrained Gasifier Flows," *AICHE Journal*, 35:1304-1314, 1989.
- R.M. LaFollette, P.O. Hedman, and P.J. Smith, "An Analysis of Coal Particle Temperature Measurements with Two-Color Optical Pyrometers," *Combustion Science and Technology*, 66:93, 1989.
- B.W. Brown, P.J. Smith, L.D. Smoot, and P.O. Hedman., "Measurement and Prediction of Entrained-Flow Gasification Processes," *AICHE Journal*, 34(3):435-446, 1988.
- J.D. Smith, T.T. Spencer, P.J. Smith, A.U. Blackham, and L.D. Smoot. "Effects of Coal Quality on Utility Furnace Performance," *Fuel*, 67:27-35, 1988.
- A.S. Jamaluddin and P.J. Smith, "Radiative Transfer in Axisymmetric Cylindrical Enclosures Using the Discrete Ordinates Method," *Combustion Science and Technology*, 62, 4-6, p.173, 1988.
- A.S. Jamaluddin and P.J. Smith, "Predicting Radiative Transfer in Rectangular Enclosures Using the Discrete Ordinates Method," *Combustion Science and Technology*, 59:321-340, 1988.
- P.J. Smith and T.H. Fletcher, "Study of Two Chemical Reaction Models in Turbulent Coal Combustion," *Combustion Science and Technology*, 58, 1988.
- J.D. Smith, P.J. Smith, and S.C. Hill, "Parametric Sensitivity Study of an Entrained-Flow Pulverized Fuel Combustion Model," *Computer and Chemical Engineering*, 1987.
- D.G. Sloan, P.J. Smith, and L.D. Smoot, "Modeling of Swirl in Turbulent Flow Systems," *Progress Energy Combustion Science*, 12(3):63-250, 1986.
- S.C. Hill, L.D. Smoot, and P.J. Smith, "Effects of Swirling Flow on Nitrogen Oxide Concentration in Pulverized Coal Combustors," *AICHE Journal*, 32(11):1917-1919, 1986.
- T. Suzuki, L.D. Smoot, T.H. Fletcher, and P.J. Smith, "Prediction of High Intensity Pulverized Coal Combustion," *Combustion Science and Technology*, 45(3-4):167-183, 1986.



- S.D. Hill, L.D. Smoot, and P.J. Smith, "Prediction of Nitrogen Oxide Formation in Turbulent Coal Flames," *20th Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA, 1985.
- L.D. Smoot, P.O. Hedman, and P.J. Smith, "Pulverized Coal Combustion Research at Brigham Young University," *Progress Energy Combustion Science*, 10:349-441, 1984.
- P.J. Smith, S.C. Hill, and L.D. Smoot, "Theory for NO Formation in Turbulent Coal Flames," *19th Symposium (International) on Combustion*, The Combustion Institute, Pittsburgh, PA, 1983.
- P.J. Smith and L.D. Smoot, "Turbulent Gaseous Combustion Part II: Theory and Evaluation for Local Properties," *Combustion and Flame*, 42:277, 1981.
- P.J. Smith, T.H. Fletcher, and L.D. Smoot, "Model for Pulverized Coal-Fired Reactors," *18th Symposium (International) on Combustion*, 1285, The Combustion Institute, Pittsburgh, PA, 1981.
- P.J. Smith and L.D. Smoot, "Local Combustion Predictions for Turbulent Gaseous Combustors: Theory and Evaluation," *Combustion and Flame*, 1980.
- P.J. Smith and L.D. Smoot, "One-Dimensional Model for Pulverized Coal Combustion," *Combustion Science Technology*, 23(17), 1980.
- P.J. Smith and J.M. Glassett, "A Mathematical Model of the Effect of the Railroad Causeway on the Great Salt Lake," in *Desertic Terminal Lakes*, edited by D.C. Greer, 1977.

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