6th International Supercritical CO_2 Power Cycles SYMPOSIUM

Pittsburgh · March 27-29, 2018

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

NAVAL NUCLEAR LABORATORY

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ABOUT THE PROGRAM

SYNOPSIS

The 6th International Supercritical CO_2 Power Cycles Symposium is a technical meeting organized and designed by industry, academia, and government agencies to advance the development of technology for power cycles with supercritical carbon dioxide (sCO_2) as the working fluid. Every two to three years, researchers, industry partners, and end users meet to learn about advancements in the field, discuss priorities, and establish a critical path for technology development. The perspective gained will allow researchers to better coordinate work and allow participants greater insight into the overall direction of this technology. The first symposium was held at the Massachusetts Institute of Technology (Cambridge, Massachusetts) in 2007, the second was held at Rensselaer Polytechnic Institute (Troy, New York) in 2009, and the third was held at the University of Colorado at Boulder (Boulder, Colorado) in 2011. The 2014 symposium was held in Pittsburgh, Pennsylvania, and the 2016 symposium was held in San Antonio, Texas. The technical papers and presentations for the 2018 symposium will be available online following the meeting, archived alongside those of the previous workshops. The goal of the symposium is to facilitate peer-to-peer knowledge sharing and collaboration across organizational and company boundaries that will create a network of expertise and accelerate advancements in the field.

TECHNOLOGY SUMMARY

Carbon dioxide is an extremely efficient working fluid in its supercritical state. Power cycles based on supercricitical carbon dioxide (sCO_2) as the working fluid, instead of steam, have the potential for higher thermal efficiencies with lower capital cost when compared to state-of-the-art, steam-based power cycles. Taken together, the unique features of sCO_2, which include having a small environmental footprint, lower water use, fuel/heat source flexibility, and the potential for lower capital cost – along with multiple performance benefits that result from higher efficiency (e.g., lower fuel use, reduced emissions, less cooling water) – are creating broad interest in the sCO_2 power cycle. Additionally, this power cycle is synergistic with a wide spectrum of heat sources (the sCO_2 cycle can be configured to operate with a variety of heat sources, including nuclear, fossil fuel, and renewables such as concentrating solar and geothermal). The high power density characteristic of the cycle tends to amplify benefits in each application. Greater thermal efficiency means more power can be produced per unit of fuel, which ultimately reduces power plant operating costs, payback periods, and emissions. Carbon dioxide is an attractive working fluid because its critical pressure and temperature are reasonable to work with, in addition to it being non-toxic, easily obtained, and inexpensive. Heat engines that use sCO_2 as a working fluid are smaller and less complex than heat engines that use many traditional working fluids, including superheated steam, helium, and organic fluids. A main purpose of this symposium is to help identify and resolve technical and cost issues in the development of this technology.

ORGANIZING COMMITTEE

SYMPOSIUM

Co-Chairs

Rich Dennis	US DOE, Fossil Energy, NETL
Eric Clementoni	Naval Nuclear Laboratory

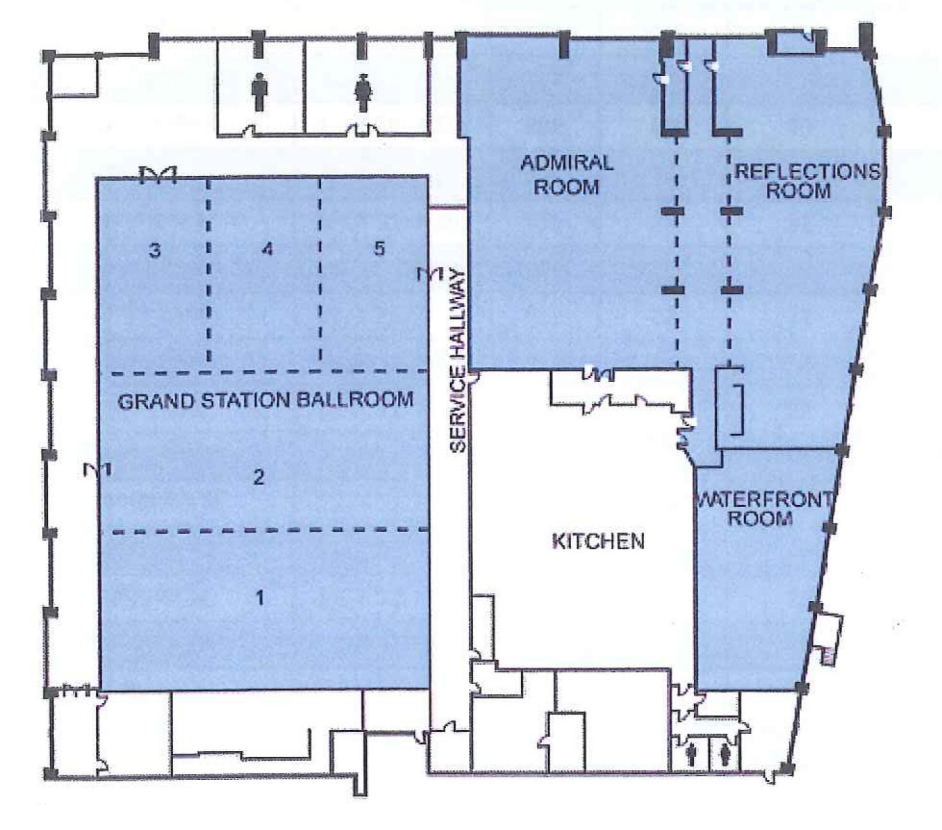
Past Co-Chair

Klaus Brun	Southwest Research Institute

Ganesan (Subbu) Subbaraman	Gas Technology Institute
Robert Fuller	Barber-Nichols
Steve Wright	Supercritical Technologies
Rene Pecnik	Delft University of Technology
Thomas Soulas	Dresser-Rand
Tim Held	Echogen
Max Peter	General Electric
Renaud Le Pierres	Heatric
Voramon Dheeradhada	General Electric
Jeong Ik Lee	KAIST
Craig Turchi	National Renewable Energy Laboratory
Doug Hofer	General Electric
Andrew Maxson	EPRI
Chendhil Periasamy	Air Liquide
Jim Pasch	Sandia National Laboratories
Lalit Chordia	Thar Energy
David Sánchez	University of Seville
Walker Dimmig	NET Power
Gary Jesionowski	KeyLogic
Paul Murray	Areva
Bhima Sastri	US DOE
Matt Usher	American Electric Power
Karl Wygant	Samsung Techwin
Avi Shultz	US DOE
Jeff Phillips	EPRI
Joseph Thorp	Aramco Services

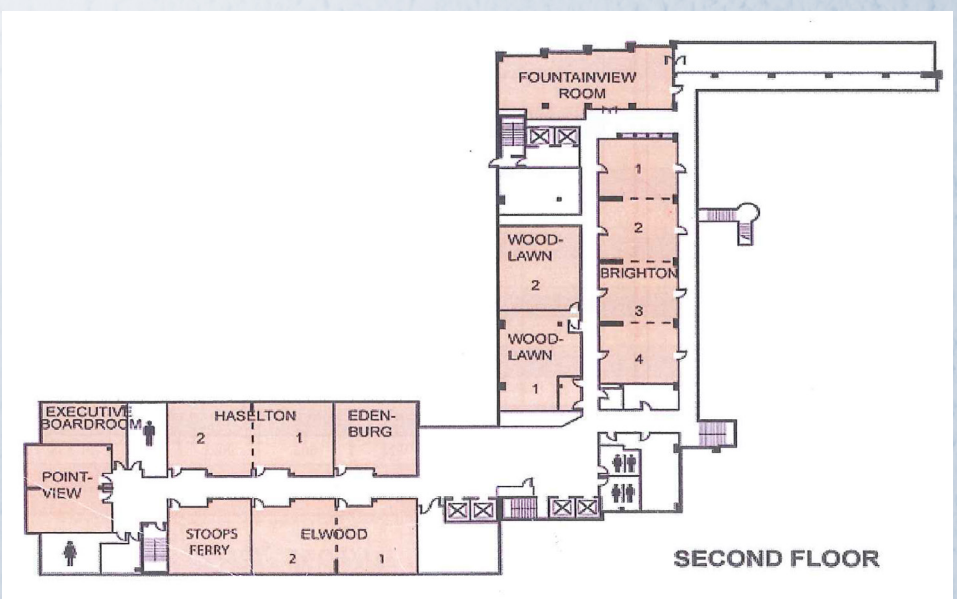
HOTEL MAP

SHERATON STATION SQUARE HOTEL - PITTSBURGH, PA



Sheraton Station Square HOTEL

First Floor



Second Floor

AGENDA-AT-GLANCE

SUPERCRITICAL SCO_2 POWER CYCLES SYMPOSIUM

6th International Supercritical Symposium CO_2 Power Cycles Symposium March 27 - 29, 2018 -- AGENDA AT-A-GLANCE				
Day/Time	**Track A**	**Track B**	**Track C**	**Track D**
Monday, March 26th				
Mon, 12:30 - 7:00 pm	Registration – Grand Station – Ballroom Foyer			
Mon, 12:30 - 6:30 pm	Pre-Conference Tutorial Sessions – Grand Station – Ballroom 3–5			
Mon, 6:30 - 8:30 pm	Industry Sponsored Reception – Reflections Room Keynote Speaker – Lalit Chordia, President and CEO, Thar Energy, LLC			
Tuesday, March 27th				
Tues, 7:00 am	Registration and Breakfast – Grand Station Ballroom Foyer			
Tues, 8:00 am	Welcome – Grand Station Ballroom 1–2			
Tues, 8:10 am	Visit Pittsburgh – Jason Fulvi, Executive Vice President			
Tues, 8:25 am	Keynote Speaker – Tom Alley, Vice President of Generation, EPRI			
Tues, 8:50 am	Keynote Speaker – Sungho Chang, Korea Electric PowerCorporation (KEPCO)			
Tues, 9:15 am	Coffee Break and Poster Session – Grand Ballroom 3–5			
Tues, 9:30 am	TURBOMACHINERY 1 170, 40, 7, 15	POWER PLANTS & APPLICATIONS 1 20, 14, 83, 141	FUNDAMENTALS 1 61, 103, 108, 160	
Tues, 11:30 am	Lunch – Admiral Room			
Tues, 12:30 pm	HEAT EXCHANGERS 2 114, 130, 77, 185	TESTING 1 26, 49, 76, 183	CYCLES 1 135, 52, 187, 102	
Tues, 2:30 pm	TURBOMACHINERY 2 54, 35, 48	MATERIALS 2 5, 8, 168	FUNDAMENTALS 3 97, 124, 23	
Tues, 4:00 pm	Coffee Break – Grand Station Ballroom 3–5			
Tues, 4:15 pm	Industry Panel Session – Grand Station Ballroom 1–2			
Tues, 6:00 pm	Dinner / Keynote Speaker – Vann Bush, Managing Director for Energy Supply, GTI			
Wednesday, March 28th				
Wed, 7:00 am	Registration and Breakfast – Grand Station Ballroom Foyer			
Wed, 8:05 am	Keynote Speaker – Claudio Spadacini, CEO, Exergy			
Wed, 8:30 am	DOE Panel Session – Grand Station Ballroom 1-2			
Wed, 10:00 am	Coffee Break – Grand Ballroom 3–5			
Wed, 10:15 am	CYCLES 2 51, 90, 113	TESTING 2 89, 105, 128	FUNDAMENTALS 2 32, 62, 180	
Wed, 11:45 am	Lunch and Award Ceremony – Admiral Room			
Wed, 12:45 pm	OXY-COMBUSTION 1 10, 33, 149, 154	COMPONENTS 1 43, 72, 111, 151	MODELING & CONTROL 1 80, 16, 25, 50	
Wed, 2:45 pm	TURBOMACHINERY 3 81, 100	MATERIALS 3 44, 45, 60	MODELING & CONTROL 2 55, 65, 186	
Wed, 4:15 pm	Coffee Break – Grand Ballroom 3–5			
Wed, 4:30 pm	University Panel Session – Grand Station Ballroom 1–2			
Thursday, March 29th				
Thurs, 7:00 am	Registration and Breakfast – Grand Station Ballroom Foyer			
Thurs, 8:00 am	POWER PLANTS & APPLICATIONS 2 71, 93, 144	HEAT EXCHANGERS 1 159, 38, 165	OXY-COMBUSTION 2 70, 119, 134	MATERIALS 1 143, 163, 11
Thurs, 9:30 am	HEAT EXCHANGERS 3 59, 127, 148	MATERIALS 4 94, 117, 146	MODELING & CONTROL 3 12, 139, 39	MATERIALS 5 147, 158
Thurs, 11:00 am	Coffee Break – Grand Ballroom 3–5			
Thurs, 11:15 am	National Lab and Research Institute Panel Session – Grand Station Ballroom 1-2			
Thurs, 12:50 pm	Closing / Adjourn			

DETAILED PROGRAM

Denotes Paper Number

MONDAY, MARCH 26, 2018

12:30 p.m. – 7:00 p.m. **Registration –** Grand Station – Ballroom Foyer
12:30 p.m. – 6:30 p.m. **Tutorial Sessions –** Grand Station – Ballroom 3–5
6:30 p.m. – 8:30 p.m. **Industry Sponsored Reception –** Reflections Room
Introduction –Klaus Brun, Southwest Research Institute
Keynote Presentation – Lalit Chordia, President and CEO, Thar Energy, LLC

TUESDAY, MARCH 27, 2018

7:00 a.m. – 8:00 a.m. **Registration –** Grand Station Ballroom Foyer

7:00 a.m. – 8:00 a.m. **Continental Breakfast – Grand Ballroom 3–5**

Welcome and Preliminaries – Grand Station Ballroom 1–2

8:00 a.m. – 8:10 a.m. **Welcome**, Rich Dennis, US DOE, National Energy Technology Laboratory
8:10 a.m. – 8:25 a.m. **Pittsburgh Welcome,** Jason Fulvi, Executive VP, Visit Pittsburgh
8:25 a.m. – 8:50 a.m. **Keynote Address,** Tom Alley, VP of Generation, EPRI – US Perspective
8:50 a.m. – 9:15 a.m. **Keynote Address,** Sungho Chang, Principal Researcher, Korea Electric Power Corporation (KEPCO) – Asia Perspective

9:15 a.m. – 9:30 a.m. **Coffee Break and Poster Session – Grand Ballroom 3–5**

Grand Station Ballroom 1- Turbomachinery 1

TRACK A

9:30 a.m. – 11:30 a.m.
Session Chairs – Klaus Brun and Jason Mortzheim

170 Design of a Supercritical CO_2 Compressor for Use in a 10 MWe Power Cycle
Stefan Cich, Southwest Research Institute

7 Numerical Simulations of CO_2 Compressors: Subcritical Inlet Conditions
Ashvin Hosangadi, Craft Tech

15 Compressor Design Methods in the Supercritical CO_2 Applications
Teemu Turunen Saaresti, Lappeenranta University of Technology

40 Aerodynamic Design of a Supercritical Carbon Dioxide Radial Inflow Turbine Stage
Can Ma, Wuhan Second Ship Design and Research Institute

Grand Station Ballroom 2 – Power Plants & Applications 1

TRACK B

9:30 a.m. – 11:30 a.m.
Session Chairs – Tim Held and Bhima Sastri

DETAILED PROGRAM

Denotes Paper Number

TUESDAY, MARCH 27, 2018

20 Challenges in Using Fuel-Fired Heaters for sCO_2 Closed Brayton Cycle
Mounir Mecheri, EDF

14 Integration of Indirect-Fired Supercritical CO_2 Power Cycles with Coal-Based Heaters
Andrew Maxson, EPRI

83 Preliminary Cost and Performance Results for a Natural Gas-Fired Direct sCO_2 Power Plant
Nathan Weiland, National Energy Technology Laboratory

141 Practical Considerations for the Conceptual Design of an sCO_2 Cycle
Aaron McClung, Southwest Research Institute

Reflections Room – Fundamentals 1
9:30 a.m. – 11:30 a.m.
Session Chairs – Rene Pecnik and Wenting Sun

TRACK C

61 Numerical Simulations of Supercritical CO_2 Flow Through Pipe Bends: Identification of a Potential Cause of Materials Erosion
Xiaoliang He, Oregon State University

103 Large Eddy Simulation of Supercritical $CH_4/CO_2/O_2$ Non-Premixed Turbulent Oxy-Combustion
Eugenio Giacomazzi, ENEA

108 RANS Turbulence Modeling for Supercritical Carbon Dioxide Flows
Timothy Grunloh, Illinois Rocstar LLC

160 Flow Distribution Measurements in sCO_2
Blake Lance, Sandia National Laboratory

11:30 a.m. – 12:30 p.m. **Lunch – Admiral Room**

Grand Station Ballroom 1 – Heat Exchangers 2
12:30 p.m. – 2:30 p.m.
Session Chairs – Marc Portnoff and Jim Pasch

TRACK A

114 Nuclear Code Case Development of Printed-Circuit Heat Exchangers with Thermal and Mechanical Performance Testing
Shaun Aakre, University of Wisconsin, Madison

130 Thermal-Hydraulic Performance of Compact Diffusion Bonded Heat Exchanger Geometries Using Supercritical Carbon Dioxide as the Working Fluid
Sandeep R. Pidaparti, Georgia Institute of Technology

DETAILED PROGRAM

Denotes Paper Number

TUESDAY, MARCH 27, 2018

77 Computational Analysis of Ceramic Heat Exchangers for Supercritical CO_2 Brayton Cycle in CSP Applications at High-Temperatures
Dorrin Jarrahbashi, Texas A&M University

185 Thermal-Hydraulic Testing of a Compact, Diffusion Bonded Heat Exchanger for a Supercritical CO_2 Brayton Power Cycle
Eric Clementoni, Naval Nuclear Laboratory

Grand Station Ballroom 2 – Testing 1

12:30 p.m. – 2:30 p.m.
Session Chairs – Seth Lawson and Jacob Delimont

TRACK B

26 Effect of Compressor Inlet Temperature on Cycle Performance for a Supercritical Carbon Dioxide Brayton Cycle
Eric Clementoni, Naval Nuclear Laboratory

49 An Overview of the Rolls-Royce sCO_2 Test Rig Project at Cranfield University
Ian Bunce, Rolls Royce

76 Commissioning of a 10 MWe Supercritical CO_2 Turbine
Jeff Moore, Southwest Research Institute

183 Test Results of a 1.5MW High Speed Motor-Generator in a Pressurized CO_2 Environment
Jason Miller, Echogen Power Systems

Reflections Room – Cycles 1

12:30 p.m. – 2:30 p.m.
Session Chairs – Jeff Phillips and Joshua Schmitt

TRACK C

135 sCO_2 Cycle as an Efficiency Improvement Opportunity for Air-Fired Coal Combustion
Walter Shelton, National Energy Technology Laboratory

52 Exergoeconomic Analysis of Different sCO_2 Cycle Configurations
Mathias Penkuhn, Technische Universitat Berlin

187 Thermal Desalination as Cooling for a Supercritical Carbon Dioxide (sCO_2) Brayton Cycle
Prashant Sharan, National Renewable Energy Laboratoy

102 Preliminary Power Generating Operation of the Supercritical Carbon Dioxide Power Cycle Experimental Test Loop with a Turbo-Generator
Junhyun Cho, Korea Institute of Energy Research

Grand Station Ballroom 1 – Turbomachinery 2

2:30 p.m. – 4:00 p.m.
Session Chairs – Rich Dennis and Stefan Cich

TRACK A

DETAILED PROGRAM

Denotes Paper Number

TUESDAY, MARCH 27, 2018

54 Test Rig Design for Large Supercritical CO_2 Turbine Seals
Aaron Rimpel, Southwest Research Institute

35 A Preliminary Comparison of Different Turbine Architectures for a 100 kW Supercritical CO_2 Rankine Cycle Turbine
Martin White, University of London

48 Managing Thermal Gradients on a Supercritical Carbon Dioxide Radial Inflow Turbine
David Stevens, Peregrine Turbine Technologies

Grand Station Ballroom 2 – Materials 2

TRACK B

2:30 p.m. – 4:00 p.m.
Session Chairs – Ömer Doğan and Matthew Walker

5 Corrosion of Heat Exchanger Alloys in Open-Fired sCO_2 Power Cycles
Steven Kung, Electric Power Research Institute

8 The Effect of Impurities on Oxidation in Supercritical CO_2 at 750°C
Bruce Pint, Oak Ridge National Laboratory

168 Creep and Tensile Properties of Direct Metal Laser Sintered (DMLS) Inconel 738LC Coupons and Comparison to Cast Properties
Jason Wilkes, Southwest Research Institute

Reflections Room – Fundamentals 3

TRACK C

2:30 p.m. – 4:00 p.m.
Session Chairs – David Sánchez and Subith Vasu

97 Numerical Investigation of Transonic Supercritical CO_2 Flows with Nonequilibrium Condensation in a Laval Nozzle
Hironori Miyazawa, Tohoku University

124 Investigation of Heat Transfer Model for Horizontal Tubes at Supercritical Pressures of CO_2
Tae Ho Kim, Postech

23 Design of SC-CO_2 Brayton Cycles Using MINLP Optimization within a Commercial Simulator
Qiao Zhao, EDF R & D

4:00 p.m. – 4:15 p.m. **Coffee Break – Grand Station Ballroom 3–5**

DETAILED PROGRAM

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TUESDAY, MARCH 27, 2018

4:15 p.m. – 6:00 p.m. **Industry Panel – Grand Station Ballroom 1–2**
Moderator: *Karl Wygant*
Thomas Soulas – Siemens
Phillip Brennan – Echogen
Renaud Le Pierres - Heatric
Tim Held – Echogen
David Stapp – Peregrine Turbine Technologies

6:00 p.m. **Dinner – Admiral Room – Introduction,** Rich Dennis, NETL

Keynote Speaker – Vann Bush, Managing Director for Energy Supply & Conversion, GTI – STEP 10 MW Pilot Plant

WEDNESDAY, MARCH 28, 2018

7:00 a.m. – 8:00 a.m. – **Registration** – Grand Station Ballroom Foyer

7:00 a.m.– 8:00 a.m. – **Continental Breakfast – Grand Ballroom 3–5**

8:00 – 8:05 a.m. – **Welcome** – Eric Clementoni, Naval Nuclear Laboratory

8:05 a.m. – 8:30 a.m. – **Keynote Address – Grand Station Ballroom 1–2**
Claudio Spadacini, CEO, Exergy – EU Perspective

8:30 a.m. – 10:00 a.m. **DOE Panel Session – Grand Station Ballroom 1-2**
Moderator: *Rich Dennis*
Darren Mollot – US DOE Office of Fossil Energy
Avi Shultz – US DOE Office of Energy Efficiency and Renewable Energy
Sal Golub – *US DOE Office of Nuclear Energy*

10:00 a.m. – 10:15 a.m. **Coffee Break – Grand Ballroom 3–5**

Grand Station Ballroom 1 – Cycles 2

TRACK A

10:15 a.m. – 11:45 a.m.
Session Chairs – Steve Wright and Michael Kutin

51 Feasibility Study of Supercritical CO_2 Rankine Cycle for Waste Heat Recovery
Ashish Kumar Dave, Nabros Pharma Pvt Ltd

90 Modelling and Testing of an Ultra-Low Temperature sCO_2 Opposing Piston Heat Engine
Joshua Schmitt, Southwest Research Institute

113 Optimized Cycle and Turbomachinery Configuration for an Intercooled, Recompressed sCO_2 Cycle
Emanuel Pesatori, Exergy

Grand Station Ballroom 2 – Testing 2

TRACK B

10:15 a.m. – 11:45 a.m.
Session Chairs – Jeong Ik Lee and Jeff Moore

DETAILED PROGRAM

Denotes Paper Number

WEDNESDAY, MARCH 28, 2018

89 Supercritical Carbon Dioxide Brayton Power Cycle Test Loop-Operations Review
Marc Portnoff, Thar Energy, LLC

105 Experimental Test Loop for Transcritical CO_2 Rankine Cycle Tests
Paolo Gaggero, Dev. Inn. Tech

128 Design and Dynamic Simulation of 200 kW_{th} Laboratory sCO_2 Test Rig
Markus Haider, Technische Universität Wien

Reflections Room – Fundamentals 2

TRACK C

10:15 a.m. – 11:45 a.m.
Session Chairs – Craig Turchi and Blake Lance

32 The Dominant Thermal Resistance Approach for Heat Transfer to Supercritical Pressure Fluids
Eckart Laurien, Universität Stuttgart

62 Partial Load Characteristics of the Supercritical CO_2 Gas Turbine System for the Solar Thermal Power System with Na-Al-CO_2 Heat Exchanger
Yasushi Muto, Tokyo Institute of Technology

180 A Novel Approach to Accurately Model Heat Transfer to Supercritical Fluids
Rene Pecnik, Delft University of Technology

11:45 a.m. – 12:45 p.m. **– Lunch and Award Ceremony in Admiral Room**

Grand Station Ballroom 1 – Oxy-Combustion 1

TRACK A

12:45 p.m. – 2:45 p.m.
Session Chairs – Peter Strakey and Walker Dimmig

10 Recent Progress in the Development of a Validated Chemical Kinetic Model for Oxy-Fuel sCO_2 Combustors
Subith Vasu, CATER, University of Central Florida

33 Measurement of Methane Autoignition Delays in a Shock Tube under Supercritical Carbon Dioxide Conditions
Miad Karimi, Georgia Institute of Technology

149 Large-Eddy Simulations of Oxy-fuel Combustors for Direct-Fired Supercritical CO_2 Power Cycles
Daniel Banuti, Cascade Technologies

154 Modeling and Testing of a Directly Heated Supercritical CO_2 Combustor
Jad Aboud, The University of Texas at El Paso

DETAILED PROGRAM

Denotes Paper Number

WEDNESDAY, MARCH 28, 2018

Grand Station Ballroom 2 – Components 1

TRACK B

12:45 p.m. – 2:45 p.m.

Session Chairs – Robin Ames and Aaron Rimpel

43 Gas Foil Bearing Coating Behavior in Environments Relevant to sCO_2 Power System Turbomachinery
Matthew Walker, Sandia National Laboratories

72 Technology Readiness of 5th and 6th Generation Compliant Foil Bearing for 10 MW sCO_2 Turbomachinery Systems
James Walton, Mohawk Innovative Technology Inc.

111 Advanced Gas Foil Bearing Design for sCO_2 Power Cycles
Peter Chapman, Mechanical Solutions, Inc.

151 Magnetic Bearings for Supercritical CO_2 Turbomachinery
Ashwanth Narayanaswamy, Waukesha Magnetic Bearings

Reflections Room – Modeling & Control 1

TRACK C

12:45 p.m. – 2:45 p.m.

Session Chairs – Nathan Weiland and Anton Moisseytsev

80 Steady State and Transient Modeling for the 10 MWe sCO_2 Test Facility Program
Megan Huang, Gas Technology Institute

16 Dynamic Modeling and Simulation of a 10MWe Supercritical CO_2 Recompression Closed Brayton Power Cycle for Off-Design, Part-Load, and Control Analysis
Stephen Zitney, National Energy Technology Laboratory

25 Advanced Regulatory Control of 10 MWe Supercritical CO_2 Recompression Brayton Cycle Towards Improving Power Ramp Rates
Eric Liese, National Energy Technology Laboratory

50 Development of a Transient Analysis Code for sCO_2 Power Conversion System
ChunTian Gao, Xi'an Jiao Tong University

Grand Station Ballroom 1 – Turbomachinery 3

TRACK A

2:45 p.m. – 4:15 p.m.

Session Chairs – Karl Wygant and Tim Allison

DETAILED PROGRAM

Denotes Paper Number

WEDNESDAY, MARCH 28, 2018

81 A Gas Turbine-Driven, Integrally Gear Compressor Solution: Enabling the Carbon Capture of the sCO_2 Allam Cycle Power Plant
Jacob Duffney, Atlas Copco Gas and Process

100 An Investigation of Turbomachinery Concepts for an Isothermal Compressor used in an sCO_2 Bottoming Cycle
Jin Young Heo, KAIST

Grand Station Ballroom 2 – Materials 3

TRACK B

2:45 p.m. – 4:15 p.m.
Session Chairs – Voramon Dheeradhada and Julie Tucker

44 Evaluating the Influence of CO_2 Purity on the Corrosion of Structural Alloys for Supercritical CO_2 Power Cycles
Matthew Walker, Sandia National Laboratory

45 Mechanical and Corrosion Performance of the Weld of 740H and 282
Andrew Brittan, University of Wisconsin, Madison

60 Corrosion Behavior of Fe and Ni Commercial Alloys in Direct-Fired Supercritical CO_2 Power Cycle Environments
Joseph Tylczak, National Energy Technology Laboratory

Reflections Room – Modeling & Control 2

TRACK C

2:45 p.m. – 4:15 p.m.
Session Chairs – Eric Clementoni and Eric Liese

55 Off-Design Performance Modeling Results for a Supercritical CO_2 Waste Heat Recovery Power System
Steven Wright, SuperCritical Technologies, Inc.

65 Dynamic Modeling and Transient Analysis of a Molten Salt Heated Recompression Supercritical CO_2 Brayton Cycle
Jinyi Zhang, EDF

186 Simulation of IST Turbomachinery Power-Neutral Tests with the ANL Plant Dynamics Code
Anton Moisseytsev, Argonne National Laboratory

4:15 p.m. – 4:30 p.m. **Coffee Break – Grand Ballroom 3–5**

DETAILED PROGRAM

Denotes Paper Number

WEDNESDAY, MARCH 28, 2018

4:30 p.m. – 6:00 p.m. **University Panel – Grand Station Ballroom 1–2**
Moderator: *David Sánchez*
Mark Anderson, University of Wisconsin, Madison
Piero Colonna di Paliano, Delft University of Technology
Vinod Narayanan, University of California, Davis
Kenneth Sandhage, Purdue University
Jeong Ik Lee, KAIST
Ingo Jahn, University of Queensland

THURSDAY, MARCH 29, 2018

7:00 a.m. – 8:00 a.m. **Registration** – Grand Station Ballroom Foyer

7:00 a.m.– 8:00 a.m. **Continental Breakfast – Grand Ballroom 3–5**

Grand Station Ballroom 1 – Power Plants & Applications 2

TRACK A

8:00 a.m – 9:30 a.m.
Session Chairs – Avi Shultz and Craig Turchi

71 sCO_2 Power Cycles with Integrated Thermochemical Energy Storage Using an MgO-Based sCO_2 Sorbent in Direct Contact with Working Fluid for Grid Energy Storage Applications
Andrew Muto, Southern Research Institute

93 Optimizing the sCO_2 Brayton Cycle for Concentrating Solar Power (CSP) Application
Rajgopal Vijaykumar, US DOE

144 Supercritical Brayton Power Conversion with a Direct Cooled Reactor for Space Power
Becky Sondelski, University of Wisconsin, Madison

Grand Station Ballroom 2 – Heat Exchangers 1

TRACK B

8:00 a.m. – 9:30 a.m.
Session Chairs – Lalit Chordia and Grant Musgrove

159 Design and Performance Characterization of a Micro-Pin Fin sCO_2 Recuperator
Vinod Narayanan, University of California, Davis

38 A Primary Supercritical CO_2 Heat Exchanger for Waste Heat Recovery
Erfan Rasouli, University of California, Davis

165 Analysis of Supercritical CO_2 Brayton Cycle Recuperative Heat Exchanger Size and Capital Cost with Variation of Layout Design
Kyle Zada, Vacuum Process Engineering

DETAILED PROGRAM

Denotes Paper Number

THURSDAY, MARCH 29, 2018

Reflections Room – Oxy-Combustion 2
8:00 a.m. – 9:30 a.m.
Session Chairs – Chendhil Periasamy and John Marion

TRACK C

70 Simulation of sCO_2 Oxy-Combustion Using Reduced Chemical Kinetic Mechanism: Effects of Reduced Mechanism and Sensitivity to Mechanism Parameters
Zefang Liu, Georgia Institute of Technology

119 Oxy-Combustion Flame Fundamentals for Supercritical CO_2 Power Cycles
Peter Strakey, National Energy Technology Laboratory

134 Computational Modeling of a Direct Fired Oxy-Fuel Combustor for sCO_2 Power Cycles
Jacob Delimont, Southwest Research Institute

Waterfront Room – Materials 1
8:00 a.m. – 9:30 a.m.
Session Chairs - Jason Wilkes and Ömer Doğan

TRACK D

143 The Ex-Situ Fatigue Response of Nickel Super Alloys in Response to Supercritical CO_2
Kyle Rozman, National Energy Technology Laboratory

163 In-Situ Environmentally Induced Cracking in Supercritical Carbon Dioxide
Lucas Teeter, Oregon State University

11 Characterization of INCONEL Alloy 740H for Tube, Pipe and Fittings for Advanced Supercritical CO_2 Systems
John deBarbadillo, Special Metals

Grand Station Ballroom 1 – Heat Exchangers 3
9:30 a.m. – 11:00 a.m.
Session Chairs – Renaud Le Pierres and Matthew Carlson

TRACK A

59 Switched Bed Regenerators for sCO_2 Cycles
Jack Hinze, University of Wisconsin, Madison

127 LES Simulation of Turbulent Supercritical CO_2 Heat Transfer in Microchannels
Alexander Rattner, Pennsylvania State University

148 Processing and Properties of Robust Ceramic/Metal Composites for Heat Exchangers Operating at >750°C with Supercritical CO_2
Kenneth Sandhage, Purdue University

DETAILED PROGRAM

Denotes Paper Number

THURSDAY, MARCH 29, 2018

Grand Station Ballroom 2 – Materials 4

TRACK B

9:30 a.m. – 11:00 a.m.

Session Chairs – Bruce Pint and Steven Kung

94 Materials Evaluation and Corrosion Test Needs for a Direct Fired sCO_2 Oxy-Combustion Plant
Florent Bocher, Southwest Research Institute

117 The Use of Glow Discharge Optical Emission Spectroscopy to Quantify Internal Carburization in Supercritical CO_2
Michael Lance, Oak Ridge National Laboratory

146 Supercritical CO_2 Round Robin Test Program
Julie Tucker, Oregon State University

Reflections Room – Modeling & Control 3

TRACK C

9:30 a.m. – 11:00 a.m.

Session Chairs – Aaron McClung and Megan Huang

12 Dynamic Modeling of Microtube Recuperators in an Indirect Supercritical Carbon Dioxide Recompression Closed Brayton Power Cycle
Eric Liese, National Energy Technology Laboratory

139 Printed Circuit Heat Exchanger and Finned-Tube Heat Exchanger Modeling for a Supercritical CO_2 Power Cycle
Vamshi Avadhanula, Echogen Power Systems (DE) Inc.

39 Development of Accelerated PCHE Off-Design Performance Model for Optimizing Power System Control Strategies in sCO_2 System
Jinsu Kwon, KAIST

Waterfront Room – Materials 5

TRACK D

9:30 a.m. – 11:00 a.m.

Session Chairs – Voramon Dheeradhada and Joseph Tylczak

147 Comparison of Grade 91 and 347H Corrosion Resistance of the Low-Temperature Components for Direct Supercritical CO_2 Power Cycles
Reyixiati (Richard) Repukaiti, Oregon State University

158 Characterization of Oxide Scale Structure on Alloys Exposed to Open-Fired sCO_2 Power Cycles
Tapasvi Lolla, EPRI

11:00 a.m. – 11:15 a.m. **– Coffee Break – Grand Ballroom 3–5**

DETAILED PROGRAM

Denotes Paper Number

THURSDAY, MARCH 29, 2018

11:15 a.m. – 12:45 p.m. **National Lab and Research Institute Panel – Grand Station Ballroom 1-2**

Moderator: *Craig Turchi and Klaus Brun*
Bruce Pint, Oak Ridge National Laboratory
Matt Carlson, Sandia National Laboratories
Anton Moisseytsev, Argonne National Laboratory
Klaus Brun, Southwest Research Institute
Craig Turchi, National Renewable Energy Laboratory
Peter Strakey, National Energy Technology Laboratory
Eric Clementoni, Naval Nuclear Laboratory

12:50 p.m. Closing/Adjourn

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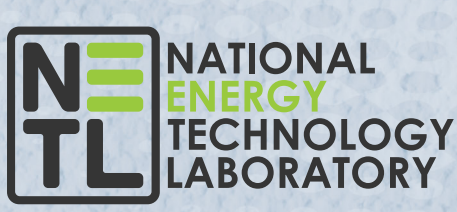
ENERGY



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