3rd Oxyfuel Combustion Conference

Programme Details

Ponferrada, Spain.
9th - 13th September 2013
The Conference Sponsors

IEAGHG

The IEA Greenhouse Gas R&D Programme (IEAGHG) is a major international collaborative programme undertaking research on greenhouse gas mitigation. IEAGHG members include 19 countries, the European Commission, OPEC and 22 multinational sponsors. IEAGHG is an impartial source of information on technologies capable of achieving deep reductions in greenhouse gas emissions. There are a range of technologies that could be used to substantially reduce emissions of greenhouse gases and IEAGHG seeks to characterise these options on a consistent basis. The important role that fossil fuels play in underpinning world economic development is recognised, and IEAGHG activities have demonstrated the opportunity for their continued use, even under scenarios involving deep reductions.

IEAGHG activities include:

*The production of technology and market information.* Deliverables include: Technical and economic assessments, technology reviews and presentation of papers at key conferences.

*Confidence building by promotion of technology development and capacity building.* Deliverables include: Support, by facilitation of and provision of advice for practical R&D programmes, and organisation of thematic networks, whilst the deliverables from capacity building include such events as the IEAGHG International CCS Summer School, now in its 7th year of operation.

*Information dissemination to government and other policy makers, industry leaders and technology developers, and public audiences such as environmental NGO’s.* Deliverables include: Public summary reports, the biannual international GHGT conference series, a quarterly newsletter, two websites and various information databases.
Conference Background

Following the success of OCC1 and OCC2, this third conference has been organised to build on that success. Continuing from the first two events in the series, the third conference will include a trip to an Oxyfuel demonstration project. For this third event, the venue is Ponferrada, Spain, and the Compostilla 300 Oxy-CFB project.

The conference organisers are very thankful to those who assisted in bringing the conference together, specifically the Organising Committee, Steering Committee and the Special Advisory Committee, whose hard work has helped to shape this second Oxyfuel Combustion Conference. A special note of thanks also goes to Sian Twinning of IEAGHG for her invaluable help in coordinating the administration, secretariat and management of the conference.

The organisers would also like to thank the experts who formed the panel of experts. They were invaluable in assessing and reviewing papers submitted, but they are unfortunately too numerous to list here.

Keynote Talks

Keynote Talks:

1. **Prof. Vicente Cortez Galeano**  
   University of Seville, Spain
2. **Arto Hotta**  
   Foster Wheeler Energia OY, Finland
3. **Pedro Otero**  
   Ciudad de la Energia (CIUDEN), Spain
4. **Ken Humphrey**  
   Futuregen Alliance, USA
5. **Prof. Zheng Chuguang**  
   Huazhong University of Science and Technology, China
6. **Dominique Copin**  
   TOTAL, France
# Conference at a Glance

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| **08.15 - 10.30**  
Welcome and Keynote Talks | **08.45 - 10.30**  
Keynote Talks | **08.30 - 10.30**  
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Technical Session 4 | Site Visits |
| **10.30 - 10.50**  
Coffee | **10.30 - 10.50**  
Coffee | **10.30 - 10.50**  
Coffee | **10.30 - 10.50**  
Coffee | **19.30 - 22.30**  
Welcome Reception  
(Sponsored by Foster Wheeler) |
| **10.50 - 13.00**  
Plenary Session 1 | **10.50 - 13.00**  
Plenary Session 2 | **10.50 - 12.50**  
Technical Session 5 | **10.50 - 12.50**  
Technical Session 5 | **19.30 - 22.30**  
Dinner (Sponsored by Ciuden)  
(Sponsored by Ciuden) |
| **13.00 - 14.00**  
Lunch | **13.00 - 14.00**  
Lunch | **12.50 - 14.00**  
Lunch | **12.50 - 14.00**  
Lunch | **19.30 - 22.30**  
Dinner (Sponsored by Vattenfall)  
(Sponsored by Vattenfall) |
| **14.00 - 15.20**  
Technical Session 1 | **14.00 - 15.20**  
Workshops & Technical Session 3 | **14.00 - 15.20**  
Technical Session 6 | **14.00 - 15.20**  
Technical Session 6 | **19.30 - 22.30**  
Dinner (Sponsored by Alstom)  
(Sponsored by Foster Wheeler) |
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Coffee | **15.20 - 15.40**  
Coffee | **15.20 - 15.40**  
Coffee | **15.20 - 15.40**  
Coffee | **19.30 - 22.30**  
Dinner (Sponsored by Alstom)  
(Sponsored by Alstom) |
| **15.40 - 17.40**  
Technical Session 2 | **15.40 - 18.00**  
Workshops & Special Session | **15.40 - 17.40**  
Closing Session | **15.40 - 17.40**  
Closing Session | **19.30 - 22.30**  
Dinner (Sponsored by Vattenfall)  
(Sponsored by Vattenfall) |
| **18.00 - 19.30**  
Poster Session | | | | |
# Plenary & Technical Sessions

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<td>Fundamentals - Oxy-PC Combustion Experiments</td>
<td>Oxyfuel Production Development and its Integration</td>
<td>SO\textsubscript{2} and NO\textsubscript{x} Emissions from Oxyfuel Combustion Boiler</td>
<td>OxyCFB Combustion</td>
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<td>Workshop on Corrosion of Superheater Tubes under Oxyfuel Conditions</td>
<td>3rd Oxy-FBC Workshop: Development in Oxy-CFB Combustion</td>
<td>Coal Devolatisation &amp; Char Burnout</td>
<td>Ash Chemistry &amp; Deposition</td>
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<td>08.30 - 10.30</td>
<td>Commercial Development - Stakeholders Perspective</td>
<td>Flue Gas Processing &amp; CO\textsubscript{2} Recovery from CPU Vent</td>
<td>Modelling &amp; Numerical Simulation of Oxy-PC Plant</td>
<td>Biomass Co-Firing and Other Non-Conventional Fuels</td>
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<td>10.50 - 12.50</td>
<td>Hg / Trace Elements Emissions and Control under Oxyfuel Combustion Conditions</td>
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<td>Modelling and Numerical Simulation of Oxy-CFB Plant</td>
<td>Chemical and Calcium Looping Combustion Technology</td>
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<td>Bubbling Fluidised Bed Combustion</td>
<td>Oxy-NG Combustion Technology</td>
<td>Process Integration and Exergy Analysis</td>
<td>Novel Hybrid Oxyfuel Combustion Concepts</td>
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**Tuesday, September 13th**

**Wednesday, September 14th**

**Thursday, September 15th**
Technical Sessions in Detail

Technical Session 1

1a Large Scale Oxyfuel Pilot Plant Experience

Callide Oxyfuel Project – Overview of Commissioning Experience
Chris Spero, CS Energy / Callide Oxyfuel Services Pty Ltd.; Toshihiko Yamada, IHI Corporation; Graeme Rees, GLP Plant Pty Ltd.; Philippe Court, Air Liquide,

Callide Oxyfuel Project – Combustion and Environmental Performance:
Chris Spero, CS Energy / Callide Oxyfuel Services Pty; Toshihiko Yamada, IHI Corporation; Peter Nelson, Tony Morrison, Macquarie University; Claire Bourhy-Weber, Air Liquide

OxyCoal™ Burner Testing to Develop Models for Oxyfuel Combustion:
David Sturgeon, JW Rogerson, Gerry Hesselmann, Doosan Power Systems Ltd.

Burner Tests in Vattenfall’s Oxyfuel Pilot Plant
Uwe Burchhardt, Rainer Giering, Vattenfall BU R&D Projects; Gerd Weiß, Vattenfall Europe Technology Research

1b Fundamentals: Flue Gas Processing and Compression

Liquefaction of Oxyfuel Flue Gases – Experimental Results and Modeling of Heat Transfer Coefficients
Thorsten Küster, Rudolf Eggers, Hamburg University of Technology, Germany

Gas Phase Oxidation of SO₂ by NO₂ in Pressurized Flue Gas Systems - An Experimental Investigation
Sima Ajdari, Fredrik Normann, Klas Andersson, Filip Johnsson, Chalmers University of Technology

Experimental Study of the Retention of SO₂ and NOₓ with the Compression of Synthetic Oxyfuel Flue Gases Using a Three-Stage Piston Compressor
Sebastian Syrigos, Alfons Kather, Hamburg University of Technology

Flue Gas Processing: Strategies for Water Management. Water Removal and Moisture Control via Dew Point Modelling
Jens Hetland, SINTEF Energy Research

1c Fundamentals: Heat Transfer and Combustion Diagnostics

Application of Optical Diagnostic Techniques to Oxy-Coal Flames
Pal Toth, Terry Ring, Eric Eddings, University of Utah; Arpad Palotas, University of Miskolc

Gas Optical Properties of Oxy-Fuel Combustion and Implications on Radiative Heat Transfer
Sebastian Rehfeldt, Hitachi Power Europe

Heat Fluxes of Interacting Swirled Coal Flames
Maximilian Blume, Andreas Baumgartner, Adrian Goanta, Pedro Dias, Technische Universität München; Hartmut Spliethoff, Zentrum für angewandte Energieforschung Bayern (ZAE Bayern)

Development and Application of a Novel Radiation Property Model for Oxy-Coal Combustion
Alessandro Pranzitelli, Alastair Clements, Rachael Porter, Lin Ma, Mohamed, Pourkashanian, University of Leeds; Augus Duncan, Doosan Power Systems Ltd.

Air Pre-heater Corrosion

1d Ash Deposition, Corrosion and Materials Selection

Behaviour Related to Halogens for Oxycoal Retrofit of Utility Boilers
Andrew Fry, University of Utah; Bradley Adams, Tim Shurtz, Kevin Davis, Reaction Engineering International; William Cox, Corrosion Management Ltd.

Oxidation Behaviour of Possible Construction Materials for Heat Exchange Components in Oxyfuel Plants in the Temperature Range of 550-650°C
P. Huczkowski, M. Schiek, Lorenz, Singheiser, W.J. Quadakkers, Forschungszentrum Jülich; A. Gerhardt, Vattenfall Research & Development AB; Uwe Burchhardt, Vattenfall Europe Generation AG

Influence of Ash Deposition in Oxyfuel Corrosion Experiments
Axel Kranzmann, Maria Mosquera Feijoo, Federal Institute for Material Science and Testing; Alba Baselga Zapater, Institut Quimic de Sarria

Behaviour of Deposit and Fly Ash under Oxyfuel Conditions
Manoj Paneru, Reinhold Spör, Gosia Stein-Brzozowska, Jörg Maier, Prof. Günter Scheffknecht, Institute of Combustion and Power Plant Technology (IFK), University of Stuttgart
**Technical Session 2**

### 2a Fundamentals: On-going Oxy-PC Combustion Experiments

**3MW Pilot-Scale Oxy-Fuel Combustion of Victorian Brown Coal**
Jian Zhang, Monash University, Shanghai Jiaotong; Wirhan Pratino, Baiqian Dai, Lian Zhang, Monash University; Ying Meng, Yoshihiko Ninomiya, Chubu University; Jianwen Zhang, Xiang Zhang, Xiaojian Wu, Shanghai Boiler Works Ltd.; Zhongxiao Zhang, Monash University

**Advanced Oxy-Fuel Combustion Technology**
Toshihiko Mine, Kenji Kiyama, Yuji Fukuda, Noriyuki Imada, Babcock-Hitachi K.K., Kure Research Laboratory; Pauli Dernjatin, Fortum Power and Heat, Power Division

**Investigations on Oxyfuel Combustion of a Subbituminous Coal in a Two-Burner Arrangement**
Andreas Baumgartner, Maximilian Blume, Adrian Goanta, Pedro Dias, Technische Universität München; Hartmut Spliethoff, Zentrum für angewandte Energieforschung Bayern (ZAE Bayern)

**Oxy-Firing at Positive Pressure in a Retrofit 300kWth Test Facility**
C. F. Moreira Selva, C. C. Chi, National Cheng Kung University; W. C. Huang, S. S. Hou, T. H. Lin, Kun Shan University

**Operation Results of 100kW Class Oxyfuel Combustion Power Generation System Integrated with Waste Heat Recovery**
Young Duk Lee, Sang Min Lee, Han Seok Kim, Kook Young Ahn, Korea Institute of Machinery & Materials (KIMM)

**Experimental Investigation of Oxy-coal Combustion at a 250 kW Combustion Test Facility**
János Szuhányszki, William Nimmo, Mohamed Pourkashanian, University of Leeds; S. Li, Moinul Hossain, Gang Lu, Yong Yan, University of Kent

### 2b Oxygen Production Development and its Integration

**Recuperative Vapor Recompression Heat Pumps for O2 Supply in Oxy-Combustion Power Plants**
Chao Fu, Truls Gundersen, Norwegian University of Science and Technology

**Engineering of Air Separation and Cryocap™ Units for Large Size Plants**
Paul Terrien, Richard Dubettier, Mathieu Leclerc, Vianney Meunier, Air Liquide, France

**Integration of ASU in Process of Power Generation:**
Dimitri Goloubev, Linde Engineering Division; Alexander Alekseev, Linde Clean Energy & Innovation Management; Thierry Pourchot, François Granier, Alstom Power Systems SA

**Oxy-combustion: An ASU Integration Option and Improved Operation Flexibility**

**Pressurised Oxygen Supply for CO2 Capture Applications**
Paul Higginbotham, Vince White, Air Products PLC

**AvantO2 II: New Generation of Advanced Ion Transport Membranes Applied to Oxygen Separation Processes for Oxyfuel Systems**
Isabel Moríña, Elíesabet Esteban, Instalaciones Inabensa, S.A.; José Manuel Serra, María Balaguer, Universidad Politécnica de Valencia; Bernabé Alonso-Fariñas, Esmeralda Portillo, University of Seville

### 2c SO\textsubscript{x} and NO\textsubscript{x} from Oxyfuel Combustion Boilers

**Experiments in a Once-Through Furnace Simulating Different Extents of Recycle Gas Cleaning in Coal-Fired Oxyfuel Combustion**
Sulphur Oxide Emission Behaviour: Reinhold Spörl, Jörg Maier, IFK, Universität Stuttgart; Lawrence Belo, Kalpit Shah, Rohan Stanger, Terry Wall, University of Newcastle

**SO\textsubscript{2}/SO\textsubscript{3} Ratio in Oxy-Fuel Combustion – The Impact of Operational Conditions**
Daniel Fleig, Klas Andersson, Filip Johnsson; Chalmers University of Technology

**SO\textsubscript{2} Sorbent Behaviour in Oxyfuel Applications**
Luke Morris, University of Nottingham and Doosan Power Systems; D. Large, Collin Snape, University of Nottingham

**Effect of Recirculated SO\textsubscript{2} on Soot Formed from Ethylene Pyrolysis. Application of Flue Gas Recirculation (FGR) Techniques**
María Abián, Angela Millera, Rafael Bilbao, María Alzueta, Aragón Institute of Engineering Research (I3A), University of Zaragoza

**Effects of Nitrogen Content in Fuel on NOx Emissions under Oxyfuel Coal Combustion**
Ryo Yoshiie, Naoki Hikosaka, Yoko Nunome, Yasuaki Ueki, Ichiro Naruse, Nagoya University
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<td>Investigation of Gas Concentrations from Oxyfuel Combustion with Flue Gas Recirculation in a 150 kWth Pilot Scale CFB</td>
<td>Gerrit Hofbauer, Theodor Beisheim, Heiko Dieter, Günter Scheffknecht, IFK University of Stuttgart</td>
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<td>Behavior of Sulfur During Circulating Fluidized Bed Oxyfuel Combustion</td>
<td>Michel Beckmann, Miroslav Cech, Andreas Hiller, Technische Universität Dresden</td>
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<td>The Effect of Excess Oxygen on Nitrogen Conversion in Oxy-fuel CFB Environment</td>
<td>Tomasz Czakiert, Waldemar Muskala, Sylwia Jankowska, Grzegorz Krawczyk, Pawel Borecki, Lukasz Jesionowski, Wojciech Nowak, Czestochowa University of Technology,</td>
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<td>The Effect of Combustion Type on the Radiation Heat Transfer in Back Pass Channel of a CFB Boiler</td>
<td>Mohammad Hadi Bordbar, Timo Hyppänen, Lappeenranta University of Technology</td>
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<td>The Oxyfuel Process with Circulating Fluidised Bed Combustion and Cryogenic Oxygen Supply</td>
<td>Claas Günther, Matthias Weng, Alfons Kather, Hamburg University of Technology</td>
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<td><strong>Ash Chemistry and Deposition</strong></td>
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<td>Transformation of Pyrite and Its Implication on Ash Deposition during Oxy-Coal Combustion</td>
<td>Dunxi Yu, Weizhi Lu, Jianqun Wu, Lanlan He, Minghou Xu, Huazhong University of Science and Technology</td>
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<td>Ash Aerosol Partitioning and Deposit Ash Compositions during Oxy-Coal Combustion under High Inlet O₂ Conditions</td>
<td>Jost Wendt, Zhonghua Zhan, University of Utah</td>
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<td>Vaporization and Transformation of Mineral Components in High CO₂ Atmosphere of Oxyfuel Combustion</td>
<td>Yongchun Zhao, Wenji Li, Junying Zhang, Chuguang Zheng, Huazhong University of Science and Technology</td>
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<td>Ash Deposition Under Oxyfuel Combustion of Coal/Biomass Blends</td>
<td>Lydia Fryda, Energy Research Centre of the Netherlands; C. Sobrino, M. Glazer, Process and Energy Department, Faculty of Mechanical, Maritime and Materials Engineering, Delft University of Technology</td>
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Technical Session 4

4a Commercial Development – Stakeholder’s Perspective

Feasibility Study of the CCS Deployment to Australia by Use of Oxyfuel Technologies
Takahiro Tanaka, Terutoshi Uchida, Akihiro Komaki, Toshihiko Yamada, Naoki Fujiwara, Takashi Kiga, IHI Corporation; Chris Spero, CS Energy/Callide Energy Services Pty Ltd

Updated Overview of a Manufacturer’s Efforts to Commercialize Oxy-Combustion for Steam Power Plants
John Marion, Armand Levasseur, ALSTOM Power; Armand, Frank Kluger, ALSTOM Boilers Deutschland GmbH; Andreas Back, ALSTOM Power Sweden, Thierry Pourchet, ALSTOM Power Systems SA, Benedicte Prodhomme, Alstom Power Systems; Olaf Stallmann, Alstom Carbon Capture GmbH

Oxy-Combustion for Carbon Capture on Coal Power Plants: Advantages, Innovative Solutions and Key Projects
Nicolas Perrin, Richard Dubbettier, Air Liquide

The Concept of Vattenfall’s Oxyfuel Demo Plant
Uwe Burchhardt, Steffen Lysk, Mario Biele, Vattenfall Europe

Future Oxy-Combustion Systems
Cyrille Paufique, Claire Bourhy-Weber, Jean-Pierre Tranier, Air Liquide Research & Development

Integration of Oxy-Combustion in a Large Size Ultra-Supercritical Pulverized Coal Plants for a Competitive Solution
Thierry Pourchet, François Granier, ALSTOM Power Systems SA; Benedicte Prodhomme, Alstom Power Systems SA; Patrick Mönckert, ALSTOM Boilers Deutschland GmbH; Olaf Stallmann, Alstom Carbon Capture GmbH

4b Flue Gas Processing and CO₂ Recovery from CPU Vent

Fine Particle and Mist Removal by a Wet ESP using 1.5 L/min/m² for Oxygen-Purverlized Coal Combustion
Hak-Joon Kim, Bangwoo Han, Yong-Jin Kim, Sang-In Keel, Korea Institute of Machinery and Materials; Kinam Kwon, Jeong-Hee Hong, KC Cottrell

Performance and System Optimisation of Flue Gas Desulphurisation for Oxy-coal Combustion
Jinying Yan, Rainer Giering, Richard Faber, Uwe Burchhardt, Vattenfall BU R&D Projects; Michaela Zennegg, Thomas Schmidt, Babcock Noell GmbH

4c Modelling & Numerical Simulation of Oxy-PC Power Plant

Dynamic Simulation of a Conceptual 600MWe Oxyfuel Combustion Power Plant
Bo Jin, Haibo Zhao, Chuangzheng Hu, Huazhong University of Science and Technology

Numerical Simulations of Oxy-Coal Combustion in Youngdong 100 MWe Retrofit Boiler
Jungeun A. Kim, Sanghyun Park, Changkook Ryu, School of Mechanical Engineering, Sungkyunkwan University; Won Yang, Energy Systems R&D Group, Korea Institute of Industrial Technology; Young-Joo Kim, Ho-Young Park, Power Generation Laboratory, Korea Electric Power Research Institute; Huk-Pil Kim, Boiler PLM team, Doosan Heavy Industries & Construction

Numerical Simulation of a Pilot Scale Combustion Test Facility in Air-Coal and Oxy-Coal Combustion Conditions
Alessandro Pranzitelli, Alastair Clements, Rachael Porter, Lin Ma, Mohamed Pourkashanian, Energy Technology and Innovation Initiative; M. Escoto de Tejada, Simone Grathwohl, Jeorg Maier, Gunter Scheffknecht, Institute of Combustion and Power Plant Technology (IFK)

Evaluation of Global Reaction Mechanisms for CFD Modelling of Oxyfuel Combustion
Fredrik Normann, Stefan Hjärtstam, Klas Andersson, Filip Johnsson, Chalmers University of Technology

LES of Oxy-Coal Combustion: An Investigation into Flame Stability
Sandy Black, Janos Szuhánszki, Lin Ma, D.B. Ingham, Mohamed Pourkashanian, University of Leeds, Leeds

CFD Model Applied for Studying Bench Scale Oxy-Burner
F. Vega, B. Navarette, M. Cano, M. Lupion, V. Cortez, University of Seville
4d Biomass Co-Firing and Other Non-Conventional Fuels

Oxidation Kinetics of Oil Shale Under Oxy-fuel Conditions
C. R. Yörük, R. Kuusik, Laboratory of Inorganic Materials, Tallinn University of Technology; T.Meriste, A. Trikkel, Estonian Energy SC

Impact of CO₂ on Biomass Devolatilisation, Nitrogen Partitioning and Char Combustion - A Drop Tube Furnace Analysis
Timipere Farrow, Chenggong Sun, Colin Snape, University of Nottingham

Effect of Oxy-Fuel Combustion with Steam and Biomass Addition on Coal Burnout in an Entrained Flow Reactor
J. Riaza, L. Álvarez, M.V. Gil, C. Pevida, J.J. Pis, F. Rubiera, Instituto Nacional del Carbón

Co-firing Performance of a Retrofitted Oxy-Combustor Burning Coal/Biomass Blends: Experimental and Simulation Study
Nelia Jurado, Hamidreza Darabkhani, E.J. Ben Anthony, John Oakey, Cranfield University

Co-Combustion Tests of Coal and Biomass using a Pilot-Scale Oxyfuel CFB
Yewen Tan, Lufei Jia and Yinghai Wu, CanmetENERGY

Air and Oxyfuel Combustion of Torrefied Biomass in New Spiral Combustion Reactor
Eyerusalem Gucho, Eddy Bramer, Gerrit Brem, University of Twente

A Comparison of Hg0 Re-emission in WFGD Systems under Air and Oxyfuel Combustion Conditions
Raquel Ochoa-González, Mercedes Díaz-Somoano and M. Rosa Martinez-Tarazona, National Institute of Coal (INCAR-CSIC)

High Pressure Conversion of NOx and Hg and their Capture as Aqueous Condensates in a Laboratory Oxyfuel Compression System
Rohan Stanger, Timothy Ting, Terry Wall, Department of Chemical Engineering, University of Newcastle

Mercury Capture by Regenerable Sorbents under Oxycoal Combustion Conditions
C.Gómez-Giménez, E.García-Diez, R.Juan, B.Rubio, M.T.Izquierdo, Instituto de Carboquímica, ICB-CSIC; D.Ballestero, Universidad San Jorge.

Measuring Trace Elements during the December 2012 Callide Oxyfuel Trial
Peter Nelson, Anthony Morrison, P. Sargent Bray, Graduate School of the Environment, Macquarie University; Hugh Malfroy, Malfroy Environmental Strategies; Rohan Stanger, Faculty of Engineering and Built Environment, Newcastle University; Chris Spero, CS Energy/Callide Oxyfuel Services Pty Ltd

5a Hg/Trace Elements Emissions and Controls Under Oxyfuel Combustion Condition

Homogeneous Oxidation of Mercury during Combustion: A Comparison Between Combustion in Air and Oxy-Combustion
N. Fernandez-Miranda, M.A. Lopez-Anton, Mercedes Diaz-Somoano, M. Rosa Martinez-Tarazona, Instituto Nacional del Carbón (CSIC)

Investigation of Mercury Measurement and Control Technologies under Oxy-fired Conditions
Brydger Van Otten, Reaction Engineering International; Bradley Adams, Andrew Fry, Geoffrey Silcox, Ignacio Preciado, University of Utah

5b CO₂ Processing Unit

Callide Oxyfuel Project - Results from the CPU
Claire Bourhy-Weber, Frederick Lockwood, Ludovic Granados, Vanessa Turmel, Air Liquide

Characteristics of SO₂ and NOx in CO₂ Processing and for Oxyfuel Combustion CO₂ Capture
Jinying Yan, Rainer Giering, Vattenfall R&D; Stephanie Tappe, Vattenfall Europe Generation AG; Helge Kaß, Vattenfall Europe Technology Research GmbH

NOx Processing Experiences for Removal in the CO₂ Plant in the Oxyfuel Combustion Process
Roland Ritter, Torsten Stoffregen, Linde Engineering Dresden GmbH; Nicole Schödel, Florian Winkler, Linde AG Linde Engineering Division

The Air Products–Vattenfall Oxyfuel CO₂ Compression and Purification Pilot Plant at Schwarze Pumpe
Vince White, Andrew Wright, Air Products PLC; Stephanie Tappe, Vattenfall Europe Generation AG; Jinying Yan, Vattenfall Research & Development AB

GPU Pilot Operation and Energy Consumption
Lars Nilsson, Alstom Power Sweden AB; Olaf Stallmann, Christian Britz, Alstom Carbon Capture GmbH
Dynamic Simulation and Control of a CO₂ Compression and Purification Process for Oxy-Coal Fired Power Plants
A. Chansomwong, P. L. Douglas, E. Croiset, L. A. Ricardez-Sandoval, Chemical Engineering Department, University of Waterloo; K. E. Zanganeh, A. Shafeen, CanmetENERGY, Natural Resources Canada

5c Modelling and Numerical Simulation of Oxy-CFB Power Plant

6a Bubbling Fluidized Bed Combustion

Characterization of Natural Copper Ore in Anthracite Fuelled Chemical-Locking with Oxygen Uncoupling (CLOU)
Daofeng Mei, Haibo Zhao, Yanfei Fang, Kun Wang, Chuguang Zheng, Huazhong University of Science and Technology

Validation of a Fuel Reactor Model for In-situ Gasification Chemical Looping Combustion
Alberto Abad, Juan Adánez, Luis F. de Diego, Pilar Gayán, Instituto de Carbonoquímica (ICB-CSIC); Francisco García-Labiano, Anders Lyngfelt, Pontus Markström, Department of Energy and Environment, Chalmers University of Technology

Alstom’s Limestone-Based (LCL™) Chemical Looping Process
Iqbal Abdulally, Herbert Andrus, Paula Chapman, John Chiu, Carla Edberg, James Kenney, Shin Kang, Paula Thibeault, David Turek, Alstom Power Inc.; Bruce Lani, US DOE/NETL

CO₂ recovery from CPU Vent by Ca-Looping Process
Matteo C. Romano, Politecnico di Milano

Anthracite Oxyfuel Combustion in Fluidized Bed
Isabel Guedea, Irene Bolea, Carlos Lupiañez, Luis I. Diez, Luis M. Romeo, CIRCE – Center of Research of Energy Resources and Consumptions; Pedro Otero, Jesús Ramos, 2CIUDET–Fundación Ciudad de la Energía

SO₂ and NOₓ Emissions in a BFB Combustor (3kWth) Under Oxyfuel Combustion. Effect of Temperature and Flue Gas Recirculation
Margarita de las Obras-Loscertales, Aránzazu Rufas, Luis F. de Diego, Francisco García-Labiano, Alberto Abad, Pilar Gayán, Juan Adánez, Instituto de Carbonoquímica (ICB-CSIC)

Oxyfuel Combustion of Victorian Brown Coal in a 10 kWth Fluidized Bed Unit
Bithi Roy, Sanar Bhattacharya, Monash University

Minimization of Air Ingress during the Retrofitting of Bubbling Fluidized Combustion to Oxyfuel Combustion
Gabriel M. Faé Gomes, Leandro Dalla Zen, Fundação de Ciência e Tecnologia do Estado do Rio Grande do Sul (CIENTEC) and Universidade do Vale do Rio dos Sinos (UNISINOS); Guilherme P.S. Priebe, Jorge A. S. Cunha, Felipe H. Guarienti, Pedro Henrique E. de Lima, Fundação de Ciência e Tecnologia do Estado do Rio Grande do Sul (CIENTEC)
6b Oxy-NG Combustion Technology

Study of a Semi-Closed OxyFuel Gas Turbine
M. Ditaranto, Ø. Langørgen, I. Saanum, P.E. Røkke, SINTEF Energy Research; J. Janczewski, S.G. Sundkvist, Siemens Industrial Turbomachinery AB

Evaluating High Temperature Oxy-Natural Gas Retrofit of a Coal-fired Boiler
Bradley Adams, Timothy Shurtz, Reaction Engineering International; Andrew Fry, University of Utah

Combined Cycle Oxyfuel Process with CO₂ Capture Based on a Conventional Natural Gas Fired Turbine
Tobias Treibs, Alexander Alekseev, Linde AG, Innovation Management/Clean Energy

Novel Oxy-Combustion Gas Turbine Concepts for Off-Shore Application
Kristin Jordal, Rahul Anantharaman, Øyvind Langørgen, SINTEF Energy Research

6c Process Integration and Exergy Analysis

Process Integration in Coal based Oxy-Combustion Power Plants
Chao Fu, Truls Gundersen, Norwegian University of Science and Technology

Exergy Analysis of Cryogenic Air Separation Unit Integrated within Oxyfuel Combustion Power Plant
Marcin Liszka, Grzegorz Nowak, Jan Składzień, Silesian University of Technology

Energy Management and Efficiency Improvement for Oxyfuel Power Generation Systems with CO₂ Capture: An Exergy-Based Approach
A. Shafeen, Chemical Engineering Department, University of Waterloo and CanmetENERGY, Natural Resources Canada; Kourosh Zanganeh, CanmetENERGY, Natural Resources Canada; Peter Douglas, Eric Croiset, Chemical Engineering Department, University of Waterloo,

Integration of the Capture Unit with the Power Generation: Technology Advances in Oxy-Combustion Plants
Luca Mancuso, Noemi Ferrari, aFoster Wheeler; Vince White, Air Products PLC; John Davison, IEA Greenhouse Gas R&D Programme

A Staged, Pressurized Oxy-Combustion System for Carbon Capture

Development of High Efficiency Oxyfuel IGCC System
Yuso Oki, Satoshi Umemoto, Hiroaki Watanabe, Kazuhiro Kidoguchi, Yoshinobu Nakao, Makoto Kobayashi, Saburo Hara, CRIEPI

COMPARAE Project: An Approach to Hybrid Oxy-Post CO₂ Capture Technology
F. Vega, M. Rodriguez-Galán, B. Alonso-Fariñas, Benito Navarrete, Vicente Cortés, University of Seville

Workshops & Special Sessions

Workshop 1: Corrosion of Superheater Tube Materials Under Oxyfuel Combustion Conditions

Material Research with Focus of Vattenfall’s Oxyfuel Pilot Plant

Superheater Corrosion Testing Of Advanced Materials Under Oxy-Fuel Conditions
Bettina Bordenet, Terry Totemeier, ALSTOM (Switzerland) Ltd.; Patrick Mönckert, Frank Kluger, ALSTOM Boiler Deutschland GmbH

Comparision of Fireside Corrosion of Superheater Alloys in Advanced Air/Coal and Oxy/Coal-Fired Boilers
Steven Kung, The Babcock and Wilcox Company

The Laboratory Coal Ash Corrosion Test Result of Superheater Tube Materials in Oxyfuel Gas Conditions
Yasuo Matsunaga, Kiyokazu Nakagawa, Materials Department, Research Laboratory; Takahiro Goto, Toshihiko Yamada, Naoki Fujiwara, Takashi, Kiga, Research and Development Dept., Energy Operations; Kazuya Kurokawa, Center for Advanced Research of Energy and Materials, Faculty of Engineering, Hokkaido University

6d Novel Hybrid Technology in Oxyfuel Combustion

Low-Temperature Oxyfuel (LTOF) Combustion
Thomas Niehoff, Linde Gas
Superheater Corrosion of Selected Martensitic and Austenitic Alloys in Sulphur-Rich and -Lean Oxy-PC-Combustion Considering Varying Water Content
Gosia Stein-Brzozowska, Jörg Maier, Günter Scheffknecht, Institute of Combustion and Power Plant Technology (IFK); Danila Cumbo, Silvia Masci, Enrico Tosi, Enel Engineering and Research; Giovanni Corraggio, Marco Faleni, Leonardo Biasci, International Flame Research Foundation (IFRF)

Fireside Corrosion of Selected Superheater Materials under Oxy-Coal Combustion Atmospheres: Thermodynamic Modelling and Experimental Studies
Roger Abang, Alexander Lisk, Hans Joachim Krautz, Brandenburg University of Technology (BTU)

Temperature Corrosion in Oxyfuel and Other Combustion Systems
William Cox, Kevin Davis, Andrew Fry, Martin de Jong, David Swensen

Development of Flexi-Burn® CFB Boiler Concept for OXY-Combustion

Workshop 2: Development in Oxy-CFB Combustion

CBF-300 Compostilla Project
Timo Eriksson, Ossi Sippu, Foster Wheeler Energia Oy; Kari Myöhänne, Timo Hyppänne, Lappeenranta University of Technology; Andres Sanchez-Biezma, Pablo Gutierrez Cerezales, Endesa Generacion

Oxy-CFB Research & Development Status at Southeast University, China
Zhao Changsui, Duan Lunbo, Chen Xiaoping, Liu Daoyin, Chen Huichao, Southeast University

Sulphur Retention in CFB Oxy-Combustion Burning Local Spanish Fuel: CIUDEN’s Experience
Jesús Ramos, Francisco Muñoz, Abraham Fernández, Ruth Diego, Fundación Ciudad de la Energía (CIUDEN); Reijo Kuivalainen, Pasi Petra, Foster Wheeler Energia Oy

NOx Emissions Experiences in a 30 MWth Circulating Fluidized Bed Boiler under Oxy-Combustion Conditions
Jesús Ramos, Benito Navarrete, Francisco Muñoz, Beatriz Gil, Pedro Otero, Fundación Ciudad de la Energía (CIUDEN); Reijo Kuivalainen, Teri Hiltunen, Foster Wheeler Energia Oy

Pilot-scale Evaluation of Oxyfuel Combustion of Anthracite Coal with CO2 Capture
Carlos Salvador, Koroush Zanganeh, A. Shafeen, A. Beigzadeh, M. Abbassi, CanmetENERGY, Natural Resource Canada; I Alvarez, Pedro Otero, CIUDEN

Agglomeration in CIUDEN 30MWth Circulating Fluidized Bed Boiler Under Oxy-Combustion Conditions
María I. Espada, Paula Ramos, Timea Kovacs, Ruth Diego, Pedro Otero, J.F Llamas

Flexible Combustion of Coal Under Elevated Pressure
Janusz Lasek, Jaroslaw Zuwala, Krzysztof Glod, Institute for Chemical Processing of Coal

Optimization of an Oxyfuel CFB Plant with Oxygen Production by Electrolytic Membrane
Matteo C. Romano, Fabio Furesi, Davide Tagliapietra, Paolo Chiesa, Politecnico di Milano, Department of Energy; Luca Mancuso, Foster Wheeler

Special Session: Industrial Oxyfuel

CO2 Emission Reduction Potential and Technological Aspects of the Oxyfuel Technology in Cement Clinker Production
Kristina Koring, Volker Hoenig, European Cement Research Academy (ECRA),

CO2 Processing Unit for Oxyfuel Fired Rotary Cement Kiln
Kenneth Burgers, Stefan Laux, Minish Shah, Praxair, Inc.

Oxy-Firing a Simulated Process Heater: CFD Analyses and Comparison with Test Data
Jamal Jamaluddin, Shell Global Solutions (US); Cliff Lowe, Nick Brancaccio, Chevron Energy Technology Company; Jaime Erazo, Chuck Baukal, John Zink Company, LLC

Design Characteristics of an Air Combustion and Oxy Combustion Steam Plant for Canadian Oil Sands with a Focus on Sustainability
John Pham, Babcock & Wilcox Canada; Richard Dubettier, Loic Joly, Air Liquide Engineering; Karina Heitnes Hofstad, Statoil ASA

Key Design/Construction Lessons from the Retrofit of a 50 MMbtu/h OTSG to Oxyfuel firing in an Operating SAGD Plant
Candice Paton, Daniel Stoffman, Cenovus Energy Inc.

Investigation of Oxyfuel Retrofit in a 250 kW CEN Boiler Using Refinery Gas
Alexis Sevault, Morten Seljeskog, SINTEF Energy Research

High Flame Temperature Oxy-Combustion Retrofit Demonstration Project With Carbon Capture
Mark Schoenfeld, Catherine Chen Jing, Jupiter Oxygen Corporation
Experiments in a Once-through Furnace Simulating Different Extents of Recycle Gas Cleaning in Coal-fired Oxy-fuel Combustion: Behaviour of Mercury
Reinhold Spörl, Jörg Maier, IFK - Institute of Combustion and Power Plant Technology, Universität Stuttgart; Lawrence Belo, Kalpit Shah, Rohan Stanger, Terry Wall, Chemical Engineering, The University of Newcastle

CO₂ Quality Control by Scrubbing in Oxy-fuel Combustion: An Evaluation of Operational pH Impacts, and Prediction of SO₂ Absorption Rate
Dunyu Liu, Terry Wall, Rohan Stanger, Yinghui Liu, Chemical Engineering, the University of Newcastle

Design of Steam Cycle for Oxy-combustion Coal based Power Plants with an emphasis on Heat Integration
R. Soundararajana, T. Gundersen, Norwegian University of Science and Technology, Dep. Energy and Process Engineering; R. Anantharaman, SINTEF Energy Research

Particle Behavior of Solid Fuels under Oxy-fuel Conditions
Christopher Thiel, Martin Pohl, Michael Beckmann, Technische Universität Dresden, Institute of Power Engineering; Thomas Herzog, Wolfgang Spiegel, CheMin GmbH

Fundamental Study on the Coal Char Combustion Rate in Oxyfuel Mode
Takamasa Ito, Takahiro Kozaki, Toshiyuki Suda, Toshiro Fujimori, Research Laboratory, IHI Corporation; Toshihiko Yamada, Takashi Kiga, Engineering Center, IHI Corporation

Influence of Steam on Sulfur Capture with Limestone under Oxy-fue lF ired Conditions in Batch BFB Experiments
Theodor Beisheim, Aline Leicht, Heiko Dieter, Günter Scheffknecht, Institute of Combustion and Power Plant Technology

Vertical Solids Suspension Distribution under Air/Carbon Dioxide Conditions in a Circulating Fluidized Bed
Maciej Komorowski, Pawel Mirek, Wojciech Nowak, Institute of Advanced Energy Technologies, Czestochowa University of Technology

Reliable and Efficient Combustion of Oxygen/Coal/Recycled Flue Gas Mixtures (RELCOM)
Steve Wilcox, University of Glamorgan, Faculty of Advanced Technology; Neil Fricker, University of Glamorgan

FLEXI BURN CFB - Development of High Efficiency CFB Technology to Provide Flexible Air/Oxy Operation for Power Plant with CCS
Antti Tournu, Toni Pikkarainen, VTT Technical Research Centre of Finland

Control Strategy of the Transition Process for the 3MWth Oxyfuel Full Chain System in China
Luo Wei, Liu Zhaohui, Huang Xiaohong, Zhang Tai, Wang Qiao, Zheng Chuguang, Huazhong University of Science and Technology

Comparison of Cryogenic Air Separation Processes Based on Energetic and Exergetic Criteria
Hayato Hagia, EDF R&D, Fluid Dynamics Power Generation and Environment Department and MINES ParisTech, DEP - Department of Energy and Processes; Yann Le Moullec, EDF R&D, Fluid Dynamics Power Generation and Environment Department; Chakib Bouallou, MINES ParisTech, DEP - Department of Energy and Processes

Exergy-Based Methodology for the Minimization of the Energy Penalty o fOxy-pulverized Coal Power Plants with CCS
Hayato Hagia, EDF R&D, Fluid Dynamics Power Generation and Environment Department and MINES ParisTech, DEP - Department of Energy and Processes; Yann Le Moullec, EDF R&D, Fluid Dynamics Power Generation and Environment Department; Maroun Nemerb, Chakib Bouallou, MINES ParisTech, DEP - Department of Energy and Processes

Oxy-fuel Combustion Demonstration Facility with Flue Gas Recirculation for Burner Evaluation
Chendhil Periasamy, Vijaykant Sadasivunia, Ken Kaiser, Scott Liedela, Rong Fana, Jiefu Ma, Air Liquide, Delaware Research and Technology Center; Niomar Marcano, Patrick Recourt, Remi Tsiava, Air Liquide, Claude Delorme Research Center

Thermodynamic Performance and NOx Emission Characteristic in Syngas-dedicated Gas Turbine in IGCC Power Plant
Hyeon-Jeong Kim, On Nu-ri Won, Gyung-Min Choi, Duck-Jool Kim, Pusan National University

Influence of Fluidizing Gas Composition on Combustion and NOx Emission
Carlos Lupiañez, Isabel Guedea, Irene Bolea, Luis M. Romeo, CIRCE – Center of Research of Energy Resources and Consumptions

Coal Char Gasification in O₂/Ar, Ar/CO₂ and O₂/CO₂ Environments
Hirotatsu Watanabea, Li Xiaofana, Ken Okazaki, Tokyo Institute of Technology

Experimental Study of a New Hybrid CO₂ Capture Configuration
K. E. Zanganeh, A. Shafeen, A. Beigzadeh, C. Salvador, M. Abbassi, CanmetENERGY, Natural Resources Canada
Carbonation of Ash Deposits During Oxy-coal Combustion
Zhonghua Zhan, Jost O.L. Wendt, Department of Chemical Engineering and Institute for Clean and Secure Energy, University of Utah

Effects of Directed Pure O₂ Injection on Flame Stability in Co-axial Oxy-fuel Turbulent Diffusion Flames
Dadmehr Rezaei, Jost O.L. Wendt, Department of Chemical Engineering and Institute for Clean and Secure Energy, University of Utah

Efficiency Assessments of Pressurized Oxy-Coal Power Generation with Integrated Flue Gas Heat Recovery
Hou-Tsen Chen, Department of Mechanical Engineering and Research Center for Energy Technology and Strategy National Cheng Kung University and Ming-Hsun Wu, Department of Mechanical Engineering, National Cheng Kung University

Influence of Water Vapour Concentration on Pulverized Coal Oxyfuel Combustion Process with Flue Gas Recirculation
Bartosz Świątkowski, Paweł Bocian, Ewa Marek, Institute of Power Engineering, Department of Thermal Processes

Development of an Advanced, Elevated Pressure, Oxy-fuel Power Plant with CO₂ capture
Mark Fitzsimmons, Pratt&Whitney Rocketdyne; Martin Kibili, Alexander Alekseev, Stevan Jovanovic, Linde Group, Clean Energy and Innovation Management

Ignition Modeling of Single Coal Particle Under Oxy-fuel Combustion
Huang Xiaohong, Yang Ming, Liu Zhaohui, Pi Ligang, Zheng Chuguan, Huazhong University of Science and Technology

Dynamic Simulation on the Transition Process of the 3MWth Oxyfuel Full Chain System
Luo Wei, Liu Zhaohui, Huang Xiaohong, Zhang Tai, Wang Qiao, Zheng Chuguan, Huazhong University of Science and Technology

Large Eddy Simulation of a 100 kWth Oxy-coal Swirl Burner
B.M. Franchetti, F. Cavallo Marincola, S. Navarro-Martinez, Department of Mechanical Engineering, Imperial College London; S. Black, M. Pourkashanian, CFD Centre/ETII, Faculty of Engineering, University of Leeds; A.M. Kempf, Universität Duisburg-Essen

Coal Dust Ignition Experiments for Oxyfuel Safety
Ignacio Trabadelo, Jon Gibbins, Institute for Materials and Processes, School of Engineering, University of Edinburgh; Hannah Chalmers, Institute for Energy Systems, School of Engineering, University of Edinburgh

EU project - Optimization of oxygen-based CFBC technology with CO₂ capture (O2GEN)
LM Romeo, CIRCE; R Kuivalainen, FWEOY; JP Tranier, Air Liquide; M Gómez, CIUDEN; A Sánchez-Biezma, ENDESA; A Tourunen, VTT Technical Research Centre of Finland; B Navarrete, Universidad de Sevilla; JL Bayort, INERCO; P Gimondo, CSM; R Bialecki, Politechnika Slaska SUT; T Hyppänen, LUT

Influence of CO₂ and Oxygen Enriched Oxidizer in Natural Gas Combustion
E. Karagianni, K. J. Hughes, D. Ingham, A. Pranzitelli, M. Pourkashanian, Energy Technology and Innovation Initiative (ETII), Faculty of Engineering, University of Leeds

New Solvents for Carbon Dioxide Capture by Means of Chemical Absorption
A. García-Abuín, D. Gómez-Díaz*, J.M. Navaza, Department of Chemical Engineering, ETSE

Research on Potential Environmental Impacts of Oxy-fuel Combustion at EPA
Chun Wai Lee, William Linak, National Risk Management Research Laboratory, U.S. Environmental Protection Agency; Christopher K. Winterrowd, ARCADIS U.S. Inc; Myrha Andersen, Department of Mechanical and Aerospace Engineering, North Carolina University

SO₂ Absorption from Oxy-Combustion Flue Gases
Ruth Diego, Miguel A. Delgado, Manuel Gómez, Tomás Coca, Pedro Otero, Fundación Ciudad de la Energía (CIUDEN); Frederick Lockwood, Ludovic Granados, Vanessa Turmel, Air Liquide

Oxy-Combustion Model and Numerical Simulation in Pulverized Coal Flames
A. Bermúdez, I. Constenla, Departamento de Matemática Aplicada, Universidad de Santiago de Compostela; Ruth Diego, J.L. Ferrina, Benito Navarrete, Pedro Otero, Jesús Ramos, CIUDEN; L. Saavedra, Departamento de Matemática Aplicada Universidad Politécnica de Madrid

Chemical Challenges to Metallic and Ceramic Materials in Oxyfuel Co-Firing CFB Combustors
M.C. Mayoral, J.M. Andrés, M.P. Gimeno, L.I. Díez, Instituto de Carboquimica – CSIC