Programme

3rd International Conference on Chemical Looping

9th-11th September 2014

Chalmers University of Technology

Scientific Committee

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Alstom Power Boilers, USA

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SINTEF Energy Research, Norway

Lyngfelt, Anders
Chalmers University of Technology, Sweden

Morin, Jean-Xavier
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Western Kentucky University, USA and
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Sit, Song P.
Cenovus Energy Inc., Canada

Snijkers, Frans
Flemish Institute for Technological Research (VITO), Belgium

Sprachmann, Gerald
Shell Global Solutions, The Netherlands

Werther, Joachim
Technische Universität Hamburg-Harburg, Germany

Williams, Gareth
Johnson Matthey, UK

Yazdanpanah, Mahdi
TOTAL, France

Welcome to the conference

The organizing committee welcomes you to Gothenburg and the 3rd International Conference on Chemical Looping.

This conference series started four years ago in Lyon, France, and then moved to Darmstadt, Germany, in 2012. The interest for the conference has grown steadily, and CLC2014 received 142 abstracts, resulting in 74 oral presentations and 35 poster presentations. This year's conference will gather approximately 170 delegates, who will enjoy a three-day conference program, including four keynote lectures, a panel discussion, and social events aimed at making new friends and promoting collaboration. The conference dinner will be held at Universeum, a science center well known for its indoor rainforest and aquarium.

We would like to express our sincere gratitude to everyone that contributed in making this conference possible. We want to acknowledge the scientific committee and supporting colleagues for valuable efforts in the reviewing of abstracts. We would also like to offer a special thanks to our sponsors, whose generous support allowed us to host this event.

Thank you for attending and participating in the 3rd International Conference on Chemical Looping.
We wish you an interesting, insightful, and fun conference!

Carl Linderholm (Chair)

Jesper Aronsson

Malin Källén

Anders Lyngfelt

Tobias Mattisson

Programme overview

TIME	Mon. 8th	Tuesday, September 9th		Wednesday, September 10th		Thursday, September 11th	
		Lecture hall **"RunAn"**	Lecture hall **"Palmstedt"**	Lecture hall **"RunAn"**	Lecture hall **"Palmstedt"**	Lecture hall **"RunAn"**	Lecture hall **"Palmstedt"**
08:30		**REGISTRATION**		**Keynote 3** Frank Kluger		**Keynote 4** Laihong Shen	
08:50							
09:10		Welcome		**3A** Oxygen carriers I	**3B** Fluid-dynamical modelling I	**6A** Oxygen carriers II	**6B** Hydrogen production II
09:30		**Keynote 1** Filip Johnsson					
09:50							
10:10		**Keynote 2** Anders Lyngfelt					
10:30							
10:50		**BREAK**		**BREAK**		**BREAK**	
11:20		**1A** Pilot operation, solid fuels I	**1B** Hydrogen production I	**4A** Process design and techno-economic studies	**4B** SO_2 & NO_x	**7A** Pilot operation, solid fuels II	**7B** Related processes
11:40							
12:00							
12:20							
12:40							
13:00		**LUNCH**		**LUNCH**		**LUNCH**	
14:00		**2A** Pilot operation, gaseous and liquid fuels	**2B** Packed bed processes	**5A** CLOU	**5B** Process modelling	**8A** Oxygen carriers III	**8B** Fluid-dynamical modelling II
14:20							
14:40							
15:00							
15:20							
15:40		**BREAK**		**BREAK**		**BREAK**	
16:00 -17:00		POSTER SESSION / LAB VISIT **GROUP A**		POSTER SESSION / LAB VISIT **GROUP C**		**Panel discussion**	
17:00 -18:00		POSTER SESSION / LAB VISIT **GROUP B**		POSTER SESSION / LAB VISIT **GROUP D**			
18:30	**Registration/ welcome mingle** (Conference venue)	**Reception by the city of Gothenburg** (Dicksonska palatset)		**Conference dinner** (Universeum)			

Monday, September 8th, 2014

18:30-21:00	**REGISTRATION & WELCOME MINGLE** At Conference Venue

Tuesday, September 9th, 2014

	Lecture hall **"RunAn"**	Lecture hall **"Palmstedt"**
08:30-09:10	**REGISTRATION**	
09:10-09:30	**WELCOME** *Dr. Carl Linderholm, Head of the Conference Organizing Committee, Chalmers, Sweden* *Dr. Anders Ådahl, Director of Energy Area of Advance, Chalmers, Sweden*	
09:30-10:10	**KEYNOTE 1** **Fossil fuels and climate-change mitigation** *Prof. Filip JOHNSSON* Chalmers University of Technology, Sweden	
10:10–10:50	**KEYNOTE 2** **A 1000 MW_{th} Chemical-Looping Combustor for Solid Fuels – Discussion of Design and Costs** *Prof. Anders LYNGFELT* Chalmers University of Technology, Sweden	
10:50-11:20	**BREAK**	
	SESSION 1A **Pilot operation, solid fuels I** *Session chair: Mr. Iqbal Abdulally, Alstom Power Boilers, USA*	**SESSION 1B** **Hydrogen production I** *Session chair: Dr. Thierry Gauthier, IFP Energies Nouvelles, France*
11:20-11:40	**Chemical Looping Combustion of Hard Coal in a 1 MW_{th} Pilot Plant Using Ilmenite as Oxygen Carrier** *Jochen STRÖHLE#, Matthias ORTH, Bernd EPPLE* Technische Universität Darmstadt, Germany	**Synthesis gas generation by chemical-looping auto-thermal reforming of biomass using Cu-based oxygen carrier** *Lei GUO#, Haibo ZHAO, Xixian ZOU* Huazhong University of Science and Technology, China
11:40-12:00	**Chemical Looping Combustion of Coal in a 5 kW_{th} Interconnected Fluidized Bed Reactor Using Hematite as Oxygen Carrier** *Jinchen MA[1#], Haibo ZHAO[1], Xin TIAN[1], Yijie WEI[1], Sharmen RAJENDRAN[2], Yongliang ZHANG[1], Sankar BHATTACHARYA[2], Chuguang ZHENG[1]* [1]Huazhong University of Science and Technology, China, [2]Monash University, Australia	**High-stability, high-capacity oxygen carriers: iron oxide-perovskite hybrid materials for hydrogen production by chemical looping** *Cristina DUESO, Claire THOMPSON, Ian METCALFE#* Newcastle University, UK

12:00-12:20	**Biomass Combustion in iG-CLC and CLOU processes** *Teresa MENDIARA, Iñaki ADÁNEZ-RUBIO, Pilar GAYÁN#, Alberto ABAD, Luis F. DE DIEGO, Francisco GARCÍA-LABIANO, Juan ADÁNEZ* Instituto de Carboquímica (ICB-CSIC), Spain	**Core-Shell Redox Catalysts for Chemical Looping Conversion of Methane** *Luke NEAL, Arya SHAFIEFARHOOD, and Fanxing LI#* North Carolina State University, USA
12:20-12:40	**Cement/CaO-decorated iron ore as oxygen carrier for chemical looping combustion of coal** *Haiming GU #, Laihong SHEN, Xin NIU, Huijun GE, Zhaoping ZHONG* Southeast University, Nanjing, China	**Development and performance of iron based oxygen carriers containing calcium ferrites for chemical looping production of hydrogen** *Mohammad ISMAIL#, Wen LIU, Stuart A. SCOTT* University of Cambridge, UK
12:40-13:00	**Chemical-Looping Coal Combustion – Results from the ACCLAIM project** *Carl LINDERHOLM[1#], Juan ADÁNEZ[2], Corinne BÉAL[3], Bernd EPPLE[4], Stefan PENTHOR[5], Anders LYNGFELT[1]* [1]Chalmers, Sweden, [2]Instituto de Carboquimica, Spain, [3]ALSTOM Boiler France, [4]TU Darmstadt, Germany, [5]Vienna UT, Austria	**Synthesis and Performance of Fe_2O_3-Based Oxygen Carriers for Hydrogen Production via Chemical Looping** *Nur Sena YÜZBASI#, Qasim IMTIAZ, Agnieszka KIERZKOWSKA, Christoph MÜLLER* ETH Zurich, Switzerland
13:00-14:00	**LUNCH** *Sponsored by Alstom*	
	SESSION 2A **Pilot operation, gaseous and liquid fuels** *Session chair: Dr. Mahdi Yazdanpanah, Total, France*	**SESSION 2B** **Packed bed processes** *Session chair: Mr. Øyvind Langørgen, SINTEF Energy Research, Norway*
14:00-14:20	**The different demands of oxygen carriers on the reactor system of a CLC plant – results of oxygen carrier testing in a 120 kW pilot plant** *Karl MAYER[1#], Stefan PENTHOR[1], Tobias PRÖLL[2], Hermann HOFBAUER[1]* [1]Vienna University of Technology, Austria, [2]University of Natural Resources and Life Sciences, Austria	**Packed Bed Reactor for CLC integrated in coal fired power plant** *Vincenzo SPALLINA[1#], Paul HAMERS[1], Matteo C. ROMANO[2], Fausto GALLUCCI[1], Paolo CHIESA[2], Martin VAN SINT ANNALAND[1], Giovanni LOZZA[2]* [1]Eindhoven University of Technology, The Netherlands, [2] Politecnico di Milano, Italy
14:20-14:40	**Sour and acid gas combustion in a 500 W_{th} CLC unit** *Arturo CABELLO[1#], Francisco GARCÍA-LABIANO[1], Luis F. DE DIEGO[1], Pilar GAYÁN[1], Alberto ABAD[1], Juan ADÁNEZ[1], Gerald SPRACHMANN[2]* [1]Instituto de Carboquímica (ICB-CSIC), Spain, [2]Shell, The Netherlands	**Optimized Design of a Ni-based Chemical Looping Combustion Process Using Fixed-beds** *José Ramón FERNÁNDEZ, Juan Carlos ABANADES* CSIC-INCAR Spanish Research Council, Spain
14:40-15:00	**Overview of Operational Experiences with Calcium Manganate Oxygen Carriers in Chemical-Looping Combustion** *Peter HALLBERG#, Malin KÄLLÉN, Tobias MATTISSON, Magnus RYDÉN and Anders LYNGFELT* Chalmers University of Technology, Sweden	**Thermal and mechanical behaviour of oxygen carrier materials for chemical looping combustion in a packed bed reactor** *M. JACOBS[1#], J. VAN NOYEN[2], Y. LARRING[3], M. MCCANN[3], M. PISHAHANG[3], S. AMINI[3], M. ORTIZ[4], F. GALLUCCI[4], M. VAN SINT-ANNALAND[4], W. HAIJE[5], P. COBDEN[5], D. TOURNIGANT[6], E. LOURADOUR[6], F. SNIJKERS[1]* [1]VITO, Belgium, [2]Dow Chemicals, the Netherlands, [3]SINTEF, Norway, [4]TU Eindhoven, the Netherlands, [5]ECN, the Netherlands, [6]CTI, France

15:00-15:20	**Chemical-looping using combined iron/manganese/ silica oxygen carriers** *Malin KÄLLÉN#, Magnus RYDÉN, Anders LYNGFELT, Tobias MATTISSON* Chalmers University of Technology, Sweden	**A Novel Gas Switching Combustion Reactor for Power Production with Integrated CO_2 Capture: Sensitivity to the Fuel Type** *Abdelghafour ZAABOUT[1 #], Schalk CLOETE[1], Martin VAN SINT ANNALAND[2], Fausto GALLUCCI[2] and Shahriar AMINI[1]* [1]SINTEF Materials and Chemistry, Norway, [2]Eindhoven University of Technology, the Netherlands
15:20-15:40	**Chemical-looping combustion of liquid hydrocarbon fuels** *Tobias MATTISSON[1], Patrick MOLDENHAUER[1#], Ali HOTEIT[2], Magnus RYDÉN[1], Aqil JAMAL[2], Anders LYNGFELT[1]* [1] Chalmers University of Technology, Sweden, [2]SAUDI ARAMCO, Saudi Arabia	**Novel reactor concepts for chemical-looping combustion** *Lu HAN, Zhiquan ZHOU, George M. BOLLAS #* University of Connecticut, USA
15:40-16:00	**BREAK**	
16:00-17:00	**POSTER SESSION / LAB VISIT GROUP A**	
17:00-18:00	**POSTER SESSION / LAB VISIT GROUP B**	
18:30-20:30	**RECEPTION by the CITY OF GOTHENBURG** at Dicksonska palatset	

Wednesday, September 10th, 2014

	Lecture hall **"RunAn"**	Lecture hall **"Palmstedt"**
08:30-09:10	**KEYNOTE 3** **Challenges of CCS and 2nd generation carbon capture technologies from an industry perspective** *Mr. Frank KLUGER* Alstom Power Systems, Germany	
	SESSION 3A **Oxygen carriers I** *Session chair: Prof. John Dennis, University of Cambridge, United Kingdom*	**SESSION 3B** **Fluid-dynamical modelling I** *Session chair: Prof. Joachim Werther, Technische Universität Hamburg-Harburg, Germany*
09:10-09:30	**Attrition of oxygen carrier particles in fluidized bed – basic theory and screening measurements with a customized jet cup test rig** *Magnus RYDÉN #, Patrick MOLDENHAUER, Tobias MATTISSON, Anders LYNGFELT* Chalmers University of Technology, Sweden	**Iron Oxide Looping for Natural Gas Conversion in a Countercurrent Moving Bed Reactor** *Liang ZENG[1], Mandar KATHE[2], Samuel BAYHAM[2#], Andrew TONG[2], Qiang ZHOU[2], Liang-Shih FAN[2]* [1]Tianjin University, China, [2]Ohio State University, USA

09:30-09:50	**Effect of Oxide Ion and Mixed Conductors as Supports on Metal Oxide Redox Kinetics in Chemical Looping Systems** *Junichiro OTOMO[1 #], Syunsuke ISOGAI[1], Fumihiko KOSAKA[1], Yoshito OSHIMA[1], Hiroyuki HATANO[2]* [1]University of Tokyo, Japan, [2]Chuo University, Japan	**3D Numerical Simulation of a 1 MW_{th} Chemical–Looping Plant** *Falah ALOBAID[#], Andreas MAI, Peter OHLEMÜLLER, Jochen STRÖHLE, Bernd EPPLE* Technische Universität Darmstadt, Germany
09:50-10:10	**Evaluation of Fe-Mn oxide system for CLC** *Yngve LARRING[#], Carole BRALEY, Mehdi PISHAHANG, Kari Anne ANDREASSEN, Rune BREDESEN* SINTEF MK, Norway	**Transient Reacting Flow Simulations of Spouted Fluidized Bed for Coal-direct Chemical Looping Combustion** *Subhodeep BANERJEE[#], Ramesh AGARWAL* Washington University in St. Louis, USA
10:10-10:30	**Characterization of Attapulgite-supported Fe_2O_3-based Oxygen Carrier for Chemical-looping Combustion of Coal** *Mingming YANG, Yongzhuo LIU, Weihua JIA, Xiude HU, Qingjie GUO[#]* Qingdao University of Science and Technology, China	**Chemical looping Combustion dynamic modelling : from hydrodynamics to combustion kinetics** *Tiago SOZINHO[1], Jean-Marc SCHWEITZER[1], Mohammad Mahdi YAZDANPANAH[2], William PELLETANT[1], Stéphane BERTHOLIN[1]* [1]IFPEN, France, [2]TOTAL SA, France
10:30-10:50	**Characterisation of a copper based oxygen carrier: stability, attrition resistance and reaction kinetics** *Wenting HU, Felix DONAT, S. A. SCOTT, J. S. DENNIS* University of Cambridge, UK	**Volatiles bypassing in CLC: CFD and cold-flow studies** *J. ARONSSON#[1], C. CORONELLA[2], D. PALLARÈS[1], A. LYNGFELT[1]* [1]Chalmers University of Technology, Sweden, [2]University of Nevada, Reno, USA
10:50-11:20	**BREAK**	
	SESSION 4A **Process design, techno-economic studies** *Session chair: Dr.-Ing. Jasmin Kemper, IEA Greenhouse Gas R&D Programme, United Kingdom*	**SESSION 4B** **SO_2 and NO_x** *Session chair: Prof. Ben Anthony, Cranfield University, United Kingdom*
11:20-11:40	**Techno-economic Analysis of a 550 MW_e Atmospheric Iron-Based Coal-Direct Chemical Looping Process** *Luis G. VELAZQUEZ-VARGAS[1], Doug J. DEVAULT[1], Tom J. FLYNN[1], Tritti SIENGCHUM[1], Liang ZENG[2], Andrew TONG[2], Samuel BAYHAM[2], L.-S. FAN[2]* [1]The Babcock & Wilcox Power Generation Group, USA, [2]The Ohio State University, USA	**Sulfur Behavior in Chemical-Looping with Oxygen Uncoupling Using a Natural Copper Ore Oxygen Carrier** *Kun WANG[#], Haibo ZHAO* Huazhong University of Science and Technology, China
11:40-12:00	**Process integration of chemical looping combustion with oxygen uncoupling** *Michele VILLANI, Maurizio SPINELLI, Aldo BISCHI, Matteo Carmelo ROMANO[#]* Politecnico di Milano, Italy	**Control of NO_x and SO_x in Chemical-Looping Combustion Plants: The Importance of Pressurized Flue Gas Systems** *Sima AJDARI[#], Fredrik NORMANN, Klas ANDERSSON* Chalmers University of Technology, Sweden
12:00-12:20	**Conceptual Design of a 100 MW_{th} CLC Unit for Solid Fuel Combustion** *Alberto ABAD[1#], Juan ADÁNEZ[1], Pilar GAYÁN[1], Luis F. de DIEGO[1], Francisco GARCÍA-LABIANO[1], Gerald SPRACHMANN[2]* [1]Instituto de Carboquímica (ICB-CSIC), Spain, [2]Shell Global Solutions International BV, the Netherlands	

12:20-12:40	**Feasibility and sensitivity of solid fuel CLC plant investment with oxygen carrier recovery** *Matti TÄHTINEN #, Eemeli TSUPARI, Janne KÄRKI* VTT Technical Research Centre, Finland	
12:40-13:00	**Process Simulation for Chemical-Looping with Oxygen Uncoupling (CLOU) Process and Comparison of Energy Output using Cu, Fe, and Mn-Based Oxygen Carriers** *Ling ZHOU[12], Xiao ZHANG[1#], Subhodeep BANERJEE[1], Ramesh AGARWAL[1]* [1]Washington University in St. Louis, USA, [2]Jiangsu University, China	
13:00-14:00	**LUNCH**	
	SESSION 5A **CLOU** *Session chair: Prof. Juan Adánez, Instituto de Carboquimica (CSIC), Spain*	**SESSION 5B** **Process modelling** *Session chair: Dr. Olivier Authier, EDF R&D, France*
14:00-14:20	**Na^+-Doped and Al_2O_3-Stabilized, CuO-Based Oxygen Carriers for Chemical Looping Combustion and Chemical Looping with Oxygen Uncoupling** *Qasim IMTIAZ[1#], Paula ABDALA[2], Agnieszka KIERZKOWSKA[1], Wouter van BEEK[2], Christoph MÜLLER[1]* [1]ETH Zürich, Switzerland, [2]European Synchrotron Radiation Facility (ESRF), France	**Mathematical modelling of a two-stage fuel reactor for chemical-looping combustion with oxygen uncoupling of solid fuels** *Antonio COPPOLA[1#], Roberto SOLIMENE[1], Piero SALATINO[2], Piero BARESCHINO[3]* [1]Istituto di Ricerche sulla Combustione, Italy, [2]Università degli Studi di Napoli Federico II, Italy. [3]Università degli Studi del Sannio, Italy.
14:20-14:40	**Characteristics of copper-based oxygen carriers supported on calcium aluminates for chemical-looping combustion with oxygen uncoupling (CLOU)** *F. DONAT#, W. HU, S.A. SCOTT, J.S. DENNIS* University of Cambridge, UK	**Modelling and scale-up study of chemical looping with oxygen uncoupling (CLOU) process** *Petteri PELTOLA#, Tero TYNJÄLÄ, Jouni RITVANEN, Timo HYPPÄNEN* Lappeenranta University of Technology, Finland
14:40-15:00	**Composite mixed oxides for chemical looping with oxygen uncoupling** *Arya SHAFIEFARHOOD, Nathan GALINSKY, Amit MISHRA, Fanxing LI#* North Carolina State University, USA	**Validation of chemical looping combustion process models by means of 100 kW_{th} tests** *Peter OHLEMÜLLER#, Falah ALOBAID, Jochen STRÖHLE, Bernd EPPLE* Technische Universität Darmstadt, Germany
15:00-15:20	**Insight into CuO-support interactions and oxygen release mechanisms of Cu-based oxygen carriers based on density functional theory calculation** *Yongliang ZHANG, Haibo ZHAO#* Huazhong University of Science and Technology, China	**Mapping out the Reactor Operating Window for the Packed bed CLC Demonstration Project DemoCLOCK** *Schalk CLOETE, Antoine SEVILLANO, Shahriar AMINI#* SINTEF Materials and Chemistry, Norway

15:20-15:40	**Preparation and properties of perovskite Mn-based oxygen carriers for chemical looping combustion by industrial spray drying method** *Frans SNIJKERS[1#], Dazheng JING[2], Jasper VAN NOYEN[1], Tobias MATTISSON[2], Marijke JACOBS[1], Anders LYNGFELT[2]* [1]Flemish Institute for Technological Research (VITO), Belgium, [2]Chalmers University of Technology, Sweden	**Thermodynamic analysis of energy conversion systems using a novel rotary chemical-looping combustion reactor** *Chukwunwike ILOEJE[#], Zhenlong ZHAO, Ahmed F. GHONIEM* Massachusetts Institute of Technology, US
15:40-16:00	**BREAK**	
16:00-17:00	**POSTER SESSION / LAB VISIT GROUP C**	
17:00-18:00	**POSTER SESSION / LAB VISIT GROUP D**	
18:30	**CONFERENCE DINNER** at Universeum	

Thursday, September 11th, 2014

Time	Lecture hall **"RunAn"**	Lecture hall **"Palmstedt"**
08:30-09:10	**KEYNOTE 4** **Enhanced Oxygen Carriers of Iron Ore for Chemical Looping Combustion of Coal** *Prof. Laihong SHEN* Southeast University Nanjing, China	
	SESSION 6A **Oxygen carriers II** *Session chair: Dr. Ranjani Siriwardane, National Energy Technology Laboratory, DOE, USA*	**SESSION 6B** **Hydrogen production II** *Session chair: Prof. Qingjie Guo, Qingdao University Science & Technology, China*
09:10-09:30	**Fluidized Bed Testing Of Commercially Prepared MgO-Promoted Hematite and CuO-Fe_2O_3 Mixed Metal Oxide Oxygen Carriers for Methane and Coal Chemical Looping Combustion** *Ranjani SIRIWARDANE[#], Hanjing TIAN, Duane MILLER, George RICHARDS* U.S. DOE/NETL, USA	**Performance of a Fe_2O_3-based oxygen carrier, stabilised with $NaAlO_2$, for the chemical looping production of hydrogen** *Wen LIU[1], Mohammad ISMAIL[1], Matthew T. DUNSTAN[1], Wenting HU[1], Zili ZHANG[2], Paul S. FENNELL[2], Stuart. A. SCOTT[1#], J. S. DENNIS[1]* [1]University of Cambridge, UK, [2]Imperial College, UK
09:30-09:50	**Silica-Encapsulated Copper-Based Oxygen Carriers for Chemical Looping Combustion** *Agnieszka M. KIERZKOWSKA[#], Qasim IMTIAZ, Christoph R. MÜLLER* ETH Zurich, Switzerland	**Chemical-looping hydrogen storage over Fe_2O_3-CeO_2 oxygen carriers: the effect of structural evolution of materials** *Lingyue SUN, Xing ZHU[#], Kongzhai LI, Hua WANG, Yonggang WEI, Min ZHENG, Yane ZHENG.* Kunming University of Science and Technology, China

09:50-10:10	**$NiO/CaAl_2O_4$ as active oxygen carrier for low temperature chemical looping applications** *José Antonio MEDRANO[1#], Paul HAMERS[1], María ORTIZ[1], Alan RAMIREZ[1], Martin van SINT ANNALAND[1], Gareth WILLIAMS[2], Fausto GALLUCCI[1]* [1]Eindhoven University of Technology, the Netherlands, [2]Johnson Matthey, UK	**Chemical Looping Hydrogen Production by the Steam Iron Process using Fixed Bed Reactor Technology** *Stephan NESTL[#], Gernot VOITIC, Viktor HACKER* Graz University of Technology, Austria
10:10-10:30	**Investigation of mechanical attrition resistance and redox properties of copper impregnated diatomite based granulates** *Yujing LIU, Noemie VAN GARDEREN, Frank J CLEMENS[#]* Empa, Swiss Federal Laboratories for Materials Science and Technology, Switzerland	**Fe-Mn-based, ZrO_2 Stabilized Oxygen Carriers for Chemical Looping based hydrogen production** *Davood HOSSEINI[#], Nur Sena YÜZBASI, Christoph R. MÜLLER* ETH Zurich, Switzerland
10:30-10:50	**Modification of traditionally impregnated Fe_2O_3/Al_2O_3 oxygen carriers by ultrasonic method and their performance in chemical looping combustion** *Shuai ZHANG[#], Rui XIAO, Peng LI* Southeast University, Nanjing, China	**Pre-combustion packed bed chemical looping (PCCL) technology or high efficient H_2-rich gas production processes** *Vincenzo SPALLINA[#], Fausto GALLUCCI, Martin VAN SINT ANNALAND* Eindhoven University of Technology, the Netherlands
10:50-11:20	**BREAK**	
	SESSION 7A **Pilot operation Solid fuels II** *Session chair: Mrs. Corinne Béal, Alstom Power Boilers, France*	**SESSION 7B** **Related processes** *Session chair: Dr. Aqil Jamal, Saudi Aramco, KSA*
11:20-11:40	**Performance of calcium manganate as oxygen carrier in chemical looping combustion of biomass in a 10 kW pilot** *Matthias SCHMITZ[#], Carl Johan LINDERHOLM, Anders LYNGFELT* Chalmers University of Technology, Sweden	**Modeling of Chemical Looping Biomass Gasification** *I. CAMPOS VELARDE[#], V. DHOOGE, F. GALLUCCI, M. VAN SINT ANNALAND* Eindhoven University of Technology, the Netherlands
11:40-12:00	**Pollutant emissions during coal combustion in iG-CLC and CLOU processes** *Iñaki ADÁNEZ-RUBIO[#], Teresa MENDIARA, Alberto ABAD, Pilar GAYÁN, Francisco, GARCÍA-LABIANO, Luis F. DE DIEGO, Juan ADÁNEZ* Instituto de Carboquímica (ICB-CSIC), Spain	**Use of CuO-$MgAl_2O_4$ and LSFO/γ-Al_2O_3 as a Bed Material in a Chemical Looping Reforming System for Tar Removal from Biomass-derived Gasification Gas** *Martin KELLER[#], Henrik LEION, Tobias MATTISSON* Chalmers University of Technology, Sweden
12:00-12:20	**Performance of chemical looping combustion of sewage sludge and phosphorus migration based on hematite oxygen carrier in a 1 kW_{th} reactor** *Xin NIU[#], Laihong SHEN, Haiming GU, Tao SONG* Southeast University, Nanjing, China	**A novel chemical looping oxy combustor process using metal oxide oxygen carriers for combustion of solid fuels** *Kalpit SHAH[#], Cheng ZHOU, Hui SONG, Elham DOROODCHI, Behdad MOGHTADERI* University of Newcastle, Australia

12:20-12:40	**Design of a 50 kW_{th} CLC Pilot Plant with Solid Fuels** *Raúl PÉREZ-VEGA#, Alberto ABAD, Luis F. DE DIEGO, Francisco GARCÍA-LABIANO, Pilar GAYÁN, Juan ADÁNEZ* Instituto de Carboquímica (ICB-CSIC), Spain	**The mechanism of oxygen uptake on carbon as a key step in looping combustion** *Osvalda SENNECA[1], Mauro CAUSA[2], Gianluca LEVI[2], Luciano CORTESE[1], Piero SALATINO[2]* [1]Combustion Research Institute, Italy, [2]University of Naples Federico II, Italy.
13:00-14:00	**LUNCH**	
	SESSION 8A **Oxygen carriers III** *Session chair: Mr. Frans Snijkers, Flemish Institute for Technological Research (VITO), Belgium*	**SESSION 8B** **Fluid-dynamical modelling II** *Session chair: Prof. Bernd Epple, Technische Universität Darmstadt, Germany*
14:00-14:20	**Direct chemical looping combustion of carbon monoxide with a Cu-based oxygen carrier and a Cu-modified manganese oxygen** *Lei XU#, Zhenshan LI, Ningsheng CAI* Tsinghua University, China	**Scale-up of CLC Fuel Reactor Hydrodynamics Using Experimental and Modeling Investigations** *Mohammad Mahdi YAZDANPANAH[1], Ann FORRET[2#], Sophia S. RODRIGUES[2], Benjamin AMBLARD[2], Helene STAINTON[1]* [1] TOTAL, France, [2] IFP Energies nouvelles, France
14:20-14:40	**Ferrites as Redox Catalysts for Chemical Looping Processes** *Lori NALBANDIAN[1#], Antigoni EVDOU[12], Vassilios ZASPALIS[12]* [1]Centre for Research and Technology Hellas, Greece, [2]Aristotle University of Thessaloniki, Greece	**Using Barracuda-VR™ to Determine Operational Parameters and the Fluidization Regime a Dual Circulating Fluidized Bed System** *Matthew A. HAMILTON#, Kevin J. WHITTY, JoAnn S. LIGHTY* University of Utah, USA
14:40-15:00	**Lanthanum oxysulfate as stable oxygen carrier for CLC process** *Luciana LISI#, Stefano CIMINO, Gabriella MANCINO* Istituto di Ricerche sulla Combustione, Italy	**Fluidization Behavior of the Binary Particles Mixture in an Interconnected Dual Fluidized Bed System Designed for Solid Fuel Chemical Looping Combustion** *Hongming SUN, Mao CHENG, Zhenshan LI, Ningsheng, CAI* Tsinghua University, China
15:00-15:20	**Studies on redox reaction kinetics of selected Fe-based oxygen carriers** *Ewelina KSEPKO#, Piotr BABINSKI, Marek SCIAZKO* Institute for Chemical Processing of Coal, POLAND	**Model Development, Validation and Transition to CFD Simulation – A Case Study using the example of Alstom's Regenerative Calcium Cycle** *Michael BALFE[1#], Christoph WEINGÄRTNER[1] , Olaf STALLMANN[1], Liv-Margrethe H. BJERGE[2], Heiko DIETER[3], Theodor BEISHEIM[3], and Gerrit HOFBAUER[3]* [1]ALSTOM Carbon Capture GmbH, Germany, [2]NORCEM AS, Norway, [3]IFK, University of Stuttgart, Germany
15:20-15:40	**Characterization of ilmenite used as oxygen carrier in a 100 kW chemical-looping combustor for solid fuels** *Pavleta KNUTSSON#, Carl LINDERHOLM* Chalmers University of Technology, Sweden	
15:40-16:00	**BREAK**	
16:00-17:00	**PANEL DISCUSSION** The future of chemical looping	

Poster Presentations

Sorted by the surname of the first author.

Relevance of Oxygen Carrier Characteristics on CLC Design for Gaseous Fuels

Alberto ABAD, Pilar GAYÁN, Francisco GARCÍA-LABIANO, Luis F. DE DIEGO, Juan ADÁNEZ

Instituto de Carboquímica (ICB-CSIC), Spain

Novel Materials and Reforming Processing Route for the Production of Ready-Separated CO_2/N_2/H_2 from Natural Gas Feedstocks

Robert BLOOM[1], Valerie DUPONT[1], Steve J. MILNE[2], Steve McBRIDE[3], Emiliana DVININOV[4], Martyn V. TWIGG[5]

[1]Energy Resource Institute, [2]The University of Leeds, UK,
[3]SAFFIL Ltd, UK, [4]MEL Chemicals, UK, [5]TST Ltd, UK

Combined Transient Gas-Solid and Catalytic Kinetics for Chemical Looping Reforming of Methane with a Ni-Based Oxygen Carrier

François-Xavier CHIRON[1] and Gregory S. PATIENCE[2]

[1]Haldor Topsøe A/S, Denmark, [2]Ecole Polytechnique, Canada

Numerical Evaluation of a Membrane-Assisted Fluidized Bed Reactor for Use in Chemical Switching Reforming

Schalk CLOETE[1], Jan Hendrik CLOETE[1], Martin VAN SINT ANNALAND[2], Fausto GALLUCCI[2], Shahriar AMINI[1]

[1]SINTEF Materials and Chemistry, Norway
[2]Eindhoven University of Technology (TU/e), the Netherlands

Limestone-Based Materials for Calcium Looping: Effect of Steam Hydration Reactivation on CO_2 Capture Capacity and Attrition Tendency

Antonio COPPOLA[1], Fabio MONTAGNARO[2], Piero SALATINO[2], Fabrizio SCALA[1]

[1]Istituto di Ricerche sulla Combustione, Italy
[2]Università degli Studi di Napoli Federico II, Italy

Characterization of CLC Oxygen Carriers Produced by Sewage Sludge Fluidized Bed Combustion

Antonio COPPOLA, Riccardo CHIRONE, Roberto SOLIMENE, Giovanna RUOPPOLO, Massimo URCIUOLO

Combustion Research Institute (National Council of Research), Italy

Chemical Looping Reforming of Ethanol in a 1 kW_{th} Unit

Enrique GARCÍA-DÍEZ[1], Luis F. de DIEGO[1], Francisco GARCÍA-LABIANO[1], Alberto ABAD[1], Pilar GAYÁN[1], Juan ADÁNEZ[1], Juan RUIZ[2]

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[2]Centro de Tecnologias do Gás e Energias Renováveis (CTGAS-ER), Brazil

Experimental Study on the Flow of Different Solid Phases in a Moving Bed Cold Flow Model

A. GIPPERICH, M. TWORKOWSKI, M. KAPPES, W. KRUMM

Universität Siegen, Germany

Dry Impregnation of Iron and Manganese Ores as Oxygen Carriers for Chemical Looping with Oxygen Uncoupling

S K HAIDER[1], G AZIMI[2], N M POUR[2], K PATCHIGOLLA[1], E J ANTHONY[1], J E OAKEY[1], H LEION[2], T MATTISSON[2], A LYNGFELT[2]

[1]Cranfield University, UK, [2]Chalmers University of Technology, Sweden

Reactivity of Ca-Fe/Bentonite Oxygen Carrier in Coal Chemical-Looping Combustion

Wei-hua JIA[1], Yongzhuo LIU[1], Qingjie GUO[1], Gang JIN[2], Wenxue LU[2], Baogui GUO[2]

[1]Qingdao University of Science & Technology, China
[2]Gasification and coal chemical industry the National Engineering Research Center for coal water slurry, China

Chemical Looping Combustion of Methane over Selected Bimetallic Fe_2O_3–CuO Oxides

Ewelina KSEPKO[1], Ranjani V. SIRIWARDANE[2], Hanjing TIAN[2], Thomas SIMONYI[2], Marek SCIAZKO[1]

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[2]National Energy Technology Laboratory U.S. Department of Energy, USA

Studies on Redox Reaction Kinetics of Selected Naturally Occurring Oxygen Carrier

Ewelina KSEPKO, Piotr BABINSKI, Marek SCIAZKO

Institute for Chemical Processing of Coal, Poland

Performance and Operability of a 150 kW Chemical Looping Combustion Reactor System for Gaseous Fuels

Øyvind LANGØRGEN, Nils Erland L. HAUGEN, Inge SAANUM

SINTEF Energy Research, Norway

Fabrication of Oxygen Carrier Materials by Different Industrial Methods for Chemical Looping Combustion

Tommy MOKKELBOST, Ove DARELL, Christian SCHØNING, Anita FOSSDAL, Yngve LARRING

SINTEF Materials and Chemistry, Norway

Process activated ilmenite as catalyst for cleaning of biomass producer gas

Huong NGYUEN, Nicolas BERGUERAND, Henrik THUNMAN

Chalmers University of Technology, Sweden

Importance of Water-Gas-Shift in Packed Bed Chemical Looping Combustion with Ilmenite

Maria ORTIZ, Paul HAMERS, Vincenzo SPALLINA, Fausto GALLUCCI, Martin VAN SINT ANNALAND

Eindhoven University of Technology, the Netherlands

Mn and Cu Oxides from First Principles Calculations: Reduction of CLC Materials

Teemu PARVIAINEN, Hannu HÄKKINEN, Karoliina HONKALA

University of Jyväskylä, Finland

Performance of Oxygen Carriers in a 3 kW Dual Fluidized CLC Rig

Mehdi PISHAHANG[1], Yngve LARRING[1], Tommy MOKKELBOST[1], Anita FOSSDAL[1], Kari Anne ANDREASSEN[1], Ove DARELL[1], Bjørnar ARSTAD[1], Richard BLOM[1] and Øyvind LANGØrgen[2]

[1]SINTEF Materials and Chemistry, Norway, [2]SINTEF Energy AS, Norway

Simulations of a Chemical Looping Combustion Power Plant Using Aspen Plus

Rosario PORRAZZO, Graeme WHITE, Raffaella OCONE

Heriot-Watt University, UK

Attapulgite as Oxygen Carrier for Chemical Looping Combustion

A.C. PSARRAS, E.F. ILIOPOULOU, A. EVDOU, L. NALBANDIAN

Centre for Research and Technology Hellas, Greece

Application of Novel Calcium Looping Process for Providing CO_2 and Heat to the Greenhouses

Mohammad RAMEZANI, Kalpit SHAH, Elham DOROODCHI, Behdad MOGHTADERI

The University of Newcastle, Australia

A Homogenized Particle Model to Describe the Redox Kinetics of Oxygen Carriers Accounting for Morphological Changes

Maria Angel SAN PIO, Ivo ROGHAIR, Fausto GALLUCCI, Martin VAN SINT ANNALAND

Eindhoven University of Technology, the Netherlands

Proceedings of Mineralogical Study on Natural Oxygen Carriers for Chemical Looping Combustion

Alexander SCHOPF, Florian MAYER, Hans-Joachim MASSONE

Universität Stuttgart, Germany

Ethanol Combustion in a CLC Unit Using Ni-and Cu-based Oxygen Carriers

Anabel SERRANO, Francisco GARCÍA-LABIANO, Luis F. de Diego, Pilar GAYÁN, Alberto ABAD, Juan ADÁNEZ

Instituto de Carboquímica (ICB-CSIC), Spain

Development of Novel Stone Dust Looping Process for Mitigation of Ventilation Air Methane

Kalpit SHAH, Yongxing ZHANG, Elham DOROODCHI, Behdad MOGHTADERI

The University of Newcastle, Australia

Cu-Based Bimetallic Oxygen Carriers with SiO_2 as a Support for Chemical Looping Air Separation

Hui SONG, Kalpit SHAH, Elham DOROODCHI, Behdad MOGHTADERI

The University of Newcastle, Australia

Development of a Kinetic Model and Comparison with Experiments for Chemical Looping Reaction: Study of $NiO/NiAl_2O_4$ Tablets in a Continuous Stirred-Tank Reactor

A. TILLAND, L. FRANCK-LACAZE, E. SCHAER

Université de Lorraine, France

CO_2 Capture via Calcium Looping Process by Multiple Fluidized Bed Reactors Configuration Conceived without Auxiliary Fuel

Claudio TREGAMBI[1], Fabio MONTAGNARO[1], Piero SALATINO[1], Roberto SOLIMENE[2]

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Development of a Steam Hydrator and its Integration into the Carbonation-Calcination Reaction Process for CO_2 Control

William WANG, Alan WANG, Niranjani DESHPANDE, Nihar PHALAK, Liang-Shih FAN

The Ohio State University, USA

Operating Experience of a 50 kW_{th} Chemical Looping Circulating Fluidized Bed Combustor and Geometrically Similar Cold Flow Unit

Justin WEBER, Douglas STRAUB, Ronald BREAULT, George RICHARDS

National Energy Technology Laboratory, U. S. Department of Energy, USA

Thermochemical Energy Storage based on the Reversible Reaction of Metal Oxides

M. WOKON, A. KOHZER, A. BENZARTI, T. BAUER, M. LINDER, A. WÖRNER, A. THESS

German Aerospace Center (DLR),
Institute of Technical Thermodynamics, Germany

Aspen Plus Simulation and Thermodynamic Assessment on Integrated Chemical Looping Gasification of Biomass with Calcium Oxide Sorbent for Hydrogen-Enriched Syngas Production

Fengkui YIN, Kalpit SHAH, Jianglong YU, Elham DOROODCHI, Behdad MOGHTADERI

The University of Newcastle, Australia

Reaction Stability of Pr-Zr Solid Solution on Chemical-Looping Selective Oxidation of Methane

Wei YONG-GANG, Li KONG-ZHAI, Zhu XING, Du YUN-PENG, Liu ZI-SONG, Wang HUA

Kunming University of Science and Technology, China

Enhanced Activity of CeO_2–ZrO_2 Solid Solutions for Chemical-Looping Steam Methane Reforming via the Formation of Macroporous Structure

Yane ZHENG, Xing ZHU, YonggangWEI, Min ZHENG, Yunpeng DU, Yuhao WANG, Hua WANG, Kongzhai LI

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Thermodynamic and Economic Feasibility of Solar-based Chemical Looping Air Separation for Oxy-Combustion System

Xixian ZOU, Bo JIN, Xiaoming HAO, Haibo ZHAO

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