



**11th IIR Gustav Lorentzen Conference on Natural Refrigerants**  
***Natural Refrigerants and Environmental Protection***  
August 31-September 2, 2014  
Hangzhou, China

# 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

## Preliminary Programme

**Organized by**



Chinese Association of Refrigeration



Zhejiang University

## Conference Chair

Guangming Chen, China

## Organizing Committee

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Lambert Kuijpers, Netherlands

Petter Neksa, Norway

Roberto Peixoto, Brazil

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## Conference Venue



### **Shangri-La Hotel, Hangzhou China**

Phone: (86 571) 8797 7951

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Email: slh@shangri-la.com

Location: 78 Beishan Road, Hangzhou, 310007, China

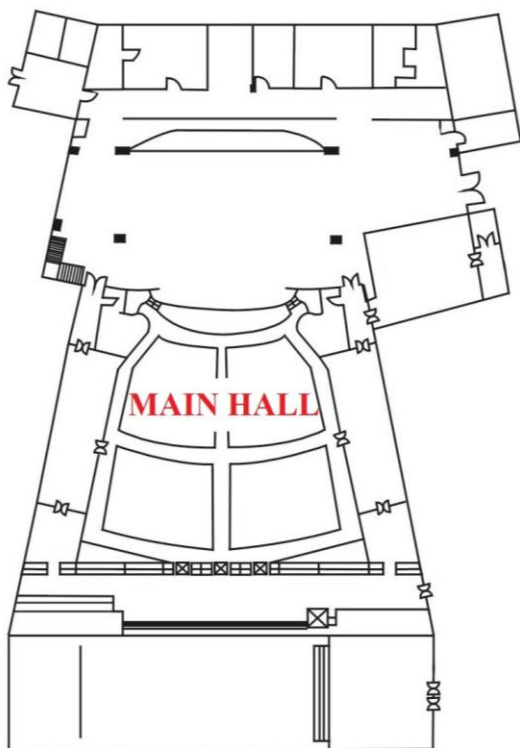
GL2014 Organizing Committee has reserved rooms for participants at lower group price (including tax & breakfast) from Aug.29 to Sep.5. Please make reservation on the conference website ([www.gl2014.org](http://www.gl2014.org)).

Free WIFI access: shangri-la

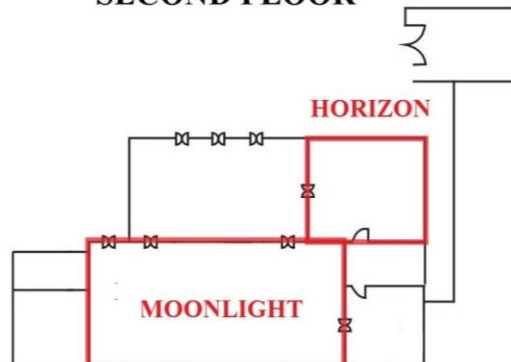
Shangri-La Hotel, Hangzhou, is 45 minutes from Xiaoshan International Airport. You can reach Shangri-La Hotel, Hangzhou, via taxis or city shuttle buses. Taxis and city shuttle buses can be found on the ground floor of the domestic and international arrival halls. Taxis are metered and the fare from the airport to the hotel costs approximately RMB 130 (USD 20) per journey.

## Auditorium Convention Center

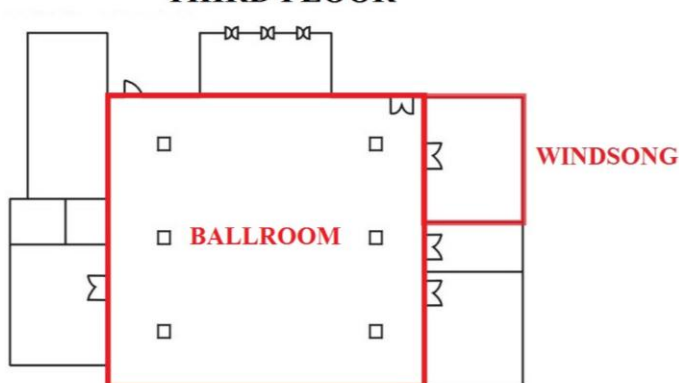
FIRST FLOOR



SECOND FLOOR




THIRD FLOOR



<p><b>MAIL HALL</b> First Floor of Auditorium Convention Center</p>	<p><u>Opening Ceremony</u> <u>Plenary Lecture 1, 2, 3, 4</u> <u>Session A1, A2, A3, A4, A5, A6</u> <u>Closing</u></p>
<p><b>MOONLIGHT</b> Second Floor of Auditorium Convention Center</p>	<p><u>Session B1, B2, B3, B4, B5, B6</u></p>
<p><b>HORIZON</b> Second Floor of Auditorium Convention Center</p>	<p><u>Session C1, C2, C3, C4, C5, C6</u></p>
<p><b>WINDSONG</b> Third Floor of Auditorium Convention Center</p>	<p><u>Session D1, D2, D3, D4, D5, D6</u></p>
<p><b>BALLROOM</b> Third Floor of Auditorium Convention Center</p>	<p><u>Banquet</u> <u>Lunch</u> <u>Dinner</u></p>

# 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

## Programme

<b>August 31, Sunday</b>		
08:00	20:00	Registration
18:30	20:00	Welcome Reception  <b>烟台冰轮</b> YANTAI MOON Sponsored by

<b>September 1, Monday</b>					
08:00	20:00	Registration			
09:00	09:15	Opening Ceremony Chair: Guangming Chen			
09:15	09:55	Plenary Lecture 1 Chair: Petter Neksa, Guangming Chen			
09:55	10:05	Coffee Break  Sponsored by			
10:05	12:05	<b>Session A1</b> Commercial & Supermarket Refrigeration Chair: Petter Neksa	<b>Session B1</b> R290  Chair: Guangming Chen	<b>Session C1</b> Ejectors  Chair: Yitai Ma	<b>Session D1</b> Emission and Energy Saving  Chair: Alexander Cohr-Pachai
12:05	13:00	Lunch  Sponsored by			
13:00	13:40	Plenary Lecture 2 Chair: Weiding Long, Reinhard Radermacher			
13:40	13:50	Coffee Break  Sponsored by 白雪电器			
13:50	15:50	<b>Session A2</b> Safety and Risk Assessment Chair: Reinhard Radermacher	<b>Session B2</b> CO <sub>2</sub> System Chair: Lambert Kuijpers	<b>Session C2</b> R290 Chair: Guogeng He	<b>Session D2</b> Refrigerant Charge Reduction in Refrigerating Systems Chair: Jos éM. Corber án
16:00	17:50	<b>Session A3</b> Commercial & Supermarket	<b>Session B3</b> CO <sub>2</sub> System Chair: Yitai Ma	<b>Session C3</b> CO <sub>2</sub> Heat Pump Chair: Eiji Hihara	<b>Session D3</b> Other Natural Refrigerants

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

		Refrigeration Chair: Weiding Long			Chair: James Calm
18:00	18:45	IIR E1/E2 Business Meeting Chair: Fabio Polonara			
19:00	21:00	Banquet  <b>Sponsored by</b> 			

<b>September 2, Tuesday</b>					
09:00	09:40	Plenary Lecture 3 Chair: Eiji Hihara, Xianting Li			
09:40	09:50	Coffee Break   Sponsored by			
09:50	12:00	<b>Session A4</b> Properties and Future Refrigerants Chair: Xianting Li	<b>Session B4</b> CO <sub>2</sub> System Chair: Petter Neksa	<b>Session C4</b> Heat Transfer and Heat Exchangers Chair: Shiming Deng	<b>Session D4</b> LCCP Chair: Yunho Hwang
12:00	13:00	Lunch   Sponsored by			
13:00	13:40	Plenary Lecture 4 Chair: Pega Hrnjak, Ruzhu Wang			
13:40	13:50	Coffee Break   Sponsored by			
13:50	15:50	<b>Session A5</b> Air & Water Chair: Pega Hrnjak	<b>Session B5</b> CO <sub>2</sub> Heat Pump Chair: Wensheng Lin	<b>Session C5</b> Heat Transfer and Heat Exchangers Chair: Daniel Colbourne	<b>Session D5</b> Sorptions Systems Chair: Xiaolin Wang
16:00	17:40	<b>Session A6</b> Air & Water Chair: Ruzhu Wang	<b>Session B6</b> CO <sub>2</sub> Heat Pump Chair: Andy Pearson	<b>Session C6</b> Heat Transfer and Heat Exchangers Chair: Yunho Hwang	<b>Session D6</b> Ammonia Chair: Yitai Ma
17:40	18:00	Closing Chair: Guangming Chen			
18:30	19:30	Dinner			

## Plenary Lecture 1

### Replacing refrigerants straightforward ?

#### The complexities in addressing the broader issues

**Lambert Kuijpers**

Technical University Eindhoven (NL)

**Abstract** This paper starts with an overview of refrigerant replacements during the last two decades and to the emphasis put on issues such as ozone depletion, global warming and energy efficiency. It presents estimated data on the demand of HCFCs and HFCs in developed and developing countries for 1995-2015. It also presents two scenarios, one a business as usual scenario and one for mitigating global warming emissions during the period up to 2030. A very important aspect to be taken into account is the growth in demand for new equipment that will occur in this timeframe, leading to a growth in climate-relevant emissions, even when emission rates for refrigeration and air conditioning (R/AC) equipment themselves can be kept low. Converting to low-GWP solutions, via both natural refrigerants and low-GWP fluorocarbons, may solve a large part of the growth in absolute climate terms. The current policy of the chemical industry is aiming at the availability of a sufficient number of low-GWP solutions, both as pure fluids and blends. The preference at the Multilateral Fund that supports developing countries in fulfilling their Montreal Protocol commitments is also focusing on the low GWP conversion away from HCFCs. Montreal Protocol Parties are asking for continuous updates on information in relation to the many issues involved in conversions or replacements. However, adequately addressing all the complexities involved in replacements will require a more holistic approach, which interlinks considerations on costs, energy efficiency, environmental aspects, engineering for different designs, design of refrigerant blends etc. This paper concludes with an analysis of these aspects and considers what may happen related to refrigerant options in the coming years.

**Keywords** BAU (business as usual), demand, HCFC, HFC, HFC blends, holistic approach, low GWP, low-GWP HFCs, replacements, mitigation, natural refrigerants, refrigerants, refrigerant demand scenarios.

**Dr. Lambert Kuijpers:** After his PhD, Lambert Kuijpers started his career at Philips Research Labs in Eindhoven, NL, where he guided a research group on thermodynamics, refrigeration and energy systems in the late 1980s, early '90s. The main issue in the R&D performed in the late 1980s was the increase of energy efficiency of equipment. However, the CFC replacement issue became more and more important, reason that, in his Philips period, Lambert Kuijpers got involved in many studies of HCFC, HFC and other replacements. He co-chaired the Refrigeration Technical Options Committee, part of the UN Environment Technology and Economic Assessment Panel (TEAP) under the Montreal Protocol, which he also co-chaired as of 1993. Lambert Kuijpers has been involved in several IPCC Assessment Reports during 1999-2007. Next to a co-authorship in the Science Assessment Panel under the Montreal Protocol in 2010 and 2014 (on atmosphere and banks and emissions of gases), he has been a co-author for several articles and reports on this issue. Lambert Kuijpers was also co-author for several publications focusing on emissions of HFC-23 to the atmosphere. In 2014 he is involved in various reports for the Montreal Protocol including one on funding HCFC consumption and production phase-out in developing countries, one on low GWP replacements, and in the quadrennial RTOC assessment report. Lambert Kuijpers started the A/genT environmental consultancy in the 1990s, which was hosted 1997-2014 at the Technical University Eindhoven.

## Plenary Lecture 2

### International standards for refrigeration safety

A. Pearson

Star Refrigeration Ltd.

**Abstract** The development of safety standards for refrigeration systems is a complex and often misunderstood process. This paper describes the way in which refrigeration safety and refrigerant international standards have been created and adapted over years and the difficulties that the present process creates. It goes on to explore the implications for the transition from fluorocarbon to natural refrigerants and draws conclusions about the best way to work within the standards process and the ways in which the process might be amended in order to provide a better match to the current needs of industry.

**Keywords** Standards, Safety, ISO, CEN, natural refrigerants

**Dr Andy Pearson** is the Group Engineering Director for Star Refrigeration Ltd, based in Glasgow, United Kingdom. He is a member of the British Standards Institute committee on Refrigeration Safety (RHE/018) and represents BSI on the equivalent committees in CEN and ISO. He was deeply involved in the development of the recently published ISO standards 5149 parts 1-4 and 817. He has held positions of responsibility in the Institute of Refrigeration (President from 2010-2013), the International Institute of Ammonia Refrigeration (member of Board of Directors 2002-2008) and ASHRAE (member of the Refrigeration Committee 2010-2012). He has been a member of IIR commission E1 (Air Conditioning) since 1991.

Dr Pearson writes extensively on subjects related to industrial refrigeration, particularly with regard to ammonia, carbon dioxide, safety, energy efficiency and system design improvements. He has edited two books for the International Institute of Refrigeration, Ammonia as a Refrigerant (3<sup>rd</sup> edition 2008) and Carbon Dioxide as a Refrigerant (1<sup>st</sup> edition 2014). He has been a Chapter Lead Author for UNEP's Refrigeration, Air-conditioning and Heat Pumps Technical Options Committee since 2006 and he contributes a popular monthly column to the ASHRAE Journal.

Dr Pearson has been recognised by several international organisations in the refrigeration and heat pump world. He was the International Institute of Ammonia Refrigeration's Member of the Year in 2006 and was awarded the J&E Hall Gold Medal by the Institute of Refrigeration in 2007. More recently he received the Charles Tellier medal from the Association Française du Froid (2013) and the Ritter von Rittenger medal from the International Energy Agency's Heat Pump Association (2014).

Dr Pearson studied Manufacturing Science and Engineering at the University of Strathclyde in Glasgow, graduating in 1986. He returned to Strathclyde in 2002 to develop his PhD thesis "The Optimisation of Carbon Dioxide Refrigeration Systems" and graduated in 2006.

Star Refrigeration is the largest independent industrial refrigeration contractor in the United Kingdom. The company designs, installs and maintains a range of industrial systems for major international companies and has supplied equipment to Europe, Asia, Africa, North America and Australasia. Half of Star's work is in the food industry, primarily in the cooling systems for food factories and distribution warehouses. Other markets served include process industries, ice rinks, data centres and building services. The company was founded in 1970 and has over three hundred employees, with an annual turnover of £40 million. It is well known for a series of leading edge technologies, including the first use of carbon dioxide in a freeze drying application (2001), the first distribution warehouse with a cascade ammonia/carbon dioxide system (2002) and the first use of carbon dioxide in IT cooling (2005). More recently Star has developed a range of low charge ammonia products to provide efficient, safe alternatives to end users faced with R-22 phase out requirements. The company also provides consultancy services and internet-based learning solutions and a subsidiary, Starfrost, manufactures industrial freezers.



## Plenary Lecture 3

### Environmentally safe and energy efficient solutions

Alexander Cohr Pachai

Sabroe Factory, Johnson Controls

**Abstract** You may get the impression from the media that, over the years, ammonia has developed a reputation of being unsafe. But is ammonia less safe than other refrigerants? The main reasons for the continued use of ammonia are high efficiency and its environmental qualities. Accidents happen with all refrigerants, but they are much less likely to occur when codes and standards of good practice are followed. Examples of this are some of the recent accidents in 2013 in China. The investigations following the accidents showed that several codes, which might have prevented the accident, had not been followed. One of the highly critical issues was the qualifications of the people who took on the job of welding<sup>1</sup>. Another critical parameter is the lack of understanding of why the standards should be followed, e.g. why you need emergency exits and that it is unacceptable to block them<sup>2</sup>. There have been several examples of this over the years in different parts of the world. You can read more about this on the Internet,<sup>3</sup> see examples in the references.

This paper is going to look at the most common reasons for accidents involving all types of refrigerant and refrigeration systems and how to avoid the most common accidents by following codes and standards. In a few cases, it is necessary to go further than set forth in standards and codes to ensure a trouble-free and reliable working life of a refrigeration plant, which is so important for the industries using these systems.

**Mr. Alexander Cohr Pachai:** has been active in the refrigeration business since 1978 when he started as apprentice in a refrigeration and air conditioning company in Aarhus, Denmark. After 10 years of practical working with installation, service and maintenance and R&D, Mr. Pachai changed direction and became teacher. During this period along with his duties he also attended engineering classes with refrigeration as specialty at Aarhus School of Engineering. After 8 years it was time to try a new part of the business and Mr. Pachai started in a distributor/wholesale company in Ebeltøft, Denmark, in 1995. At this time the industry had turned from CFC technology to HCFC but it was clear to Mr. Pachai that new changes were to come. In late 1995 a contact came in place to start selling HC refrigerants and components. Also Mr. Pachai published many articles on this topic in this period and he was active in promoting new technologies. New products were taken up and contacts to the market players came in place. Also the first CO<sub>2</sub> compressors came to the market in this period and this was also pushed forward. One of the contacts ended up with a job at York Refrigeration, now part of Johnson Controls. Mr. Pachai then started developing cascade systems using HC and CO<sub>2</sub>. During this work Mr. Pachai came in contact with many colleagues and the fruitful work done then is still taking up a big part of Mr. Pachai's time. One of the barriers for changes is fear of accidents. Safety and safe design has therefore always had a high priority for Mr. Pachai. Mr. Pachai has been focusing on safety subjects for many years and this is also the subject of this presentation.

Mr. Pachai is member of RTOC under the UNEP, associate member of AIRAH, ASHRAE, and private member of IIR and IoR, member of Danish Refrigeration Association (DKF), The Danish society for refrigeration (SfK).

## Plenary Lecture 4

### Analysis of ammonia incidents recently happened in China

Jiang Shen

Tianjian University Of Commerce

**Abstract** China had three serious ammonia-related cold storage accidents in 2013, which caused heavy casualties and thus influenced the application of ammonia refrigeration. On the one hand, relevant departments of the Chinese government have adopted measures to conduct safety checks to existing ammonia-related cold storages and close down those unqualified. On the other hand, be stricter about the approval of newly-built cold storage with ammonia as the refrigerant. In this way, it urges related enterprises and research institutions to conduct new technical research on cold storage refrigerating system, reduce the usage amount of ammonia, and increase the application of carbon dioxide refrigerant and other natural refrigerant. The presentation analyzes China's serious ammonia-related cold storage accidents in 2013, and summarizes the types and reasons based on accident statistics over the years. The presentation introduces China's rectification measures about ammonia-related cold storages as well as status and technological development of China's cold storage refrigeration system that use natural refrigerant, especially the research status of carbon dioxide refrigerating fluid in cold storage energy conservation.

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

### Opening Ceremony (September 1, 09:00~09:15)

**Location: Main Hall, First Floor of Auditorium Convention Center**

### Plenary Lecture (September 1, 09:15~09:55)

**Location: Main Hall, First Floor of Auditorium Convention Center**

Replacing refrigerants straightforward? the complexities in addressing the broader issues

——Dr. Lambert Kuijpers (Technical University Eindhoven)

### Coffee Break (September 1, 09:55~10:05)

**Location: First Floor of Auditorium Convention Center**

### A1: Commercial & Supermarket Refrigeration (September 1, 10:05~12:05)

**Location: Main Hall, First Floor of Auditorium Convention Center**

Time	ID	Presentation
10:05-10:25	Invited	The application of CO <sub>2</sub> in the refrigeration industry —— Yantai Moon Group
10:25-10:45	145	Natural refrigerants in food retail - an overview of market, technology and policy trends in North America, Europe, China & Japan ——N. Masson, K. Skacanova, M. Chasserot, S. Tasiou, E. Milner (Shecco)
10:45-11:05	105	CO <sub>2</sub> supermarket refrigeration systems for southeast Asia and the USA ——V. Sharma, B. Fricke, P. Bansal (Oak Ridge National Laboratory)
11:05-11:25	49	Thermoeconomic optimization of an ejector refrigeration system working with isobutene ——J. Chen, H. Havtun, B. Palm (Royal Institute of Technology)
11:25-11:45	78	Applications of the supersmart energy-benchmark tool for supermarkets ——N. Fidorra, A. Hafner, S. Minetto, J.K öhler (TU Braunschweig, Institut für Thermodynamik)
11:55-12:05	64	Post HCFC22 commercial refrigeration sector in Mauritius: HFC or natural refrigerants ——D. Sooben, R. Mohee, F. Meunier (Universit édes Mascareignes)

### B1: R290 (September 1, 10:05~12:05)

**Location: Moonlight, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
10:05-10:25	Invited	Australia, the Land of Opportunity for Hydrocarbon Refrigerants ——John K Clark (HyChill Australia Pty Ltd)
10:25-10:45	Invited	Research on the key technology of propane in household air conditioners ——Yanxun Li (Midea Group)
10:45-11:05	Invited	Technique programing of GMCC R290 rotary compressor development ——Bin Gao (GMCC)
11:05-11:25	98	Extremely low refrigerant charge beverage display cooler technology using propane ——Y. Padilla Fuentes, S. Elbel, P. Hrnjak (Creative Thermal Solutions, Inc.)
11:25-11:45	175	The theoretical study of optimal performance for R290 refrigeration cycle by using Taguchi method ——Yang-Cheng Shih, Sheau-Wen Shiah, Shih-Hao Shih, Shan-Li Chang (National

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

		Taipei University Of Technology)
11:45-12:05	<b>51</b>	A propane water-to-water heat pump booster for sanitary hot water production: seasonal performance analysis of a new solution optimizing COP ——M. Tammaro, C. Montagud, J. M. Corberán, A. W. Mauro, R. Mastrullo (Università degli Studi di Napoli Federico II)

### **C1: Ejectors (September 1, 10:05~12:05)**

**Location: Horizon, Second Floor of Auditorium Convention Center**

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
10:05-10:25	<b>52</b>	Numerical investigation of two-phase ejector liquid recirculation cycles with natural refrigerants ——Neal Lawrence, Stefan Elbel (University of Illinois)
10:25-10:45	<b>70</b>	Test facility for a multiejector R744 refrigeration system ——K. Banasiak, A. Hafner, O. Haddal, T. Eikevik (SINTEF Energy Research)
10:45-11:05	<b>19</b>	Experience with ejectors implemented in a R744 booster system operating in a supermarket ——J. Schönenberger, A. Hafner, K. Banasiak, S. Giroto (Frigo-consulting Ltd.)
11:05-11:25	<b>156</b>	Investigation on a two-stage ejection refrigeration system ——Yijiang He, Zuozhou Chen, Liming Tang, Guangming Chen (Zhejiang University)
11:25-11:45	<b>53</b>	Review and analysis of the effect of ejector geometry on the performance of two-phase CO <sub>2</sub> ejectors ——Neal Lawrence, Stefan Elbel (University of Illinois at Urbana-Champaign)
11:45-12:05	<b>107</b>	CFD case study of R744 ejectors ——K. Banasiak, A. Hafner, T. Eikevik, O. Haddal (SINTEF Energy Research)

### **D1: Emission and Energy Saving (September 1, 10:05~12:05)**

**Location: Windsong, Third Floor of Auditorium Convention Center**

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
10:05-10:25	<b>11</b>	Technical and economic working domains of industrial heat pumps: part 1 - vapour compression heat pumps ——T. Ommen, J. K. Jensen, W. B. Markussen, L. Reinholdt, B. Elmegaard (Technical University of Denmark)
10:25-10:45	<b>17</b>	Possible solutions to improve energy efficiency for typical refrigeration control system in China cold storage ——Huang Zhihua, Anatolii Mikhailov (Danfoss Automatic Controls Management (Shanghai) Co., Ltd.)
10:45-11:05	<b>118</b>	Experimental study on an LFG based biogas engine driven air source heat pump ——Wu Jiying, Ma Yimin (Jimei University)
11:05-11:25	<b>94</b>	Energy efficiency by vapor compression in superheated steam drying systems ——I. Tolstorebrov, M. Bantle, A. Hafner, B. Kuz, T. M. Eikevik (Norwegian University of Science and Technology)
11:25-11:45	<b>73</b>	Mitigation of GHG emissions through the use of natural refrigerants for mobile air conditioning in cars in China ——Johanna Glođ, Daniel Colbourne, Dietram Oppelt, Volkmar Hasse, Hu Jianxin, Robin Langebach (GIZ Proklima, c/o HEAT GmbH)
11:45-12:05	<b>143</b>	Analysis of the trilateral flash cycle and the partially evaporating cycle for power production from low temperature heat sources

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

		—S. Trædal, D. Rohde, T. M. Eikevik (The Norwegian University of Science and Technology (NTNU))
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### **Lunch (September 1, 12:05~13:00)**

**Location: Ballroom, Third Floor of Auditorium Convention Center**

### **Plenary Lecture (September 1, 13:00~13:40)**

**Location: Main Hall, First Floor of Auditorium Convention Center**

International standards for refrigeration safety

—Dr. Andy Pearson (Star Refrigeration Ltd.)

### **Coffee Break (September 1, 13:40~13:50)**

**Location: First Floor of Auditorium Convention Center**

### **A2: Safety and Risk Assessment (September 1, 13:50~15:50)**

**Location: Main Hall, First Floor of Auditorium Convention Center**

Time	ID	Presentation
13:50-14:10	5	Characterisation of a leak of flammable refrigerant within equipment enclosures —D. Colbourne, K. O. Suen (Re-phridge)
14:10-14:30	109	Risk assessment for reefer containers with flammable refrigerants —H. König, M. Bararu (Ref-tech Engineering)
14:30-14:50	13	Research on risk of hot gas defrosting and liquid hammer in ammonia refrigeration —Yitai Ma, Haoxiang Gu (Key Laboratory of Efficient Utilization of Low and Medium Grade Energy, MOE )
14:50-15:10	126	Simulation of the boiling liquid expanding vapor explosion (Bleve) process of R290 —W. Lin, R. Jia, A. Gu, X. Lu (Shanghai Jiao Tong University)
15:10-15:30	58	The simulation of the leaking distribution characteristics of R290 household air-conditioner —Dehua Cai, Guogeng He, Weier Tang, Liang Huang, Tengjiao Hai (Huazhong University of Science and Technology)
15:30-15:50	6	Comparative risk assessment of hydrocarbon refrigerant in a refrigerator and split air conditioner —D. Colbourne (c/o GIZ Proklima)

### **B2: CO<sub>2</sub> System (September 1, 13:50~15:50)**

**Location: Moonlight, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
13:50-14:10	47	Experimental study and solution of CO <sub>2</sub> refrigeration —Liu Changfeng, Han Xianjun, Yu Zhiqiang (Yantai Moon Co.,Ltd)
14:10-14:30	81	Experimental observation of sedimentation phenomena of CO <sub>2</sub> dry ice in model channel —H. Yamaguchi, Y. Iwamoto, S. Ozaki, P. Neksa(Doshisha University)
14:30-14:50	102	Vortex flow sensor in CO <sub>2</sub> refrigeration system —C. Heerup, K. Frederiksen (Danish Technological Institute)
14:50-15:10	114	Solar driven production using CO <sub>2</sub> as working fluid —G. Zhao, T. Eikevik, Yong. Li (Shanghai Jiao Tong University)
15:10-15:30	71	Investigation of using internal heat exchangers in CO <sub>2</sub> trans-critical booster system —M. Karampour, S. Sawalha (The Royal Institute of Technology)

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

15:30-15:50		Q&A
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### **C2: R290 (September 1, 13:50~15:50)**

**Location: Horizon, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
13:50-14:10	<b>Invited</b>	
14:10-14:30	<b>8</b>	An experimental analysis of R290 application in household refrigerator ——Qin Zongmin (Beijing Embraco Snowflake Compressor Ltd.)
14:30-14:50	<b>66</b>	R-290 scroll compressor technology ——Leping Zhang, Pierre Ginies , Philippe Dewitte (Danfoss Commercial Compressor)
14:50-15:10	<b>50</b>	The first 60,000 HC-290 split air conditioners in India ——D. Rajadhyaksha, B. J. Wadia, D. Colbourne (Godrej & Boyce Mfg. Co. Ltd)
15:10-15:30	<b>119</b>	Operation characteristics and the method of heating capacity enhanced of R290 air-conditioning and its analysis ——Gao Zheng, Li Hongqi (Beijing University of Technology)
15:30-15:50	<b>177</b>	Study on a R32/R290 blend as replacement for R410a in household applications ——Q. Tian, D. Cai, L. Ren, W. Tang, Y. Xie, G. He, F. Liu (Huazhong University of Science and Technology)

### **D2: Refrigerant Charge Reduction in Refrigerating Systems (September 1, 13:50~15:50)**

**Location: Windsong, Third Floor of Auditorium Convention Center**

**Chair:** Jos éM. Corber án (Instituto de Ingenier á Energ ética (IIE))

Time	ID	Presentation
13:50-14:05	<b>106</b>	Supermarket refrigeration system charge reduction using cascade systems ——V. Sharma, B. Fricke, P. Bansal (Oak Ridge National Laboratory)
14:05-14:20	<b>128</b>	The advantages and disadvantages of charge reduction in industrial systems ——A. Pearson (Star Refrigeration Ltd.)
14:20-14:35	<b>151</b>	Refrigerant charge minimization of a small geothermal heat pump ——C. Montagud, I. Mart ínez-Galv án, J. Gonz ávez-Maci á E.Navarro-Peris, J.M. Corbern (Universitat Polit ècnica de Val ència)
14:35-14:50	<b>152</b>	Evaluation of joining techniques for air-conditioning and refrigeration systems using concentration accumulation method ——Y. Yu, D. Clodic (EReIE)
14:50-15:05	<b>155</b>	Charge minimization in a 30 KW air to water heat pump ——B. Palm (Royal Institute of Technology, KTH)
15:05-15:20	<b>159</b>	Design and analysis of R290 high capacity air to water heat pump with finned tube heat exchanger of small diameter ——E Navarro-Peris, J Gonzalvez-Macia, JM. Corberan, S Filippini (Universitat Polit ècnica de Val ència)
15:20-15:35	<b>172</b>	Recent advances in ammonia LPR systems for freezer applications ——A. B. Pearson, D. Hamilton ( Star Refrigeration Ltd.)
15:35-15:50	<b>Invited</b>	25th Informatory Note on Refrigeration Technologies ——Jos éM. Corber án (Instituto de Ingenier á Energ ética (IIE))

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

<b>A3: Commercial &amp; Supermarket Refrigeration (September 1, 16:00~17:50)</b>		
<b>Location: Main Hall, First Floor of Auditorium Convention Center</b>		
<b>Time</b>	<b>ID</b>	<b>Presentation</b>
16:00-16:30	<b>Invited</b>	CO <sub>2</sub> as refrigerant for Supermarkets utilising heat recovery ——Torben Funder-Kristensen ( Head of Public Industry Affairs, Danfoss)
16:30-16:50	<b>67</b>	System configurations for supermarkets in warm climates applying R744 refrigeration technologies. Case studies of selected Chinese cities ——A. Hafner, A. K. Hemmingsen, P. Neks å(SINTEF Energy Research)
16:50-17:10	<b>69</b>	Efficient and integrated energy systems for supermarkets ——A. Hafner, I.C. Claussen (SINTEF Energy Research)
17:10-17:30	<b>10</b>	A comparative study on the environmental impact of CO <sub>2</sub> supermarket refrigeration systems ——M. Beshr, V. Aute, V. Sharma, O. Abdelaziz, B. Fricke, R. Radermacher (University of Maryland)
17:30-17:50	<b>28</b>	Heat recovery investigation of a supermarket refrigeration system using carbon dioxide as refrigerant ——A. Abdi, S. Sawalha, M. Karampour (Royal Institute of Technology)

<b>B3: CO<sub>2</sub> System (September 1, 16:00~17:50)</b>		
<b>Location: Moonlight, Second Floor of Auditorium Convention Center</b>		
<b>Time</b>	<b>ID</b>	<b>Presentation</b>
16:00-16:30	<b>Keynote</b> <b>176</b>	Oil effects on in-tube boiling of CO <sub>2</sub> ——Pega Hrnjak, Seongho Kim (University of Illinois)
16:30-16:50	<b>108</b>	A study on the performance characteristics of carbon dioxide refrigerating systems with multi-speed twostage compression ——B.Y.K. Carvalho, C. Melo, R. H. Pereira (Federal University of Santa Catarina)
16:50-17:10	<b>144</b>	CO <sub>2</sub> as a refrigerant for cooling of data-center: a case study ——Y. Solemdal, T.M. Eikevik, I. Tolstorebrov, O. J.Veiby (Norwegian University of Science and Technology)
17:10-17:30	<b>46</b>	Research on CO <sub>2</sub> refrigeration system ——Ge Changwei, Jiang Shaoming, Yu Zhiqiang (Yantai Moon Co., Ltd)
17:30-17:50	<b>20</b>	Efficiency analysis and comparison of innovative R744-refrigerating systems in commercial applications ——E. Wiedenmann, J. Schoenenberger, M. Baertsch (Frigo-Consulting Ltd)

<b>C3: CO<sub>2</sub> Heat Pump (September 2, 16:00~17:50)</b>		
<b>Location: Horizon, Second Floor of Auditorium Convention Center</b>		
<b>Time</b>	<b>ID</b>	<b>Presentation</b>
16:00-16:30	<b>Keynote</b>	Research and Development of Expander in CO <sub>2</sub> Transcritical Cycle ——Yitai Ma (Tianjin University)
16:30-16:50	<b>16</b>	Performance analysis of a carbon dioxide heat pump installed in a residential

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

		application —A. Arteconi, E. Ciarrocchi, F. Polonara, J.F. Chen, S. Deng, R.Z. Wang (Universit�� Politecnica delle Marche)
16:50-17:10	<b>37</b>	Performance and economy analysis of a solar assisted CO <sub>2</sub> ground source heat pump with air-cooled gas cooler under different climate conditions —J. Ye, T.M. Eikevik, P. Neks �� A. Hafner, G. Ding, H. Hu (Norwegian University of Science and Technology)
17:10-17:30	<b>26</b>	Thermodynamic performance assessment of carbon dioxide blends with low GWP working fluids used for heat pump water heater —Baomin Dai, Minxia Li, Chaobin Dang, Yitai Ma (Tianjin University)
17:30-17:50	<b>39</b>	Performance of refrigeration & heat pump system by using binary mixtures of R32/R744 —Zhili Sun, Minxia Li, Yitai Ma, Pai Wang (Tianjin University)

### **D3: Other Natural Refrigerants (September 1, 16:00~17:50)**

**Location: Windsong, Third Floor of Auditorium Convention Center**

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
16:00-16:30	<b>Keynote 112</b>	An application of nanotechnologies in refrigeration – perspectives and challenges —V.P. Zhelezny ( Odessa National Academy of Food Technologies)
16:30-16:50	<b>41</b>	Performance investigation of saturation cycle with natural working fluids —H. Lee, Y. Hwang, R. Radermacher (University of Maryland)
16:50-17:10	<b>79</b>	Project NxtHPG: next generation of heat pumps working with natural fluids —J. M. Corberan, C. Montagud (Universitat Polit��cnica de Val��ncia)
17:10-17:30	<b>111</b>	Reducing heavy hydrocarbons in mixed refrigerant used in natural gas liquefaction processes —R. Jia, Y. Song, W. Lin (Shanghai Jiao Tong University)
17:30-17:50	<b>75</b>	Analysis of high temperature heat pumps applying natural working fluids —O. Stavset, K. Banasiak, A. Hafner (SINTEF Energy Research)

### **IIR E1/E2 Business Meeting (September 1, 18:00~18:45)**

**Location: Horizon, Second Floor of Auditorium Convention Center**

**Chair:** Fabio Polonara

#### **Agenda Items**

##### *Item/Presenter*

1. Outcomes from the IIR statutory meeting hold in Paris on June 11-13, 2014
2. State of the art of the Working Parties
3. IIR Conferences for Commission E1/E2
4. Informatory notes produced and to be programmed
5. Possible future working parties

### **Banquet (September 1, 19:00~21:00)**

**Location: Ballroom, Third Floor of Auditorium Convention Center**



## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

### Plenary Lecture (September 2, 09:00~09:40)

**Location: Main Hall, First Floor of Auditorium Convention Center**

Environmentally safe and energy efficient solutions

—Mr. Alexander Cohr Pachai (Johnson Controls)

### Coffee Break (September 2, 09:40~09:50)

**Location: First Floor of Auditorium Convention Center**

### A4: Properties and Future Refrigerants (September 2, 09:50~12:00)

**Location: Main Hall, First Floor of Auditorium Convention Center**

Time	ID	Presentation
09:50-10:20	<b>Keynote</b>	Are fluorinated refrigerants needed — will “natural” refrigerants suffice? —James M. Calm (Engineering Consultant)
10:20-10:40	<b>Invited</b>	Refrigerant selection criteria —Xianghua Hu (Johnson Controls Inc.)
10:40-11:00	<b>25</b>	Global refrigerant trends —T. Funder-Kristensen, A. L. Vonsild (Danfoss A/S)
11:00-11:20	<b>23</b>	HFC taxation in Europe and beyond: leveling the playing field for natural refrigerants —A. Maratou, K. Skacanova, M. Chasserot (Shecco)
11:20-11:40	<b>80</b>	R30: an overlooked natural refrigerant —W. Kopko, X. Wu, S. Kulankara (Johnson Controls Inc.)
11:40-12:00	<b>90</b>	Evaluation of thermophysical properties of ethyl alcohol based secondary fluids —M. Ignatowicz, Å. Melinder, B. Palm (Royal Institute of Technology, KTH)

### B4: CO<sub>2</sub> System (September 2, 10:00~12:00)

**Location: Moonlight, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
10:00-10:20	<b>100</b>	Load shifting by ice storage in retail CO <sub>2</sub> systems —C. Heerup, T. Green (Danish Technological Institute)
10:20-10:40	<b>123</b>	The CO <sub>2</sub> hydrates produced in a compression cycle used for cool storage on different initial pressure —Yingming Xie, Xingfa Zhou, Zhenxing Xie, Yajun Fang (University of Shanghai for Science and Technology)
10:40-11:00	<b>44</b>	Successful conversion and validation of glass door merchandisers using transcritical R744 —S. Elbel, Y. Padilla Fuentes, C. Bowers, P. Hrnjak (Creative Thermal Solutions, Inc.)
11:00-11:20	<b>14</b>	Theoretical analysis of a new two-stage absorption-transcritical hybrid refrigeration system —Y.Y Jiang, N. Gao, Y.J. He, G.M. Chen, L.M. Tang (Zhejiang University)
11:20-11:40	<b>22</b>	Analysis and optimization of different two stage transcritical carbon dioxide cycles for

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

		heating applications —M. Pitarch, E. Navarro-Peris, J. Gonzalvez, JM. Corberan (Universitat Politècnica de València)
11:40-12:00	<b>56</b>	Twin screw compressors for natural refrigerants —Zhaorui Zhao, Feng Hou, Wenqing Chen, Ziwen Xing (Xi'an Jiaotong University)

### **C4: Heat Transfer and Heat Exchangers (September 2, 09:50~12:00)**

**Location: Horizon, Second Floor of Auditorium Convention Center**

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
09:50-10:20	<b>Keynote</b>	Study on cooling heat transfer of supercritical carbon dioxide applied to transcritical carbon dioxide heat pump —Eiji Hihara (Institute of frontier studies, The University of Tokyo)
10:20-10:40	<b>63</b>	A new method for measuring refrigerating capacity of fin-tube type heat exchanger —Hao Wang, Manabu Watanabe, Tatsunori Man'o, Toru Suzuki (Tokyo University of Marine Science and Technology)
10:40-11:00	<b>74</b>	The effects of operating and geometric parameters on CaCO <sub>3</sub> fouling in plate heat exchangers —K. Song, E. Lee, J. Jeon, H. Kang, Y. Kim (Korea University)
11:00-11:20	<b>138</b>	Two-dimensional simulation of a cylindrical latent heat thermal energy storage system —S. Seddegh, Z. He, X. Wang, A. D. Henderson (University of Tasmania)
11:20-11:40	<b>161</b>	Experimental and theoretical study on direct contact condensation affected by noncondensable gas —S.Y. Feng, C. B. Dang, H. Okamoto, E. Hihara (Nanjing University of Aeronautics and Astronautics)
11:40-12:00	<b>86</b>	Experimental investigation on pool boiling of R600a/mineral oil solution —Guangming Chen, V.P. Zhelezny, K.O. Shestopalov, A. Nikulin, Yu.V. Semenyuk (Zhejiang University)

### **D4: LCCP (September 2, 09:50~12:00)**

**Location: Windsong, Third Floor of Auditorium Convention Center**

**Chair:** Yunho Hwang, Chairman of the WP, Vice President of Commission B1, University of Maryland

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
09:50-10:20	<b>Invited</b>	LCCP WP Overview —Yunho Hwang ( Chairman of the WP, Vice President of Commission B1, University of Maryland)
10:20-10:40	<b>Invited</b>	An extensible framework for life cycle climate performance based design and evaluation of hvac&r systems: overview and case studies —Vikrant Aute (Integrated Systems Optimization Consortium)
10:40-11:00	<b>Invited</b>	Brief on acquirement of fundamental data of LCCP calculation in China —Baolong Wang (Tsinghua University)
11:00-11:20	<b>168</b>	Drop in life cycle climate performance of low GWP R-410a alternatives for heat pumps —Gang Li, Abdullah Alabdulkarem, Yunho Hwang, Reinhard Radermacher (University of Maryland)
11:20-11:40	<b>Invited</b>	Discussion on Further Steps of WP —Yunho Hwang ( Chairman of the WP, Vice President of Commission B1, University of Maryland)
11:40-12:00		Q&A

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

**Lunch (September 2, 12:00~13:00)**

**Location: Ballroom, Third Floor of Auditorium Convention Center**

**Plenary Lecture (September 2, 13:00~13:40)**

**Location: Main Hall, First Floor of Auditorium Convention Center**

Analysis of ammonia incidents recently happened in China

——Prof. Jiang Shen (Tianjian University Of Commerce)

**Coffee Break (September 2, 13:40~13:50)**

**Location: First Floor of Auditorium Convention Center**

**A5: Air & Water (September 2, 13:50~15:50)**

**Location: Main Hall, First Floor of Auditorium Convention Center**

Time	ID	Presentation
13:50-14:10	55	A high temperature heat pump using water vapor as working fluid ——P. De Larminat, D. Arnou, P. Le Sausse, F. Clunet, J-L Peureux (Johnson Controls Industries)
14: 10-14: 30	61	Properties of seawater with ice slurry use in focus ——A. Melinder, M. Ignatowicz (Royal Institute of Technology, KTH )
14:30-14:50	91	Development of a water vapor compressor for high temperature heat pump applications ——H. Madsboell, M. Weel, A. Kolstrup (Danish Technological Institute)
14:50-15:10	54	Regenerated air cycle potentials in heat pump applications ——H. Yuan, C-L. Zhang (Tongji University)
15:10-15:30	30	Optimal concentration of 2-ethylhexanol aqueous solution in water vapor compression refrigeration system ——L.H. Yu, S. Li, G.Y. Ma (Beijing University of Technology)
15:30-15:50		Q&A

**B5: CO<sub>2</sub> Heat Pump (September 2, 13:50~15:50)**

**Location: Moonlight, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
13:50-14:10	146	Optimized operation conditions for a CO <sub>2</sub> heat pump for chilling of ice water / heating of hot tap water to 80 °C ——M. Rustad Berntsen, T.M. Eikevik, S. Jenssen, I. Tolstorebrov (Norwegian University of Science and Technology)
14: 10-14: 30	125	System optimization of CO <sub>2</sub> heat pump water heater based on economy ——F.Z. Zhang, P.X. Jiang, Y.H. Zhu, S.S. Sun (Tsinghua University)
14:30-14:50	42	Review of AC, heat pump and refrigeration systems using natural refrigerants ——F. Liu (Shanghai University of Electric Power)
14:50-15:10	160	Development and validation of variable frequency transcritical CO <sub>2</sub> heat pump systems ——H. M. Qi, Q. Chen, J. Wei, L. M. Tang, G. M. Chen ( Zhejiang University)
15:10-15:30	83	Carbon dioxide in ice rink refrigeration ——J. Rogstam, A. Abdi, S. Sawalha (Energi & Kylanalys AB)
15:30-15:50		Q&A

**C5: Heat Transfer and Heat Exchangers (September 2, 13:50~15:50)**

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

<b>Location: Horizon, Second Floor of Auditorium Convention Center</b>		
<b>Time</b>	<b>ID</b>	<b>Presentation</b>
13:50-14:10	<b>87</b>	Experimental and theoretical investigation of heat transfer coefficient for boiling of the isobutane/compressor oil solution flow in a pipe ——V.P. Zhelezny, G.M. Chen, K.O. Shestopalov, A.V. Melnyk (Odessa National Academy of Food Technologies)
14:10-14:30	<b>27</b>	Heat transfer and flow characteristics during the formation of TBAB hydrate slurry ——Hongxia Zhou, Carlos Infante Ferreira (Delft University of Technology)
14:30-14:50	<b>99</b>	A survey of correlations for heat transfer and pressure drop during evaporation in plate heat exchanger ——R. Eldeeb, V. Aute, R. Radermacher (University of Maryland)
14:50-15:10	<b>31</b>	An analysis of bubble formation and fluid dynamics in pool boiling of propane on horizontal tubes ——Y. Wang, A. Luke (University of Kassel)
15:10-15:30	<b>140</b>	Experimental validation of a mini-channel multi-tube ammonia/water absorption/desorption model ——C.W.M. Nefs, D.M. Van De Bor, C.A. Infante Ferreira (Delft University of Technology)
15:30-15:50	<b>88</b>	Experimental investigation of the mixed refrigerants solubility in compressor oils ——YU.V. Semenyuk, V.P. Zhelezny, G.M. Chen, K.O. Shestopalov (Odessa National Academy of Food Technologies)

### **D5: Sorption Systems (September 2, 13:50~15:50)**

#### **Location: Windsong, Third Floor of Auditorium Convention Center**

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
13:50-14:10	<b>121</b>	Preliminary evaluation of a pre-industrial air-cooled LiBr-H <sub>2</sub> O small capacity absorption machine ——J. Farnós, J. Castro, S. Morales, E. Garcia-rivera, A. Oliva (Termo Fluids S. L.)
14:10-14:30	<b>139</b>	Performance simulation of multi-bed silical gel-water adsorption chillers ——X. Wang, Z. He, H.T. Chua (University of Tasmania)
14:30-14:50	<b>162</b>	Performance predication of desiccant rotor made by silica based adsorbent ——S.Y Feng, N. Nakagawa, C. B. Dang, Z. S. Wang, E. Hihara (Nanjing University of Aeronautics and Astronautics)
14:50-15:10	<b>142</b>	Numerical analysis of a new heat integrated structure for vapor purification of an ammonia water absorption refrigeration system ——S. Du, R.Z.Wang, Z.Z. Xia (Shanghai Jiao Tong University)
15:10-15:30	<b>9</b>	Technical and economic working domains of industrial heat pumps: part 2 - ammonia-water hybrid absorption-compression heat pumps ——J. K. Jensen, T. Ommen, W. B. Markussen, L. Reinholdt, B. Elmegaard (Technical University of Denmark)
15:30-15:50		Q&A

### **A6: Air & Water (September 2, 16:00~17:40)**

#### **Location: Main Hall, First Floor of Auditorium Convention Center**

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
16:00-16:20	<b>77</b>	Density modification of ice particles in ice slurry ——Y. Friess, M. Koffler, M. Kauffeld (University of Applied Sciences Karlsruhe)

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

16:20-16:40	<b>43</b>	Vortex tubes used as expansion device in vapor compression systems ——J. Zhu, M. Mohiuddin, S. Elbel (University of Illinois at Urbana-Champaign)
16:40-17:00	<b>127</b>	Experimental study of the energy separation in a vortex tube ——N. Li, Z.Y. Zeng, Z. Wang, G. M. Chen, X.H. Han (Zhejiang University)
17:00-17:20	<b>89</b>	Evaporative coolers of water and air for cooling systems. analysis and perspectives ——G.M. Chen, A.V. Doroshenko, K.O. Shestopalov, O.Y. Khliyeva (Zhejiang University)
17:20-17:40	<b>171</b>	Performance of desiccant wheel affected by isotherm ——S.Y. Feng, C. B. Dang , Z. S. Wang , E. Hihara (Nanjing University of Aeronautics and Astronautics)

### **B6: CO<sub>2</sub> Heat Pump (September 2, 16:00~17:40)**

**Location: Moonlight, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
16:00-16:30	<b>45</b>	Performace of the separate heat pipe using CO <sub>2</sub> as the working fluid ——Liu Bin, Ma Xiaoyan, Dong Xiaoyong (Tianjin University of Commerce)
16:30-17:00	<b>40</b>	Transient simulation of R744 hybrid ground coupled heat pump with modelica ——Zhequan Jin , Trygve M. Eikevik , Petter Neks å, Armin Hafner , Guoliang Ding , Haitao Hu (Norwegian University of Science and Technology)
17:00-17:20	<b>163</b>	Experimental analysis of the influence of operating conditions on the performance (COP and ejector efficiency) of R744 heat pump with one-phase ejector ——Jie Xiong, Trygve Magne Eikevik, Ruzhu Wang, Krzysztof Banasiak, Armin Hafner (Norwegian University of Science and Technology)
17:20-17:40	<b>141</b>	The experimental research of microchannel heat exchanger on packaged air conditioning system ——Wang Ying, Zhang Ziqi, Chen Jiang-ping, Ge Fang-gen, Wang Feng, Li Feng (Shanghai Jiao Tong University)

### **C6: Heat Transfer and Heat Exchangers (September 2, 16:00~17:40)**

**Location: Horizon, Second Floor of Auditorium Convention Center**

Time	ID	Presentation
16:00-16:20	<b>169</b>	A distributed-parameter model for spiral wound LNG heat exchanger based on graph theory ——Tingting Wang, Guoliang Ding, Jie Chen, Hui Pu (Shanghai Jiao Tong University)
16:20-16:40	<b>32</b>	Optimization of correlations for tube bundles during boiling heat transfer with hydrocarbons ——Y. Wang, A. Luke, E. Estiot (University of Kassel)
16:40-17:00	<b>65</b>	Experimental research on CO <sub>2</sub> pool boiling heat transfer ——Shengchun Liu, Lan Li, Chunyuan Zhu, Jinghong Ning (Tianjin University of Commerce)
17:00-17:20	<b>21</b>	Design optimization of microchannel heat exchangers with variable geometry for natural refrigerants ——L. Huang, V. Aute, R. Radermacher (University of Maryland )
17:20-17:40	<b>18</b>	Latest development of air cooled heat exchangers for CO <sub>2</sub> applications ——S. Filippini, U. Merlo, M. Romano (LU-VE Group)

### **D6: Ammonia (September 2, 16:00~17:40)**

**Location: Windsong, Third Floor of Auditorium Convention Center**

## 11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

<b>Time</b>	<b>ID</b>	<b>Presentation</b>
16:00-16:30	<b>24</b>	The successful use of ammonia systems in industrial applications ——Niels P Vestergaard, Torben Funder-Kristensen (Danfoss A/S)
16:30-17:00	<b>48</b>	High efficient ammonia heat pump system for industrial process water using the isec concept - part I ——E. Rothuizen, C. Madsen, B. Elmegaard, M. Olesen, W. B. Markussen (Technical University of Denmark)
17:00-17:20	<b>92</b>	High efficient ammonia heat pump system for industrial process water using the isec concept - part II ——Martin F. Olesen, Claus Madsen, Lars Olsen, Bjarke Paaske, Erasmus Rothuizen (Danish Technological Institute)
17:20-17:40	<b>68</b>	Design of a R717 / R744 cascade system for the pelagic fish industry ——A. Hafner, T.S. Nordtvedt, E. Gukelberger, K. Banasiak, K. Widell (SINTEF Energy Research)

**Closing (September 2, 17:40~18:00)**

**Location: Main Hall, First Floor of Auditorium Convention Center**

**Dinner (September 2, 18:30~19:30)**

**Location: Ballroom, Third Floor of Auditorium Convention Center**

11<sup>th</sup> IIR Gustav Lorentzen Conference on Natural Refrigerants

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