

10th IIR-Gustav Lorentzen Conference on Natural Working Fluids 2012

(GL2012)

Refrigeration Science and Technology Proceedings 2012-1

**Delft, The Netherlands
25-27 June 2012**

Volume 1 of 2

Editors:

Carlos Infante Ferreira

**ISBN: 978-1-62276-273-6
ISSN: 0151-1637**

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2012) by the International Institute of Refrigeration
All rights reserved.

Printed by Curran Associates, Inc. (2012)

For permission requests, please contact the International Institute of Refrigeration
at the address below.

International Institute of Refrigeration
177 Boulevard Malesherbes
F 75017 Paris France

Phone: 33 1 422 73 235
Fax: 33 1 422 31 798

iifiir@iifiir.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

Technologies Needed to Advance the Position of Major Natural Refrigerants: HC, NH₃, and CO₂.....	1
<i>Pega Hrnjak</i>	
Magnetocaloric Materials For Cooling Applications Near Room Temperature.....	8
<i>E. Bruck, N. H. Dung, Z. Q. Ou, L. Caron, L. Zhang, K. H. J. Buschow</i>	
Developments In New Components And Applications For Natural Refrigerants In Commercial And Industrial Heating And Cooling.....	16
<i>David Bostock</i>	
Heat Transfer and Pressure Drop of Natural Refrigerants in Minichannels (Low Charge Equipment).....	22
<i>Alberto Cavallini, Davide De Col, Luisa Rossetto</i>	
Market Successes of Natural Refrigerants: Twenty Years of Progress.....	38
<i>Andy Pearson</i>	
Theoretical Analysis of a CO₂ Transcritical Refrigeration Cycle with a Fixed Geometry Ejector	48
<i>Jiwen Cen, Jinliang Xu, Pei Liu, Chunhua Dong</i>	
Dedicated Compressor Technology for a Next Generation Domestic Heat Pump - Free Piston with Oil Free Torsion Drive	56
<i>Edo Bart Wissink</i>	
Frost Characteristics and Heat and Mass Transfer of Fin-Tube Model Under Heat Pump Condition	63
<i>Dongkeun Kwak, Seungyoun Kim, Keumnam Cho</i>	
Combining the Use of Thermal Storage and Indirect Evaporative Cooling to Minimize the Installed Chiller Capacity	71
<i>Gert Nielson</i>	
Impact of Fin Cuts and Refrigerant Layout on the Performance of a Microchannel Gas Cooler Working with Transcritical CO₂.....	79
<i>Santiago Martinez-Ballester, Jose-M. Corberan, Jose Gonzalvez-Macia</i>	
Numerical Assessment of Efficiency Improvement by Implementation of a Control Technique in Transcritical CO₂ Air Conditioning Systems	87
<i>Santiago Martinez-Ballester, Ashish Kadam, Atul Padalkar, Jose Gonzalvez-Macia</i>	
Cuban Experiences with Hydrocarbon Refrigerants	95
<i>Ragael Quintero, Reinaldo Guillen</i>	
Potential Air-Conditioning Emissions Reduction using a Solar Cooling-Heating System for the Spanish Housing	103
<i>Jose Daniel Marcos, Marcelo Izquierdo, David Parra, Esther Palacios, Raquel Lizarte, Arturo Gonzalez-Gil</i>	
Theoretical Study on the Effects of Two-Stage Compression and Internal Heat Exchanger on the Ejector Expansion CO₂ Refrigeration Cycle	111
<i>Arash Jamali, Ali Keshavarz</i>	
Performance of a Novel Directly Air-Cooled LIBR/H₂O Absorption Chiller Prototype on a Hot Day, Experimental Results	119
<i>Raquel Lizarte, Marcelo Izquierdo, Esther Palacios, Jose Daniel Marcos</i>	
A New Model for Plate Heat Exchangers with Generalized Flow Configurations and Phase Change	127
<i>Hongtao Qiao, Vikrant Aute, Hoseong Lee, Renhard Radermacher</i>	
A Mass Flow Based Generalized Microchannel Heat Exchanger Model	136
<i>L. Huang, V. Aute, R. Radermacher</i>	
The Benefits of Basing Short Term Climate Protection Policies on the 20 Year GWP of HCFCs	145
<i>Janos Mate, David Kanter</i>	
Next-Generation Heat Transportation System for Data Center Using CO₂ as Refrigerant - 1st Report: Outline and Forced Circulation	152
<i>Kiyoshi Saito, Jongsoo Jeong, Yosuke Udagawa</i>	
Next-Generation Heat Transportation System for Data Center Using CO₂ as Refrigerant - 2nd Report: Natural Circulation	160
<i>Jongsoo Jeong, Kiyoshi Saito, Yosuke Udagawa</i>	
Experimental Analysis and Simulation of the Operating Behavior of an Ammonia/Water Absorption Chiller	166
<i>David Hannl, Markus Pausakerl, Harald Moser, Rene Rieberer</i>	
New Components for Natural Refrigerants	174
<i>Torben Funder-Kristensen, Robert Wilkins, Asbjorn Leth Vonsild</i>	
An Overview of Experience Gained with CO₂ as Refrigerant	182
<i>A. C. Pachai</i>	
Performance Enhancement of R744 Systems by Separate Sensible and Latent Cooling Technology	190
<i>Jiazen Ling, Yunho Hwang, Reinhard Radermacher</i>	
Performance Enhancement of CO₂ Refrigeration Systems by Thermoelectric Subcooler	198
<i>Jonathan Schoenfeld, Yunho Hwang, Reinhard Radermacher</i>	
Development of Double-Output Absorption Heat Pump Chiller With Improved Heating Efficiency	206
<i>Tatsuo Fujii, Yoshitaka Sakano, Shuichiro Uchida, Noriyuki Nishiyama</i>	
Noise and Efficiency Improvement of Light Commercial Compressor using Propane Refrigerant	214
<i>Jozek Sedliak</i>	

Two-phase Flow Pressure Drop of Ammonia-Water Mixtures in Mini-Channels	220
<i>Dennis Van De Bor, Jasper Van Leeuwen, Catalina Vasilescu, Carlos Infante Ferreira</i>	
Energy Efficiency of Small Refrigeration System Powered with Variable Cooling Capacity Compressor - Case Study	228
<i>Libor Novak</i>	
A Comparative Cycle and Refrigerant Simulation Procedure Applied on Air-Water Heat Pumps	235
<i>Gunda Mader, Bjorn Palm, Brian Elmegaard</i>	
Safety Standards for Hydrocarbon Refrigerants.....	243
<i>Ashjorn Leth Vonsild</i>	
Simulation on the Performance of Carbon Dioxide and Hydrocarbon Heat Pumps for Medium-and High-Temperature Heating.....	251
<i>Minsung Kim, Young-Jin Baik, Ho-Sang Ra</i>	
A Progress Report on the World's First Multifunction Two Stage Transcritical CO₂ Refrigeration System.....	257
<i>K. Visser</i>	
Theoretical Analysis of Cold Storage Device Effects on the Performance and Regulation of a CO₂ Supermarket Refrigeration Plant.....	266
<i>C. Ferrandi, M. Orlando</i>	
The Effect of Reduced Air Fan Speed on Freezing Times and Energy Consumption in a Freezing Tunnel	274
<i>K. N. Widell, T. M. Eikevik, H. T. Walnum</i>	
Experimental and Theoretical Study on CO₂ Hydrate Slurry Production.....	282
<i>Corne Groen, Catalina Vasilescu, Carlos Infante Ferreira</i>	
Heat and Mass Transfer During Desorption of Ammonia-Water in Mini-Channels	290
<i>Dennis M. Van De Bor, Jasper M. Van Leeuwen, Catalina Vasilescu, Carlos Infante Ferreira</i>	
Hot Gas Defrost of Low Temperature Refrigeration Evaporators with Natural Refrigerants.....	298
<i>Anatolii Mikhailov, Joris Kortstee</i>	
Analysis and Simulation of Energetic Performance of a Transcritical Installation using Different Configurations	306
<i>V. Perez-Garcia, J. M. Belman-Flores, J. Navarro-Esbri, J. M. Riesco-Avila</i>	
CO₂ Absorption Enhancement by Natural Refrigerant with AL₂O₃ Nanoparticles	314
<i>Israel Torres Pineda, Jae Won Lee, Yong Tae Kang</i>	
Improvement of Compression Refrigeration Machine using Environmentally Friendly Working Fluid	321
<i>Yuriy Baydak</i>	
Energetic Benefit of Latent Cold Thermal Energy Storage	328
<i>Michael Kauffeld, Karin Ruhling</i>	
Development of Phase Change Material Containing Multi-Walled Carbon Nanotube for Heat Storage Applications.....	336
<i>Da Hee Choi, Young-Jin Kim, Yong Tae Kang</i>	
Thermal-to-Work and Thermal-to-Thermal Recovery Compression Heat Pumping.....	343
<i>S. C. Ve, S. R. L. Ipae</i>	
A Study on Cycle Designs for Light Commercial CO₂ Refrigeration Systems.....	351
<i>Gustavo Portella Montagner, Claudio Melo</i>	
Experimental Study on An Ejector Used in Transcritical CO₂ Heat Pump System	359
<i>Yu-jie Lu, Qi Chen, Yang Tong, Li-ming Tang, Guang-ming Chen</i>	
Low-grade Industrial Waste Heat Recovery with CO₂ Trans-critical Heat Pumps in Cold Climate.....	365
<i>Vasile Minea</i>	
New Development of Air Cooled Finned Heat Exchangers for CO₂ Applications.....	373
<i>Stefano Filippini</i>	
Sensitivity and Design of a Transcritical CO₂ Cooling and Heating System.....	381
<i>Chan Nguyen, Christian T. Veje, Morten Willatzen, Peer Andersen</i>	
Development of a Compact CO₂ Heat Pump for Industrial Drying	389
<i>Katsumi Hashimoto, Michiyuki Saikawa, Shuichi Misumi, Teruhiko Taira, Yoshitaka Kume</i>	
Modeling and Experimental Study of an Ejector for Transcritical CO₂ Refrigeration System.....	397
<i>A. Bouziane, A. Bensafi, P. Haberschill</i>	
Heat Recovery Solutions for R744 Booster Commercial Refrigeration Systems	405
<i>Julius Denecke, A. Hafner, T. Eikevik, Yves Ladam</i>	
Experimental Study of a Triple-Passage Motive Nozzle Ejector in a Small R744 Heat Pump	413
<i>Krzysztof Banasiak, Armin Hafner, Trygve M. Eikevik</i>	
High Efficient 100 kW_{el} R744 Compressor	421
<i>Christian Schmalzle, Petter Neksa, Frank Obrist, Havard Rekstad</i>	
Integration of Two-phase Ejector into a Compact, Lightweight Unitary-type Air-conditioner using R744 for Energy Efficient Operation in Hot Climates	429
<i>Stefan Elbel, Manuel Reichle, Chad Bowers, Pega Hrujak</i>	
Next Generation Commercial Heat Pumpwater Heater using Carbon Dioxide Using Different Improvement Approaches.....	437
<i>Chad Bowers, Michael Petersen, Stefan Elbel, Pega Hrujak</i>	
Risking the Success of the Montreal Protocol Emissions of F-Gases.....	445
<i>Rajendra Shende</i>	
Seasonal Storage of Solar Heat: Reactor Modeling	451
<i>Antonio Rubino, Robert De Boer</i>	
1990 to 2010 Refrigerant Inventories for Europe: Previsions on Banks and Emissions from 2006 to 2030 for the European Union.....	459
<i>Andrea Voigt</i>	

R290 Leakage Mass Flow Rate from a Refrigeration System	.....467
<i>Daniel Colbourne, Zhi Xin Liu</i>	
Industrial-sized, High-temperature Heat Pumps: Technologies and Application	.....475
<i>Lars Reinholdt, Michael Markussen, Tage Petersen, Peter Brondum</i>	
Scroll Compressor Assessment with R-290 and R-1270	.....483
<i>Heiko Arnemann, Bachir Bella, Norbert Kaemmer, Jesus Nohales</i>	
Effect of Tube Diameter on the Cocurrent CO₂-Water Slug Flow in Vertical Mesoscale Tubes	.....491
<i>Kyung-Jae Lee, Seok-Hyun Kye, Dong-Seon Kim</i>	
An On-line Control Method of Optimal Heat Rejection Pressure for CO₂ Refrigeration Cycle	.....499
<i>Mo Se Kim, Min Soo Kim</i>	
Experimental Analysis of a Commercial Refrigeration System Operating with R22 and the Hydrocarbon R1270	.....507
<i>Enio P. Bandarra Filho, Arthur H. P. Antunes, Luis M. P. Souza, Oscar S. H. Mendoza, Alessandro Silva</i>	
Feasability Study of Use of Surplus Heat for Cold Production in the Fish Industry	.....515
<i>Stein Rune Nordvedt, Eva Rosenberg, Tom Stale Nordvedt</i>	
The Transient Behavior of Pulsed Supercooling for Thermoelectric Coolers (TEC)	.....521
<i>Jiani Mao, Huanxin Chen, Xiaodong Qian</i>	
Measurement and Modelling of Ice Rink Heat Loads	.....528
<i>Mazyar Karampour, Jorgen Rogstam</i>	
Evaluation of Concepts for a 10kW Reversible Absorption Heat Pump	.....536
<i>Annett Kuhn, Stefan Dahn, Felix Ziegler</i>	
Transport Refrigeration Systems using CO₂	.....544
<i>Samvit Dutta, Pierce Kennedy, Francesco Cattaneo</i>	
Numerical Investigation on PCM Solidification in a Finned Thermal Storage Based on Enthalpy Method	.....551
<i>Amirhossein Mosaffa, Faramarz Talati, Marc A. Rosen, Carlos Infante Ferreira, Hassan Basirat Tabrizi</i>	

VOLUME 2

Thermodynamic Analysis of a Novel Combined Ejector-Double Effect Absorption Refrigeration System	.....559
<i>Leili Garousi Farshi, S. Mohammad Seyed Mahmoudi, Marc A. Rosen, Carlos Infante Ferreira</i>	
New High Efficiency Piston Compressors for Ammonia	.....567
<i>Geroge Bon</i>	
Simulation of Shock Waves in Supersonic Flow of CO₂ Through a Converging-Diverging Nozzle of Transcritical Ejector Refrigerator System	.....576
<i>Menandro Serrano Berana, Masafumi Nakagawa</i>	
Modelling of Surplus Heat Exploitation in a Dairy	.....584
<i>Arne Lind, Eva Rosenberg, Stein Rune Nordvedt</i>	
Experience from the Danish Regulations of F-Gases and Implications for the Refrigerator Industry	.....592
<i>Per Henrik Pedersen, Mikkel Aamann Sorensen</i>	
Development of Compact CO₂ Compressor for Transcritical Mobile and Stationary Refrigeration Systems	.....600
<i>Manuel Froeschle</i>	
Experimental Analysis of a R744 Heat Pump Equipped with an Ejector	.....608
<i>Silvia Minetto, Riccardo Brignoli, Krzysztof Banasiak, Armin Hafner, Francesco Tesser</i>	
Mitigation of HFC and CO₂ Emissions Through Nationally Appropriate Mitigation Actions (NAMAS) in the Refrigeration, Air-conditioning and Foam Blowing Sector	.....616
<i>Linda Ederberg, Irene Papst, Dietram Oppelt, Daniel Colbourne, Markus Wupior</i>	
Comparison of Refrigeration Cycles with Natural Refrigerants for Very Rapid Food Freezing	.....624
<i>Alessia Arteconi, Caterina Brandoni, Giovanni Di Nicola, Fabio Polonara</i>	
Specific Heat Capacity of LIBR+H₂O and LIBT+H₂O+TEG Solutions at Temperatures from 308k to 343k and Atmospheric Pressure	.....632
<i>Neng Gao, Yijian He, Guangming Chen</i>	
Safety Concept for Hydrocarbon Refrigerants in Split Air Conditioner	.....639
<i>Daniel Colbourne, Rolf Huuren, Asbjorn Vonsild</i>	
Natural or Synthetic Refrigerants - What Options for High Temperature Heat Pumps?	.....647
<i>Paul De Larminat, Damien Arnou</i>	
New Capacity Control for Ammonia Chiller Screw Compressors with High Part Load Efficiency	.....655
<i>Dmytro Zaytsev</i>	
A Cross-sector Analysis of Decision Factors & Market Forecasts for the European HVAC&R Industry using Natural Working Fluids	.....663
<i>Nina Masson, Janaina Topley Lira, Marc Chasserot, Alexandra Maratou</i>	
Photovoltaic vs Solar Thermal Cooling: A Comparison for Europe	.....672
<i>Paul Kohlenbach, Jeremy Osborne, Uli Jakob</i>	
First Operating Experiences with Novel Resorption Chillers to Generate Cooling from Waste Heat and Biomass	.....679
<i>Kirsten Helle, Thomas Weimer, Marlis Morschel, Stefan Peil, Mariusz Zieba, Roland Berger</i>	
Experimental Study of Performance in a Refrigerated Truck using Electronic Expansion Valve	.....687
<i>Chiwook Myung, Jaekyung Oh, Honghyun Cho</i>	
Numerical Study of Performance Variation with Frost Growth of a Refrigerating System in a Refrigerated Truck	.....693
<i>Sanghun Kim, Chasik Park, Honghyun Cho</i>	
Small Ammonia Heat Pump with Variable Speed Compressor	.....701
<i>Behzah A. Monfared, Bjorn Palm</i>	

Optimal Control of Desiccant Cooling using Solar Energy	709
<i>Young Soo Chang, Chang Hun Pi, Byung Ha Kang</i>	
Numerical Simulation of Natural Refrigerants Flow Boiling in a Tube	716
<i>Fatima Zohra Mecieb, Ahmed Ouadha</i>	
CFD Modelling and Energy Analysis of a Vortex Tube using CO₂ as the Working Fluid	724
<i>Mohammed Baghdad, Ahmed Ouadha, Yacine Addad</i>	
Experimentally Validated Microchannel Heat Exchanger Performance and Charge Predictions used to Compare Change Reduction Potentials of some Refrigerants	732
<i>Yadira Padilla Fuentes, Pega Hrnjak</i>	
Implementation of Ejector Thermocompression in Refrigerating Systems and Heat Pumps	740
<i>Vasko Sarevski, Milan Sarevski</i>	
Preliminary Study of a Novel R718 Refrigerating Cycle with Single Stage Centrifugal Compressor and Two-phase Ejector	748
<i>Milan Sarevski, Vasko Sarevski</i>	
Industrial Chillers with Ammonia as Refrigerant: An End-user Perspective	756
<i>Rene Van Gerwen, Subhankar Raha</i>	
Dynamic Modeling of a Combined Supermarket Refrigeration and HVAC System	764
<i>Maren Titze, Nicholas Lemke, Petter Neksa, Armin Hafner, Jurgen Kohler</i>	
Experimental Analysis of the Energy Performance of a CO₂ Transcritical Vapour Compression Cycle Based on Refrigerant Vapour Injection in Suction Line	771
<i>Daniel Sanchez Garcia-Vacas, Ramon Cabello Lopez, Jorge Patino Perez, Rodrigo Llopis Domenech, Enrique Torrella Alcaraz</i>	
Theoretical Comparative Study Case, Hydrocarbons and HFC Mixture Alternatives Retrofit	779
<i>Tarlea Gratiela-Maria, Vinceriuc Miorara, Tarlea Ana, Popescu Gherghe</i>	
Oil Free Turbo-Compressors for Refrigeration Applications	784
<i>Bartosz Kus, Petter Neksa</i>	
Solutions for Enhancing the Performance of Voorhees-Modified R744 Cycles	792
<i>Andrea Chesi, Giovanni Ferrara, Lorenzo Ferarri, Fabio Tarani</i>	
Flow Boiling Heat Transfer Characteristics of Ammonia in Horizontal Small Diameter Tubes	801
<i>Szu-Wei Chen, Satoshi Takabayashi, Kiyoshi Saito, Kimitaka Kadowaki, Masashi Kato</i>	
The Cora CO₂ Cooling Plant	809
<i>V. Bhanoit, L. Zwalinski, J. Noite, H. Postema, J. Godlewski, T. Kottig, B. Verlaat</i>	
Experimental Investigation on R1270 as Alternative Refrigerant of R22 in Residential Air Conditioners	816
<i>Tingxiang Jin, Changqing Tian, Zuyi Zheng</i>	
Comparison of Heat Transfer Coefficient During Evaporation of Natural Refrigerants and R-1234YF in Horizontal Small Tubes	823
<i>Jong-Taeck Oh, Kwang-Il Choi, Kiyoshi Saito, Jong Soo Jeong, Hoo-Kyu Oh</i>	
Thermodynamic and Phase Behavior of Natural Refrigerants Embedded with Nanostructured Materials	833
<i>Vitaly Bondarenko, Denis Kuleshov, Michael Khmeljuk, Victor Mazur</i>	
Investigation of a Reversible Cooling and Heating System for Electric Vehicles using CO₂ as Working Fluid under Frosting Conditions	841
<i>Alois Steiner, Rene Rieberer</i>	
Effect of Advanced Surfaces on Heat and Mass Transfer Processes in a Tubular Bubble Absorber with NH₃/LiNO₃ for Absorption Refrigeration Cycles	849
<i>Carlos Amaral, Mahmoud Bourouis, Manel Valles</i>	
Investigation of the Performance of a CO₂ Transcritical Cycle with Heat Recovery for Retail Application	857
<i>Ina Colombo, Graeme Maidment, Issa Chaer</i>	
Working Gases Characteristics' Influence on Energy Separation of the Vortex Tube	864
<i>Kongxiang Wu, Zheng Wang, Xiaohong Han, Liming Tang, Guang Ming Chen</i>	
Modelling of Absorption of H₂O Vapor in Falling Film of LIBR Aqueous Solution in Vertical Tubes with Presence of Non-Condensables	872
<i>E. Garcia-Rivera, J. Castro, J. Farnos, A. Oliva</i>	
Analysis of Refrigerating Cycles Working with Isobutane Under Transient Conditions	880
<i>N. Ablanque, J. Rigola, C. Oliet, C. D. Perez-Segarra</i>	
An Alternative Calculation Procedure for Real Mixture Fluid Properties Demonstrated with a Kalina Cycle	888
<i>Ragnar Sondalen, Christian Schulze, Juergen Koehler</i>	
Extension of the Working Map of Scroll Compressors for R407C Heat Pumps When They are Working with Propane	896
<i>J. Alonso, E. Navarro, I. O. Martinez, J. Gonzalvez</i>	
Comparative Experimental Study of an Open Piston Compressor for Buses Working with R1234YF, R134A and R290	903
<i>J. Nohales, E. Navarro, I. O. Martinez, J. Gonzalvez</i>	
Energy Efficient Dairy Shed Milk Cooler and Water Heater Using Carbon Dioxide as Refrigerant	911
<i>Havard Rekstad, Armin Hafner, Sigmund Janssen</i>	
Practical Experience with Ammonia Add-on Heat Pumps	918
<i>Jan Gerritsen</i>	
Experimental Study on Heat Pump System for Hot Water Heating using CO₂ as a Refrigerant	926
<i>O. Kosuda, T. Ogata, K. Taniguchi, A. Kakimoto, H. Hasegawa</i>	
Design Considerations of Long Length Evaporative CO₂ Cooling Lines	934
<i>Bart Verlaat, Joao Noite</i>	

Traci, A Multipurpose CO₂ Cooling System for R&D	940
<i>B. Verlaat, L. Zwaliński, R. Dumps, M. Ostrega, P. Petagna, T. Szwarc</i>	
CO₂ Expander-Compressor-Unit (ECU) in Refrigeration Systems.....	946
<i>Mario Wenzel, Ullrich Hesse</i>	
Development of a Scroll Compressor Model for Propane	954
<i>Paul Byrne, Redouane Ghoubali, Jacques Miriel</i>	
World's Oldest 400m Artificial Skating Rink, The "JAAP Eden BAAN" at Amsterdam	962
<i>Ernst Berends</i>	
Performance of Integral Hydrocarbon Cabinets For Supermarket Applications	970
<i>Inyoman Suamir, Savvas A. Tassou, Paul Arrowsmith, Mark Bushell</i>	
Accordance Between a Mathematical Simulation Model and Test Results from a CO₂ Heat Pump Test Rig	978
<i>Asa Jardeby, Roger Nordman, Lennart Rolfsman</i>	
Absorption Refrigeration and Heat Pump Systems using Ammonia	986
<i>Alexandru Serban, Ioan Boian, Florea Chiriac, Gabriel Nastase, Sorin Bolocan, Razvan Colata</i>	
Heat Pumps for Steam Production from Waste Heat	994
<i>Daniel Rohde, Yves Ladam, Harald Taxt Walnum, Petter Neksa</i>	
Performance Improvement of Sequential Dual Evaporator Refrigeration Cycle In Domestic Refrigerator-Freezer Charged with R600A: Prototype Testing.....	1001
<i>Matej Visek, Cesare Maria Joppolo, Luca Molinaroli, Andrea Olivani</i>	
Ammonia and Carbon Dioxide Heat Pumps for Heat Recovery in Industry	1009
<i>Wiebke Brix, Stefan W. Christensen, Michael M. Markussen, Lars Reinholdt, Brian Elmegaard</i>	
Mathematical Modeling of the Phase Transition Processes with Metastability Effects for Transcritical R744 Converging-Diverging Nozzles.....	1017
<i>Krzysztof Banasiak, Armin Hafner</i>	
Self Adaptive Refrigerant Flow Low Temperature Driven Dual Lift Absorption Cycle	1025
<i>Marco Guerra</i>	
Viable Solutions to Increase Efficiencies of Transcritical CO₂ Systems for Commercial Refrigeration.....	1033
<i>Hans Huff, Oliver Finckh, Parmesh Verma, Hongsheng Liu</i>	
Development of Commercial Refrigeration Systems with Heat Recovery for Supermarket Building.....	1040
<i>Armin Hafner, Stefano Poppi, Petter Neksa, Silvia Minetto, Trygve M. Eikevik</i>	
Hermetic Engine Driven Compressor Using R-744 as Refrigerant and Natural Gas as Fuel	1051
<i>Marcel Van Beek, Martien Janssen, David Berchowitz</i>	
Energy Saving and Increasing Reliability at CO₂ Transcritical Boosters - A Case Study	1059
<i>Janos Winter, Sandor Murin</i>	
Evaporative CO₂ Cooling System for the Upgrade of the CMS Pixel Detector at CERN.....	1066
<i>J. Daguin, K. Arndt, W. Bertl, J. Noite, P. Petagna, H. Postema, P. Tropea, B. Verlaat</i>	
Energy Optimization of a Solar Cooling Plant with PCM Heat Storage	1074
<i>Renato Lazzarin, Filippo Busato, Marco Noro</i>	
Mathematical Modelling of a Low Approach Evaporative Cooling Process for Space Cooling in Buildings	1082
<i>Mehdi Nasrabadi, Donal Finn, Ben Costelloe</i>	
Integration of Refrigeration and HVAC in Supermarkets.....	1090
<i>Tom Stale Nordvedt, Armin Hafner</i>	
Developing Low Charge R290 Room Air Conditioner by Using Smaller Diameter Copper Tubes	1097
<i>Guoliang Ding, Tao Ren, Wei Wu, Yongxin Zheng, Yifeng Gao, Ji Song, Zhongmin Liu, Shaokai Chen</i>	
Supermarket Application CO₂ System with Groundwater Sink Model Simulation.....	1106
<i>Daniele Mazzola, Alice Toffolo, Maurizio Orlando</i>	
Application of Phase Change Materials (PCM) in Thermal Storage Systems for Pressurised Lukewarm Water	1114
<i>M. Van Der Hoff, J. Verbeek, A. Joling, M. Mooren</i>	
Author Index	