PROCEEDINGS OF THE

2010 INTERNATIONAL COMPRESSOR ENGINEERING CONFERENCE AT PURDUE

VOLUME I

July 12-15, 2010
Purdue University, West Lafayette, Indiana USA

General Chairperson:
Eckhard A. Groll, Professor of Mechanical Engineering, Purdue University

Chairperson:
W. Travis Horton, Assistant Professor of Civil Engineering, Purdue University

Sponsored by:
Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University
C-1: Compressor Valves I
Room 310  Monday, July 12 - 12:30 p.m. - 2:30 p.m.

1308 Impact Fatigue Characteristics of Valve Leaves for Small Hermetic Reciprocating Compressors: Abdullah Can Altunlu and Ismail Lazoglu, KOC University, Turkey; Emre Oguz and Serkan Kara; Arcelik A.S., Turkey

1273 Analysis of Dynamic Behavior of Suction Valve Using Strain Gauge in Reciprocating Compressor: Shuhei Nagata, Tsutomu Nozaki, Mechanical Engineering Research Laboratory, Hitachi, Ltd., Japan; Takehiro Akizawa, Refrigerator Design Department, Hitachi Appliances, Inc., Japan

1359 A Theoretical Account of the Piston Influence on Effective Flow and Force Areas of Reciprocating Compressor Valves: Evandro L.L. Pereira and Cesar J. Deschamps, Federal University of Santa Catarina, Brazil

1321 Surface of Flow and Force Effective Areas Applied to Development of Reciprocating Compressors: Eric H. Murakami and Rodrigo Link, Embraco, Brazil; Francisco Lajus Jr., Federal University of Santa Catarina, Brazil

1319 Numerical Analysis of Transient Effects on Effective Flow and Force Areas of Compressor Valves: Rodrigo Link, Embraco, Brazil; César José Deschamps, Federal University of Santa Catarina, Brazil

C-2: Compressor Modeling I
Room 322  Monday, July 12 - 12:30 p.m. - 2:30 p.m.

1125 Pressure Fatigue Testing of Compressor Enclosures: Titus Broek, Emerson Climate Technologies, USA

1141 Dynamic Transfer Stiffness of Suspension Springs and Discharge Tubes in Hermetic Reciprocating Compressors: Christian Svendsen, Jan Thomsen and Sven Eric Nielsen, Danfoss Compressors GmbH, Germany

1244 Stresses in Reciprocating Compressor Discharge Tubes During Starting: James R. Lenz, Tecumseh Products Company, USA

1281 Simple Modeling and Modal Analysis of Reciprocating Compressor Crankshaft System: Binyan Yu, Xiaoling Yu and Quanke Feng, Xi’an Jiaotong University, P. R. of China

1298 Fatigue Analysis of Helical Suspension Springs for Reciprocating Compressors: Marcos G. D. de Bortoli, Raul Bosco, Jr. and Rinaldo Puff, Embraco, Brazil

C-3: Compressor Valves II
Room 310  Monday, July 12 - 3:00 p.m. - 5:00 p.m.

1295 Analysis of the Flow in Hermetic Compressor Valves Using the Immersed Boundary Method: Jonatas Lacerda, Tecumseh do Brasil, LTDA, Brazil; José Luiz Gasche, UNESP - Ilha Solteira, Brazil

1328 Flow Simulation Through Moving Hermetic Compressor Valves Using the Immersed Boundary Method: Tadeu Tonheiro Rodrigues and José Luiz Gasche, UNESP-Ilha Solteira, Brazil; Júlio Militzer, Dalhousie University, Canada

1256 Study of CFD Considering Valve Behavior in Reciprocating Compressor: Kenji Kinjo, Akira Nakano and Takumi Hikichi, Panasonic Corporation, Japan; Koji Morinishi, Kyoto Institute of Technology, Japan

1360 Investigation on Ring Valve Motion and Impact Stress in Reciprocating Compressors: Yu Wang, Jianmei Feng, Yuefei Wang and Xueyuan Peng, Xi’an Jiaotong University, P. R. of China

1343 A Study of Flapper Valve Motion in a Variable Speed Compressor: James R. Lenz and Douglas Andrew Collings, Tecumseh Products Company, USA

C-4: Compressor Modeling II
Room 322  Monday, July 12 - 3:00 p.m. - 5:00 p.m.

1460 Consistent Initialization of System of Differential-Algebraic Equations for Dynamic Simulation of Centrifugal Chillers: Pengfei Li and Yaoyu Li, University of Wisconsin-Milwaukee, USA; John E. Seem; Johnson Controls Inc., USA
1486 An Algebraic Model for Transient Simulation of Reciprocating Compressors: Cezar O. R. Negrão, Raul H. Erthal, Diogo E. V. Andrade, Federal University of Technology-Paraná, Brazil; Luciana W. Silva, Embraco, Brazil

1383 Full Numerical Simulation of an Object Oriented Program for Hermetic Reciprocating Compressors: Numerical Verification and Experimental Validation: Oriol Lehmkuhl, Termo Fluids, S.L., Spain & Universitat Politècnica de Catalunya (UPC), Spain; Rashmin Damle, Joaquim Rigola and Joan López, Universitat Politècnica de Catalunya (UPC), Spain

1382 Introduction of CFD&HT Analysis Into an Object Oriented One Dimensional and Transient Program for Numerically Simulate Hermetic Refrigeration Compressors: Joan López, Joaquim Rigola and Assensi Oliva, Universitat Politècnica de Catalunya (UPC), Spain; Oriol Lehmkuhl, Termo Fluids, S.L., Spain & Universitat Politècnica de Catalunya (UPC), Spain

1230 Application of Computational Fluid Dynamics for the Thermodynamic Development of a New Generation of Hermetic Reciprocating Compressor: Raimund Almbauer, Wolfgang Lang, Erwin Berger and Daniel Nagy, Graz University of Technology, Austria

TUESDAY SESSIONS

C-5: Noise Reduction Technologies I
Room 310 Tuesday, July 13 – 9:45 – 11:45 a.m.

1138 An Analytical Model for Calculating Transmission Loss of Compressor’s Mufflers Based on the Modal Series Expansion Method: Li Lin, Xu Zhang, Yun Li and Guangsu Cheng, Xi'an Jiaotong University, P. R. of China

1162 Investigation on Multi-Helmholtz Resonator in the Discharge System of Rotary Compressor: Rongting Zhang, Huanhuan Gu, Yusheng Hu and Sihai Xia, Gree Electric Appliances, Inc. of Zhuhai, P. R. of China

1392 The Diagnosis and Optimization of Scroll Compressor Noise Based on the Theory of Near-Field Acoustical Holography: Zhigang Huang, Hong Guo, Binsheng Zhu and Canyu Qian, Guangdong Meizhi Compressor Company, Ltd., P. R. of China

1390 Effects of Sound Radiation Direction in Faulty Hermetic Compressors: Emin Germen, Anadolu University, Turkey; Atilla Kaya and Umit Unlii, Arcelik, Turkey

1331 Experimental Characterization of Noise Source in the Suction Chamber of a Reciprocating Hermetic Compressor: Marcelo Alexandre Real, Ana Lucia Libardi De Marqui, Eduardo Augusto Gomes Pereira, Tecumseh do Brasil, Brazil; Maria Alzira de Araujo Nunea, Federal University of Brasilia at Gama, Brazil

C-6: Compressor Modeling III
Room 322 Tuesday, July 13 – 9:45 a.m. – 11:45 a.m.

1302 Numerical Simulation of Transient Heat Transfer During Welding Process: Celso Kenzo Takemori and Moises Alves de Oliveira, Embraco, Brazil; Daniel Tiago Muller, Santa Catarina State University, Brazil

1224 CFD Analysis of Discharge Gas Flow in Rotary Compressor for OCR Reduction: Kamal Sharma, V. Koteswara Rao, M N S V Kiran and Anil Gopinathan, Tecumseh Product India Pvt Limited, India

1225 Using PV Diagram Synchronized With the Valve Functioning to Increase the Efficiency on the Reciprocating Hermetic Compressors: Marcelo Alexandre Real and Eduardo Augusto Gomes Pereira, Tecumseh Company, Brazil

1114 Analytical and Experimental Study of Discharge Flow Behavior Provided by Electronically Controlled Valves in Hermetic Compressors: Sidnei Jose Oliveira and Marcelo Alexandre Real, Tecumseh do Brasil, Brazil

1292 Efficient Cooling in Cylinder Heads for Air Brake Compressors: Andreas Brandl, Hoerbiger Ventilwerke GmbH & Co. KG, Austria

C-7: New Compressor Concepts
Room 310 Tuesday, July 13 – 1:30 p.m. – 3:30 p.m.


1394 Development of High Efficiency Swing Type Compressor Using New Interior Permanent Magnet Synchronous Motor: Hiroki Kamiishida, Naoto Tomioka, Kazuo Ida, Kenichi Yuasa and Yoshihiro Kataoka, Daikin Industries. Ltd., Japan; Akio Yamagiwa and Keiji Aota, Daikin Industries. Ltd., Japan
1389 Evaluation of a Prototype Rotating Spool Compressor in Liquid Flooded Operation: Gregory T. Kemp and Leonard Elwood, TORAD Engineering, USA; Eckhard A. Groll, Purdue University, USA

1284 Development of a High Efficiency Dual Compressor for Air Conditioner: Koji Hirano, Shogo Shida, Takeshi Tominaga and Shoichiro Kitaichi, Toshiba Carrier Corporation, Japan

1275 Analysis and Development of a Turbivo Compressor for MVR Applications: Elias Boulawz Ksayer and Denis Clodic, Ecole des Mines de Paris, France

1153 Geometrical and Thermodynamic Model of a Three Lobes Compressor With Simulation and Experimental Validation: Járemié M'Boua, Benjamin Blunier and Abdellatif Miraoui, University of Technology of Belfort-Montbéliard, France

C-8: Compressor Thermal Management
Room 322  Tuesday, July 13 – 1:30 p.m. – 3:30 p.m.

1238 Influence of the Heat Transfer on the Pressure Field in Radial Difusers Flows: Franco Barbi, Iara de Souza Barbosa and José Luiz Gasche, UNESP-Ilha Solteira, Brazil

1307 Thermal Analysis of a Small Hermetic Reciprocating Compressor: Serkan Kara and Emre Oğuz, Arcelik A. S., Turkey

1310 Numerical Analysis of Heat Transfer Inside the Cylinder of Reciprocating Compressors in the Presence of Suction and Discharge Processes: Evandro L.L. Pereira and Cesar J. Deschamps, Federal University of Santa Catarina, Brazil; Fernando A. Ribas Jr., Embraco, Brazil

1346 Experimental Investigation of Heat Transfer in Components of a Hermetic Reciprocating Compressor: Thiago Dutra and Cesar J Deschamps, Federal University of Santa Catarina, Brazil

1347 An Assessment of Experimental Techniques for Measuring Fast Temperature Transients in Compressors: André Morriesen and Cesar J Deschamps, Federal University of Santa Catarina, Brazil

C-9: Compressor Efficiency Enhancements
Room 310  Tuesday, July 13 – 4:00 p.m. – 6:00 p.m.

1446 Numerical Investigation of the Influence of the Transient Flow Inside the Suction and Discharge Chamber on Heat Transfer of a Small Reciprocating Compressor: Stephan Lehr, Technische Universität Dresden, Germany

1522 A Hybrid Approach of Calculating Gas Pulsations in the Suction Manifold of a Reciprocating Compressor: Nasir Bilal and Douglas E. Adams, Purdue University, USA; Keith Novak and Jack Sauls, Trane - Ingersoll Rand, USA

1348 Theoretical Analysis of the Volumetric Efficiency Reduction in Reciprocating Compressors Due to In-Cylinder Thermodynamics: João Ernesto Schreiner, Jader R. Barbosa Jr. and Cesar J. Deschamps, Federal University of Santa Catarina, Brazil

1358 Fundamental Optimal Performance Design Guidelines for Off-Set Type Reciprocating Compressors to Maximize Mechanical Efficiency: Takuma Tsuji and Noriaki Ishii, Osaka Electro-Communication University, Japan; Keiko Anami, Ashikaga Institute of Technology, Japan; Kiyoshi Sawai, Akira Hiwata, Takashi Morimoto and Kiyoshi Sano, Panasonic Corporation, Japan; Charles Knisely, Bucknell University, USA

1425 High Efficiency Development of a Reciprocating Compressor by Clarification of Loss Generation in Bearings: Masaru Matsui, Yoko Kitsunai and Ko Inagaki, Panasonic Corporation, Japan

C-10: Alternative Refrigerant Compressors
Room 322  Tuesday, July 13 – 4:00 p.m. – 6:00 p.m.

1351 A Proposed Centrifugal Refrigeration Compressor Rating Method: Joost J Brasz, Danfoss Turbocor Compressors, USA

1349 The Part-Load Efficiency Benefit of Oil-Free, High-Speed, Direct-Drive Centrifugal Compressors: Jose Alvares, Danfoss Turbocor Compressors, USA

1448 Experimental Performance of a Semi-Hermetic Reciprocating Compressor Working With Propane: Enrico Da Riva, Davide Del Col and Alberto Cavallini, University of Padova, Italy

1405 Modeling and Control of a High Speed Three-Lobe Compressor for Fuel Cell System: Járemié M'Boua, Benjamin Blunier and Abdellatif Miraoui, University of Technology of Belfort-Montbéliard, France; Marcelo Godoy Sinoes, Colorado School of Mines, USA

1229 Comparative Study of Two Different Equations of State for Modelling a Reciprocating Compressor for the Refrigerant R600a: Wolfgang Lang, Raimund A. Almbauer, Erwin Berger and Daniel Nagy, Graz University of Technology, Austria
WEDNESDAY SESSIONS

C-11: Linear Compressors
Room 310 Wednesday, July 14 – 9:45 a.m. – 11:45 a.m.

1259 A Comprehensive Model of a Miniature-Scale Linear Compressor for Electronics Cooling: Craig R. Bradshaw, Eckhard A. Groll and Suresh V. Garimella, Purdue University, USA

1272 New Capacity Modulation Algorithm for Linear Compressor: Jaeyoo Yoo, Sungho Park, Hyuk Lee and Sangsub Jeong, LG Electronics, Korea

1269 The Characteristics of LG Electronics Linear Oscillating Motor: Sangsub Jeong, Wonsik Oh, Sungman Cho, Hyuk Lee, Jaeyoo Yoo and Hyuk Lee, LG Electronics, Korea

1218 Performance Evaluation of the Energy Efficiency of Crank-Driven Compressor and Linear Compressor for a Household Refrigerator: Boncheol Ku, Junghoon Park, Yujin Hwang and Jaekeun Lee, Pusan National University, Korea

1288 Characteristic of a Miniature Linear Compressor: Wen Wang and Xiaoliang Tai, Shanghai Jiao Tong University, P. R. of China

C-12: Rotary Compressors I
Room 322 Wednesday, July 14 – 9:45 a.m. – 11:45 a.m.

1164 Investigation of Refrigerant Flow Simulation and Experiment of Rolling Piston Compressors: Shebing Liang, Xiaoli Kang, Qiang Liu, Peng Zhou, Sihai Xia, Yusheng Hu, Gree Electric Appliances, Inc. of Zhuhai, P. R. of China

1165 Research on the Effect of Nano-Materials Used in Rotary Compressor: Yin Zhu, Sihai Xia and Zhengliang Shi, Gree Electric Appliances, Inc. of Zhuhai, P. R. of China

1408 Experimental Study on Reduction of Oil Circulation Rate in Rotary Compressor: Bo Huang, Min Ma, Wei Geng, Shanghai Hitachi Electrical Appliances Co., Ltd., P. R. of China

1134 Study of the Endface Friction of the Revolving Vane Mechanism: Alison Subiantoro and Kim Tiow Ooi, Nanyang Technological University, Singapore

1132 Analysis of the Vane Contact Force and the Vane Side Friction Loss of the Various Revolving Vane Expander Designs: Alison Subiantoro and Kim Tiow Ooi, Nanyang Technological University, Singapore

-13: Lubrication/Tribology
Room 310 Wednesday, July 14 – 1:00 p.m. – 3:00 p.m.

1467 Tribological Behavior of PTFE, PEEK and Fluorocarbon-Based Polymeric Coatings Used in Air-Conditioning and Refrigeration Compressors: Emerson Escobar Nunez, Seung Min Yeo and Andreas A. Polycarpou, University of Illinois at Urbana-Champaign, USA

1445 Effect of Surface Texture on Compressor Piston Lubrication: Bilgin Hacioglu, Arcelik A.S, Turkey; Zafer Dursunkaya, Middle East Technical University, Turkey

1393 Wear Characteristics of Ductile Cast Iron Crankshaft Coating: Ruihong Kong, Chunhui Liu, Xiaowei Liang, Qingchun Zheng and Le Xu, Shanghai Hitachi Electrical Appliances Co., Ltd., P. R. of China

1207 Lubricating Condition Between Swashplate and Shoe in Swashplate Compressor: Mitsuhiro Fukuta Yasuhiko Nakahara, Naoya Tanabashi and Tadashi Yanagisawa, Shizuoka University, Japan; Hisashi Suzuki, Sanden Corporation, Japan

1255 A Simplified Analysis of Lubrication of a Wristpin: Hubert Bukac, Little Dynamics, Inc., USA

C-14: Scroll Compressors I
Room 322 Wednesday, July 14 – 1:00 – 3:00 p.m.

1357 On the Development of Optimal Efficient Compact Scroll Compressors for Refrigerators: Takuma Tsuji and Noriaki Ishii, Osaka Electro-Communication University, Japan; Kiyoshi Sawai, Akira Hiwata, Takashi Morimoto and Kiyoshi Sano, Panasonic Corporation, Japan; Keiko Anami, Ashikaga Institute of Technology, Japan; Charles Knesely, Bucknell University, USA

1105 Development of 3D Scroll Compressor and Its Application: Hajime Sato and Makoto Takeuchi, Mitsubishi Heavy Industries, Ltd., Nagoya Research and Development Center, Japan; Hiroyuki Kobayashi, Tetsuzo Ukai and Hisao Mizuno, Mitsubishi Heavy Industries, Ltd., Japan
C-15: Lubrication in Scroll & Other Compressors
Room 310  Wednesday, July 14 - 3:20 p.m. - 5:20 p.m.

1196 A Study of a New Oil Injection to Compression Chambers on Scroll Compressors: Kiyoshi Sawai, Akira Hiwata, Atsushi Sakuda, Noboru Iida and Takashi Morimoto, Panasonic Corporation, Japan; Noriaki Ishii, Osaka Electro-Communication University, Japan

1412 Development of High-Side Shell Scroll Compressor With Novel Oil Return Mechanism: Cheolhwan Kim, Seheon Choi, Yunghee Cho, Byeongchul Lee, Junbo Yun, Samchul Ha, Air Conditioning Research Laboratory, LG Electronics Inc., Korea; Kwangneoh Eom and Sungchoon Kim, Air Conditioning Company, LG Electronics Inc., Korea

1181 A Study on Contact Force Between Wraps of Scroll Compressor for CO₂ Refrigerant: Akira Hiwata, Kiyoshi Sawai, Atsushi Sakuda and Takashi Morimoto, Panasonic Corporation, Japan; Mitsuhiro Fukuta and Tadashi Yanagisawa, Shizuoka University, Japan

1239 Oil-Refrigerant R134a Mixture Non-Isothermal Two-Phase Flow Through the Radial Clearance of Rolling Piston Compressors: José Luiz Gasche and Andriano Domingos Ferreira, Sao Paulo State University, Brazil

1326 Fluid Flow in a Screw Pump Oil Supply System for Reciprocating Compressors: Marcus V. C Alves, Jader R Barbosa Jr., Alvaro T Prata, Federal University of Santa Catarina, Brazil; Fernando A Ribas Jr., Embraco, Brazil

1168 Analysis of Oil Pumping in the Hermetic Reciprocating Compressor for Household Refrigerators: Weifeng Wu, Jian Li and Quanke Feng, Xi'an Jiaotong University, P. R. of China; Longquan Lu, Jiaxipera Compressor Co., Ltd., P. R. of China

C-16: Rotary Compressors II
Room 322  Wednesday, July 14 - 3:20 p.m. - 5:20 p.m.

1352 A Lumped Thermodynamic Model for Scroll Compressors With Special Attention to the Geometric Characterization During the Discharge Process: Evandro L.L. Pereira and Cesar J. Deschamps, Federal University of Santa Catarina, Brazil

1139 Noise Reduction Technology for Inverter Controlled Rotary Compressor: Jianping Huang, Yusheng Hu, Sihai Xia and Jia Xu, Gree Electric Appliances, Inc. of Zhuhai, P. R. of China

1217 Numerical Analysis for Rotating Motion of a Rolling Piston in Rotary Compressors – Effective Factors on Characteristics of Rotating Motion of a Rolling Piston: Yasutaka Ito, Hitoshi Hattori, Toshiba Corporation, Japan; Kazuhiko Miura, Toshiba Carrier Corporation, Japan

1276 High Efficiency Development of a Rotary Compressor by Clarification of Its Shaft Dynamic Motion: Yoko Kitsunai, Panasonic Corporation Living Environment Development Center, Japan; Masaru Matsui and Singo Oyagi, Panasonic Corporation Appliances Development Center, Japan

1140 Dynamic Balance Technology of Inverter Controller Rotary Compressor: Jianping Huang, Yusheng Hu, Sihai Xia and Liping Ren, Gree Electric Appliances, Inc. of Zhuhai, P. R. of China

THURSDAY SESSIONS

C-17: CO₂ Compressors
Room 310  Thursday, July 15 - 10:00 a.m. - 12:00 p.m.

1525 Experimental Performance of a Prototype Carbon Dioxide Compressor: Seth Holloway, W. Travis Horton and Eckhard A. Groll, Purdue University, USA; Dan Sherman and Marc Albertin, EcoThermics Corp., USA

1411 Development of a Two-Cylinder Rolling Piston CO₂ Expander: Jun Yang, Shanghai Jiaotong University & Shanghai Hitachi Electrical Appliances Col., Ltd., P. R. of China; Long Zhang, Li Zhang and Hao Yuan Li, Shanghai Hitachi Electrical Appliances Co., Ltd., P. R. of China
C-18: Lubrication/Oils
Room 322 Thursday, July 15 - 10:00 a.m. – 12:00 p.m.

1398 Numerical Investigation of Oil Flow in a Hermetic Reciprocating Compressor: Husnu Kerpicci and Emre Oguz, Arcelik A.S., Turkey; Seyhan Onbasioglu and Alper Yagci, ITU Mechanical Faculty, Turkey

1306 Investigation of Pressure Distribution and Frictional Heat on Self-Lubricated Piston Rings in Reciprocating Compressors: Dianbo Xin, Jianmei Feng, Yanjing Xu and Xueyuan Peng, Xi'an Jiaotong University, P. R. of China

1305 Absorption of Isobutane (R-600a) in Lubricant Oil: Moises A. Marcelino Neto and Jader R. Barbosa Jr., Federal University of Santa Catarina, Brazil

1291 Cooling of a Reciprocating Compressor Through Oil Atomization in the Cylinder: Rodrigo Kremer, Federal University of Santa Catarina & Embraco, Brazil; Jader R. Barbosa Jr. and Cesar J. Deschamps, Federal University of Santa Catarina, Brazil

1135 Tribology Characteristics of HFO and HC Refrigerants With Immiscible Oils - Effect of Refrigerant With Unsaturated Bond: Tatsuya Sasaki, Hideto Nakao and Kota Mizuno, Mitsubishi Electric Corporation, Japan; Hideaki Maeyama, Mitsubishi Electric Corporation, Shizuoka Works, Japan

C-19: Screw Compressors
Room 310 Thursday, July 15 – 1:00 p.m. – 3:00 p.m.

1413 Analysis of Oil Film Force in Single Screw Compressor: Shuo Sun, Weifeng Wu, Xiaoling Yu and Quanke Feng, Xi'an Jiaotong University, P. R. of China

1243 Advanced Design Environment for Screw Machines: Elvedin Mujic, Ahmed Kovacevic, Nikola Stosic and Ian Smith, City University London, United Kingdom

1214 Comparative Experimental Study on Wear Resistance of Different Types of Star Wheels in the Single Screw Compressor: Jian Li, Xiaoling Yu, Bo Hu and Quanke Feng, Xi'an Jiaotong University, P. R. of China

1158 Advances in Numerical Modelling of Helical Screw Machines: Ahmed Kovacevic, Nikola Stosic, Elvedin Mujic and Ian K. Smith, City University London, United Kingdom

1116 Three Decades of Modern Practice in Screw Compressors: Nikola Stosic, Ahmed Kovacevic and Elvedin Mujic and Ian K Smith, City University London, United Kingdom