

# Predrag Hrnjak

## COLLEGE OF ENGINEERING BIOGRAPHICAL DATA

### University of Illinois at Urbana-Champaign for

**Department (% appnt):** Mechanical Science and Engineering (100%) **Date:** July 2011

**1. Name:** Hrnjak, Predrag Stojan **Birth Date:** 8/5/1952

**2. Present Academic Rank:** Research Professor

**4. Administrative Title:** Co-Director, Air Conditioning and Refrigeration Center

#### 5. Degrees (field, institution)

1. Dipl. Ing. Mech. Eng. University of Belgrade, Yugoslavia
2. M.S. Mech. Eng. University of Belgrade, Yugoslavia
3. D.Sc. Mech. Eng. University of Belgrade, Yugoslavia

#### 6. Academic Positions at U of I and elsewhere (*rank, institution, field, inclusive dates*) (*show % if you hold multiple appointments*)

1. Lecturer, Department of Mechanical and Industrial Engineering, University of Belgrade, Belgrade, Yugoslavia, 1980-84
2. Visiting Scholar, Danish Technical University, Lyngby-Kopenhagen, Denmark, 1984
3. Assistant Professor, Department of Mechanical and Industrial Engineering, University of Belgrade, Belgrade, Yugoslavia, 1984-92
4. Visiting Professor, University of Missouri, Rolla, Rolla, Missouri, 1989-90
5. Postdoctoral Research Associate, Department of Mechanical and Industrial Engineering, UIUC, 1993-94
6. Visiting Research Assistant Professor, Department of Mechanical and Industrial Engineering, UIUC, 1994-95
7. Adjunct Assistant Professor, Department of Mechanical and Industrial Engineering, UIUC, 1995-98
8. Associate Director, Air Conditioning and Refrigeration Center (ACRC), Department of Mechanical and Industrial Engineering, UIUC, 1997-01
9. Adjunct Associate Professor, Department of Mechanical and Industrial Engineering, UIUC, 1998-00
10. Research Professor, Department of Mechanical Science and Engineering, UIUC, 2000-date
11. Co-Director, Air Conditioning and Refrigeration Center (ACRC), Department of Mechanical and Industrial Engineering, UIUC, Jan. 2001-date

#### 7. Professional Activities

##### a. Other Professional Employment (*title, organization, location, inclusive dates*)

1. Creative Thermal Solutions. Inc., President 2004 - now
2. Engineer, Jugostroj, refrigeration equipment factory, Belgrade, Yugoslavia, 1976-80

#### 8. Honors, Recognition, and Outstanding Achievements (*list year*)

1. 2008 Rittinger Medal at the International Energy Agency Heat Pump Center
2. Fellow, American Society of Heating, Refrigeration and Air Conditioning Engineers
3. 2011 Gustav Lorentzen Medal
4. 2011 J7E Hall Award, IoR

## FACTUAL INFORMATION

### Instructional Activities (*prelim and final exams, course development, short courses, etc.*)

#### a. Prelim and Final Exams

Doctoral Candidate	Prelim Exam Date	Final Exam Date	Chair	Director
Enrique Rodarte	1999	2001		
Willy Adriansyah (Norwegian University of Science and Technology) - Opponent		2001	*	
Victor Nino	2001	2002	*	*
Wilson Terrell	2001	2002		
Xuan Bai	2001			
Geir Skaugen (Norwegian University of Science and Technology) - Opponent		2002	*	
Monica Axell (Chalmers University of Technology) - Opponent		2002	*	
Xiao Tu	2002	2004	*	*
Peng Fei	2002	2004	*	*
Denis Owaga (Rand Afrikaans University)		2003		
Georges El Khoury (Ecole des Mines, Paris)		2005	*	
Daqing Li (Purdue University)	2004	2006		
Greg Michna	2005	2006		
Yanping Xia	2005	2006		
Christopher Seeton	2006	2009	*	*
Brandon Field	2006	2007	*	*
Chang Yong Park	2006	2006	*	*
Young-Gil Park	2006	2007		
Stefan Elbel	2006	2007	*	*
Chad Bowers	2008	2009	*	*
Jianchang Huang (University of the Witwatersrand, Johannesburg)		2010		
Steffen Peuker	2010	2010	*	*
Claudi Martin-Callizo, KTH - Royal Technical University Stockholm, opponent		2010		
Scott Wujek	2010	2011	*	*
Gustavo Pottker	2011		*	*
Augusto Zimmermann	2012		*	*
Hanfei Tuo	2012		*	*

Doctoral Candidate	Prelim Exam Date	Final Exam Date	Chair	Director
Yang Zou	2013		*	*

## b. Course Development

1. "Fundamentals of Supermarket Refrigeration," (Co-Director with W. F. Stoecker), Department of Mechanical and Industrial Engineering, UIUC, Aug. 26-28, 1997
2. "Fundamentals of Supermarket Refrigeration," (Co-Director with W. F. Stoecker), Department of Mechanical and Industrial Engineering, UIUC, May 26-28, 1998
3. "Fundamentals of Supermarket Refrigeration," (Co-Director with W. F. Stoecker), Department of Mechanical and Industrial Engineering, UIUC, May 18-20, 1999
4. "Controls of Commercial Refrigeration Systems," Advanced Focus Seminar, (Co-Director with W. F. Stoecker), Department of Mechanical and Industrial Engineering, UIUC, May 21, 1999
5. "CO2 as a Working Fluid," XXth IIR Congress, Sydney, Australia, Sept. 24, 1999
6. "Fundamentals of Supermarket Refrigeration," (Director), Department of Mechanical and Industrial Engineering, UIUC, May 16-18, 2000
7. "Secondary Coolant Systems" Advanced Focus Seminar, (Director), Department of Mechanical and Industrial Engineering, UIUC, May 19, 2000
8. "Fundamentals of the Transcritical CO2 Cycle Technology," USNC/IIR Short course, Purdue University, July 24, 2000
9. "Fundamentals of Supermarket Refrigeration," (Director), Department of Mechanical and Industrial Engineering, UIUC, May 21-23, 2001
10. "Carbon Dioxide as a Refrigerant," Advanced Focus Seminar, (Director), Department of Mechanical and Industrial Engineering, UIUC, May 24, 2001
11. "Analysis and Design of Microchannel Heat Exchangers," Purdue University, July 14-15, 2002
12. "New Technologies in Commercial Refrigeration" UIUC/IIR Short course, University of Illinois, July 22-23, 2002

## 4. Undergraduate Advising

1. "Design and Construction of an Ice Slurry System," D. Boewe, L. Liudahl, and B. Mosier, 1997 Spring Semester
2. "The Design of an Ice Slurry Secondary Refrigeration System - Pressure Drop and Heat Transfer in Ice Slurry," D. L. Chang, A. McConnell, and C. Webb, 1998 Spring Semester
3. "Digital Scroll," J. Jang, J. Vorac, R. Schuetz, and J. Perko, 2000 Fall Semester
4. "Improving Refrigerant Distribution in Headers of Plate Evaporators," P. Chinn, F. Khan, B. Slosson, G. Uhrhan, 2001 Spring Semester
5. "Two-Phase Flow in Micro-Scale Channels," C. Lam, S. Schrock, P. To, A. Toreja, 2001 Fall Semester
6. "Visualization of CO2 when Condensing in Small Channels," M. Poulakos, R. Looper, G. Bacci, M. Reding, 2003 Fall
7. "Visualization of Two Phase Flow of CO2 with and without Oil Through Small Channels," M. Lin, K. Aita, C. Miller, M. Warden, 2004 Spring
8. "Opportunities for Refrigerant R410A at Low Temperature Applications," Mark Bucheit, Arthur Evans, Jeffrey Held, Isaac Wilson, 2005 Spring

## d. Other (*individual projects, engineering open house, etc. past five years*) ME 599:

1. "CO<sub>2</sub> as a Secondary Refrigerant," D. Yashar, 1997 Spring Semester
2. "Performance of CO<sub>2</sub> Evaporator," R. Reef, 1997 Fall Semester
3. "Condensation of CO<sub>2</sub> at Low Temperatures," J. Burnett, 2002 Spring Semester
4. "Expansion of CO<sub>2</sub> through a Small Orifice," A. Koonsman, 2002 Spring Semester
5. "Charge Reduction in Microchannel Heat Exchangers," Adnan Boghri, 2003 Fall
6. "Two Phase Flow Regimes in Very Small Channels," Scott Wujek, 2004 Spring
7. "Transcritical CO<sub>2</sub> systems for ECU," Taehoon Jung, 2005 Spring
8. "R410A at Low Temperatures," Brandt Pedota, 2005 Spring
9. "Oil Concentration Effects," Felix Dieter Pflaum, 2007 Spring
10. "Measurements of Oil in Circulation," Joseph Edwin Bower, 2008, Summer

## B. Research, Creative, and Other Scholarly Activities

### 1. Publications

#### Books Edited or Co-Edited

##### 1. Original Editions

1. P. S. Hrnjak (ed.), "New Technologies in Commercial Refrigeration," Proceedings of the International Conference Sponsored by IIR and ASHRAE, Urbana, IL, July 22 and 23, 2002.

##### 2. Chapters in Books

1. Vujic, S., M. Markoski, R. Raicevic, S. Pejovic, and P. Hrnjak, "Refrigeration Controls," Chapter XII in Refrigeration, University of Belgrade, Belgrade, Yugoslavia, 329-397, first edition 1983, revised editions: 1984, 1988, 1990, 1995, 1997.
2. Hrnjak, P. S., "Refrigeration," Chapter 11 in Perry's Chemical Engineers' Handbook, R. H. Perry and D. Green, eds., McGraw-Hill Publishing Co., New York, NY, 11.76-11.96, 1997.
3. Hrnjak, P. S., "ASHRAE Handbook Refrigeration," Chapter 39 in Low Temperature Refrigeration, Contributor, ASHRAE, Atlanta, GA, 1988.

### 3. Articles

#### 3.1. Articles In Journals

1. (\*) Vujic, S., M. Markoski, and P. S. Hrnjak, "On Generalization of Test Results for Air Coolers with Moisture Extraction," KGH, 4, Belgrade, Yugoslavia (in Serbocroatian), 1983.
2. (\*) Rodarte, E., N. Miller, P. S. Hrnjak, "Acoustic Resonance in Plate Heat Exchangers," International Journal of Refrigeration, 21:8, 626-638, 1998.
3. (\*) Peixoto, R. A. and P. S. Hrnjak, "Eliminação de CFCs na Refrigeração de Supermercados," Abrava, Sao Paulo, Brazil, 50-58, March/April 1998.
4. (\*) (W) Rodarte, E., G. Singh, N. R. Miller, and P. S. Hrnjak, "Refrigerant Expansion Noise Propagation through Downstream Tube Walls," Journal of Passenger Cars, 108:6, 2224-2234, 1999.

5. (\*) (W) Rodarte, E., G. Singh, N. R. Miller, and P. S. Hrnjak, "Sound Attenuation In Tubes Due to Visco-Thermal Effects," *Journal of Sound and Vibration*, 231:5, 1221-1242, 2000.
6. (\*) (W) Shannon, M. A., T. M. Leicht, P. S. Hrnjak, N. R. Miller, and F. A. Kahn, "Thin-Film Resistance Sensor for Measuring Liquid Mass Fraction in Super-Heated Refrigerant," *Sensors and Actuators A*, 88, 164-177, 2001.
7. (\*) (W) Boewe, D. E., C. W. Bullard, J. M. Yin, and P. S. Hrnjak, "Contribution of Internal Heat Exchanger to Transcritical R744 Cycle Performance," *International Journal of HVAC&R Research*, 7:2, 155-168, 2001.
8. (\*) Yin, J. M., C. W. Bullard, and P. S. Hrnjak, "R-744 Gas Cooler Model Development and Validation," *International Journal of Refrigeration*, 24, 692-701, 2001.
9. (\*) Stoecker, W. F., P. S. Hrnjak, and C. A. Infante Ferreira, "Application of Ammonia and CO2 in Supermarkets," *Koude and Luchtbehandeling*, 94:8, 17-20, 2001.
10. (\*) (W) Drozdek, J., J. Chappel, C. Cusano, P. S. Hrnjak, N. R. Miller, and T. A. Newell, "Methods for Detection of Lubrication Failure Applied to a Swashplate Compressor," *Journal of Passenger Cars*, 109:6, 1553-1557, 2001.
11. (\*) (W) McEnaney, R. P. and P. S. Hrnjak, "Control Strategies for Transcritical R744 Systems," *Journal of Passenger Cars*, 109:6, 1711-1720, 2001.
12. (\*) (W) Hrnjak, P. S., M. A. Shannon, T. M. Leicht, and N. R. Miller, "Detection of Liquid Mass Fraction at the Evaporator Exit of Refrigeration Systems," *International Journal of Thermal Sciences*, 40, 773-786, 2001.
13. (\*) (W) Singh, G. M., P. S. Hrnjak, and C. W. Bullard, "Flow of Refrigerant R134a through Orifice Tubes," *International Journal of HVAC&R Research*, V.7 No. 3, 245-262, July 2001.
14. Fang, X., D., C. W. Bullard, and P. S. Hrnjak, "Heat Transfer and Pressure Drop of Gas Coolers," *ASHRAE Transactions*, 107:1, 255-266, 2001.
15. Fang, X., D., C. W. Bullard, and P. S. Hrnjak, "Modeling and Analysis of Gas Coolers," *ASHRAE Transactions*, 107:1, 4-13, 2001.
16. Hrnjak, P. S. and Y. Mao, "Defrost Issues in Indirectly Refrigerated Display Cases," *ASHRAE Transactions*, 107:1, 466-472, 2001.
17. Yin, J. M., C. W. Bullard and P. S. Hrnjak, "R-744 Gas Cooler Model Development and Validation," *International Journal of Refrigeration*, 24, 692-701, 2001.
18. Bullard, C. W., J. M. Yin, and P. S. Hrnjak, "Compact Counterflow Gas Cooler for R744," *Transactions of ASHRAE*, 108:1, 487-491, 2002.
19. (\*) Yin, J. M., C. W. Bullard, and P. S. Hrnjak, "Single-phase Pressure Drop Measurements in a Microchannel Heat Exchanger," *Journal of Heat Transfer Engineering*, 23:4, 3-12, 2002.
20. Song, S., C. W. Bullard, and P. S. Hrnjak, "Frost Deposition and Refrigerant Distribution in Microchannel Heat Exchangers," *Transactions of ASHRAE*, 108:2, 944-953, 2002.
21. (\*\*) Bullard, C. W. and P. S. Hrnjak, "Research in Transcritical R744 at ACRC, University of Illinois at Urbana-Champaign," *J. Soc. Air Conditioning and Refrig. Engrs. of Korea*, 31:7, 32-52, 2002.
22. (\*) Nino, V. G., P. S. Hrnjak, and T. A. Newell, "Two-phase Flow Visualization of R134a in a Multiport Microchannel Tube," *Heat Transfer Engineering*, 24:1, 41-52, 2003.
23. (W) Giannavola, S. M., J. M. Yin, C. W. Bullard, and P. S. Hrnjak, "Contribution of Heat Exchangers in Improved Performance of New Generation Automotive Air Conditioning System with R744," *Transactions of ASHRAE*, 109:1, 542-554, 2003.
24. (W) Tu, X., and P. S. Hrnjak, "Pressure Drop and Visualization of R134a Two-phase Flow in a Rectangular Microchannel," *Transactions of ASHRAE*, 109:1, 703-710, 2003.
25. Tu, X., P. S., Hrnjak, and C. W. Bullard, "Refrigerant 134a Liquid Flow through Micro-Scale Short Tube Orifices with/without Phase Change," *Experimental Heat Transfer and Fluid Flow*, 30, 253-262, 2003.

26. (\*) (W) ElSherbini, A. I., A. M. Jacobi, and P. S. Hrnjak, "Experimental Investigation of Thermal Contact Resistance in Plain-fin-and-tube Evaporators with Collarless Fins," *International Journal of Refrigeration*, 26:5, 527-536., 2003.
27. (\*\*) Hrnjak, P. S., "Developing Adiabatic Two-phase Flow in Headers – Distribution Issue in Parallel Flow Microchannel Heat Exchangers," *Heat Transfer Engineering*, 25:3, 61-68, 2004.
28. (\*) Hrnjak, P. S., "Flow Distribution Issues in Parallel Flow Heat Exchangers," *ASHRAE Transactions*, 110:1, 301-306, 2004.
29. "Microchannel Heat Exchangers", KGH, 2004
30. Elbel, S. and P. S. Hrnjak "Flash Gas Bypass for Improving the Performance of Transcritical R744 Systems that Use Microchannel Evaporators," *International Journal of Refrigeration*, 27:7, 724-735, 2004.
31. Richter, M. R., S. M. Song, J. M. Yin, M. H. Kim, C. W. Bullard, and P. S. Hrnjak, "Experimental Results of Transcritical CO<sub>2</sub> Heat Pump for Residential Application," *Energy*, 28:10, 1005-1019, 2005.
32. Xia, Y, P. S. Hrnjak, and A. M. Jacobi, "The Air-Side Thermal-Hydraulic Performance of Louvered-Fin, Flat-Tube Heat Exchangers with Sequential Frost-Growth Cycles," *ASHRAE Transactions*, 111:1, 487-495, 2005.
33. Park, C. Y. and P. Hrnjak, "Flow Boiling Heat Transfer of CO<sub>2</sub> at Low Temperatures in a Horizontal Smooth Tube," *ASME Journal of Heat Transfer*, 127:12, 1305-1312, 2005.
34. McEnaney, R. and P. S. Hrnjak, "Clutch Cycling Mode of Compressor Capacity Control of Transcritical R744 systems compared to R134a systems," *Society of Automotive Engineering Journal of Passenger Cars – Mechanical Systems*, 2005-01-2033.
35. Tu, X., P. S. Hrnjak, and C. W. Bullard, "Refrigerant 134a Liquid Flow Through Micro-Scale Short Tube Orifices with/with Phase Change," *Experimental Thermal and Fluid Science*, 30:3, 253-262, 2006.
36. Niño, V. G., E. W. Jassim, P. S. Hrnjak, and T. A. Newell, "Flow-Regime-Based Model for Pressure Drop Predictions in Microchannels," *International Journal of HVAC&R Research*, 12:1, 17-34, 2006.
37. Xia, Y, Y. Zhong, P. S. Hrnjak, and A. M. Jacobi, "Frost, Defrost, and Refrost and Its Impact on the Air-Side Thermal-Hydraulic Performance of Louvered-Fin, Flat Tube Heat Exchangers," *International Journal of Refrigeration*, 29:7, 1066-1179, 2006.
38. Hrnjak, P. S. "Carbon Dioxide Systems" *HVAC&R Research* 12:1, 1-2 Jan 2006.
39. Field, B. S. and P. S. Hrnjak, "Adiabatic Two-Phase Pressure Drop of Refrigerants in Small Channels," *Heat Transfer Engineering*, 28:8, 1-11, 2007.
40. Park, C.Y. and P. S. Hrnjak, "CO<sub>2</sub> and R410A Flow Boiling Heat Transfer, Pressure Drop, and Flow Pattern at Low Temperatures in a Horizontal Smooth Tube," *International Journal of Refrigeration*, 166-178, 2007.
41. Park, C.Y. and P. S. Hrnjak, "Effect of Heat Conduction Through the Fins of a Microchannel Serpentine Gas Cooler of Transcritical CO<sub>2</sub> System," *International Journal of Refrigeration*, 389-397, 2007.
42. Hrnjak, P. S. and X. Tu, "Single Phase Pressure Drop in Microchannels," *International Journal of Heat and Fluid Flow*, 28:1, 2-14, Feb 2007.
43. Park, C.Y. and P. S. Hrnjak, "CO<sub>2</sub> and R410A Flow Boiling Heat Transfer, Pressure Drop, and Flow Pattern at Low Temperatures in a Horizontal Smooth Tube," *International Journal of Refrigeration*, 30:1, 166-178, 2007.
44. Hrnjak, P. S. and X. Tu, "Single Phase Pressure Drop in Microchannels," *International Journal of Heat and Fluid Flow*, 28:1, 2-14, 2007.

45. Elbel, S. W. and P. S. Hrnjak, "Experimental Validation of a Prototype Ejector Designed to Reduce Throttling Losses Encountered in Transcritical R744 System Operation," *International Journal of Refrigeration*, 31:3, 411-422, 2008.
46. Hrnjak, P.S. and A. D. Litch, "Microchannel Heat Exchangers for Charge Minimization in Air-Cooled Ammonia Condensers and Chillers," *International Journal of Refrigeration*, 31:4, 658-668, 2008.
47. Park, C.Y. and P. S. Hrnjak, "NH<sub>3</sub> In-Tube Condensation Heat Transfer and Pressure Drop in a Smooth Tube," *International Journal of Refrigeration*, 31:4, 643-651, June 2008.
48. Park, C. Y. and P. S. Hrnjak, "Experimental and Numerical Study on Microchannel and Round-Tube Condensers in a R410A Residential Air-Conditioning System," *International Journal of Refrigeration*, 31:5, 822-831, 2008.
49. Kim, Y. J. , J. Jang, P. S. Hrnjak, and M. S. Kim, "Adiabatic Horizontal and Vertical Pressure Drop of Carbon Dioxide Inside Smooth and Microfin Tubes at Low Temperatures," *Journal of Heat Transfer*, 130:11, 111001-1-111001-10, November 2008.
50. Kim, Y. J., J. Jang, P. S. Hrnjak, and M. S. Kim, "Condensation Heat Transfer of Carbon Dioxide Inside Horizontal and Vertical Pressure Smooth and Microfin Tubes at Low Temperatures," *Journal of Heat Transfer*, 131:2, 2009.
51. Zhang, P. and P. S. Hrnjak, "Air-side Performance Evaluation of Three Types of Heat Exchangers in Dry, Wet and Periodic Frosting Conditions," *International Journal of Refrigeration*, 32:5, 911-921, 2009.
52. Park, C. Y. and P. S. Hrnjak, "Flow Boiling Heat Transfer, Pressure Drop, and Flow Pattern for CO<sub>2</sub> in a 3.5 mm Horizontal Smooth Tube," *Journal of Heat Transfer*, 131, 091501-1, 2009.
53. Park, C.Y., and P.S. Hrnjak, "CONDENSACIÓN, TRANSMISIÓN DE CALOR Y CAÍDA DE PRESIÓN DEL NH<sub>3</sub> EN EL INTERIOR DE UN TUBO LISO, Frio-Calor-Aire Acondicionado, January 2009 (Based on #40)
54. Elbel, S., and P. S. Hrnjak "REFRIGERACIÓN CON EYECTOR EN APLICACIONES DE AIRE ACONDICIONADO VISIÓN GENERAL DE LA EVOLUCIÓN DE DESARROLLOS," Frio-Calor-Aire Acondicionado, Jul/August 2009 (based on #123 conference publication)
55. Hrnjak, P. S., J. Manzione, D. Adams, D. Garski, and S. Collier, "EXITOSA CONVERSIÓN A R744 EN UNA UNIDAD DE CONTROL MEDIOAMBIENTAL, Frio-Calor-Aire Acondicionado, September 2009, (Based on #125 conference publication)
56. (W) Wujek, S.S., and P.S. Hrnjak, "Using Density to Calculate the Oil Circulation Ratio of a PAG Oil in R134A," *SAE International Journal of Materials and Manufacturing* 1 (1), pp. 362-368, 2009.
57. (W) Peuker, S., and P.S. Hrnjak, "Transient Refrigerant Migration and Oil Distribution of an R134a Automotive A/C System," *SAE International Journal of Passenger Cars - Mechanical Systems* 2 (1), pp. 714-724, 2009.
58. Choi, K.-I., A. S. Pamitran, J.-T. Oh, P. Hrnjak, and C. Y. Park, "Effect on Flow Boiling Heat Transfer of Minichannel Diameter for R-410A," *설비공학논문집 제21권 제12호*, 12,663-670, 2009.
59. Pamitran, A. S., K.-I. Choi, J.-T. Oh, and P. Hrnjak, "Experimental Investigation of Flow Boiling Heat Transfer of R-410A and R-134a in Horizontal Small Tubes," *ëœí•œì„æ¹„ê³µí•™íŒ*, 2009. í•ê³„í•™î ì°œí°œëœíŒ, pp. 1141~1146, 2009.6
60. Park, CY and P.S. Hrnjak, "Flow Condensation Heat Transfer and Pressure Drop in Multi-Port Microchannels at Low Temperatures," *International Journal of Refrigeration* 32 (6), pp. 1129-1139, 2009.
61. Pamitran, A. S., K.-I. Choi, J.-T. Oh, and P. Hrnjak, "Characteristics of Two-phase Flow Pattern Transitions and Pressure Drop of Five Refrigerants in Horizontal Circular Small Tubes," *International Journal of Refrigeration*, 33:3, 578-588, May 2010.
62. Zhang, P., and P.S. Hrnjak, "Air-side Performance of a Parallel-flow Parallel-fin (PF2) Heat Exchanger in Sequential Frosting," *International Journal of Refrigeration* 33 (6), pp. 1118-1128, 2010.

63. Hrnjak, P.S., and S. H. Hong, "Effect of Return Bend and Entrance on Heat Transfer in Thermally Developing Laminar Flow in Round Pipes of Some Heat Transfer Fluids with High Prandtl Numbers," *Journal of Heat Transfer* 132 (6), pp. 1-12, 2010.
64. Zhang, P., and P.S. Hrnjak, "Effect of Some Geometric Parameters on Performance of PF2 Heat Exchangers in Periodic Frosting," *International Journal of Refrigeration* 33 (2), pp. 334-346, 2010.
65. Hrnjak, P.S. "Issues in Two Phase Flow Distribution in Microchannel Heat Exchangers, KGH - Air conditioning, Heating and Refrigeration" (in Serbian: Problematika raspodele dvofaznih tokova u mikrokanalnim razmenjivačima toplote) vol. 39, No. 1, pp. 63-74, 2010
66. Park, C.Y and P.S. Hrnjak, "Pure Nh3 and Co2 Heat Transfer and Pressure Drop in Horizontal Smooth Tubes for Nh3 Two-Stage And Nh3/Co2 Cascade Refrigeration Systems: A Review," *International Journal of Air-Conditioning and Refrigeration*, 18 (2), pp. 85-100, 2010.
67. Li, B., S. Peuker, P. S. Hrnjak and A. G. Alleyne, "Refrigerant Mass Migration Modeling and Simulation for Air Conditioning Systems," *Applied Thermal Engineering*, 31 (10), 1770-1779, 2011.
68. Kondou, C. and P. Hrnjak, "Heat Rejection from R744 Flow Under Uniform Temperature Cooling in a Horizontal Smooth Tube Around the Critical Point", *International Journal of Refrigeration*, 34 (3), pp. 719-731, 2011.
69. Oh, J.-T., A.S. Pamitran, K.-I. Choi, P. Hrnjak, "Experimental Investigation on Two-Phase Flow Boiling Heat Transfer of Five Refrigerants in Horizontal Small Tubes Of 0.5, 1.5 and 3.0 Mm Inner Diameters," *International Journal of Heat and Mass Transfer*, 54 (9-10), pp. 2080-2088, 2011.
70. Li, B., S. Peuker, P. Hrnjak, and A. Alleyne, "Evaluation of Transient Refrigerant Migration Modeling Approach on Automotive Air Conditioning Systems," *SAE International Journal of Materials and Manufacturing*, 4(1), pp. 864-874, 2011.
71. Tuo, H., A. Bielskus, and P. Hrnjak, "Effect of Flash Gas Bypass on the Performance of R134a Mobile Air-Conditioning System with Microchannel Evaporator," *SAE International Journal of Materials and Manufacturing*, 4(1), pp. 231-239, 2011

### 3. 2. Articles In Conference Proceedings

1. Vujic, S., M. Markoski, P. S. Hrnjak, and M. Vranic, "Calorimetric Installation for Testing Monoblock and Split Type Air Conditioning Equipment at Refrigeration Laboratory in Belgrade," *Proceedings of the INTERKLIMA, Zagreb, Yugoslavia (in Serbocroatian)*, 403-409, June 1981.
2. Hrnjak, P. S., "Steady State Mathematical Model for Evaporator-Thermostatic Expansion Valve Loop," *Proceedings of the INTERKLIMA, Zagreb, Yugoslavia (in Serbocroatian)*, 267-276, June 1984.
3. Vujic, S., M. Markoski, P. S. Hrnjak and N. Ilic, "Thermal Characteristic of Specially Designed Copper Aluminum Finned Tubes," *Proceedings of the INTERKLIMA, Zagreb, Yugoslavia (in Serbocroatian)*, 233-244, June 1985.
4. Hrnjak, P. S., "Mathematical Model for Dynamic Behavior of Evaporator-Thermoexpansion Valve Loop Influence of the Bulb," *Proceedings of XIIIth Congress of Yugoslav Society of Heating, Refrigeration and Air Conditioning Engineers, Klimatizacija Grejanje Hladjenje, Belgrade, Yugoslavia, Nov. 1985.*
5. Markoski, M. and P. S. Hrnjak, "Determination of Exergetic Efficiency for Evaporation of Water in Evaporative Condensers," *Proceedings of XVIIth International Congress of Refrigeration, Vienna, Austria, Vol. B, 35-39, 1987.*
6. Markoski, M. and P. S. Hrnjak, "Exergetic Efficiency for Conversion of Concentrational into Thermal Nonequilibrium," in *Thermodynamics Analysis and Improvement of Energy Systems*, Pergamon Press, C. Ruxian and M. J. Moran, eds., Oxford, United Kingdom, 583-589, 1989.
7. Sheffield, J. W. and P. S. Hrnjak, "Contact Resistance in Plate Finned Tubed Heat Exchangers," *Proceedings of the 9th International Heat Transfer Conference, Jerusalem, Israel, Aug. 1990.*



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120. Wujek, S. S. and P. S. Hrnjak, "Using Density to Calculate the Oil Circulation Ratio of a PAG Oil in R134a," 2008 SAE Commercial Vehicle Engineering Congress and Exhibition, 2008-01-0833, April 2008.
121. Peuker, S. and P. S. Hrnjak, "Experiences from Experimental Investigation of an R744 Dual Evaporator Automotive A/C System," 2008 SAE Commercial Vehicle Engineering Congress and Exhibition, 2008-01-0834, April 2008.
122. Peuker, J. M. and P. S. Hrnjak, "Investigation to Improve Efficiency of Transcritical R744 Two-Stage Vapor Compression Systems," Proceedings of the 12th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, paper 2171, July 2008.
123. Zhang, P. and P. S. Hrnjak, "Air-Side Performance of a Parallel Fin Parallel Flow (PF2) Heat Exchanger in Sequential Frosting," Proceedings of the 12th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, paper 2275, July 2008.
124. Bowers, C. D. and P. S. Hrnjak, "Developing Two-Phase R134a Flow after an Expansion Valve in an 8.7mm Tube," Proceedings of the 12th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, paper 2378, July 2008.
125. Peuker, S. and P. S. Hrnjak, "Refrigerant Mass and Oil Migration During Start-up Transient," Proceedings of the 12th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, paper 2169, July 2008.
126. Elbel, S. and P. S. Hrnjak, "Ejector Refrigeration: An Overview of Historical and Present Developments with an Emphasis on Air-Conditioning Applications," Proceedings of the 12th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2350, July 2008.

127. Pamitran, A. S., K. I. Choi, and J. T. Oh, "Flow Boiling Heat Transfer of R410A in 0.5mm and 0.3mm Diameter Horizontal tube," Summer Annual Conference SAREK (The Society of Air-Conditioning and Refrigeration Engineers of Korea), June 25 2008.
128. Hrnjak, P., J. Manzione, D. Adams, D. Garski, and S. Collier, "Successful Conversion of R134a ECU Air Conditioner to R744," 8th IIR/IIR Gustav Lorentzen Conference on Natural Working Fluids, Copenhagen/Denmark, Session T3, CDP10-T3-02, Sept 7-10, 2008.
129. Hrnjak, P. S., "Carbon Dioxide as Refrigerant Challenges, the Role and the Prospective," 6th International Conference on Compressors and Refrigeration, Xi'an, China, September 25-28, 2008.
130. Pamitran, A. S., K. I. Choi, and J. T. Oh, "Flow Boiling Heat Transfer of R410A in 0.5mm and 0.3mm Diameter Horizontal Tube," Summer Annual Conference SAREK, The Society of Air-Conditioning and Refrigeration Engineers of Korea, June 25, 2008.
131. Hrnjak, P. S., "Carbon Dioxide is Becoming Stronger Contender," IIR-KGH Conference, Belgrade, December 2008.
132. Hrnjak, P. S., "Trends in CO<sub>2</sub> as Refrigerant, Reaching Out For A Greener Tomorrow," Int. Conference ACRECONF 20, February 21, 2009.
133. Hrnjak, P. S., "Carbon Dioxide in Light of New Low GWP Fluids," 3rd Korean Congress of Refrigeration, Seoul, March 19, 2009.
134. Hrnjak, P. S. "Refrigerant Charge Reduction: Strategies and Experience," IIR 1st Workshop on Refrigerant Charge Reduction, Cemagref Antony, France, 2009.
135. Hrnjak, P. S., "Low Charge Chillers Based on Microchannel Heat Exchangers: Opportunity for Expanding Use of Ammonia," Ammonia Refrigeration Conference, Ohrid- Macedonia, May 2009.
136. Hrnjak, P. "New Opportunities for Al Microchannel Heat Exchangers," 1st International Congress Aluminum Brazing Technologies for HVAC&R, Düsseldorf, June 16-17, 2009.
137. Seeton, C, and P. S. Hrnjak, "Measurements of Solubility, Liquid Density, and Liquid Viscosity for CO<sub>2</sub> Lubricant Mixtures," 3rd IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Boulder, CO, June 23-26, 2009.
138. Seeton, C, and P. S. Hrnjak, "Interfacial Tension of CO<sub>2</sub>-POE and CO<sub>2</sub>-PVE Mixtures," 3rd IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Boulder, CO, June 23-26, 2009.
139. Park, C. Y., and P. S. Hrnjak, "CO<sub>2</sub> Condensation Heat Transfer and Pressure Drop in Multi-Port Microchannels," 3rd IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Boulder, CO, June 23-26, 2009.
140. Pamitran, A. S., Ardiyansyah, J. T. Oh, and P. S. Hrnjak, "Flow Boiling Heat Transfer Characteristics in Horizontal Minichannels with R-410A, 3rd IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Boulder, CO, June 23-26, 2009.
141. Hrnjak, P. S., "New Opportunities for Al Microchannel Heat Exchangers," 1st International Congress Aluminum Brazing Technologies for HVAC&R, Düsseldorf, June 16-17, 2009.
142. Hrnjak, P. S., "Competition between Synthetic and Natural Refrigerants: Contributions to the Art and Science of Thermal Systems," 3rd IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants; Boulder, CO, June 23-26, 2009.
143. Hrnjak, P. S. "Two Phase Distribution Issues in Microchannel HXs," ECI International Conference Enhanced Compact and Ultra-Compact Heat Exchangers: from Microscale Phenomena to Industrial Applications, Heredia, Costa Rica, September 13-18, 2009.
144. Hrnjak, P.S., "Thermodynamic Possibilities and Technological Opportunities for Improving the Science of Refrigeration in search for Low Global Warming Thermal Systems," International Symposium on Next-generation Air Conditioning and Refrigeration Technology, Tokyo, Japan, February 17-19, 2010.
145. Hrnjak, P., "Ultra Low Charged Air Cooled Ammonia Chillers," 9th IIR Gustav Lorentzen Conference on Natural Working Fluids, Sydney, April 12-14, 2010.
146. Elbel, S. J.A. Manzione, S.J. Collier, and P. Hrnjak, "Compact, Lighweights Unitary-Type Air Conditioner using Transcritical R744 Designed for Energy Efficient Operation in Hot Climates," 9th IIR Gustav Lorentzen Conference on Natural Working Fluids, Sydney, April 12-14, 2010



147. Hrnjak, P.S., "Developments in Charge Reduction and Microchannel Technology-Mass Flux as a way to Affect Void Fraction-Charge," 2nd IIR Workshop on Refrigerant Charge Reduction, KTH, Stockholm, June 16-17, 2010.
148. Kondo, C and P. Hrnjak, "Excellent Heat Rejection from CO<sub>2</sub> Near the Critical Point-Opportunity for High Efficiency," IIR Conference Sustainable Refrigeration and Heat Pump Technology, KTH Stockholm June 13-16, 2010.
149. Hrnjak, P.S., "The Search for Natural Refrigerants and Sustainable Solutions Greatly Improves the Art and Science of Refrigeration," IIR Conference Sustainable Refrigeration and Heat Pump Technology, KTH, Stockholm June 13-16, 2010.
150. Hrnjak, P., "Operation of R-744 Environmental Control Units at High-Ambient Temperatures," ASHRAE 2010 Annual Conference, Albuquerque, NM, June 26-30, 2010.
151. Elbel, S. and P. S. Hrnjak, "Design, Build-Up, and Performance Investigation of a 35 kW (10 Ton) Military Environmental Control Unit Using Transcritical R744 Technology," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2205, July 2010.
152. (W) Peuker, S. and P. S. Hrnjak, "Experimental Techniques to Determine Oil Distribution in Automotive A/C Systems," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2107, July 2010.
153. Li, B., Peuker, S., A. G. Alleyne, and P. S. Hrnjak, "Refrigerant Migration Modeling During Shut-Down and Start-Up Cycling Transients," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2317, July 2010.
154. Zhao, H., S. Elbel, and P. S. Hrnjak, "Transport Phenomena Involved in Controlled Atmosphere Brazing of Microchannel Aluminum Heat Exchanger," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2406, July 2010.
155. Bowers, C. D., S. S. Wujek, and P. S. Hrnjak, "Quantification of Refrigerant Distribution and Effectiveness in Microchannel Heat Exchangers Using Infrared Thermography," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2117, July 2010.
156. (W) Pottker, G., P. S. Hrnjak, and B. Guo "Experimental Investigation of an R410A Vapor Compression System Working With an Ejector," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2473, July 2010.
157. (W) Zoellick, K. F. and P. S. Hrnjak, "Oil Retention and Pressure Drop in Horizontal and Vertical Suction Lines With R410A/POE," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2327, July 2010.
158. (W) Wujek, S. S. and P. S. Hrnjak, "Method for Quantitatively Analyzing Flow Phenomena in Annular-Mist Two-Phase Flows," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2174, July 2010.
159. (W) Wujek, S. S., S. Peuker, H. Mai, J. Bower, M. Koffler, and P. S. Hrnjak, "Method for Measuring Oil Contained in Air-Conditioning Components," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2173, July 2010.
160. (W) Kim, S., N. Pehlivanoglu, and P. S. Hrnjak, "R744 Flow Boiling Heat Transfer With and Without Oil at Low Temperatures in 11.2 mm Horizontal Smooth Tube," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2459, July 2010.
161. (W) Pehlivanoglu, N., S. Kim, and P. S. Hrnjak, "Effect of Oil on Heat Transfer and Pressure Drop of R744 in 6.1 mm Horizontal Smooth Tube," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2438, July 2010.
162. (W) Kondo, C. and P. S. Hrnjak, "Heat Rejection from R744 Near the Critical Point," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2424, July 2010.
163. (W) Bowers, C. D. and P. S. Hrnjak, "Determination of Void Fraction in Separated Two-Phase Flows Using Optical Techniques," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2293, July 2010.

- 164.(W) Wang, X., P. S. Hrnjak, S. Elbel, A. M. Jacobi, and M. He, "Flow Patterns and Mode Transitions for Falling-Films on Flat Tubes," Proceedings of the 13th International Refrigeration and Air Conditioning Conference at Purdue, West Lafayette, IN, 2461, July 2010.
- 165.Park, Y.C., and P.S. Hrnjak, "A study on the improving seasonal energy efficiency of an A/C System," 2010 The 2nd International Conference on Computer and Automation Engineering, ICCAE 2010 5, art. no. 5451434, pp. 313-316, 2010.
- 166.(W) Kondo, C. and P. S. Hrnjak, "Excellent Heat rejection from CO<sub>2</sub> near the critical point – opportunity for high efficiency", IIR Conference Sustainable Refrigeration and Heat Pump Technology, KTH Stockholm 2010
- 167.Hrnjak, P.S., "Developments in charge reduction and microchannel technology - Mass flux as a way to affect void fraction – charge", IIR Conference Sustainable Refrigeration and Heat Pump Technology, KTH Stockholm 2010
- 168.(W) Li, B., S. Peuker, P. Hrnjak, and A. Alleyne, "Evaluation of Transient Refrigerant Migration Modeling Approach on Automotive Air Conditioning Systems," SAE Congress Paper#2011.
- 169.(W) Tu, H., A. Bielskus, and P. Hrnjak, "Effect of Flash Gas Bypass on the Performance of R134a Mobile Air-Conditioning System with Microchannel Evaporator," SAE Congress Paper #, 2011
- 170.Hrnjak, P. S., "Low charged hermetic ammonia chillers are excellent opportunity for air conditioning and indirect refrigeration," IIR Ammonia Refrigeration Conference, Ohrid-Macedonia, April 2011.
- 171.Hrnjak, P. S., "New Opportunities for Al Microchannel Heat Exchangers," 2nd International Congress Aluminum Brazing Technologies for HVAC&R, Düsseldorf, May, 2011
- 172.Hrnjak, P.S. and Kondo, C., "Heat Rejection in Condensers Close to Critical Point - desuperheating, condensation in superheated region and condensation of two phase fluid," Proceedings of the HEFAT2011, 8th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics, 11 – 13 July 2011

### 3.3. Invited Lectures

1. "Secondary Loops-Is it the Only Option for Some Natural Refrigerants?" IEA Annex 22: Natural Working Fluids for Compression Refrigeration Systems, Gatlinburg, TN, Oct. 1997.
2. "Low Temperature Refrigeration and Secondary Loops," CRMA/NRCA Joint Meeting, Phoenix, AZ, Jan. 5-7, 1997.
3. "Indirect Refrigeration for Supermarkets," Southern California Edison CTAC Workshop, Los Angeles, CA, April 23, 1997.
4. "Acoustic Resonance in Plate Evaporators," Politechnica University, Sao Paulo, Brazil, May 15, 1997.
5. "Expansion Device Generated Noise," Embraco, Joinville, Brazil, May 19, 1997.
6. "Indirect Refrigeration for Supermarkets," MAUA Technical University, Sao Paulo, Brazil, May 21, 1997.
7. "Benefits and Penalties Associated with the Use of Secondary Loops," Proceedings of NIST - ASHRAE Conference, Gaithersburg, MD, 85-95, Oct. 1997.
8. "Space Conditioning for Mobile and Residential Applications Based on Transcritical CO<sub>2</sub> Cycle," Xi'an Jiaotong University, Xi'an, China, July 1999.
9. "Indirectly Refrigerated Display Cases," University of Commerce, Tianjin, China, July 1999.
10. "Transcritical Systems with CO<sub>2</sub> as a Refrigerant," Tianjin University, Tianjin, China, July 1999.
11. "Air Conditioning and Heat Pumps for Automobiles Based on Transcritical CO<sub>2</sub> Cycle," Shanghai Jiaotong University, Shanghai, China, Aug. 1999.
12. "Refrigeration Systems with CO<sub>2</sub> as Working Fluid Operating in Transcritical Mode," University of Sao Paulo, Sao Paulo, Brazil, April 5, 2000.
13. "New Technologies in Commercial Refrigeration," ENTRAC/Federal University of Pernambuco, Recife, Brazil, April 7, 2000.

14. "Carbon Dioxide as a Refrigerant for Commercial Refrigeration," CRMD-ARI (Commercial Refrigeration Manufacturers Division of Air Conditioning and Refrigeration Institute) Annual Meeting, Washington, D.C., June 6, 2000.
15. "Heat Transfer Issues in Laminar Flow of Single-phase Secondary Refrigerants through the Pipes," IAE Annex 26 Meeting, Stockholm, September 2000.
16. "Transcritical Refrigeration Systems with CO<sub>2</sub> and Some Refrigerant Issues of Today and Tomorrow," ASHRAE St. Louis Chapter, St. Louis, MO, Jan. 8, 2001.
17. "Secondary Loops in Commercial Refrigeration," ASHRAE Illinois Chapter, Chicago, IL, Jan. 15, 2001.
18. "Microchannel Heat Exchangers for Ammonia Systems," KGH – SMEITS, Belgrade, May 2001.
19. "Transcritical CO<sub>2</sub> Systems for Air-Conditioning and Refrigeration," KGH – SMEITS, Belgrade, May 2001.
20. "Some Lessons Learned from SAE AR CRP," SAE Alternate Refrigerant Meeting, Scottsdale, AZ, 2002.
21. "Microchannel Heat Exchangers as a Design Option for Charge Minimization on NH<sub>3</sub> and HC Systems," IIR Conference Zero Leakage - Minimal Charge, Stockholm, 2002.
22. "Some Issues in R744 Heat Exchangers," Alternative Refrigerant Winter Meeting VDA, 2002.
23. "International Trends in Commercial Refrigeration," Danish Technological Institute Meeting, Aarhus, November 27, 2002.
24. "New Options in Increasing Energy Efficiency in Commercial Refrigeration – Microchannel Heat Exchangers," FREE 2002, pp. 1-19, Milano, Italy, 2002.
25. "Alternate Refrigerant Cooperative Research Program," Alternative Refrigerant Winter Meeting VDA, 2003.
26. "New Options in Increasing Energy Efficiency in Commercial Refrigeration – Microchannel Heat Exchangers," FREE2002, Milano, Italy, November, 2002.
27. "Two-phase Flow Distribution in Headers of Parallel Flow Heat Exchangers and its Effect on Performance," Keynote Lecture, HEFAT 2003, Victoria Falls, June 2003.
28. "Developing Adiabatic Two-phase Flow in Headers – Distribution Issue in Parallel Flow Microchannel Heat Exchangers," Keynote Lecture, First International Conference on Microchannels and Microchannels, Rochester, NY, April 24-25, 2003.
29. "Refrigeration and its Environmental Impact," Keynote Lecture, CISBE-ASHRAE Worldwide Gathering of the Building Services Industry Conference, Edinburgh, September 24-26, 2003.
30. "Condensation of Carbon Dioxide at Low Temperatures," D-dig Meeting, Glasgow, September 22-24, 2003.
31. "Transcritical R744 Systems - Challenges and Some Recent Achievements," University of Tokyo, February 5, 2004.
32. "Microchannel Heat Exchangers", Keynote Lecture, 35 International Conference KGH, Beograd, December 1, 2004
33. "Charge Reduction in Ammonia Systems," Keynote Lecture, IIR Conference Ohrid, 2005.
34. "Major Issues in Transcritical CO<sub>2</sub> Systems," Keynote Lecture, 5th International Conference on Compressors and Refrigeration, July 18th -21st, 2005, Dalian City, China.
35. "Transcritical CO<sub>2</sub> Systems", at Fundamentals and Applications of HVAC & R Systems, KAIST, Korea, July 5-7, 2005.
36. "Transcritical CO<sub>2</sub> Systems for Mobile Applications," ATECH, Korea, July 8, 2005.
37. "Single Phase Pressure Drop in Microchannels" Keynote lecture, Heat Transfer and Fluid Flow in Microscale, Castelvecchio Pascoli, Italia, 25-30 September 2005.
38. "Improvement options for CO<sub>2</sub> and R134a systems," 4th Summit, Saalfelden, Austria, February 17, 2006.
39. "Natural Working Fluids: Development And Future Perspectives With Emphasis On Carbon Dioxide Issues," Keynote lecture, 7th IIR Gustav Lorentzen Conference on Natural Working Fluids, Trondheim, Norway, May 28-31, 2006.

40. "Optimization and Innovation in Practice" Keynote lecture, Institution of Mechanical Engineers, Institute of Refrigeration, Annual Conference, London, UK , November 15, 2006.
41. "Microsystems for Cooling" Invited presentation, Institution of Mechanical Engineers, Institute of Refrigeration, Annual Conference, London, UK, November 15, 2006.
42. "Technological and Theoretical Opportunities for Further Improvement of Efficiency and Performance of the Refrigerant Candidates – Achievements and Potentials for Efficiency Increase," VDA Meeting at Saalfelden, Austria 2007.
43. "In-tube Heat Transfer and Pressure Drop of Pure NH<sub>3</sub> and CO<sub>2</sub>," Keynote Lecture, IIR Conference, Ohrid, 2007.
44. "Ejector as an Option for Efficiency Improvement of Transcritical R744 Systems," University of Belgrade, Serbia Invited Lecture 2007.
45. "Low Charge Air Cooled Ammonia Chiller," ASHRAE Annual Meeting at Long Beach, June 27, 2007.
46. "Secondary Loop Systems Pros and Cons Compared to Other Options," 2nd European Workshop on MOBILE AIR CONDITIONING and AUXILIARIES, Torino, Italia, November 2007.
47. "Carbon Dioxide, State of the Art and Perspectives," Keynote lecture, AICARR – PADUA, Italy Dec 4, 2007.
48. "Carbon Dioxide as Refrigerant in New Circumstances," 38th International Congress on Heating, Refrigeration and Air Conditioning, Belgrade, Serbia, December 2007.
49. "New Trends and Technologies in Rac and Thermal Systems," Hangzhou, China, Danfoss, 2008.
50. "Carbon Dioxide is Becoming Stronger Contender," IIR – KGH Belgrade, December 2008.
51. "Trends in CO<sub>2</sub> as Refrigerant, Reaching Out For A Greener Tomorrow," International Conference ACRECONF 20, February 21, 2009.
52. "Carbon Dioxide in Light of New Low GWP Fluids," 3rd Korean Congress of Refrigeration, Seoul, March 19, 2009.
53. "Developing Two-phase Flow After an Expansion Valve," Seminar at Seoul National University, March 20, 2009.
54. "Refrigerant Charge Reduction: Strategies and Experience," IIR 1st Workshop on Refrigerant Charge Reduction, Cemagref Antony, France, 2009.
55. "Low Charge Chillers Based on Microchannel Heat Exchangers: Opportunity for Expanding Use of Ammonia," Ammonia Refrigeration Conference, Ohrid- Macedonia, May 2009.
56. "Minimizacija punjenja rashladnim fluidom," University of Belgrade, May 2009.
57. "New Opportunities for Al Microchannel Heat Exchangers," 1st International Congress Aluminum Brazing Technologies for HVAC&R, Düsseldorf, June 16-17, 2009.
58. "Competition between Synthetic and Natural Refrigerants: Contributions to the Art and Science of Thermal Systems," 3rd IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Boulder, June 23-26, 2009.
59. "Two Phase Distribution Issues in Microchannel HXs," ECI International Conference Enhanced Compact and Ultra-Compact Heat Exchangers: From Microscale Phenomena to Industrial Applications Heredia, Costa Rica, September 13-18, 2009.
60. "Thermodynamic Possibilities and Technological Opportunities for Improving the Science of Refrigeration in search for Low Global Warming Thermal Systems," International Symposium on Next-generation Air Conditioning and Refrigeration Technology, Tokyo, Japan, February 17-19, 2010.
61. "Reduction of Charge in Refrigeration Systems – Microchannel Condensers in Air Cooled Ammonia Chillers," the University of Queensland, April 16, 2010.
62. "Developments in Charge Reduction and Microchannel Thechnology-Mass Flux as a way to Affect Void Fraction-Charge," 2nd IIR Workshop on Refrigerant Charge Reduction, KTH, Stockholm, June 16-17, 2010.

63. "The Search for Natural Refrigerants and Sustainable Solutions Greatly Improves the Art and Science of Refrigeration," IIR Conference Sustainable Refrigeration and Heat Pump Technology, KTH, Stockholm, June 13-16, 2010.
64. "Condensation in Superheated Zone and Heat Rejection around Critical Point," The University of Tokyo, Kashiwa Campus, July 27nd, 2010.
65. "Low Charge Systems make NH3 Excellent Refrigerant Choice for Chillers," NEDO Seminar, University of Tokyo, Hongo Campus, July 30, 2010.
66. "Refrigerant Charge Reduction - Design of Microchannel Heat Exchangers," NEDO Seminar, University of Tokyo, Hongo Campus, July 30, 2010.
67. "CO2 as refrigerant for small AC systems" International Workshop on Alternatives to HCFC-22 in RAC Sector, Hefei, China, November 2nd, 2010
68. "Charge reduction in DX evaporators and MCHX - flow regimes and distribution," IIR Annual Conference, Orlando March, 2011
69. "Low charged hermetic ammonia chillers are excellent opportunity for air conditioning and indirect refrigeration," IIR Ammonia Refrigeration Conference, Ohrid- Macedonia, April 2011.
70. "New Opportunities for Al Microchannel Heat Exchangers," 2nd International Congress Aluminum Brazing Technologies for HVAC&R, Düsseldorf, May, 2011
71. "Heat Rejection in Condensers Close to Critical Point - desuperheating, condensation in superheated region and condensation of two phase fluid," 8th HEFAT 11–13 July 2011

### 3.4. Reports

1. Davis, M. A., P. S. Hrnjak, and A. M. Jacobi, "Evaporator Calorimeter: The Study of Overall Heat Transfer Performance," ACRC Report No. TR-107, Sept. 1996.
2. (W) Wood, A. C., P. S. Hrnjak, and D. L. Thurston, "Modeling and Comparison of Primary and Secondary Refrigeration System Performance," ACRC Report No. CR-7, Sept. 1996.
3. (W) Terrell Jr., W. J., Y. Mao, and P. S. Hrnjak, "Evaluation of Secondary Loop Processes for Supermarket Refrigeration," ACRC Report CR-15, Oct. 1996.
4. Hrnjak, P. S., N. R. Miller, and E. Rodarte, "Transient Tests of Air Conditioning System Performed on a Caravan 1994," ACRC Report CR-13, Sept. 1997.
5. Miller, N. R., P. S. Hrnjak, and E. Rodarte, "Transient Tests of Air Conditioning System Performed on a Caravan 1997," ACRC Report, CR- 12, December 1997.
6. Hrnjak, P. S., N. R. Miller, and E. Rodarte, "Acoustic Resonance in Plate Evaporators," ACRC Report CR-10, Nov. 1997.
7. Miller, N. R., P. S. Hrnjak, and E. Rodarte, "Continued Research on Plate Evaporator Noise Emission," ACRC Report CR-31, Nov. 1998.
8. (W) Lenger, M. and A. M. Jacobi and P. S. Hrnjak, "Superheat Stability of an Evaporator and Thermostatic Expansion Valve," ACRC Report No. TR-138, July 1998.
9. (W) Mao, Y., W. J. Terrell, and R. C. Reef, and P. S. Hrnjak, "New Coolant for Indirect Refrigeration Based on Potassium Formate," ACRC Report CR-11, Sept. 1997.
10. (W) Shannon, M., P. S. Hrnjak, and T. Leicht, "Exploratory Research on MEMS Technology for Air Conditioning and Heat Pumps," EPRI Report No. TR111699, Dec. 1998.
11. (W) Boewe, D. E., R. P. McEnaney, Y. C. Park, J. M. Yin, and C. W. Bullard, and P. S. Hrnjak, "Comparative Experimental Study of Subcritical R134a and Transcritical Systems for Mobile Applications," ACRC Report No. CR-17, July 1999.
12. (W) Singh, G. M., E. Rodarte, and N. R. Miller, "Noise Generation from Expansion Devices in Refrigerant," ACRC Report No. TR-152, July 1999.

13. (W) McEnaney, R. P., J. M. Yin, C. W. Bullard, and P. S. Hrnjak, "An Investigation of Control-Related Issues In Transcritical R744 and Subcritical R134a Mobile Air Conditioning Systems," ACRC Report No. CR-19, July 1999.
14. (W) Beaver, A. C., J. M. Yin, C. W. Bullard, and P. S. Hrnjak, "An Experimental Investigation of Transcritical Carbon Dioxide Systems for Residential Air Conditioning," ACRC Report No. CR-18, July 1999.
15. (W) Litch, A. D. and P. S. Hrnjak, "Condensation of Ammonia in Microchannel Heat Exchangers," ACRC Report No. CR-22, Aug. 1999.
16. (W) Hong, S. H. and P. S. Hrnjak, "Heat Transfer in Thermally Developing Flow of Fluids with High Prandtl Numbers Proceeding and Following U-Bend," ACRC Report No. CR-24, Oct. 1999.
17. (W) Drozdek, J. C., J. D. Chappell, C. Cusano, P. S. Hrnjak, N. R. Miller, and T. A. Newell, "Methods for Detecting Lubricant Failure Applied to a Swashplate Compressor," ACRC Report No. TR-160, Feb. 2000.
18. (W) Solberg, J. R., N. R. Miller, and P. S. Hrnjak, "A Sensor for Estimating the Liquid Mass Fraction of the Refrigerant Exiting an Evaporator," ACRC Report No. TR-161, Feb. 2000.
19. (W) Singh, G. M., E. Rodarte, N. R. Miller, and P. S. Hrnjak, "Modification of a Standard Aeroacoustic Valve Noise Model for Friction and Two Phase Flow," ACRC Report No. TR-162, April 2000.
20. (W) Singh, G. M., E. Rodarte, N. R. Miller, and P. S. Hrnjak, "Prediction of Noise Generated by Expansion Devices Throttling Refrigerant," ACRC Report No. TR-163, April 2000.
21. Yin, J. M., C. W. Bullard, and P. S. Hrnjak, "R744 Gas Cooler Model Development and Validation," ACRC Report No. CR-29, April 2000.
22. Yin, J. M., C. W. Bullard, and P. S. Hrnjak, "Pressure Drop Measurements in Microchannel Heat Exchangers," ACRC Report No. CR-30, April 2000.
23. (W) Carlson, D., P. S. Hrnjak, and C. W. Bullard, "Deposition, Distribution and Effects of Frost on a Multi-Row Heat Exchanger Performance," ACRC Report TR-183, Urbana, IL, June 2000.
24. (W) Wu, Y., P. Verma, C. W. Bullard, and P. S. Hrnjak, "Simulating the Performance of a Heat Exchanger During Frosting," ACRC Report TR-186, Urbana, IL, June 2000.
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77. Sethi, A. and P. S. Hrnjak, "Oil Retention and Pressure Drop of R1234yf and R134a with POE ISO 32 in Suction Lines," ACRC Report No. TR-281, June 2011.
78. Rajan, S. and P. S. Hrnjak, "Comparison of Refrigerants R410a and R404a for Use in Low Temperature Applications: A Computer Model Study," ACRC Report No. TR-282, June 2011.
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80. Fay, M. A. and P. S. Hrnjak, "Effect of Conical Distributors on Evaporator and System Performance," ACRC Report No. TR-284, October 2011.
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82. Bielskus, A. V. and P. S. Hrnjak, "Two Phase Flow Distribution in Parallel Flow Heat Exchangers – Experimentally Verified Model," ACRC Report No. TR-286, December 2011.

## 2. Grants, contracts and gifts (*in chronological order up to past ten years*)

### a. For Research

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
96 to 97	New Secondary Refrigerant Based on Potassium Formate	Kemira Oy, Finland	\$30,148	\$30,148	1
96 to 98	Stability of the Superheat Signal in Evaporators and Valves / A. M. Jacobi	ACRC	\$66,648	\$33,324	2/A. M. Jacobi
96 to 98	Exploratory Research on MEMS Technology for Air – Conditioning and Heat-Pumps / M. A. Shannon	EPRI	\$123,804	\$61,902	2
96 to 98	Fractionation and Maldistribution of Refrigerant Ternary Blends when Evaporating with Low Mass Flux in Brazed Plate Heat Exchangers	NIST, Trane	\$141,710	\$141,710	1
96 to 98	Modes of Propagation of an Acoustic Signal from Expansion Devices and Investigation of Possible Attenuation / N. R. Miller	ACRC	\$71,398	\$35,689	2/N. R. Miller
96 to 99	Evaluation of Secondary Loop Processes for Use in Low-Temperature Refrigeration for Supermarkets	US EPA, Hussmann and Tyler	\$173,494	\$173,494	1

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
96 to 99	Air Conditioning and Refrigeration Using Carbon Dioxide Refrigerant	Hydro Aluminum A. S.	\$747,642	\$747,642	1
97 to 99	Acoustic Phenomena in Plate Heat Exchangers / N. R. Miller	Chrysler Dayton Thermal Products	\$103,854	\$51,927	2
97 to 00	Integrated Mesoscopic Cooler Circuits / (N. R. Miller, C. W. Bullard, D. J. Beebe, A. M. Jacobi, P. S. Hrnjak, T. Saif, N. Aluru, H. Sehitoglu, A. Rockett, and J. Economy are faculty associates)	DARPA	\$3,991,118	\$332,593	12/M. L. Philpott, M. A. Shannon
98 to 99	Modes of Propagation of an Acoustic Signal from Expansion Devices and Investigation of Possible Attenuation	ACRC	\$49,991	\$24,990	2/N. R. Miller
98 to 99	Condensation of Ammonia in Microchannel Heat Exchangers	Hydro Aluminum	\$15,000	\$15,000	1
98 to 99	Phenomena in Heat Exchangers with Secondary Refrigerants	Norsk Hydro	\$30,000	\$30,000	1
98 to 99	Condensation of Ammonia in Microchannel Heat Exchangers	IIAR	\$15,000	\$15,000	1
98 to 99	Condensation of Ammonia in Microchannel Heat Exchangers	Modine	\$15,000	\$15,000	1
98 to 99	Research in Secondary Refrigerants	Kemira Oy, Finland	\$20,000	\$20,000	1
98 to 00	Measurement of the Relationship Between Oil Circulation and Compressor Lubrication in a Mobile Air Conditioning System Under a Variety of Transient and Steady State Operating Conditions / N. R. Miller, T. A. Newell	ACRC	\$137,414	\$34,353	4/C. Cusano
98 to 00	An Experimental and Computational Study of Two-phase Flow in Distribution Headers / S. P. Vanka	ACRC	\$168,033	\$59,014	3/J. E. Peters
98 to 00	Heat Transfer in Developing Laminar Flow	Heatcraft	\$20,000	\$20,000	1
98 to 00	Heat Transfer in Secondary Refrigerants Based on Potassium Formate	Kemira	\$20,000	\$20,000	1
98 to 01	Optimization of a Mobile Air Conditioning System	Ford-Visteon	\$110,467	\$110,467	1
99 to 00	Sound Generation Mechanisms in Expansion Devices	ACRC	\$131,451	\$65,725	2/N. R. Miller

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
99 to 00	Impact of Elliptical Tubes on Evaporator Frosting	Evapco technical testing agreement	\$18,000	\$18,000	1
99 to 00	Studies of Evaporator Frosting	Evapco	\$14,000	\$14,000	1
99 to 00	Increasing Efficiency while Reducing Charge in Supermarket Display Case Evaporators	DoE	\$55,390	\$27,485	2/C. W. Bullard
99 to 01	Effect of Hydrodynamics, Substrate Energy and Structure of Frost Growth / J. G. Georgiadis	ACRC	\$179,039	\$57,676	3/A. M. Jacobi
99 to 01	Void Fraction and Pressure Drop in Microchannels	ACRC	\$126,951	\$63,475	2/T. A. Newell
99 to 01	Understanding and Reducing Air-Curtain Entrainment	ACRC	\$125,820	\$62,910	2/E. Loth
99 to 01	Potential of CO2 for Vehicle Space Conditioning / C. W. Bullard	GM-Delphi	\$241,832	\$120,916	2
99 to 01	Studies in Scroll Compressor Flow Modulation	Copeland	\$78,000	\$78,000	1
99 to 01	Research in Parallel Flow Heat Exchangers for CO2	Modine	\$50,000	\$50,000	1
99 to 01	Feasibility of Transcritical R744 Systems for Mobile Space Air Conditioning Applications: Phase I C. W. Bullard	NSF, DoE & US Army CECOM	\$138,390	\$69,165	2
99 to 01	Transcritical CO2 Cycle for Residential Air Conditioning	Trane	\$80,000	\$80,000	1
99 to 01	Residential Heat Pumps with Transcritical CO2 / C. W. Bullard	Hydro Aluminum A.S.	\$120,000	\$60,000	2
00 to 02	An Experimental and Computational Study of Disperse Two-Phase Flow in Headers / S. P. Vanka	ACRC	\$148,691	\$49,564	3/J. E. Peters
00 to 02	Strategies for Improving Operation and Reliability of Vapor Compression Systems / N. R. Miller, C. W. Bullard	ACRC	\$134,372	\$33,343	4/A. G. Alleyne
00 to 02	Evaporator Frosting and Defrosting Strategies	ACRC	\$81,423	\$40,717	2/C. W. Bullard
00 to 02	Control Strategies in Transcritical CO2 Systems	Visteon	\$60,000	\$60,000	1
01 to 02	Alternate Refrigerants Cooperative Research Project / C. W. Bullard	SAE	\$298,393	\$149,194	2
01 to 03	Transcritical CO2 for Residential Air Conditioning	The Trane Company	\$20,000	\$20,000	1

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
01 to 03	Heat Transfer in Low Temperature Boiling and Condensing CO2	Wolverine	\$37,000	\$37,000	1
01 to 03	Improving Refrigerant Distribution and Heat Exchanger Performance in Transcritical CO2 Systems / C. W. Bullard	NSF/US Army CECOM	\$160,000	\$80,000	2
01 to 03	Designing and Optimizing Systems with Compressor Short-cycling	ACRC	\$130,944	\$65,472	2/C. W. Bullard
01 to 03	Charge Minimization in Components and Refrigeration Systems that use Hydrocarbons as a Refrigerant	ACRC	\$81,644	\$81,644	1
01 to 03	Frost Accumulation Effects on Louvered-Fin, Microchannel Heat Exchangers / J. G. Georgiadis	ACRC	\$110,000	\$36,667	3/A. M. Jacobi
01 to 03	Flow Distribution and Pressure Drop in Microchannel Manifolds	ACRC	\$139,524	\$69,762	2/T. A. Newell
01 to 03	Void Fraction and Pressure Drop in Microchannels / T. A. Newell	ACRC	\$65,833	\$32,912	2
01 to 03	In-Tube Condensation of Ammonia in Smooth and Enhanced Tubes with and without Miscible Oil / T. A. Newell	ASHRAE	\$146,941	\$73,471	2
01 to 02	Evaluation of Potential of A Current Improved & Alternative Tech. In Mobile A/C Systems	SAE International	\$1,073,898.00	\$1,073,898.00	1
01 to 02	Impact Of Frosting On Supermarket Display Cases / C. W. Bullard	DOE	\$84,989	\$42,494	2
01 to 02	Feasibility Of Transcritical R744 Systems For Mobile Space Conditioning Applications / C. W. Bullard	NSF	\$290,204	\$145,102	2
01 to 02	Condenser Reheating	Caterpillar	\$135,000	\$135,000	1
01 to 03	In-Tube Condensation Of Ammonia In Smooth & Enhanced Tubes With & W/O Miscible Oil/. T. A. Newell	ASHRAE	\$146,961	\$73,481	2
01 to 03	Condensation of CO2 at Low Temperatures	Wolverine	\$15,000	\$15,000	1
01 to 04	A Theoretical and Experimental Approach to Rapid Screening & Design of Secondary Refrigerants / P. J. A. Kenis (Chem. Eng.)	NSF	\$424,561	\$159,275	3/N. Sahinidis (Chem. Eng.)
01 to 02	Heat Transfer in Microchannel Condensers for R410A	Modine	\$15,000	\$15,000	1
02 to 04	Refrigerant Lubricant Interaction in Transcritical CO2 systems	Visteon	\$90,000	\$90,000	1

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
02 to 04	Oil Effects on Heat Transfer and Pressure Drop in Small Channels	ACRC	\$138,058	\$138,058	1
02 to 05	Heat Transfer in the Transcritical CO2 System for Mobile Heat Pumping and Refrigeration	Daimler Chrysler	\$140,000	\$140,000	1
02 to 04	Small Systems for Transcritical CO2	Hussmann	\$90,000	\$90,000	1
02 to 04	Small Systems for Transcritical CO2	Sanyo	\$80,000	\$80,000	1
02 to 03	Thermosyphon loops with CO2	Embraco	\$20,000	\$20,000	1
02 to 03	Evaluation of Potential of A Current Improved & Alternative Tech. In Mobile A/C Systems	SAE International	\$94,800	\$94,800	1
03	Advanced R744 systems for mobile a/c applications	Hydro	\$50,000	\$50,000	1
03	Advanced R744 systems for mobile a/c applications	BMW	\$7,500	\$7,500	1
03	Advanced R744 systems for mobile a/c applications	Audi	\$7,500	\$7,500	1
03	Advanced R744 systems for mobile a/c applications	Visteon	\$30,000	\$30,000	1
03	Advanced R744 systems for mobile a/c applications	Modine	\$15,000	\$15,000	1
03	Small Systems for Transcritical CO2	Modine	\$10,000	\$10,000	1
03 to 05	Thermosyphon loops with CO2	Embraco	\$80,000	\$80,000	1
03 to 05	Development of an Unbrazed, Flattened Copper Tube Condenser	CDA	\$280,000	\$140,000	2/w. Newell
03 to 05	Advanced Dynamic Modeling, Control, and Diagnostics for Vapor Compression Systems, #163	ACRC	\$72,000	\$36,000	3/w. Alleyne & Bullard
03 to 05	Heat Pipes and Thermosyphons for Air-Conditioning and Refrigeration Applications #164	ACRC	\$80,000	\$27,000	2/w. Jacobi
03 to 05	Experimental Investigation of Two-Phase Fluid Distribution in Microchannel Manifolds #154	ACRC	\$84,000	\$42,000	2/w. Newell
03 to 05	Experimental Investigation of Viscous Two-Phase Flow in Microchannels #158	ACRC	\$84,000	\$42,000	2/w. Newell
03 to 05	Refrigerant R410A in Commercial Refrigeration Systems #167	ACRC	\$79,000	\$79,000	1
03 to 05	Applications and Control of Systems Using Rapid-Cycling to Modulate Capacity #161	ACRC	\$83,000	\$41,500	2/w. Bullard

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
03 to 05	Refrigerant and Oil Migration and Retention in Refrigeration Systems #164	ACRC	\$84,000	\$42,000	2/w. Newell
03 to 05	Advanced Control and Fault Detection for Vapor Compression Systems #156	ACRC	\$80,000	\$27,000	3/w. Alleyne & Bullard
03 to 04	Plus-up Development of Transcritical CO2 systems for Mobile and ECU Applications	Modine	\$235,300	\$235,300	1
03 to 04	Evaluation of Potential of R152a, R134a And R744 as Refrigerants in Mobile Air Conditioning Systems	SAE	\$187,200	\$187,200	1
03 to 04	Plus-up Development of Transcritical CO2 systems for ECU Applications in Heat Pump Mode	Modine	\$36,900	\$36,900	1
04 to 06	Experimental and Modeling Investigation of Two Evaporator Systems #176	ACRC	\$83,000	\$83,000	1
04 to 06	Charge Minimization of Small Systems #179	ACRC	\$83,000	\$83,000	1
04 to 06	Evaporation of R744 with and without Oil in Round Smooth and Enhanced Tubes #183	ACRC	\$82,780	\$82,780	1
04	Evaluation of Potential of R152a, R134a And R744 as Refrigerants in Mobile Air Conditioning Systems - extension	SAE	\$95,000	\$95,000	1
05 to 07	I-MAC 3-/50 Phase	SAE	\$461,000	\$461,000	1
05 to 07	Plus-up phase II - Development of Transcritical CO2 systems for Mobile and ECU Applications	Modine	\$200,000	\$200,000	1
05 to 08	Transcritical CO2 for residential applications	SANYO	\$120,000	\$120,000	1
05 to 07	Condensation of R744 with and without Oil in Round Smooth and Enhanced Tubes #191	ACRC	\$75,000	\$75,000	1
05 to 07	Effects of Oil Migration and Retention #197	ACRC	\$75,000	\$75,000	1
05 to 07	Two-Phase Flow of Refrigerant with Oil in Small Channels #201	ACRC	\$75,000	\$75,000	1
05 to 07	Developing Adiabatic Two-Phase Flow after Expansion Valve #204	ACRC	\$75,000	\$75,000	1

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
06 to 08	Plus-up phase III - Development of Transcritical CO2 systems for Mobile and ECU Applications	Modine	\$150,000	\$150,000	1
06 to 08	Experimental and Modeling Investigation of Cool Down (Start- up) Transients in A/C Systems #209	ACRC	\$80,280	\$80,280	1
06 to 08	Oil Separation and Oil Separators	ACRC	\$80,000	\$80,000	1
07 to 08	Exploration of potential for R410A systems efficiency increase by utilization of microchannel heat exchangers	Daikin	\$120,000	\$120,000	1
07 to 08	Investigation of effects of a/c system on CO2 emission of the vehicles	California Air Resource Board	\$100,000	\$100,000	1
07 to 09	Evaporation of R744 with and without Oil in Round Smooth and Enhanced Tubes 3 - 6mm at -10 to 0 °C: Heat Transfer, Pressure Drop, Flow Regimes #223	ACRC	\$79,000	\$79,000	1
07 to 09	Effect of Refrigerant Maldistribution in MC Evaporators on Performance #227	ACRC	\$79,000	\$79,000	1
07 to 09	Evaluation of potential for COP increase #230	ACRC	\$79,000	\$79,000	1
07 to 09	Effect of Using Flash Gas Separator on Evaporator Effectiveness and System Efficiency when Operating with Low Pressure Refrigerants #234	ACRC	\$79,000	\$79,000	1
08 to 10	Adiabatic two phase flow distribution of R410A	Daikin	\$160,000	\$160,000	1
08 to 10	Oil return in vertical pipes of R410A #241	ACRC	\$90,000	\$90,000	1
08 to 10	Cool-down (Start-up) Transients in A/C Systems #244	ACRC	\$90,000	\$90,000	1
08 to 10	Evaluation of potential for efficiency increase #247	ACRC	\$90,000	\$90,000	1
08 to 10	Evaporation of R744 with and without oil in round, smooth and enhanced tubes 9.52 - 12mm at -15 to 0 °C heat transfer, pressure drop, flow regimes# 238	ACRC	\$90,000	\$90,000	1

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
09 to 11	Heat Rejection from R744 in Smooth and Microgrooved Tubes Close to Critical Point: Condensation in Presence of Superheated Vapor #261	ACRC	\$90,000	\$90,000	1
09 to 11	Effect of Conventional Conical Distributors on Evaporator and System Performance #259	ACRC	\$90,000	\$90,000	1
09 to 11	Developing Flow of Oil at Compressor Discharge #256	ACRC	\$90,000	\$90,000	1
09 to 11	Compact Separators for Flash Gas Removal #250	ACRC	\$90,000	\$90,000	1
10 to 12	Heat Rejection of R410A in Smooth and Microgrooved Tubes Close to Critical Point - Condensation in Presence of Superheated Vapor #264	ACRC	\$90,000	\$90,000	1
10 to 12	Oil Retention and Return in Horizontal Vertical Pipes of R1234yf #266	ACRC	\$90,000	\$90,000	1
10 to 12	Refrigerant Distribution in Vertical Headers #268	ACRC	\$90,000	\$90,000	1
10 to 12	Experimental Evaluation of Ejector for R410A and Other Refrigerants #270	ACRC	\$90,000	\$90,000	2 w/S. Elbel
10 to 12	Charge Minimization of Refrigeration Systems #277	ACRC	\$90,000	\$90,000	1
11 to 13	Oil Flow at Compressor Discharge Valve and Shell #279	ACRC	\$90,000	\$90,000	1
11 to 13	Effect of Oil on Refrigerant Distribution in MC Evaporators #282	ACRC	\$90,000	\$90,000	1
11 to 13	Heat Rejection of Low GWP fluids in Smooth and Microgrooved Tubes Condensation in Two Phase and Superheated Region #284	ACRC	\$90,000	\$90,000	1
11 to 13	OCR and Oil Migration in HFO1234yf - MAC-Systems (TXV-controlled) #286	ACRC	\$90,000	\$90,000	1
11 to 13	Heat Pump Water Heater #289	ACRC	\$90,000	\$90,000	1
11 to 13	Flash Gas Bypass (FGB) for Stationary Systems #291	ACRC	\$90,000	\$90,000	1

## b. For Instruction

Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
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Years (Inclusive)	Brief Title or Description	Source of Funds	Total Funding	Funds Allocated to this prof	#PI's and lead PI if not this prof
97	Application of a Hot Wire Anemometry Measurement System to Product Performance / N. R. Miller, J. W. Nowak	ASHRAE	\$4,590	\$1,530	3

#### 4. Graduate Thesis Research Advising (*list co-advisor, if any*)

##### a. M.S. Thesis Students (*name and year granted or anticipated*)

Student Name	Year Graduated	Thesis Title	Placement
1996	Adam Wood (D. L. Thurston, co-advisor)	Modeling and Comparison of Primary and Secondary Refrigeration System Performances	Hughes Missile Command
1998	Matthew Lenger (A. M. Jacobi, co-advisor)	Superheat Stability of an Evaporator and Thermostatic Expansion Valve	
1999	Wilson Terrell	Evaluation of Secondary Fluids for Use in Low-Temperature Supermarket Applications	Professor at Trinity University, San Antonio, TX
1999	George Singh	Noise Generation from Expansion Devices in Refrigerant	The Trane Company
1999	Ryan McEnaney	An Investigation of Control-Related Issues in Transcritical R744 and Subcritical R134a Mobile Air Conditioning Systems	Caterpillar, Inc.
1999	Daniel Boewe	Comparative Experimental Study of Subcritical R134a and Transcritical R744 Refrigeration Systems for Mobile Applications	Cummins Engine Company
1999	Andrew Beaver	An Experimental Investigation of Transcritical Carbon Dioxide Systems for Residential Air Conditioning	Baltimore Air Coil
2000	Soong Hong	Heat Transfer in Thermal Developing Flow of Fluids with High Prandtl Numbers Preceding and Following U-Bend	Hamilton-Sundstrand
1999	Andrew Litch	Condensation of Ammonia in Microchannel Heat Exchangers	Whirlpool, Inc.
2000	Wesley Payne (T. A. Newell, co-advisor)	Void Fraction and Pressure Drop in Microchannels	Unknown
2001	Daniel Tallitsch	Fractionation of R-407C in Brazed Plate Heat Exchangers at Low Mass Flux	Duke Energy
2001	Todd Leicht (M. A. Shannon, co-advisor)	Exploratory Research on MEMS Technology for Air Conditioning and Heat Pumps	HSWCC
2001	Diane Carlson (C. W. Bullard, co-advisor)	Deposition, Distribution, and Effects of Frost on a Multi-Row Heat Exchanger Performance	Northrop Grumman Corp.

Student Name	Year Graduated	Thesis Title	Placement
2001	Yixia Wu (C. W. Bullard, co-advisor)	Simulating the Performance of a Heat Exchanger During Frosting	Z. S. Associates Global Consulting
2001	S. Ilic (C. W. Bullard, co-advisor)	Effect of Short-Cycling Compressor Modulation on Refrigeration System Performance	Praxair
2001	S. Song (C. W. Bullard, co-advisor)	Experimental and Simulation Analysis of Microchannel Evaporators	Doctoral Candidate, UIUC
2001	Matthew Richter (C. W. Bullard, co-advisor)	Comparison of R744 and R410A for Residential Heating and Cooling Applications	Agilent
2002	Shawn Nelson	Improved R134A Mobile Air Conditioning Systems	Hamilton-Sundstrand
2002	Michael Giannavola	Experimental Study of System Performance Improvements in Transcritical R744 Systems for Mobile Air-Conditioning and Heat Pumping	Evapco
2002	Parmesh Verma (C. W. Bullard, co-advisor)	Design Tool for Display Case Heat Exchanger Frosting and Defrosting	UTRC
2002	Tae Yoo (T. A. Newell, co-advisor)	An Experimental Investigation of Two-Phase Flow Distribution in Microchannel Manifold	
2002	Dan Tomkins (T. A. Newell, co-advisor)	Single Phase, Two-Phase Modeling; X-Ray Visualization for a Microchannel Manifold Distribution System	Royce Royce
2003	James Vollrath (T. A. Newell, co-advisor)	An Experimental Investigation of Pressure Drop and Heat Transfer in an In-Tube Condensation System of Pure Ammonia	
2003	Mark Hoehne	Charge Minimization in Systems and Components using Hydrocarbons as a Refrigerant	Modine
2003	Mike Zhang (T. A. Newell, co-advisor)	An Experimental Investigation of R134a Flow Distribution in Horizontal Microchannel Manifolds	
2003	Stefan Elbel	Experimental and Analytical Validation of New Approaches to Improve Transcritical CO <sub>2</sub> Environmental Control Units	CTS Urbana, IL
2003	David Adams (T. A. Newell, co-advisor)	Pressure Drop and Void Fraction in Microchannels Using Carbon Dioxide, Ammonia, and R245FA as Refrigerants	CTS/Univ. of Maryland
2004	Hardy Komandiwirya (T. A. Newell, co-advisor)	An Experimental Investigation of Pressure Drop and Heat Transfer in an In-Tube Condensation System of Ammonia with and Without Miscible Oil in Smooth and Enhanced Tubes	
2004	Jeremy Jang	Condensation of CO <sub>2</sub> at Low Temperatures	
2004	Andrew Musser	Control Issues in Variable Displacement Compressors for Transcritical CO <sub>2</sub> Systems	CTS, Urbana IL
2006	Christopher Rennels	Defrosting/Refrosting Issues in Louvered Folded Fins	

Student Name	Year Graduated	Thesis Title	Placement
2006	Steffen Peuker	Experimental and Modeling Investigation of Two Evaporator Automotive Air Conditioning Systems	Continuing PhD
2005	Joseph DeAngelis	Experimental Study of System Performance Improvements in Transcritical R744 Systems with Applications to Bottle Coolers	CTS/Ford
2005	Kevin Traeger	Charge Minimization of Microchannel Heat Exchangers	Modine
2006	Chad Bowers (T. A. Newell, co-advisor)	Experimental Investigation of Two-Phase Refrigerant Distribution in a Microchannel Manifold	CTS, Urbana IL
2005	Jason Burr (T. A. Newell, co-advisor)	Experimental Investigation of Viscous Two-Phase Flow in Microchannels	Rolls Roys
2006	Shelvin Salomon		Left UIUC
2005	Vishal Sheth (T. A. Newell, co-advisor)	Refrigerant and Oil Migration and Retention in Air Conditioning and Refrigeration Systems	
2005	Timothy Beavers (T. A. Newell, co-advisor)	Numerical Analysis of an Unbrazed Flattened Copper Tube Condenser	Tecumseh
2005	Thomas Gaddis (T. A. Newell, co-advisor)	Flat Copper Tube Folded Fin Heat Exchanger Analysis	CTS, Urbana, IL
2006	Scott Wujek	Experimental Investigation of an Environmental Control Unit Utilizing Carbon Dioxide for Heating and Cooling	Continuing PhD
2007	Jennifer Mott	Investigation of Options to Improve Efficiency of Transcritical R744 Two-Stage Vapor Compression Systems	Continuing PhD
2008	Michael Dschida	Performance Evaluation of Microchannel Heat Exchangers for a Residential Mini-Split Type Heat Pump System	American Electric Power
2011	Alen Milosevic	Flash Gas Bypass Concept Utilizing Low Pressure Refrigerants	TI
2011	Suri Rajan	Comparison of Refrigerants R410a and R404a for Use in Low Temperature Applications: A Computer Model Study	
2010	Kurt Zoelick	Oil Retention and Pressure Drop in Horizontal and Vertical Suction Lines with R410A / POE ISO 32	Cornelius
2010	Yang Zou	Performance measurement and visualization on the refrigerant distribution in the vertical manifold of the microchannel tube heat exchanger	Continued PhD
2011(anticipated)	Michael Fay		CTS, Urbana, IL
2011	Ankit Sethi	Oil Retention and Pressure Drop of R1234yf and R134a with POE ISO 32 in Suction Lines	Honeywell
2011	Algirdas Vincas Bielskus		
2012	Yadira Fuentes Padilla		CTS, Urbana, IL

Student Name	Year Graduated	Thesis Title	Placement
2012 (anticipated)	Bharat Budhiraja		
2012	Shenghan Jin		CTS, Urbana, IL
2012(anticipated)	Neal Lawrence		PhD
2013 (anticipated)	Huize Li		
2013 (anticipated)	Aravind Ramakrishnan		

**b. Ph.D. Thesis Students (*name and year granted or anticipated*)**

Student Name	Year Graduated	Thesis Title	Placement
2002	Victor Nino (T. A. Newell, co-advisor)	Characterization of Two-Phase Flow in Microchannels,	Modine
2004	Fei Peng	Adiabatic Developing Two-Phase Refrigerant Flow in Manifolds of Heat Exchangers	State Street Global Advisors
2004	Xiao Tu	Flow and Heat Transfer in Microchannels 30 to 300 Microns in Hydraulic Diameter	Microsoft
2009	Christopher Seeton	Refrigerant - Oil Interaction in Small Channels	Honeywell
2007	Stefan Elbel	New Approaches in Transcritical CO <sub>2</sub> Cycles	CTS, Urbana, IL
2006	Chang Yong Park	Condensation of CO <sub>2</sub> and R410a in Microchannel Heat Exchangers	Professor Korea University of Technology
2007	Brandon Field	Refrigerant/Oil Pressure Drop and Fluid Flow in Small channels	Professor at Indiana University
	Jeremy Jang	Condensation of CO <sub>2</sub> at low temperatures in presence of oil	Transferred to another department
2010	Steffen Peuker	Experimental and Analytical Investigation of Refrigerant and Lubricant Migration	Professor, University of Alaska Anchorage
2009	Chad Bowers	Developing Adiabatic Two Phase Flow	CTS, Urbana, IL
2011	Scott Wujek		CTS, Urbana, IL
2012	Gustavo Pottker		Honeywell
2012 (anticipated)	Augusto Zimmermann		
2013(anticipated)	Yang Zou		
2013 (anticipated)	Hangfei Tuo		

**5. Editorships of Journals or Other Learned Publications (*list year*)**

1. KGH - Air conditioning, Heating and Refrigeration Journal, 1982-1992
2. HVAC&R Research Journal, 2004-2008
3. SAREK, 2009-2013

**6. Post-doctoral Associates and Visiting Scientists (>3 months stay in the past three years) (list name, year(s), country of origin, permanent employer)**

Name	Title (percent time)	Country of Origin	Permanent Employer	Years
Ma Yitai	Visiting Scholar (100%)	China	Tianjin University	1997
Youn Cheol Park	Visiting Scholar (100%)	Korea	Korea University	1997-98
Jostein Pettersen	Visiting Scholar (100%)	Norway	Norwegian University of Science and Technology	1997-98
Jian Min Yin	Visiting Scholar (100%)	China	Xi'an Jiaotang University	1997-01
Xiande Fang	Visiting Scholar (100%)	China	Nanjing University	1998-99
Bjorn Fagerli	Visiting Scholar (100%)	Norway	Norwegian University of Science and Technology	1998-99
José R. Simoes	Visiting Scholar (100%)	Brazil	University of Sao Paulo	1998-99
Man Hoe Kim	Visiting Scholar (100%)	Korea	Samsung	1999-01
Xinzhong Li	Visiting Scholar (100%)	China	Xi'an Jiaotang University	2000-date
Sasu Karkiainen	Visiting Scholar (100%)	Finland	Technical University, Tampere	2000-01
Keumnam Cho	Visiting Scholar (100%)	Korea	Sungkyunkwan University	2000-01
Thomas Hajesh	Visiting Scholar (100%)	Germany	U. of Applied Sciences, Gießen	2001-02
Peter Binneberg	Visiting Scholar (100%)	Germany	Technical University of Dresden	2002-date
Che Yin	Visiting Scholar (100%)	China	University of Commerce, Tjianjin	2002-date
Michael Daniel	Visiting Scholar (100%)	Germany	U. of Applied Sciences Esslingen	2002-2003
Johannes Zilly	Visiting Scholar (100%)	Germany	Technical University of Karlsruhe	2002-2003
Gustavo Weber	Visiting Engineer (100%)	Brazil	Embraco/Univ. of S. Catharina	2002-2003
Yoon Jo Kim	Visiting Scholar (100%)	South Korea	Seoul National University	2003

Name	Title (percent time)	Country of Origin	Permanent Employer	Years
Ping Zhang	Visiting Scholar (100%)	China	Zhejiang College of Commerce	2003-date
Donal Finn	Visiting Scholar (100%)	Ireland	University College Dublin	2003-2004
Jong-Taek Oh	Visiting Scholar (100%)	South Korea	Yosu National University	2003-2005
Thomas O'Connor	Visiting Scholar (100%)	Ireland	University College Dublin	2004
Donal Finn	Visiting Scholar (100%)	Ireland	University College Dublin	2004-2005
Thomas O'Connor	Visiting Scholar (100%)	Ireland	University College Dublin	2004-2005
Radko Brock	Visiting Scholar (100%)	Germany	Technical University of Dresden	2004-2006
Geun Sik Lee	Visiting Scholar (100%)	South Korea	University of Ulsan	2005-2006
Kiyoshi Saito	Visiting Scholar (100%)	Japan	Waseda University	2005-2006
Alen Milosevic	Visiting Scholar (100%)	Serbia	University of Belgrade	2006-2007
Manuel Reichle	Visiting Scholar (100%)	Germany	University of Karlsruhe	2006-2007
Andrew Killian	Visiting Scholar (100%)	Germany	University of Karlsruhe	2006-2007
Jong-Taek Oh	Visiting Scholar (100%)	South Korea	Yosu National University	2007
Nils Ahbling	Visiting Scholar (100%)	Germany	University of Braunschweig	2006-2007
Youn Cheol Park	Visiting Scholar (100%)	South Korea	Jeju University	2007-2008
Gustavo Pottker	Visiting Scholar (100%)	Brazil	University Federal Santa Katarina	2007
Seong Ho Kim	Visiting Scholar (100%)	South Korea		2007-2008
Hyun Young Kim	Visiting Scholar (100%)	Japan	Daikin	2007-2008
Agus Parmitran	Visiting Scholar (100%)	South Korea	Yosu National University	2007-2008
Stefan Scherrieb	Visiting Scholar (100%)	Germany	University of Karlsruhe	2007-2008
Yuri Han	Visiting Scholar (100%)	South Korea	Jeju University	2007-2008

Name	Title (percent time)	Country of Origin	Permanent Employer	Years
Michael Petersen	Visiting Scholar (100%)	Germany	University of Karlsruhe	2007-2008
Ho Seong Kim	Visiting Scholar (100%)			2007 - date
Wiebeke Brix	Visiting Scholar (100%)	Denmark	Danish Technical University	2007-2008
Nur Pehlivanogly	Visiting Scholar (100%)	Turkey	Istanbul Technical University	2008 - 2010
Helena Mai	Visiting Scholar (100%)	Germany	University of Karlsruhe	2008–2009
Manuel Chiarello	Visiting Scholar (100%)	Italy	Univerity of Padua	2008-2009
Guo Bei	Visiting Scholar (100%)	China	Xi'an Jiaotong University	2009-2010
Chieko Kondou	Visiting Scholar (100%)	Japan	Kyushu University	2009-date
Matthias Koffler	Visiting Scholar (100%)	Germany	University of Karlsruhe	2009-2010
Wei Wang	Visiting Scholar (100%)	China	Beijing University of Technology (BJUT)	2009-2010
Wei Xinli	Visiting Scholar (100%)	China		2007
Wojciech Angielczyk	Visiting Scholar (100%)	Belgium	Université Catholique de Louvain, Belgium	2010-
Xiaoxiao Hu	Visiting Scholar (100%)	China	Zhejiang University	2009-
YUAN Weixing	Visiting Scholar (100%)	China	Beihang University (BUAA), Beijing, China	2009-2010
Sebastian Belim	Visiting Scholar (100%)	Germany	University of Karlsruhe	2009-2010
Shouguo Wang	Visiting Scholar (100%)	China	Xi'an Jiaotong University	2010-
Qiang Wang	Visiting Scholar (100%)	China		
Huagen Wu	Visiting Scholar (100%)	China		
Xingjuan Zhang	Visiting Scholar (100%)	China		
Yuanyang Zhao	Visiting Scholar (100%)	China		
Chaobin Dang	Visiting Scholar (100%)	Japan	The University of Tokyo	2011-2011

## **7. Other Scholarly Activities in the past five years (*conferences organized or chaired, unpublished presentations, etc.*)**

### **a. Conferences Organized or Chaired**

1. Organizer and Chair of Seminar, "Transcritical CO<sub>2</sub> Systems in Transportation Sector," Annual Meeting of ASHRAE, Seattle, WA, June 1999
2. Session Chair, "Commercial Refrigeration," XX World Congress of Refrigeration, Sydney, Australia, Sept. 1999
3. Organizer and Chair of Seminar, "Transcritical Cycles for Refrigeration and Heat Pumping," 2001 International Mechanical Engineering Congress and Exposition, New York, NY, 2001
4. Organizer and Chair of Symposium, "Advances in Commercial Refrigeration," ASHRAE Meeting, Atlantic City, NJ, 2002
5. Organizer and Chair of Seminar, "Heat Transfer in Transcritical Cycles for Refrigeration and Heat Pumping" 2002 International Mechanical Engineering Congress and Exposition (IMECE), New Orleans, LA, 2002
6. Session Chair, "Low Charge Minimal Leakage," IIR Stockholm, 2002
7. Organizer and Chair of Symposium, "Energy Efficient Commercial Refrigeration," ASHRAE Meeting, Chicago, IL, 2003
8. Organizer, "New Technologies in Commercial Refrigeration," International Conference, Urbana, IL, July 2002, under sponsorship of IIR (International Institute of Refrigeration, Paris, France) and ASHRAE
9. Organizer, "C-dig" International Meeting, Urbana, IL, Oct. 2004

### **b. Unpublished Presentations**

1. "Low Temperature Refrigeration and Secondary Loops," CRMA/NRCA Joint Meeting, Phoenix, AZ, Jan. 5-7, 1997
2. "Indirect Refrigeration for Supermarkets," Southern California Edison CTAC Workshop, Los Angeles, CA, April 23, 1997
3. "Acoustic Resonance in Plate Evaporators," Politecnica University, Sao Paulo, Brazil, May 15, 1997
4. "Expansion Device Generated Noise," Embraco, Joinville, Brazil, May 19, 1997
5. "Orifice Tube Performance," Multibras, Joinville, Brazil, May 20, 1997
6. "Organization of ACRC," MAUA Technical University, Sao Paulo, Brazil, May 21, 1997
7. "Supermarket Refrigeration Industry in USA," MAUA Technical University, Sao Paulo, Brazil, May 21, 1997
8. "Indirect Refrigeration for Supermarkets," MAUA Technical University, Sao Paulo, Brazil, May 21, 1997
9. "ACRC Results for R404a Versus Secondary Refrigerant Tests," MAUA Technical University, Sao Paulo, Brazil, May 21, 1997
10. "European Experiences in Secondary Loops for Low Temperature Applications," MAUA Technical University, Sao Paulo, Brazil, May 21, 1997
11. "Secondary Loops-Is it the Only Option for Some Natural Refrigerants?" IEA Annex 22: Natural Working Fluids for Compression Refrigeration Systems, Gatlinburg, TN, Oct. 2-3, 1997 (published)
12. "Benefits and Penalties Associated with the Use of Secondary Loops," NIST-ASHRAE Conference, Gaithersburg, MD, Oct. 6-7, 1997 (published)



13. "Space Conditioning for Mobile and Residential Applications Based on Transcritical CO<sub>2</sub> Cycle," Xi'an Jiaotong University, Xi'an, China, July 1999
14. "Indirectly Refrigerated Display Cases," University of Commerce, Tianjin, China, July 1999
15. "Transcritical Systems with CO<sub>2</sub> as a Refrigerant," Tianjin University, Tianjin, China, July 1999
16. "Air Conditioning and Heat Pumps for Automobiles Based on Transcritical CO<sub>2</sub> Cycle," Shanghai Jiaotong University, Shanghai, China, Aug. 1999
17. "Refrigeration Systems with CO<sub>2</sub> as Working Fluid Operating in Transcritical Mode," University of Sao Paulo, Sao Paulo, Brazil, April 5, 2000
18. "New Technologies in Commercial Refrigeration," ENTRAC/Federal University of Pernambuco, Recife, Brazil, April 7, 2000
19. "Carbon Dioxide as a Refrigerant for Commercial Refrigeration," CRMD-ARI (Commercial Refrigeration Manufacturers Division of Air Conditioning and Refrigeration Institute) Annual Meeting, Washington, D.C., June 6, 2000
20. "Transcritical Refrigeration Systems with CO<sub>2</sub> and some Refrigerant Issues of Today and Tomorrow," ASHRAE St. Louis Chapter, St. Louis, MO, Jan. 8, 2001, (two presentations)
21. "Secondary Loops in Commercial Refrigeration," ASHRAE Illinois Chapter, Chicago, IL, Jan. 15, 2001
22. "Some Issues in R744 Heat Exchangers," Alternative Refrigerant Winter Meeting, VDA 2002
23. "Some Lessons Learned from SAE AR CRP," SAE Alternative Refrigerant Meeting Phoenix 2002
24. "Alternate Refrigerant Cooperative Research Program," Alternative Refrigerant Winter Meeting VDA 2003
25. "Acoustic Resonance in Plate Evaporators," VTMS, Toronto, 2005
26. "Heat Transfer Issues in Hybrid Cars," Embraco, Brazil 2007

### **c. Other Scholarly Activities**

#### **Professional Societies (*list membership; office held, with dates; major committees or boards*)**

1. ASHRAE - American Society of Heating, Refrigeration, and Air Conditioning, 1989-date, Technical Committees TCs 9.4, 10.4, 10.6 and 10.7, 2001-date, Fellow, ASHRAE
2. IIR - International Institute of Refrigeration, U.S. Representative to B2, 1995-date
3. ASME, American Society of Mechanical Engineers, 1999-date
4. SAE – Society of Automotive Engineers, 2002-date,
5. IIR – International Institute of Ammonia Refrigeration, Director, 2002–2008