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*Improving Vapor  
Compression System  
Efficiency  
through Advanced Vapor  
Compression Technologies*



**ABSTRACT:**

The phase-out of ozone depleting and climate changing refrigerants as well as recent advances in compressor and other vapor compression component technologies, such as novel capacity control methods, use of smart sensors, materials and manufacturing practices, has rapidly increased the research efforts related to vapor compression systems for the HVAC&R industry. This presentation provides an overview of several research efforts related to novel compression concepts and unique cycle integration measures for refrigeration, air-conditioning and heat pumping applications with the goal to reduce irreversibilities and move system performance closer to Carnot efficiency. These research efforts include refrigerant injected compression with economization, near-isothermal compression with cylinder cooling and internal regeneration and rotor-cooled compression in twin screw compressors. The latest state-of-the-art of each of these research efforts will be introduced and discussed.

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**BIOGRAPHY:**

Dr. Eckhard A. Groll is the Reilly Distinguished Professor of Mechanical Engineering and currently serves as the William E. and Florence E. Perry Head of Mechanical Engineering. He joined Purdue University as an Assistant Professor in 1994 and was promoted to Associate Professor in 2000, to Professor in 2005, to Reilly Professor in 2013, and to Reilly Distinguished Professor in 2024. He received his Diploma in Mechanical Engineering from the University of the Ruhr in Bochum, Germany, in 1989 and his Doctorate in Mechanical Engineering from the University of Hannover, Germany, in 1994.

Prof. Groll teaches thermodynamics and his research focuses on the fundamental thermal sciences as applied to advanced energy conversion systems, components, and their working fluids. He is a world-renown expert in positive displacement compressors and expanders. Since joining Purdue University, he has been the principal investigator or co-principal investigator on more than 160 research grants and more than 50 educational grants with a total budget of more than \$18 million from various governmental agencies, professional societies, and more than 30 different industrial sponsors. He has advised and co-advised 36 PhD students, close to 100 MS students and more than 190 undergraduate project students, visiting scholars, and visiting research associates. He has authored or co-authored 170 archival journal articles and more than 320 conference papers. He has been the co-author of 7 book chapters and the editor or co-editor of 7 conference proceedings. He holds 8 patents. He has given more than 110 invited lectures and seminars, and 16 conference keynote lectures. He serves as the Regional Editor for the Americas for the International Journal of Refrigeration and is a fellow of ASHRAE and ASME. He has organized and chaired 11 international conferences on topics of Refrigeration, Air Conditioning, Compressors, and Natural Working Fluids.

Prof. Groll has been recognized for his academic leadership in higher education. He is a 2010-2011 Fellow of the American Council on Education (ACE) and 2009-2010 Fellow of the Academic Leadership Program of the Committee on Institutional Collaboration (CIC-ALP). He has received numerous awards for his research and teaching excellence including most notably the 2024 F. Paul Anderson Award (ASHRAE's highest technical achievement award), being named a 2020 Honorary Fellow of the Institution of Engineers in Scotland, the 2018 J&E Hall International Gold Medal in Refrigeration by the Institute of Refrigeration, and the 2017 Peter Ritter von Rittinger International Heat Pump Award by the IEA Heat Pump Centre. In addition, he was inducted into Purdue's Book of Great Teachers in 2008.