Heat Transfer Studies for Gas Turbine Hot Gas Path Components

Gas turbine hot section components are being pushed to the limit with every increasing combustion firing temperatures and improved expectations of life and durability. Gas path components inside gas turbines see some of the harshest conditions including high pressure and temperatures. It is imperative that heat transfer plays a major role in the evaluation and survival of these components. An overview of the challenges in gas turbine heat transfer measurements and design of cooling systems will be discussed in this presentation. Two major issues will be focused on during the talk. The study of heat load in gas turbine combustors will be presented using a realistic combustor experiment. The measurements inside the optical combustor will be made using PIV and Infrared thermography. Detailed flow and heat load measurements will help in understanding the complex interactions in the reacting flow and help design cooling for modern low emission combustors. The other study will focus on advanced cooling designs for turbine airfoils. Improved internal cooling of turbine blades is a critical need for the interest. With the advent of additive manufacturing, the designs of internal cooling feature options are unlimited. With that in mind, detailed heat transfer measurements are presented for complex internal cooling channels with and without rotation to evaluate performance and applicability of such cooling designs to turbine blade cooling. Aspects of additively manufactured complex designs as a tool to enhance heat transfer compared to conventional manufacturing methods are discussed. The cooling channels have features such as ribs, dimples, impinging jets and a combination of these features. The challenge of making detailed measurements inside such rotating channels is displayed through the measurements. In addition, some examples of additively designed geometries are demonstrated.

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Dr. S. V. Ekkad is the Department Head and RJ Reynolds Professor in the Mechanical & Aerospace Engineering Department at North Carolina State University since September 2017. He previously served asthe Associate Vice President for Research Programs at Virginia Tech. He also held the title of Rolls-Royce Commonwealth Professor for Aerospace Propulsion Systems at Virginia Tech. He was also the Founder and Director of the Rolls-Royce University Technology Center for Advanced System Diagnostics at Virginia Tech, one of 30 centers around the world, prior to joining NC State.He was in the Mechanical Engineering department at Virginia Tech from August 2007 to September 2017 after 9 years at LSU and 2 years at Rolls-Royce Allison Engine Company in Indianapolis. He received his Ph.D. from Texas A&M University and M.S. from Arizona State University. He has over 25 years of experience in heat transfer related research. He has published over 250 journal & conference articles, three patents and co-authored a book and three book chapters. He currently has funding from Honeywell Aerospace, Boeing, Pratt & Whitney, and Trilotus Aerospace Systems/Chromalloy. He has been working on gas turbine cooling and heat transfer issues since 1989 including a stint as a design engineer at Rolls-Royce, Indianapolis before his academic career. Dr. Ekkad has also served as a summer faculty fellow at AFRL, Dayton in 2003. He is well known for his contributions to heat transfer experimental methods. In 2004, he received the inaugural ASME Bergles/Rohsenow Young Investigator in Heat Transfer Award for significant contributions to the field of heat transfer by a researcher under the age of 36. He is also the Editor-in-Chief for the ASME Journal for Thermal Science and Engineering Applications. He received the 2022 AIAA Air Breathing Propulsion Award and the 2022 ASME Heat Transfer Memorial Award and was named a fellow of the Royal Aeronautical Society in 2023 and Fellow of AIAA in 2024.

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