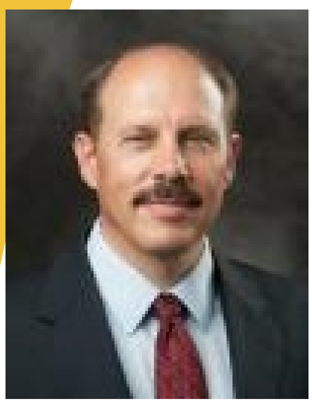
LSU College of Engineering | Department of Mechanical & Industrial Engineering

The Sidney E. Fuchs Seminar Series

3:30-4:20pm, Friday, November 1, 2013
Frank H. Walk Design Presentation Room



The Influence of Turbulence on Stagnation Region Heat Transfer, Downstream Boundary Layer Development and Film Cooling

by Forrest Ames*

Professor of Mechanical Engineering, University of North Dakota

In spite of many years of research, gas turbine hot section heat load prediction remains a very difficult problem with a number of challenging areas for researchers and engineers. The stagnation region of first vanes is one of the more challenging regions. High levels of turbulence generated in combustion systems impinge on the leading edge causing high levels of turbulent augmentation to the highly accelerating laminar boundary layer in the region. New large scale stationary gas turbines result in leading edge Reynolds based on approach flow velocity and leading edge diameter in excess of 300,000 at turbulence levels reported to approach 30%. Most leading edge regions are cooled using showerhead film cooling arrays which further disrupt the leading edge and pressure surface boundary layers. The high levels of turbulence cause rapid dissipation of pressure side film cooling largely nullifying the benefits of "optimized" arrays of shaped holes.

This presentation will cover recent research on the stagnation region heat transfer problem including measurements of turbulence approaching the stagnation region as well as downstream boundary layer measurements. Some of the issues involved in trying to correlate the response of turbulence and the resulting heat transfer in the presence of a large stagnation region will be discussed. Current research on pressure side film cooling with high levels of turbulence will also be presented. The impact of turbulence on pressure side film cooling dissipation has been studied using turbulence with a range of characteristics. This film cooling data show the impact of transitional flow on film cooling effectiveness in this highly accelerating region.

* Dr. Forrest Ames is a Professor of Mechanical Engineering and a Fellow of the ASME. Prior to his academic position at the University of North Dakota, Dr. Ames held a research position at Allison Gas Turbine Division of General Motors which later became Rolls Royce of North America. As a GM employee Forrest attended Stanford University on a GM Fellowship between 1986 and 1990. At Rolls Royce (Allison) Dr. Ames conducted research on advanced cooling designs and studied the impact of turbulence on turbine heat transfer and film cooling. Dr. Ames joined the faculty of the University of North Dakota in 1997 where he established the Turbulent Transport in Turbines Group. The TTT Group has conducted research on gas path heat transfer, heat transfer and turbulence mechanics in pin fin arrays, trailing edge cooling and aerodynamics, leading edge heat transfer and film cooling subjected to high turbulence and acceleration, and low pressure turbine aerodynamics.