

Aerothermal Challenges in Coal-Gas Based Turbine Systems

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ABSTRACT

To meet the performance goals of next generation power and propulsion systems, future coal-gas fired turbines will likely be operated at temperatures unprecedentedly higher than those in the current turbine fleets. The working fluid in these future turbines could contain substantial moisture (steam) mixed with carbon dioxide, instead of air or nitrogen in the conventional gas turbines. Moisture is found to be especially detrimental to the structural integrity of thermal barrier coating (TBC) and rendering excessive level of thermal load on the gas side of thermal airfoil. As a result, the aerothermal characteristics and hot section issues for the coal-gas based turbines are distinctly different and challenging. Due mainly to mandated efficiency requirements, future turbines will have to be operated with a limited amount of coolant and reduced usage of external cooling. Thus internal cooling with innovative enhancement techniques which result in not only elevated heat transfer coefficient but improved cooling uniformity is particularly desirable. This presentation will begin with an overview of potential thermodynamic cycles for future clean-coal based turbines. The impact of carbon capture and sequestration on the cycle efficiency will be assessed. This will be followed by a discussion on the effects of cycle options on the level of thermal loading on the turbine airfoils. Various cooling technologies currently being pursued at the University of Pittsburgh and in other public domains will be discussed. While the primary applications of this talk are directed to large-scale utility turbine systems, they are applicable to the thermal control of aircraft engine turbines.