Journal of Propulsion and Power
Vol. 22, No. 2, March–April 2006

Introduction: Turbine Science and Technology

GAS turbines—highly effective engineered systems for converting chemical energy in fuels first into thermal energy and then into mechanical energy—are widely used for propulsion and electric power generation. Although gas turbine science and technology have advanced tremendously over the past half century, rising fuel prices, diminishing supply of crude oil and natural gas by as early as 2015, and concerns about global warming are creating new demands on efficiency, emissions, and service life that challenge the limits of our knowledge and capabilities.

Whether the fuel burned is kerosene, natural gas, syngas, or a hydrogen mixture, the efficiency and service life of a gas turbine are strongly affected by the turbine component, where thermal energy in the high-pressure and high-temperature gas that exited the combustor is converted to mechanical energy to drive the compressor and fan for propulsion or the compressor and electric generator for power generation. The most effective way to increase the efficiency of gas turbines is to raise the temperature of the gas entering the turbine component, which can be as high as the adiabatic flame temperature from the combustion of fuel and oxidizer. The challenge lies in the fact that the inlet temperatures sought today, though still considerably lower than the adiabatic flame temperature, already far exceed the maximum temperatures at which even the best materials can maintain structural integrity with reasonable service life.

This special section contains 10 invited review articles from leading researchers that address some of the most pressing issues limiting further increases in efficiency and service life. The first two papers deal with internal and film cooling of turbine components. The next three papers discuss parts of the turbine where cooling is the most difficult and where most failures in high-pressure turbines take place—the trailing edge, the blade tip, and the endwall. Next is a paper on degradation in performance and service life from erosion and deposition by ingested matter or products of combustion, and a paper on how clearance between rotating and nonrotating parts is controlled from cold-start to operation, when large geometry changes take place due to rotation and thermal expansion, in a way that maintains efficiency and service life. Two papers that follow address material issues. One discusses advances in superalloys that have high-temperature strength and toughness, and the other is on thermal-barrier coatings that insulate the superalloys from the hot gases to provide protection against oxidation and excessive thermal gradients. This special section concludes with a paper that addresses ways to assess and mitigate harmful impacts of mistuning that arise from manufacturing tolerances, wear, and other causes on high-cycle fatigue. We hope readers will find this special section that brings together thermal management with mechanics and materials informative. Further advances in gas turbine efficiency and durability require a synergistic effort.

This special section was made possible by the contributions of quite a few people. First, we want to thank the authors and the reviewers for their excellent work. Next, we want to thank Professor Vigor Yang, the Editor-in-Chief of the *Journal of Propulsion and Power*, for the invitation and the encouragement to edit this special section and for his help throughout the review process. Finally, but not least, we want to thank Ms. Amanda Maguire and the AIAA staff for the publication of this special section.

Tom I-P. Shih
Iowa State University

Minking Chyu
University of Pittsburgh