PREFACE

Measurement Methods in Rotating Components of Turbomachinery

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Techniques for making measurements in turbomachinery—fluid dynamic, structural, and thermal measurements—continue to be improved. Over the past decade, optical, noncontact methods, in particular, have been rapidly developed for measuring structural and fluid dymanic properties within the rotating components of turbomachines. Hot wire technique has been applied to both rotating and stationary reference frames to make flow measurements inside and at the exit of the rotor. Microprocessors and computers have revoluntionized data acquisition, processing and display techniques. These innovative approaches to measurement and data processing have provided new and/or supplemental information to that obtained using more conventional instrumentation. A symposium was held at the Joint Gas Turbine/Fluids Engineering Conference, New Orleans, March 9–13, 1980, to display the wide range of instrumentation methods available today for taking measurements on the rotating components of turbomachines by demonstrating the use of these techniques to obtain information needed by the research, development, and design engineer. The emphasis was on the development of new techniques, improvements in existing techniques, as well as new applications of conventional techniques of measurements.

Measurements made on turbomachinery rotors are among the most difficult fluid dynamic, structural, or thermal measurements performed today. These difficulties arise due to the complexity of the flow and the complicated nature of the stress, vibration, and heat transfer phenomena. The flow itself may be unsteady, with subsonic, supersonic, and transonic regions and associated shock phenomena. It is certainly viscous and usually turbulent with appreciable three dimensionality. Laminar, transition, and turbulent boundary layers with separated regions along the blade are often encountered. Almost invariably it is rotational with concentrated combined vortices due to blade tip leakage and induced secondary flow. The flow is noisy. Blade vibration and flutter cause many additional complications in designing high performance hardware. Good structural measurements are essential for the design of reliable machinery. Temperature and heat transfer measurements in turbine rotors where the environment is very hostile are both complicated and difficult. Above all, the transmission of mechanical, pressure or electrical data from a rotor presents a situation which is almost unique to turbomachinery. This symposium covered all of these aspects while addressing measurements on fluid flow (pressure, velocity, density, turbulence intensity and stress, wall shear stress, unsteady blade pressure) and temperature, vibration, strain and flutter measurements. Some of the world's newer facilities where these techniques have been incorporated were also described.

B. Lakshminarayana wrote the keynote paper for the sessions on Aerodynamics Measurements; in it he reviewed all of the non-optical techniques for the measurement of aerodynamic properties in a rotor. In addition, one paper describing a facility for rotor flow measurements and two papers on the use of high frequency response probes (hot wire and sphere probes) for exit flow measurement were presented. The sessions on Aerodynamic Measurements also had four papers dealing with flow measurement and blade flow visualization inside low speed rotor passages, using both conventional probes and hot wire/film probes.

The keynote paper for the sessions on Optical Flow Measurement was written by H. Weyer. He reviewed the state of the art of the laser velocimeter for flow measurement in rotor passages as well as discussing other optical methods of flow visualization, velocity and fluid property measurement. Use of LV systems in measuring two and three-dimensional flows in centrifugal and axial turbomachinery, marine propulsor as well as an improved LV data processing system were described in the eight papers in this session.

In the session on Unsteady Aerodynamic Measurements, F. Carta and R. L. O'Brien reviewed the techniques applicable to unsteady aerodynamic measurements in a rotor. Three papers in this session dealt with the use of laser systems, unsteady blade pressure on the rotor blade, and a system for measurement of blade static pressure undergoing flutter.

M. J. Hartmann wrote the keynote paper for the session on Vibration, Stress and Flutter Measurements. Two papers in this session dealt with a strain gage and a telemetry system. Two other papers dealt with vibration and flutter measurements using optical and pressure probes, respectively. Two of the papers covered the measurement of vibration and temperature in aero engines. In addition, there was one paper each on aerodynamic damping, a digital system for blade displacement, and on steady stress measurements.

The last session was on instrumentation systems for temperature and heat transfer measurements in turbomachines; the keynote was written by R. W. Graham. Two of the papers in this session described high temperature facilities and their instrumentation while the other papers dealt with disk cooling and pyrometry for the high speed turbine.

Thirty-six papers were presented at this symposium and published in the symposium volume *Measurement Methods in Rotating Components of Turbomachinery*, ASME, New York, Edited by B. Lakshminarayana and P. Runstadler Jr., March 1980. Fourteen of these papers, considered to be of permanent interest, are published in this issue of the *Journal of Engineering for Power*. Four of the remaining papers appeared in the December 1980 issue of the *Journal of Fluids Engineering*.