

# Advanced Experimental Techniques In Turbomachinery

The modern worker often finds the process of information documentation, storage and retrieval to be overwhelming. The task of remaining current in a technical discipline is almost a full time occupation, in addition to the daily responsibility of contributing to progress in a technical field. The material in this volume has been selected from principal lectures provided by key contributors to the turbomachinery field. Each chapter in this book has been prepared in close collaboration with the original author. Extensive editing has been carried out to ensure a readable and accurate text.

The intent of this text is to make available the key material collected by recognized lecturers for the general usage in industry. Since the authors of the various chapters are key experts in their field, these chapters should serve as appropriate starting points for thought by many readers.

## Advanced Experimental Techniques for Turbomachinery Development (D. Echardt)

- Introductory Survey
- Time-Averaging Measurement Techniques
- Development and Test Experiences with Dynamic Non-Optical Measurement Systems
- Typical Combined Applications of Stationary and Dynamic Measurement Systems
- Optical Methods for Flow Visualization and Measurement
- L2F Velocimeter Applications

## Pressure and Velocity Measurements

(T.R. Heidrick)

- Pressure Measurements
  - Introduction
  - Basic Instruments for Pressure Measurement and Calibration
- Velocity Measurement
  - Introduction
  - Measurement of Velocities of Known Direction (Pitot Tubes)
  - Measurement of Velocities of Unknown Direction
  - Flow Direction Measurements (Yaw Probes)

## Thermocouple Theory and Practice

(R.J. Moffat)

- Introduction
- Temperature - EMF Relationships
- Circuits of Homogenous Material
- The Laws of Thermoelectricity

- Where is the EMF Generated?
- Switches, Connectors, Zone Boxes, and Reference Baths
- Obtaining High Accuracy with Thermocouples
- Parallel Elements
- Sources of Spurious EMF's

## Standards for Turbomachinery Laboratory Work (D. Japikse)

- Developing a Test Program - A Useful Overview
- Conventional Testing and Instrumentation - Practical Testing with Microcomputers and Microprocessors
- Advanced High Frequency Measurements
- System Measurements

## Successes in the Application of Laser Velocimetry to Turbo-machinery Studies (H. Krain, R. Schodl, A. Binder, R. Dunker)

- Nomenclature
- Introduction
- Principles of Laser Velocimetry
- Unsteady Flow Phenomena in a Turbine Rotor Revealed by L2F Measurement Techniques
- Transonic Axial Compressor Flow Characteristics Analyzed by L2F Measurements
- Results of L2F Measurements within a Centrifugal Compressor Stage

## Blade Pressure Measurements

(J.W.H. Chivers)

- Introduction
- Rotating Miniature Pressure Transducers
- Pressure Pineapple
- Rotating Scanivalve

## The Design, Development and Operation of Gas Turbine Radio Telemetry Systems

(J.G.B. Worthy)

- The Requirement for Radio Telemetry in Aero Gas Turbine Development
- Constraints on the Measure System
- Design of Rolls-Royce Telemetry Systems
- Performance in Service
- Future Work

## State-of-the-Art Gas Turbine Measurement Techniques (W.G. Alwang)

- Measurement of Steady State Fluid Dynamic Quantities
  - Introduction
  - Overview - Steady State Measurements
  - Steady State Fluid Dynamic Quantities Measured

- Measurement of Non-Steady Fluid Dynamic Quantities
  - Introduction
  - General Description of Measurement System Dynamics
  - Pressure Measurements
  - Non-Steady Velocity Measurements
  - Non-Steady Temperature Measurement
  - Laser Velocity Measurement in Unsteady Flows
  - Flow Visualization
  - Clearance Measurements
- Measurement of Metal Temperature, Heat Flux, and Strain
  - Durability Related Parameters in the Gas Path of a Gas Turbine Engine - An Introduction
  - Metal Temperature Measurement
  - Heat Flux Measurement
  - Strain Measurement and Analysis

## Solving 100 Turbomachinery Fluid Dynamic Test Problems (D. Japikse)

- Developing a Test Program: A Useful Overview
- Safety
- Test Procedures and Setup
- Flow Rate Measurement
- Speed Measurement
- Heat Loss and Heat Inflow
- Thermometry
- Pressure Measurement
- Leak Detection
- Traversing
- Proximity Measurements
- Thermodynamic Properties
- Instrumentation Procedures
- Data Processing/Accuracy
- Flow Visualization
- Torque Measurement
- Computer Usage
- Dynamic Measurement



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