Axial Compressor

Experiments were performed on a low-speed multistage axial-flow compressor to assess the effects of shrouded stator cavity flows on aerodynamic performance. Five configurations, which involved changes in seal-tooth leakage rates and/or elimination of the shrouded stator cavities, were tested. Data collected enabled differences in overall individual stage and the third stage blade element performance parameters to be compared. The results show conclusively that seal-tooth leakage ran have a large impact on compressor aerodynamic performance while the presence of the shrouded stator cavities alone seemed to have little influence. Overall performance data revealed that for every 1% increase in the seal-tooth clearance to blade-height ratio the pressure rise dropped up to 3% while efficiency was reduced by 1 to 1.5 points. These observed efficiency penalty slopes are comparable to those commonly reported for rotor and cantilevered stator tip clearance variations. Therefore, it appears that in order to correctly predict overall performance it is equally important to account for the effects of seal-tooth leakage as it is to include the influence of tip clearance flows. Third stage blade element performance data suggested that the performance degradation observed when leakage was increased was brought about in two distinct ways. First, increasing seal-tooth leakage directly spoiled the near hub performance of the stator row in which leakage occurred. Second, the altered stator exit now conditions caused by increased leakage impaired the performance of the next downstream stage by decreasing the work input of the downstream rotor and increasing total pressure loss of the downstream stator. These trends caused downstream stages to progressively perform worse. Other measurements were acquired to determine spatial and temporal flow field variations within the up-and-downstream shrouded stator cavities. Flow within the cavities involved low momentum fluid traveling primarily in...

This is the second edition of Cumpsty's excellent self-contained introduction to the aerodynamic and thermodynamic design of modern civil and military jet engines. Through two engine design projects, first for a new large passenger aircraft, and second for a new fighter aircraft, the text introduces, illustrates and explains the important facets of modern engine design. Individual sections cover aircraft requirements and aerodynamics, principles of gas turbines and jet engines, elementary compressible fluid mechanics, bypass ratio selection, scaling and dimensional analysis, turbine and compressor design and characteristics, design optimization, and off-design performance. The book emphasises principles and ideas, with simplification and approximation used where this helps understanding. This edition has been thoroughly updated and revised, and includes a new appendix on noise control and an expanded treatment of combustion emissions. Suitable for student courses in aircraft propulsion, but also an invaluable reference for engineers in the engine and airframe industry.

Over the past three decades turbomachines experienced a steep increase in efficiency and performance. Based on fundamental principles of turbomachinery thermo-fluid mechanics, numerous CFD based calculation methods are being developed to simulate the complex 3-dimensional, highly unsteady turbulent flow within turbine or compressor stages. The objective of this book is to present the fundamental principals of turbomachinery fluid-thermodynamic design process of turbine and compressor components, power generation and aircraft gas turbines in a unified and compact manner. The book provides senior undergraduate students, graduate students and engineers in the turbomachinery industry with a solid background of turbomachinery flow physics and performance fundamentals that are essential for understanding turbomachinery performance and flow complexes.

The design of a single stage axial supersonic compressor with a predicted performance of 2.8:1 stage pressure ratio at 82% adiabatic efficiency and 4 lb/sec airflow is discussed. The results of a gas generator performance study to evaluate non-regenerated designs with 16:1 pressure ratio compressors and turbine inlet temperatures between 2500 F and 3000 F are presented and discussed. The design point specific fuel consumption of the engines studied ranged from 0.415 to 0.438 lb/hp/hr. At 50% power this range increased to 0.465 and 0.534 respectively. The engine configuration which indicated the lowest specific fuel consumption has a two spool gas generator and variable stator free power turbine. The preliminary designs of a two stage axial/centrifugal compressor and an advanced gas generator which incorporates this compressor are discussed. The predicted performance of the compressor is 16:1 pressure ratio at an adiabatic efficiency of 77.5% and an airflow of 4 lb/sec. The predicted design point specific fuel consumption and power at a 2500 F turbine inlet temperature are 0.431 lb/hp/hr and 785 hp respectively. The results of a preliminary design study for a variable geometry axial compressor rotor concept are also discussed. This concept offers the potential for improved part speed compressor performance and stage matching. (Author).

A comprehensive introduction to turbomachines and their applications With up-to-date coverage of all types of turbomachinery for students and practitioners, Fundamentals of Turbomachinery covers machines from gas, steam, wind, and hydraulic turbines to simple pumps, fans, blowers, and compressors used throughout industry. After reviewing the history of turbomachinery and the fluid mechanical principles involved in their design and operation, the book focuses on the application and selection of machines for various uses, teaching basic theory as well as how to select the right machine for a specific use. With a practical emphasis on engineering applications of turbomachines, this book discusses the full range of both turbines and pumping devices. For each type, the author explains: * Basic principles * Preliminary design procedure * Ideal performance characteristics * Actual performance curves published by the manufacturers * Application and appropriate selection of the machine Throughout, worked sample problems illustrate the principles discussed and end-of-chapter problems, employing both SI and the English system of units, provide practice to help solidify the reader's grasp of the material.

Developed by the recognized authority in the field, PROCESS TECHNOLOGY EQUIPMENT AND SYSTEMS, 4e introduces you to the concepts and techniques used in today's most sophisticated manufacturing facilities. This book delivers technical accuracy along with an engaging writing style, and supports readings with full-color graphics and photos that show how systems and equipment operate in the real world. Chapters explore the workings of valves, vessels, and piping; pumps and compressors; motors and turbines; heat exchangers, cooling towers, boilers, and furnaces; reactors and distillation; extraction and separation systems; process instrumentation; and much more. Upholding the tradition of excellence established by the first two editions, PROCESS TECHNOLOGY EQUIPMENT AND SYSTEMS, 4e can help launch your career as a process technology technician! Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

Volume X of the High Speed Aerodynamics and Jet Propulsion series. Contents include: Theory of Two-Dimensional Flow through Cascades; Three-Dimensional Flow in Turbomachines; Experimental Techniques; Flow in Cascades; The Axial Compressor Stage; The Supersonic Compressor; Aerodynamic Design of Axial Flow Turbines; The Radial Turbine; The Centrifugal Compressor; Intermittent Flow Effects. Originally published in 1964. The Princeton Legacy Library uses the latest print-on-demand technology to again make available previously out-of-print books from the distinguished backlist of Princeton University Press. These editions preserve the original texts of these important books while presenting them in durable paperback and hardcover editions. The goal of the Princeton Legacy Library is to vastly increase access to the rich scholarly heritage found in the thousands of books published by Princeton University Press since its founding in 1905.

Chapter 1: Overview of Gas Turbines -- Chapter 2: Theoretical and Actual Cycle Analysis -- Chapter 3: Compressor and Turbine Performance Characteristics -- Chapter 4: Performance and Mechanical Standards -- Chapter 5: Rotor Dynamics -- Chapter 6: Centrifugal Compressors -- Chapter 7: Axial-Flow Compressors -- Chapter 8: Radial-Inflow Turbines -- Chapter 9: Axial-Flow Turbines -- Chapter 10: Combustors -- Chapter 11: Materials -- Chapter 12: Gas Clean Up System -- Chapter 13: Bearings and Seals -- Chapter 14: Gears -- Chapter 15: Lubrication -- Chapter 16: Spectrum Analysis -- Chapter 17: Balancing -- Chapter 18: Couplings and Alignment -- Chapter 19: Control Systems and Instrumentation -- Chapter 20: Gas Turbine Performance Test -- Chapter 21: Maintenance Techniques -- Chapter 22: Case Studies -- Appendix: Equivalent Units.

This practical reference provides in-depth information required to understand and properly estimate compressor capabilities and to select the proper designs. Engineers and students will gain a thorough understanding of compression principles, equipment, applications, selection, sizing, installation, and maintenance. The many examples clearly illustrate key aspects to help readers understand the "real world" of compressor technology. Compressors: Selection and Sizing, third edition is completely updated with new API standards. Additions requested by readers include a new section on diaphragm compressors in the reciprocating compressors chapter, and a new section on rotor dynamics stability in the chapter on diaphragm compressors. The latest technology is presented in the areas of efficiency, 3-D geometry, electronics, CAD, and the use of plant computers. The critical chapter on negotiating the purchase of a compressor now reflects current industry practices for preparing detailed specifications, bid evaluations, engineering reviews, and installation. A key chapter compares the reliability of various types of compressors. * Everything you need to select the right compressor for your specific application. * Practical information on compression principles, equipment, applications, selection, sizing, installation, and maintenance. * New sections on diaphragm compressors and an introduction to rotor dynamics stability.

Control engineers, mechanical engineers and mechanical technicians will learn how to select the proper control systems for axial and centrifugal compressors for proper throughput and surge control, with a particular emphasis on surge control. Readers will learn to understand the importance of transmitter speed, digital controller sample time, and control valve stroking time in helping to prevent surge. Engineers and technicians will find this book to be a highly valuable guide on compressor control schemes and the importance of mitigating costly and sometimes catastrophic surge problems. It can be used as a self-tutorial guide or in the classroom with the book's helpful end-of-chapter questions and exercises and sections for keeping notes.

Throughout the last decades, centrifugal compressor research and development have been revolutionized. Computational fluid dynamics have provided a better understanding of the flow and physical phenomena, and the design of new cen trifugal compressor components has been transformed from an "art" into a "sci ence". New materials and manufacturing techniques now create new geometries that could only be dreamed of in the past, and new challenging applications have pushed the limits beyond what was considered the state of the art. This new book presenting a comprehensive look at industrial compressors is therefore very timely. Readers will find a large amount of information based on extensive experience, a clear and well-founded approach to real-gas handling and solutions to many practical problems. It will provide engineering contractors and users of industrial compressors with a better insight into the "how" and "why" of different design features thus allowing a more profound basis for discussions with manufacturers. It will also cast a light on the day-by-day design practice to academia by revealing the limitations and requirements of practical applications and economics. This book combines a strict mathematical approach with practical experience and is illustrated with many examples. It fills in the gap between academic text books and encyclopaedic descriptions of industrial compressors. I have no doubt that this book, based on several decades of experience in the industry, both in the USA and Europe, will be well received by the centrifugal compressor community.

The report presents the redesign analysis of a two-stage axial compressor program for the advancement of small gas turbine component technology. The discussion covers fabrication, test, and redesign of the axial compressor which was presented in Volume I. (Author).

The Handbook of Engineering Design aims to give accurate information on design from past publications and past papers that are relevant to design. The book is divided into two parts. Part 1 deals with stages in design as well as the factors to consider such as economics, safety, and reliability; engineering materials, its factors of safety, and the choice of material; stress analysis; and the design aspects of production processes. Part 2 covers the expansion and contraction of design; the preparation of technical specification; the design audit; and the structure and organization of design offices. The text is recommended to engineers who are in need of a guide that is easy to understand and concise.

A cursory design study of the gas generator involving the preliminary design and analysis of a family of axial compressors was conducted. Each axial compressor was designed to be capable of match with advanced centrifugal technology. The minimum overall axial-centrifugal design pressure ratio for each compressor configuration was 16:1. The engine performance using the characteristics of the compressor designs was evaluated and an optimum gas generator configuration was selected. The axial compressor for the optimum gas generator configuration was detail designed for test rig evaluation. This axial compressor has two stages and a 3.0:1 design pressure ratio. The design flow rate is 5.0 pound-per-second and the inlet tip radius is 2.72 inches. (Author).

The report describes the results of a program to redesign the exit stators of a 2.8:1 pressure ratio supersonic axial compressor, and to fabricate and test the redesigned stators to evaluate the effect of the redesign on the overall stage performance. This compressor is intended to serve as a boost stage in axial centrifugal compressors with overall pressure ratios of 16:1 for small gas turbine engines. The redesign was undertaken to provide an essentially cylindrical flow path aft of the rotor. This redesign eliminates an 'S' shaped duct in the exit stator assembly of the original design. The measured performance showed no improvement over the original design, and indicated a two-point degradation in efficiency. The demonstrated exit stator and duct total pressure loss at design speed and stator setting was consistent with that demonstrated by the previous exit stators. Variation in the angle setting of the adjustable stator blades caused some movement of the surge line and flow range of the compressor, but offered no improvement in peak performance relative to the design setting. (Author).

A method of designing circular blade systems of finite spacing is developed. First, the theory of flow and through a system of infinitesimally spaced surfaces is formulated by means of a continuous axially symmetric force field which is uniform in the cricumferential direction. This force field replaces the effect of the blade system, with its hub and shroud boundary surfaces. Second, the force field is the space between the blades, hub, and shroud is replaced in the equations of finite spacing by inertia and pressure terms, which were omitted in equations of infinitesimal spacing. These terms will change values of flow variables of infinitesimal spacing.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 47. Chapters: Axial compressor, Centrifugal compressor, Centrifugal fan, Centrifugal pump, Flow through cascades, Francis turbine, Gas turbine, Industrial fans, Jet engine, Mechanical fan, Mixed flow compressor. Excerpt: A gas turbine, also called a combustion turbine, is a type of internal combustion engine. It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber in-between. The basic operation of the gas turbine is similar to that of the steam power plant except that air is used instead of water. Fresh atmospheric air flows through a compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high-temperature flow. This high-temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process. The turbine shaft work is used to drive the compressor and other devices such as an electric generator that may be coupled to the shaft. The energy that is not used for shaft work comes out in the exhaust gases, so these have either a high temperature or a high velocity. The purpose of the gas turbine determines the design so that the most desirable energy form is maximized. Gas turbines are used to power aircrafts, trains, ships, electrical generators, or even tanks. Gases passing through an ideal gas turbine undergo three thermodynamic processes. These are isentropic compression, isobaric (constant pressure) combustion and isentropic expansion. Together, these make up the Brayton cycle. In a practical gas turbine, gases are first accelerated in either a centrifugal or axial compressor. These gases are then slowed using a diverging nozzle known as a diffuser; these processes increase the pressure and temperature of the flow. In an ideal system, ..

This textbook is a collection of technical papers that were presented at the 10th International Symposium on Unsteady Aerodynamics, Aeroacoustics, and Aeroelasticity of Turbomachines held September 8-11, 2003 at Duke University in Durham, North Carolina. The papers represent the latest in state of the art research in the areas of aeroacoustics, aerothermodynamics, computational methods, experimental testing related to flow instabilities, flutter, forced response, multistage, and rotor-stator effects for turbomachinery.

Over the past three decades, information in the aerospace and mechanical engineering fields in general and turbomachinery in particular has grown at an exponential rate. Fluid Dynamics and Heat Transfer of Turbomachinery is the first book, in one complete volume, to bring together the modern approaches and advances in the field, providing the most up-to-date, unified treatment available on basic principles, physical aspects of the aerothermal field, analysis, performance, theory, and computation of turbomachinery flow and heat transfer. Presenting a unified approach to turbomachinery fluid dynamics and aerothermodynamics, the book concentrates on the fluid dynamic aspects of flows and thermodynamic considerations rather than on those related to materials, structure, or mechanical aspects. It covers the latest material and all types of turbomachinery used in modern-day aircraft, automotive, marine, spacecraft, power, and industrial applications; and there is an entire chapter devoted to modern approaches on computation of turbomachinery flow. An additional chapter on turbine cooling and heat transfer is unique for a turbomachinery book. The author has undertaken a systematic approach, through more than three hundred illustrations, in developing the knowledge base. He uses analysis and data correlation in his discussion of most recent developments in this area, drawn from over nine hundred references and from research projects carried out by various organizations in the United States and abroad. This book is extremely useful for anyone involved in the analysis, design, and testing of turbomachinery. For students, it can be used as a two-semester course of senior undergraduate or graduate study: the first semester dealing with the basic principles and analysis of turbomachinery, the second exploring three-dimensional viscid flows, computation, and heat transfer. Many sections are quite general and applicable to other areas in fluid dynamics and heat transfer. The book can also be used as a self-study guide to those who want to acquire this knowledge. The ordered, meticulous, and unified approach of Fluid Dynamics and Heat Transfer of Turbomachinery should make the specialization of turbomachinery in aerospace and mechanical engineering much more accessible to students and professionals alike, in universities, industry, and government. Turbomachinery theory, performance, and analysis made accessible with a new, unified approach For the first time in nearly three decades, here is a completely up-to-date and unified approach to turbomachinery fluid dynamics and aerothermodynamics. Combining the latest advances, methods, and approaches in the field, Fluid Dynamics and Heat Transfer of Turbomachinery features: The most comprehensive and complete coverage of the fluid dynamics and aerothermodynamics of turbomachinery to date A spotlight on the fluid dynamic aspects of flows and the thermodynamic considerations for turbomachinery (rather than the structural or material aspects) A detailed, step-by-step presentation of the analytical and computational models involved, which allows the reader to easily construct a flowchart from which to operate Critical reviews of all the existing analytical and numerical models, highlighting the advantages and drawbacks of each Comprehensive coverage of turbine cooling and heat transfer, a unique feature for a book on turbomachinery An appendix of basic computation techniques, numerous tables, and listings of common terminology, abbreviations, and nomenclature Broad in scope, yet concise, and drawing on the author's teaching experience and research projects for government and industry, Fluid Dynamics and Heat Transfer of Turbomachinery explains and simplifies an increasingly complex field. It is an invaluable resource for undergraduate and graduate students in aerospace and mechanical engineering specializing in turbomachinery, for research and design engineers, and for all professionals who are—or wish to be—at the cutting edge of this technology.

This book provides a thorough description of an aerodynamic design and analysis systems for Axial-Flow Compressors. It describes the basic fluid dynamic and thermodynamic principles, empirical models and numerical methods used for the full range of procedures and analytical tools that an engineer needs for virtually any tupe of Axial-Flow Compressor, aerodynamic design or analysis activity. It reviews and evaluates several design strategies that have been recommended in the literature or which have been found to be effective. It gives a complete description of an actual working system, such that readers can implement all or part of the system. Engineers responsible for developing, maintaining of improving design and analysis systems can benefit greatly from this type of reference. The technology has become so complex and the role of computers so pervasive that about the only way this can be done today is to concentrate on a specific design and analysis system. The author provides practical methodology as well as the details needed to implement the suggested procedures.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 40. Chapters: Affinity laws, Axial compressor, British Thomson-Houston, C. A. Parsons and Company, Centrifugal compressor, Centrifugal fan, Centrifugal pump, Charles Algernon Parsons, Corrected flow, Corrected speed, Degree of reaction, Elliott Company, Ellipse Law, Euler's pump and turbine equation, Gas turbine, Hydrogen-cooled turbo generator, Hydrogen turboexpander-generator, Industrial fans, Laboratory for Energy Conversion, Malibu Hydro, Mechanical fan, Metropolitan-Vickers, Mixed flow compressor, Radial turbine, Solar fan, Steam turbine, Tesla turbine, Turbine engine failure, Turbine hall, Turbine map, Turbomachinery, Turbopump, Variable geometry turbomachine, Wells turbine.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 38. Chapters: Air preheater, Axial compressor, Bimetallic strip, Cylinder (engine), Expander cycle (rocket), Gas turbine, Industrial fans, Jet engine, Mechanical fan, Mixed flow compressor, Moving bed heat exchanger, Plant efficiency, Recuperator, Sectional cooler. Excerpt: A gas turbine, also called a combustion turbine, is a type of internal combustion engine. It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber in-between. The basic operation of the gas turbine is similar to the of the steam power plant except that air is used instead of water. Fresh atmospheric air flows through a compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high-temperature flow. This high-temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process. The turbine shaft work is used to drive the compressor and other devices such as an electric generator that may be coupled to the shaft. The energy that is not used for shaft work comes out in the exhaust gases, so these have either a high temperature or a high velocity. The purpose of the gas turbine determines the design so that the most desirable energy form is maximized. Gas turbines are used to power aircrafts, trains, ships, electrical generators, or even tanks. Gases passing through an ideal gas turbine undergo three thermodynamic processes. These are isentropic compression, isobaric (constant pressure) combustion and isentropic expansion. Together, these make up the Brayton cycle. In a practical gas turbine, gases are first accelerated in either a centrifugal or axial compressor. These gases are then slowed using a diverging nozzle known as a diffuser; these processes increase the...

The new edition will continue to be of use to engineers in industry and technological establishments, especially as brief reviews are included on many important aspects of Turbomachinery, giving pointers towards more advanced sources of information. For readers looking towards the wider reaches of the subject area, very useful additional reading is referenced in the bibliography. The subject of Turbomachinery is in continual review, and while the basics do not change, research can lead to refinements in popular methods, and new data can emerge. This book has applications for professionals and students in many subsets of the mechanical engineering discipline, with carryover into thermal sciences; which include fluid mechanics, combustion and heat transfer; dynamics and vibrations, as well as structural mechanics and materials engineering. An important, long overdue new chapter on Wind Turbines, with a focus on blade aerodynamics, with useful worked examples Includes important material on axial flow compressors and pumps Example questions and answers throughout

Turbomachines are used extensively in Aerospace, Power Generation, and Oil & Gas Industries. Efficiency of these machines is often an important factor and has led to the continuous effort to improve the design to achieve better efficiency. The axial flow compressor is a major component in a gas turbine with the turbine's overall performance depending strongly on compressor performance. Traditional analysis of axial compressors involves through flow calculations, isolated blade passage analysis, Quasi-3D blade-to-blade analysis, single-stage (rotor-stator) analysis, and multi-stage analysis involving larger design cycles. In the current study, the detailed flow through a 15 stage axial compressor is analyzed using a 3-D Navier Stokes CFD solver in a parallel computing environment. Methodology is described for steady state (frozen rotor stator) analysis of one blade passage per component. Various effects such as mesh type and density, boundary conditions, tip clearance and numerical issues such as turbulence model choice, advection model choice, and parallel processing performance are analyzed. A high sensitivity of the predictions to the above was found. Physical explanation to the flow features observed in the computational study are given. The total pressure rise verses mass flow rate was computed.