Axial Compressor

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WISGSK, a Computer Code for the Prediction of a Multistage Axial Compressor Performance with Water Ingestion - T. Tsuchiya 1982

"Axial Compressor Theory and Design" - Frank J. Gardiner 1946

Process Centrifugal Compressors - Klaus H. Lüdtke 2004-02-09
Originating in the process compressor industry, this text primarily addresses: rotating equipment engineers, project engineers, engineering contractors, and compressor user companies in oil and gas field operations, natural gas processing, petroleum refining, petrochemical processing, industrial refrigeration, and chemical industries. It enables the reader to assess compressors and defines the constraints influencing the compressor design.

Axial Compressor Middle Stage Secondary Flow Study - Joel H. Wagner 1983
This report describes an experimental investigation of the secondary flow within and

aft on an axial compressor model with thick endwall boundary layers. The objective wa sto obtain detailed aerodynamic and trace gas concentration traverse data aft of a well documented isolated rotor for the ultimate purpose of improving the design phases of compressor development based on an improved physical understanding of secondary flow. It was determined from the flow visualization, aerodynamic, and trace gas concentration results that the relative unloading of the midspan region of the airfoil inhibited a fullspan separation at high loading, thus preventing the massive radial displacement of the hub corner stall to the tip. Radial distribution of high and low total pressure fluid influenced the magnitude of the spanwise distribution of loss, such that there was a general decrease in loss near the hub to the extent that, for th least loaded case, a negative loss (increase in total pressure) was observed. The ability to determine the spanwise distribution of blockage was demonstrated. Large blockage was present in the endwall regions due to the corner stall and tip leakage with little blockage in the core flow region. Hub blockage was found to increase rapidly with loading.

Axial Compressor Middle Stage Secondary Flow Study - Joel H. Wagner 1983

Fluid Mechanics and Thermodynamics of Turbomachinery - S. Larry Dixon 2005-03-30

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

Physics Based Modeling of Axial Compressor Stall - Mina Adel Zaki 2009

Axial compressors are used in a wide variety of aerodynamic applications and are one of the most important components in aero-engines. The operability of compressors is however limited at low-mass flow rates by fluid dynamic instabilities such as stall and surge. These instabilities can lead to engine failure and loss of engine power which can compromise the aircraft safety and reliability. Therefore, a better understanding of how stall occurs and the causes behind its inception is extremely important. In the vicinity of the stall line, the flow field is inherently unsteady due to the interactions between adjacent rows of blades, formation of separation cells, and the viscous effects including shock-boundary layer interaction. Accurate modeling of these phenomena requires a proper set of stable and accurate boundary conditions at the rotorstator interface that conserve mass, momentum and energy, while eliminating false reflections. As a part of this effort, an existing 3D Navier-Stokes analysis for modeling single stage compressors has been modified to model multi-stage axial compressors and turbines. Several rotor-stator interface boundary conditions have been implemented. These have been evaluated for the first stage (a stator and a rotor) of the two stage fuel turbine on the space shuttle main engine (SSME). Their effectiveness in conserving global properties such as mass, momentum, and energy across the interface, while yielding good performance predictions has been evaluated. While all the methods gave satisfactory results, a characteristic based approach and an unsteady sliding mesh approach are found to work best. Accurate modeling of the formation of stall cells requires the use of advanced turbulence models. As a part of this effort, a new advanced turbulence model called Hybrid RANS/KES (HRKES) has been developed and implemented. This model solves Menter's k--SST model near walls and switches to a Kinetic Eddy Simulation (KES) model away from walls. The KES model solves directly for local turbulent kinetic energy and local turbulent length scales, alleviating the grid spacing dependency of the length scales found in other Detached Eddy Simulation (DES) and Hybrid RANS/LES (HRLES) models. Within the HRKES model, combinations of two different blending functions have been evaluated for blending the near wall model to the KES model. The use of realizability constraints to bound the KES model parameters has also been studied for several internal and external flows. The current methodology is used in the prediction of the performance map for the NASA Stage 35 compressor configuration as a representative of a modern compressor stage. The present approach is found to satisfactory predict the onset of stall. It is found that the rotor blade tip leakage vortex and its interaction with the shock wave is mainly the reason behind the stall inception in this compressor stage.

Axial-flow Compressors - Ronald H. Aungier 2003

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.

Single-Stage Axial Compressor Component Development for Small Gas Turbine Engines. Volume I. Design - Charles H. Muller 1969

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 Revised Computer Program for Axial Compressor Design - Richard M. Hearsey 1975

This report, in two volumes, describes a computer program that has been developed for the design of axial compressors. The principal purpose of the program is to enable a single computer program to determine the geometry of the compressor blading, details of the flow within the compressor, and the design point performance of the machine. Some optional calculation routines will also enable effects of mixing of the flow to be investigated. The program consists fundamentally of three sections; two alternative means of determining blade geometry, and an aerodynamic computation for the flow through the compressor.

Measurements of Flow Through a Single-stage Axial Compressor - Massachusetts Institute of Technology. Gas Turbine Laboratory 1954

Aerodynamic Design of Axial-flow Compressors - Lewis Research Center 1965

Centrifugal and Axial Compressor Control - G. K. MacMillan 1983-01-01

The Design of an Axial Compressor Stage for a Total Ratio of 3 to 1 - Arthur J. Wennerstrom 1971

A Revised Computer Program for Axial Compressor Design. Volume 2. Program Listing and Program Use Example - Richard M. Hearsey 1975

A computer program for the design of axial compressors is presented. It comprises of three principal sections; two alternative means of determining blade geometry, and an aerodynamic computation for the flow through the compressor. The report shows the Fortran program listing and an example of the use of the program.

Centrifugal and Axial Compressor Control - Gregory K. McMillan 1983-01-01

Turbines - Source Wikipedia 2013-09

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.

A State Space Model of a Multistage Axial Compressor System - Cheung-Sing Cheung 1982

Compressibility Effects on Rotating Stall in a Two-stage Axial Compressor - Jaideep Sahai Mathur 1987

A Revised Computer Program for Axial Compressor Design - Richard M. Hearsey 1975

This report, in two volumes, describes a computer program that has been developed for the design of axial compressors. The principal purpose of the program is to enable a single computer program to determine the geometry of the compressor blading, details of the flow within the compressor, and the design point performance of the machine. Some optional calculation routines will also enable effects of mixing of the flow to be investigated. The program consists fundamentally of three sections; two alternative means of determining blade geometry, and an aerodynamic computation for the flow through the compressor.

Aerodynamics of Turbines and Compressors. (HSA-1), Volume 1 - William R. Hawthorne 2017-03-14

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.

Advances in Axial Compressor Aerodynamics - R. Dénos 2006

Simplified Design Theory for Highly Loaded Axial Compressor Rotors and Experimental Study of Two Transonic Examples - Arthur John Wennerstrom 1965

Axial Compressor Reversed Flow Performance - Robert Normand Gamache 1985
The results of an analytical study of compression system forced response and an experimental investigation of the reversed flow performance of a three-stage axial-flow compressor are presented. A one dimensional lumped parameter description of the dynamics of a simple compression system was found to be capable of simulating the circumstances under which the imposition of a periodic external excitation can 'force' a normally surging compression system into a small amplitude oscillation about the nonrecoverable stall point. This forces oscillation can then decay into a system stagnation upon termination of the external excitation. It was also found, however, that predictions of compression system forced response behavior were heavily dependent upon the model used for defining compressor post-stall performance, both steady state and transient, especially in the reverse flow and mass flow and shutoff operating regimes. The complete set of pressure rise and torque characteristics of a three-stage axial-flow compressor are presented. Two stable stalled flow modes have been observed in the multi-stage axial compressor builds tested: 1) rotating stall, and 2) full annulus stalled flow. The transition to each of the two stalled modes is accompanied by a discontinuous drop in overall time-averaged pressure rise and torque performance. Although a large hysteresis is associated with the unstall-rotating stall transition (which occurs at a relatively large positive flow coefficient), the transition from rotating stall to the annulus stall mode (which occurs at a negative flow coefficient near shutoff) has no hysteresis.

A Revised Computer Program for Axial Compressor Design. Volume 1. Theory, Descriptions, and User's Instructions - Richard M. Hearsey 1975
This report, in two volumes,

describes a computer program that has been developed for the design of axial compressors. The principal purpose of the program is to enable a single computer program to determine the geometry of the compressor blading, details of the flow within the compressor, and the design point performance of the machine. Some optional calculation routines will also enable effects of mixing of the flow to be investigated. The program consists fundamentally of three sections; two alternative means of determining blade geometry, and an aerodynamic computation for the flow through the compressor.

A First Principles Based Methodology for Design of Axial Compressor Configurations - Vishwas Iyengar 2007

Axial compressors are widely used in many aerodynamic applications. The design of an axial compressor configuration presents many challenges. Until recently, compressor design was done using 2-D viscous flow analyses that solve the flow field around cascades or in meridional planes or 3-D inviscid analyses. With the advent of modern computational methods it is now possible to analyze the 3-D viscous flow and accurately predict the performance of 3-D multistage compressors. It is necessary to retool the design methodologies to take advantage of the improved accuracy and physical fidelity of these advanced methods. In this is study, a first-principles based multi-objective technique for designing single stage compressors is described. The study accounts for stage aerodynamic characteristics, rotor-stator interactions and blade elastic deformations. A parametric representation of compressor blades that include leading and trailing edge camber line angles, thickness and camber distributions was used in this study A design of experiment approach is used to reduce the large combinations of design variables into a smaller subset. A response surface method is used to approximately map the output variables as a function of design variables. An optimized configuration is determined as the extremum of all extrema. This method has been applied to a rotor-stator stage similar to NASA Stage 35. The study has two parts: a preliminary study where a limited number of design variables were used to give an understanding of the important design variables for subsequent use, and a comprehensive application of the methodology where a larger, more complete set of design variables are used. The extended methodology also attempts to minimize the acoustic fluctuations at the rotor-stator interface by considering a rotor-wake influence coefficient (RWIC). Results presented include performance map calculations at design and off-design speed along with a detailed visualization of the flow field at design and off-design conditions. The present methodology provides a way to systematically screening through the plethora of design variables. By selecting the most influential design parameters and by optimizing the blade leading edge and trailing edge mean camber line angles, phenomenon's such as tip blockages, blade-to-blade shock structures and other loss mechanisms can be weakened or alleviated. It is found that these changes to the configuration can have a beneficial effect on total pressure ratio and stage adiabatic efficiency, thereby improving the performance of the axial compression system. Aeroacoustic benefits were found by minimizing the noise generating mechanisms associated with rotor wake-stator interactions. The new method presented is reliable, low time cost, and easily applicable to industry daily design optimization of turbomachinery blades.

Temporally and Spatially Resolved Flow in a Two-stage Axial Compressor. Part 2: Computational Assessment - 1990

Analysis of an Axial

Compressor Stage with Infinitesimal and Finite Blade Spacing - H. J. Reissner 1951

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.

Computational Analysis of a Multistage Axial Compressor - Chaithanya Mamidoju 2014

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.

Axial and Centrifugal Compressor Mean Line Flow Analysis Method - Nasa Technical Reports Server (Ntrs) 2013-07

This paper describes a method to estimate key aerodynamic parameters of single and multistage axial and centrifugal compressors. This mean-line compressor code COMDES provides the capability of sizing single and multistage compressors quickly during the conceptual design process. Based on the compressible fluid flow equations and the Euler equation, the code can estimate rotor inlet and exit blade angles when run in the design mode. The design point rotor efficiency and stator losses are inputs to the code, and are modeled at off design. When run in the off-design analysis mode, it can be used to generate performance maps based on simple models for losses due to rotor incidence and inlet guide vane reset angle. The code can provide an improved understanding of basic aerodynamic parameters such as diffusion factor, loading levels and incidence, when matching multistage compressor blade rows at design and at part-speed operation. Rotor loading levels and relative velocity ratio are correlated to the onset of compressor surge. NASA Stage 37 and the three-stage NASA 74-A axial compressors were analyzed and the results compared to test data. The code has been used to generate the performance map for the NASA 76-B three-stage axial compressor featuring variable geometry. The compressor stages were aerodynamically matched at off-design speeds by adjusting the variable inlet guide vane and variable stator geometry angles to control the rotor diffusion factor and incidence angles.

Aerodynamic Design of Axial Flow Compressors - Robert O. Bullock 1965

Early Jet Engines and the Transition from Centrifugal to Axial Compressors - Brian John Nichelson 1988

The transition from centrifugal-flow compressors to axial-flow compressors in the jet engines of the late 1940's and early 1950's provides an illuminating case study of the evolutionary nature of technological change. A look at the development of the turbojet in light of engineering design reveals that incremental changes came about in response to changing needs. The iterative nature of engineering design, whereby a designer repeats a step until he arrives at an acceptable solution, allows the designer to take into account new needs and new information. The first two turbojets, invented independently in England and Germany in the mid-1930's, both used centrifugal compressors. The inventors built upon the two hundred year-old tradition of centrifugal-flow turbomachinery to design a successful turbojet compressor. In contrast, all attempts at designing and building an axial-flow compressor prior to the twentieth century failed. Yet, researchers in four different countries persisted in their efforts because of their faith in the potential of the axial compressor to produce a higher pressure ratio at a better efficiency than the centrifugal compressor. Theses. (mjm).

WISGSK, a Computer Code for the Prediction of a Multistage Axial Compressor Performance with Water Ingestion - T. Tsuchiya 1982

Program for the Design of an Axial Compressor Stage Based on the Radial Equilibrium Equations - Kyriacos D. Papailiou 1971

A computer program is presented to determine the three-dimensional flow conditions in an axial flow compressor stage. Entropy and energy gradients are taken into account as well as the radial shift and the curvatures of the axisymmetric stream surfaces. The program can be used at elevated Mach numbers since shock losses and compressibility effects are included. It represents an extension of work done for a research program to investigate the tip clearance effects in a three-stage compressor.

Investigation of an Impulse Axial-flow Compressor - John R. Erwin 1950

The Design of Axial Flow Compressors by the Method of Vortex Sheets - Robert DeWitt Baird 1951

Compressor Performance - M. Theodore Gresh 1991

Intended for equipment users as a guide in selecting, monitoring, and enhancing the aerodynamic performance of various types of compressors. Some basic theory is included, but the emphasis is on day-to-day performance tending and troubleshooting. Includes many examples and abundant reference data. A.

Centrifugal and Axial Compressor Control - Gregory K. McMillan 2010

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.

NASA Low-speed Axial Compressor for Fundamental

Research - Charles A. Wasserbauer 1995

Design of an Axial Compressor - Elie Harb 2016