AIAA JOURNAL
Vol. 36, No. 7, July 1998

Book Reviews

Niedriggeschwindigkeitsprofile

Dieter Althaus, Verlag Vieweg, Wiesbaden, Germany, 1996, 592 pp., DM 348

Here is a unique catalog of wind tunnel results for an array of high-performance, low-speed airfoils. Applications of the subject airfoils include sailplanes, low-speed general aviation aircraft, helicopters, and windmills. All data have been meticulously taken in the legendary Laminarwindkanal at Stuttgart. This permits the user of this catalog to compare the performance increments between the airfoils with an unusually high degree of confidence. Comparisons with results from other wind tunnels (the NASA Low Turbulence Pressure Tunnel and the University of Delft wind tunnel) show good agreement. Translation from German to English in the text is very clear. The figures remain in German; however, this presents no difficulty.

The Laminarwindkanal at Stuttgart is famous for its low turbulence and overall flow quality. Lift and pitching moment are obtained from an integration of the floor and ceiling pressures in the test section, and drag is obtained from a wake rake. Airfoil model cost is low because the models have no pressure taps. Consequently, experimental chordwise pressure distributions are not available, although theoretical inviscid pressure distributions, calculated by potential flow, are given for each airfoil studied.

It is unfortunate that the experimental data are limited to lift, drag, and pitching moment coefficients, particularly in this relatively low-Reynolds-number regime. Here the boundary-layer thickness has a significant effect on the pressure distribution, and transition typically occurs via a laminar separation bubble whose streamwise length can be on the order of 5% of the airfoil chord. None of this is revealed in the potential flow pressure distributions, and the existence and severity of laminar separation bubbles can be only vaguely inferred from the experimental drag polars. The location of transition itself is not given. Instead of providing simple potential flow analyses of the airfoils, it would have been more useful to theoretically analyze them using a code such as ISIS developed by Mark Drela at the Massachusetts Institute of Technology. This would provide solutions with the effects of viscosity, and this particular code reliably predicts the existence and effects of laminar bubbles. Correlation of the code's predictions with the experimental drag polars would also be quite valuable.

Most of the airfoils studied are those developed by Wortmann and Eppler at Stuttgart, where very low profile drag has typically been a primary design goal. It would have been interesting to see more data and comparisons with other airfoil designs such as those developed by Michael Selig at the University of Illinois.

It is, of course, easy to suggest extensions to others' work. Dieter Althaus's collection of low-speed airfoil data is a classic and should be studied by anyone considering the design and development of a flight vehicle for this flow regime.

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Three-Dimensional Velocity and Vorticity Measuring and Image Analysis Techniques

Edited by T. Dracos, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1996, 310 pp., $150.00

This is Volume 4 of the ERCOFTAC (European Research Community on Flow, Turbulence, and Combustion) series on new techniques for three-dimensional measurements of velocity and vorticity of flow. It is a collection of lecture notes from a short course held in Zurich, Switzerland, in 1996. Most of the contents of this volume reflect the contributions made by a group of institutions at the ETH Zurich (Swiss Federal Institute of Technology) in the development of new measurement techniques for turbulent flow research. The other contributors are from the University of Patras, Greece; DLR, German Aerospace Research Establishment; the University of Oldenburg, Germany; Dantec Measurement Technology; and TSI, Inc.

Four chapters deal with the topics of multi-hot-wire anemometry, particle image velocimetry (PIV), particle tracking velocimetry (PTV), and laser-induced fluorescence velocimetry. These are the techniques in which rapid, new developments have been made by many research groups and institutions around the world to facilitate the exploration of turbulence. Hot-wire anemometry is a point measurement technique capable of measuring three velocity components, whereas the other three techniques have the potential to make not only spatial whole-field measurements but also three-dimensional point velocity measurements. The book fulfills its purpose of presenting the efforts and achievements made by the authors in three-dimensional measurements of turbulence in the past decade.

Chapter one is devoted to multi-hot-wire anemometry. It includes two papers by research groups of the University of Patras, ETH Zurich, and Dantec Measurement Technology. The first paper describes the principle of hot-wire anemometry, the layout and construction of the multi-hot-wire probes, and their calibration for measurements of three velocity components and their first derivatives. The second paper introduces a commercial product, the Multi-Channel Constant Temperature Anemometer. As point measurement techniques, hot-wire as well as laser-Doppler anemometers are capable of measuring three components and have been developed and used for several decades. However, a relatively common nonintrusive optical technique, laser Doppler anemometry, is not included in these lecture notes. PIV and PTV, which are new instantaneous whole-field optical imaging techniques, have been developed and widely utilized over the past decade for turbulence studies. They first appeared as two-dimensional techniques but are now being extended into three-dimensional tools. Chapter two includes four papers contributed by TSI Inc., Dantec Measurement Technology, DLR, and the University of Oldenburg. The two main commercial PIV system manufacturers have developed a real-time, image-capturing, and batch-processing PIV for two-dimensional and stereoscopic measurements (TSI) and a real-time PIV processor for synchronization and on-line processing of vector fields with multiple cameras (Dantec). The developments and applications of PIV by DLR are very encouraging. The PIV measurements were performed for low-speed and transonic flows of grid turbulence, boundary layers, rotors, and the wake of cascade blades in a large industrial wind tunnel. Readers can also find development trends for stereoscopic PIV (two dimensional in space with three velocity components) and true three-dimensional holographic PIV. Chapter three contains five papers by authors from the ETH Zurich that present their work in PTV techniques for measuring three-dimensional flows. These papers are very informative, providing details of the PTV system, multiple-charge-coupled-device cameras, three-dimensional particle tracking algorithms, flow tracers used, image processing, calibration (very important), and, finally, measurements in turbulence in an open channel flow. The accuracy of the measurements depends on software (the tracking algorithm) as well as hardware. Much research has been done by other groups worldwide, and it would have been helpful to provide a comparative assessment of performance. Chapter four includes four papers on laser-induced fluorescence velocimetry, also by authors from the ETH Zurich. This technique was developed mainly for measurements of three-dimensional velocity fields in turbulent mixing flows by tracking flow patterns from two consecutive images generated by varied concentrations of fluorescent dye (fluid markers). The authors successfully developed and utilized their system to study the performances of the technique and measured the three-dimensional velocity field in turbulence mixing in a waterjet.

This book is a fruitful source of turbulence measurement tools for professionals, including researchers and graduate students, who are interested in three-dimensional techniques in measurements of turbulent flows, transport, and mixing. The book represents lecture notes for a short course and should not be expected to offer a comprehensive collection of the techniques used worldwide. Comparing the title of this book with its contents, the reader may be frustrated to find little information on contributions from research groups outside Europe. However, the latter are represented in the extensive references in each of the chapters. There is some printing negligence, and there are errors. For example, the last line is missing on page 17; Fig. 16 on page 251 should be flipped; "eq. (3)" in line 10 of page 267 should be "eq. (1)."

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