losses and turbulence characteristics have been determined and simple design rules formulated.

Although turbulence intensity levels of order 10% have been generated, the decay rate was found to be higher than that associated with grid-generated turbulence: $Tu \propto x^{-\frac{3}{4}}$ compared with a grid decay rate, $Tu \propto x^{-\frac{5}{8}}$.

The present results have been compared with other limited measurements in the literature, and found to be in good agreement.

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BOOK REVIEW

Numerical Methods in Heat Transfer Vol III

Eds R. W. Lewis and K. Morgan

The 13 chapters in this book consist of invited contributions arising from papers presented at the Third International Conference on Numerical Methods in Thermal Problems, held at Seattle in 1983. The book contains a useful blend of new computational modelling techniques and standard methods. In almost all cases, numerical results are presented of flows and heat transfer in real engineering situations.

All but one of the chapters employ either finite element (FE) or finite difference (FD) methods. Two chapters deal with welding problems using FE methods. Of these, one uses an implicit integration scheme for the calculation of transient thermal stresses caused by the highly localized heating and cooling of arc-welding. The other is concerned with automatic butt-welding and identifies the importance of the gap between the tack-welded plates in front of the arc. In another contribution, FE 'engineering elements' are presented which can be used for the analysis of the three modes of heat transfer in problems involving complex geometries; examples are given of flows inside a conducting pipe and between two surfaces of 'inverted cup' shape.

Problems which arise in reservoir engineering of mass and heat transfer in porous media is the subject of one chapter. Particular emphasis is given to minimizing numerical diffusion effects. Another chapter uses FE methods in dealing with the important problem of the non-isothermal extrudate swell of elastic liquids which occurs in polymer processing. Earlier work is extended to cover liquids with significant elasticity, with the 'melt-spinning' of nylon-6 chosen as the numerical example.

Seven of the chapters use various finite difference methods. In the first, an inverse formulation is presented to solve the problem of a moving boundary in phase change calculations. A novel approach is used which allows convergence to be obtained about the singular point where the solidification front meets a boundary. Transient heat transfer in typical structural elements found in (aero)space constructions is analysed in another paper by coupling finite difference solutions in the 'skin' of the elements with exact Laplace transform solutions in the 'web' of the elements.

Calculations are made of natural convection flows in enclosures in two chapters. In the first, block ADI methods are extended and applied to the classical unitary square cavity. The vorticity and stream function are solved both together with and separately from the temperature equation. A useful computer listing of a general block-tridiagonal solution routine is provided. The second paper studies natural convection in tilted enclosures, such as those found in solar collectors, both with and without radiation effects. Such effects are found to be significant.

There are two chapters which use FD methods to calculate combustion phenomena in or near porous material. One addresses the problem of ignition in unmixed gases in the stagnation region of a bluff body by a hot surface when fuel is injected through a porous medium. This extends work which previously had been confined to premixed gases. The second paper presents calculations of combustion within porous material such as occur in coal gasification, coal bed burning, etc. The major novelty of this work is the use of a two-stage chemical reaction model which takes account of the diffusion of oxygen from the gas stream into the solid at the first stage before the chemical combination occurs at the second stage.

The remaining chapter using FD methods looks at the problem of transient conjugate forced convection from circular tubes in cross flow during start-up or shut-down in, for example, heat exchangers and power plants.

The remaining chapter of the book applies the 'gridless' random-walk technique of Chorin, for simulating diffusion effects, to calculate the transient heat transfer from a flat plate in steady motion. A method of repeated application is developed which allows ensemble averaging, thereby yielding smooth instantaneous temperature profiles and hence reliable heat transfer values.

Overall I judge this to be a very useful book which, whatever your interest in numerical heat transfer research, is likely to yield nuggets of valuable information.

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The Exergy Method of Thermal Plant Analysis

T. J. Kotas

The publication of Professor Kotas' book is an important event that will be noted by the engineers and educators who are active on the frontier of engineering thermodynamics today. The title of the book is very descriptive: it draws attention to the main mission of this treatise, which is to present the method of exergy analysis (or second-law analysis) and its main applications in energy and chemical engineering. Professor Kotas' treatment extends well beyond the simple 'presentation' of the method. This book is also an effort to make the engineer comfortable with the terminology and methodology of second-law analysis. The book is rich in worked-out examples and graphical construction of high quality.

I see two additional reasons why this book will be received with interest. My own view of the exergy field is that over the past 20–30 years, the growing popularity of the exergy method has led to a distinct body of literature, for example, journal articles and, especially, research monographs. Professor Kotas' book is one of the very few that bridge the gap between this new methodology and the traditional coverage of engineering thermodynamics. If used as a textbook, this book will be very effective in blending exergy analysis with engineering thermodynamics in the classroom.

The second reason has to do with the historical development of the exergy based methodology. Although the search for the true measure of 'useful energy is as old as the subject of classical thermodynamics', the exergy method took shape as a distinct chapter in engineering thermodynamics in the 1950s. A significant portion of the early growth of this new field was documented in German, Polish, Russian and a few other languages of Central Europe, in the works of Bosnjakovic, Rant, Brodyanskii, Szargut and Petela, among others. Professor Kotas' contribution is that it presents a balanced coverage of the English-language literature, which is relatively newer, next to the literature of the other Europe.

The book is organized into six large chapters:

1. Review of the fundamentals
2. Basic exergy concepts
3. Elements of plant analysis
4. Exergy analysis of simple processes
5. Examples of thermal and chemical plant analysis
6. Thermoeconomic applications of exergy

The six appendices (51 pages) that complete the book contain a large amount of thermodynamic data, especially on chemical exergy. The total number of references quoted is 90.

I recommend this book without any reservation. It presents a bird's-eye-view of the newest sector of engineering thermodynamics, and teaches the exergy method attractively and effectively. Mechanical and chemical engineering departments should consider adopting Professor Kotas' book as text for the second-level, applications-orientated, courses on engineering thermodynamics.

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