

PROBLEM 1.10

KNOWN: Thickness, diameter and inner surface temperature of bottom of pan used to boil water. Rate of heat transfer to the pan.

FIND: Outer surface temperature of pan for an aluminum and a copper bottom.

SCHEMATIC:



ASSUMPTIONS: (1) One-dimensional, steady-state conduction through bottom of pan.

ANALYSIS: From Fourier's law, the rate of heat transfer by conduction through the bottom of the pan is

$$q = kA \frac{T_1 - T_2}{L}$$

Hence,

$$T_1 = T_2 + \frac{qL}{kA}$$

where $A = \pi D^2 / 4 = \pi (0.2 \text{ m})^2 / 4 = 0.0314 \text{ m}^2$.

$$\text{Aluminum: } T_1 = 110^\circ\text{C} + \frac{600 \text{ W} (0.005 \text{ m})}{240 \text{ W/m}\cdot\text{K} (0.0314 \text{ m}^2)} = 110.40^\circ\text{C}$$

$$\text{Copper: } T_1 = 110^\circ\text{C} + \frac{600 \text{ W} (0.005 \text{ m})}{390 \text{ W/m}\cdot\text{K} (0.0314 \text{ m}^2)} = 110.25^\circ\text{C}$$

COMMENTS: Although the temperature drop across the bottom is slightly larger for aluminum (due to its smaller thermal conductivity), it is sufficiently small to be negligible for both materials. To a good approximation, the bottom may be considered *isothermal* at $T = 110^\circ\text{C}$, which is a desirable feature of pots and pans.

Foundation Of Heat Transfer Solution

Hans Dieter Baehr, Karl Stephan



Foundation Of Heat Transfer Solution:

Fundamentals of Heat and Mass Transfer C. P. Kothandaraman, 2006 About the Book Salient features A number of Complex problems along with the solutions are provided Objective type questions for self evaluation and better understanding of the subject Problems related to the practical aspects of the subject have been worked out Checking the authenticity of dimensional homogeneity in case of all derived equations Validation of numerical solutions by cross checking Plenty of graded exercise problems from simple to complex situations are included Variety of questions have been included for the clear grasping of the basic principles Redrawing of all the figures for more clarity and understanding Radiation shape factor charts and Heisler charts have also been included Essential tables are included The basic topics have been elaborately discussed Presented in a more better and fresher way Contents An Overview of Heat Transfer Steady State Conduction Conduction with Heat Generation Heat Transfer with Extended Surfaces FINS Two Dimensional Steady Heat Conduction Transient Heat Conduction Convection Convective Heat Transfer Practical Correlation Flow Over Surfaces Forced Convection Natural Convection Phase Change Processes Boiling Condensation Freezing and Melting Heat Exchangers Thermal Radiation Mass Transfer

Foundations of Heat Transfer Dorin Vasilescu, 2015-08 Heat may be defined as the transfer of thermal energy across a well defined boundary around a thermodynamic system The thermodynamic free energy is the amount of work that a thermodynamic system can perform Enthalpy is a thermodynamic potential that is the sum of the internal energy of the system plus the product of pressure and volume Heat transfer is the exchange of thermal energy between physical systems depending on the temperature and pressure by dissipating heat The fundamental modes of heat transfer are conduction or diffusion convection and radiation Heat transfer always occurs from a region of high temperature to another region of lower temperature In the simplest of terms the discipline of heat transfer is concerned with only two things temperature and the flow of heat Temperature represents the amount of thermal energy available whereas heat flow represents the movement of thermal energy from place to place Heat transfer is a process function as opposed to functions of state therefore the amount of heat transferred in a thermodynamic process that changes the state of a system depends on how that process occurs not only the net difference between the initial and final states of the process Several material properties serve to modulate the heat transferred between two regions at differing temperatures Examples include thermal conductivities specific heats material densities fluid velocities fluid viscosities surface emissivities and more Taken together these properties serve to make the solution of many heat transfer problems an involved process Foundations of Heat Transfer focuses on the basic modes of heat transfer

Engineering Heat Transfer Donatello Annaratone, 2010-03-14 This book is a generalist textbook it is designed for anybody interested in heat transmission including scholars designers and students Two criteria constitute the foundation of Annaratone's books including the present one The first one consists of indispensable scientific rigor without theoretical exasperation The inclusion in the book of some theoretical studies even if admirable for

their scientific rigor would have strengthened the scientific foundation of this publication yet without providing the reader with further applicable know how The second criterion is to deliver practical solution to operational problems This criterion is fulfilled through equations based on scientific rigor as well as a series of approximated equations leading to convenient and practically acceptable solutions and through diagrams and tables When a practical case is close to a well defined theoretical solution corrective factors are shown to offer simple and correct solutions to the problem

Energy Audit of Building Systems Moncef Krarti, 2016-04-19 Buildings account for almost half of total primary energy use and related greenhouse emissions worldwide Although current energy systems are improving they still fall disappointingly short of meeting acceptable limits for efficiency Well trained energy auditors are essential to the success of building energy efficiency programs and Energy Audit

INTRODUCTION TO HEAT TRANSFER S. K. SOM, 2008-10-24 This book presents a comprehensive treatment of the essential fundamentals of the topics that should be taught as the first level course in Heat Transfer to the students of engineering disciplines The book is designed to stimulate student learning through clear concise language The theoretical content is well balanced with the problem solving methodology necessary for developing an orderly approach to solving a variety of engineering problems The book provides adequate mathematical rigour to help students achieve a sound understanding of the physical processes involved Key Features A well balanced coverage between analytical treatments physical concepts and practical demonstrations Analytical descriptions of theories pertaining to different modes of heat transfer by the application of conservation equations to control volume and also by the application of conservation equations in differential form like continuity equation Navier Stokes equations and energy equation A short description of convective heat transfer based on physical understanding and practical applications without going into mathematical analyses Chapter 5 A comprehensive description of the principles of convective heat transfer based on mathematical foundation of fluid mechanics with generalized analytical treatments Chapters 6 7 and 8 A separate chapter describing the basic mechanisms and principles of mass transfer showing the development of mathematical formulations and finding the solution of simple mass transfer problems A summary at the end of each chapter to highlight key terminologies and concepts and important formulae developed in that chapter A number of worked out examples throughout the text review questions and exercise problems with answers at the end of each chapter This book is appropriate for a one semester course in Heat Transfer for undergraduate engineering students pursuing careers in mechanical metallurgical aerospace and chemical disciplines

Guidelines for Design Solutions for Process Equipment Failures CCPS (Center for Chemical Process Safety), 2010-09-17 While there is no perfect solution or absolute zero risk engineering design can significantly reduce risk potential in the CPI In Guidelines for Design Solutions to Process Equipment Failures industry experts offer their broad experience in identifying numerous solutions to the more common process equipment failures including inherent safer passive active and procedural solutions in decreasing order of robustness and reliability The book challenges the engineer to

identify opportunities for inherent and passive safety features early and use a risk based approach to process safety systems specification The book is organized into three basic sections 1 a technique for making risk based design decisions 2 potential failure scenarios for 10 major processing equipment categories and 3 two worked examples showing how the techniques can be applied The equipment categories covered are vessels reactors mass transfer equipment fluid transfer equipment solids fluid separators solids handling and processing equipment and piping and piping components Special Details Hardcover book plus 3 5 diskette for use in any word processing program with design solutions for use in PHAs Applied Mechanics Reviews ,1970 **Solar Engineering** American Society of Mechanical Engineers. Solar Energy Division. Conference,2001

Heat and Mass Transfer Hans Dieter Baehr,Karl Stephan,2013-04-17 This book is the English translation of our German publication which appeared in 1994 with the title Wärme und Stoffübertragung 2nd edition Berlin Springer Verlag 1996 The German version originated from lecture courses in heat and mass transfer which we have held for many years at the Universities of Hannover and Stuttgart respectively Our book is intended for students of mechanical and chemical engineering at universities and engineering schools but will also be of use to students of other subjects such as electrical engineering physics and chemistry Firstly our book should be used as a textbook alongside the lecture course Its intention is to make the student familiar with the fundamentals of heat and mass transfer and enable him to solve practical problems On the other hand we placed special emphasis on a systematic development of the theory of heat and mass transfer and gave extensive discussions of the essential solution methods for heat and mass transfer problems Therefore the book will also serve in the advanced training of practising engineers and scientists and as a reference work for the solution of their tasks The material is explained with the assistance of a large number of calculated examples and at the end of each chapter a series of exercises is given This should also make self study easier **Thermoactive Foundations for Sustainable Buildings** Moncef Krarti,2015-10-14 This monograph documents the current of state of art in Thermo Active Foundations TAFs suitable for efficiently and sustainably heat and cooling buildings TAFs also referred to as thermal or energy piles offer innovative and sustainable alternatives to ground source heat pumps as well as other conventional heating ventilating and air conditioning HVAC systems to heat and cool commercial as well as residential buildings in several regions in the world In summary this monograph collects the latest multi disciplinary advances in modeling designing and monitoring TAFs Ultimately it is hoped that this monograph will provide a comprehensive reference for both researchers and professionals interested in structural and thermal performance of TAFs and their applications in developing integrated and sustainable equipment and systems for the built environment Computational Fluid Dynamics Guozhao Ji,Jingliang Dong,2023-12-20 Computational fluid dynamics CFD is a powerful tool that enables engineers and scientists to simulate fluid flows in a variety of applications including thermal engineering biomedical engineering and environmental modeling This book provides a comprehensive introduction to CFD encompassing fundamental theory mathematical and numerical techniques and practical

applications The book begins by systematically introducing the basic concepts and terminology of CFD such as the continuity equation Navier Stokes equations energy equation source sink terms and types of grids The mathematical and numerical methods utilized to solve the CFD governing equations including the finite difference method and the finite volume method are then described in a beginner friendly manner accompanied by vivid and straightforward graphical illustrations In addition to covering the foundation of CFD theory the book presents several practical applications of CFD in diverse fields such as biomedical modeling renewable energy and thermal engineering To extract useful information the simulated CFD results need to be analyzed and visualized Therefore the book demonstrates common post processing and visualization techniques such as contour plots streamlines vectors and charts Overall this book provides a comprehensive introduction to CFD encompassing the essential theory methods and applications making it an ideal choice as a textbook for graduate and post graduate students or a reference for researchers and engineers working on CFD simulations

Analysis and Design of Energy Geostructures Lyesse Laloui, Alessandro F. Rotta Loria, 2019-10-19 Analysis and Design of Energy Geostructures gathers in a unified framework the theoretical and experimental competence available on energy geostructures innovative multifunctional earth contact structures that can provide renewable energy supply and structural support to any built environment The book covers the broad interdisciplinary and integrated knowledge required to address the analysis and design of energy geostructures from energy geotechnical and structural perspectives This knowledge includes Part A an introduction to the technology Part B the fundamentals of heat and mass transfers as well as of the mechanics of geomaterials and structures required to address the unprecedented behavior of energy geostructures Part C the experimental evidence characterizing the considered geostructures Part D various analytical and numerical modeling approaches to analyze the response of energy geostructures and Part E the performance based design and detailing essentials of energy geostructures Proposes the theoretical and practical application essentials required to address the analysis and design of energy geostructures from energy geotechnical and structural perspectives Presents a substantial amount of resolved exercises on key aspects governing the behavior and performance of energy geostructures to be considered in analysis and design Summarizes and discusses the most recent scientific and technical knowledge about energy geostructures including energy piles energy tunnels and energy walls

Soils and Foundations, 1992
Computational Fluid Dynamics in Industrial Combustion Jr., Charles E. Baukal, Vladimir Gershtein, Xianming Jimmy Li, 2000-10-26 Although many books have been written on computational fluid dynamics CFD and many written on combustion most contain very limited coverage of the combination of CFD and industrial combustion Furthermore most of these books are written at an advanced academic level emphasize theory over practice and provide little help to engineers who need
Cleaner Treatment Technologies and Productions in The Energy Industry, 2nd edition Jiang Bian, Xuewen Cao, Chuang Wen, Lin Teng, Zheng Li, 2023-04-29 s the rapid development of the world s economy brought serious

environmental problems the economy must accelerate industrial structure adjustment and development mode transformation to achieve sustainable development A cleaner production mode based on cleaner technology is a crucial way to solve the conflict between economic growth and environmental protection effectively In essence cleaner production is a kind of production mode in which the environmental strategy of overall prevention is adopted for the production process to reduce or eliminate their possible harm to human beings and the environment while fully meeting human needs and maximizing social and economic benefits Fossil energy and renewable energy have promoted the development of many emerging industries such as the automobile industry aerospace technology modern production and processing and modern transportation industry and preventing waste production while increasing efficiencies in the uses of energy is a crucial issue Specific measures include Using clean energy and raw materials Adopting advanced technology and equipment Comprehensive utilization Reducing pollution from the source Improving utilization efficiency Reducing or avoiding the generation and emission of pollutants in the process of production This Research Topic aims to report the most important and latest technological advances in cleaner treatment technologies of fossil energy such as oil and natural gas and renewable energy such as hydrogen energy and geothermal energy and serves as a platform for addressing and discussing theoretical and practical cleaner production

ASME Technical Papers, 1979 **Introduction to Heat Transfer** Frank P. Incropera, David P. DeWitt, 1985 The market leader noted for its readability comprehensiveness and relevancy due to its integration of theory with actual engineering practice Also known for its systematic problem solving methodology extensive use of first law thermodynamics and detailed Solutions Manual

Heat Transfer Basics Jamil Ghajjar, 2023-11-01 **HEAT TRANSFER BASICS** Concise introduction to heat transfer with a focus on worked example problems to aid in reader comprehension and student learning Heat Transfer Basics covers the essential topics of heat transfer in a focused manner starting with an introduction to heat transfer that explains its relationship to thermodynamics and fluid mechanics and continuing on to key topics such as free convection boiling and condensation radiation heat exchangers and more for an accessible and reader friendly yet comprehensive treatment of the subject Each chapter features multiple worked out example problems including derivations of key governing equations and comparisons of worked solutions with computer modeled results which helps students become familiar with the types of problems they will encounter in the field Throughout the book figures and diagrams liberally illustrate the concepts discussed and practice problems allow students to test their understanding of the content The text is accompanied by an online instructor's manual Heat Transfer Basics includes information on One dimensional steady state conduction covering the plane wall the composite wall solid and hollow cylinders and sphere conduction with and without internal energy generation and conduction with constant and temperature dependent thermal conductivity Heat transfer from extended surfaces fins of uniform and variable cross sectional area fin performance and overall fin efficiency Transient conduction covering general lumped capacitance solution method one and

multi dimensional transient conduction and the finite difference method for solving transient problems Free and forced convection covering hydrodynamic and thermal considerations the energy balance and thermal analysis and convection correlations More advanced than introductory textbooks yet not as overwhelming as textbooks targeted at specialists Heat Transfer Basics is ideal for students in introductory and advanced heat transfer courses who do not intend to specialize in heat transfer and is a helpful reference for advanced students and practicing engineers *Report [of] Project Supported by the Ford Foundation in the College of Engineering, University of Michigan, Ann Arbor: The use of computers in engineering education; final report, Jan. 1, 1963* University of Michigan. Project on the Use of Computers in Engineering Education, 1960

Transactions of the American Society of Mechanical Engineers American Society of Mechanical Engineers, 1930 Vols 2 4 11 62 68 include the Society's Membership list v 55 80 include the Journal of applied mechanics also issued separately as contributions from the Society's Applied Mechanics Division

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