Fouling Of Heat Exchanger Surfaces

A direct solution of the heat conduction equation with prescribed initial and boundary conditions yields temperature distribution inside a specimen. The direct solution is mathematically considered as a well-posed one because the solution exists, is unique, and continuously depends on input data. The estimation of unknown parameters from the measured temperature data is known as the inverse problem of heat conduction. An error in temperature measurement, thermal time lagging, thermocouple-cavity, or signal noise data makes stability a problem in the estimation of unknown parameters. The solution of the inverse problem can be obtained by employing the gradient or non-gradient based inverse algorithm. The aim of this book is to analyze the inverse problem and heat exchanger applications in the fields of aerospace, mechanical, applied mechanics, environment sciences, and engineering.

Please note that the content of this book primarily consists of articles available from Wikipedia or other free sources online. Pages: 30. Chapters: Baffle (in vessel), Concentric tube heat exchanger, Downhole heat exchanger, Dynamic scraped surface heat exchanger, Flue-gas condensation, Fouling, Grate heater, Jacketed vessel, Micro heat exchanger,

Pillowplate, Plate fin heat exchanger, Plate heat exchanger, Regenerative heat exchanger, Shell and tube heat exchanger, Thermal wheel, Waste heat recovery unit, Wellman Group. Excerpt: Fouling is the accumulation of unwanted material on solid surfaces to the detriment of function. The fouling material can consist of either living organisms (biofouling) or a non-living substance (inorganic or organic). Fouling is usually distinguished from other surface-growth phenomena in that it occurs on a surface of a component, system or plant performing a defined and useful function, and that the fouling process impedes or interferes with this function. Other terms used in the literature to describe fouling include: deposit formation, encrustation, crudding, deposition, scaling, scale formation, slagging, and sludge formation. The last six terms have a more narrow meaning than fouling within the scope of the fouling science and technology, and they also have meanings outside of this scope; therefore, they should be used with caution. Fouling phenomena are common and diverse, ranging from fouling of ship hulls, natural surfaces in the marine environment (marine fouling), fouling of heat-transfer components through ingredients contained in the cooling water or gases, and even the development of plaque or calculus on teeth, or deposits on solar panels on Mars, among other examples. This article is primarily devoted to the fouling of industrial heat exchangers,

although the same theory is generally applicable to other varieties of fouling. In the cooling technology and other technical fields, a distinction is made between macro...

Fluidized bed (FB) combustion and gasification are advanced techniques for fuel flexible, high efficiency and low emission conversion. Fuels are combusted or gasified as a fluidized bed suspended by jets with sorbents that remove harmful emissions such as SOx. CO2 capture can also be incorporated. Fluidized bed technologies for near-zero emission combustion and gasification provides an overview of established FB technologies while also detailing recent developments in the field. Part one, an introductory section, reviews fluidization science and FB technologies and includes chapters on particle characterization and behaviour, properties of stationary and circulating fluidized beds, heat and mass transfer and attrition in FB combustion and gasification systems. Part two expands on this introduction to explore the fundamentals of FB combustion and gasification including the conversion of solid, liquid and gaseous fuels, pollutant emission and reactor design and scale up. Part three highlights recent advances in a variety of FB combustion and gasification technologies before part four moves on to focus on emerging CO2 capture technologies. Finally, part five explores other applications of FB technology including (FB)

petroleum refining and chemical production. Fluidized bed technologies for near-zero emission combustion and gasification is a technical resource for power plant operators, industrial engineers working with fluidized bed combustion and gasification systems and researchers, scientists and academics in the field. Examines the fundamentals of fluidized bed (FB) technologies, including the conversion of solid, liquid and gaseous fuels Explores recent advances in a variety of technologies such as pressurized FB combustion, and the measurement, monitoring and control of FB combustion and gasification Discusses emerging technologies and examines applications of FB in other processes

This handbook presents the most important technologies concerning the reduction of fouling in heat exchangers and the appropriate technologies of removal and cleaning. Furthermore, the general and scientific fundamentals of heat transfer are explained. Written by experts from Germany, UK and the USA, this book is a reliable adviser for engineers, managers, technicians and students who want to have an overview concerning this field. Advertisements and a table of addresses will enable the reader to get in direct contract with the specialised problem solvers.

Learning process - Correlation matrix memory - The perceptron - Least-mean-square algorithm -

Multilayer perceptrons - Radial-basic function networks - Recurrent networks rooted in statistical physics - Self-organizing systems I : hebbian learning - Self-organizing systems II : competitive learning - Self-organizing systems III : information-theoretic models - Modular networks - Temporal processing - Neurodynamics - VLSI implementations of neural networks.

This thesis presents a thorough examination of the corrosion and fouling behaviour of crude oil at refining conditions on industrially applicable heat transfer surfaces. The depletion of light sweet crude oil reserves means that the processing of ever heavier and more sour crude oils is inevitable. These less-ideal crude oils present a particularly challenging set of problems for a refinery. They often have a high asphaltene and sulfur content, which creates a very aggressive feedstock in terms of fouling and corrosion. Thermal processing is known to exacerbate the situation, however the inorganically driven fouling behaviour from corrosion of heat exchanger materials at high temperature is not well understood. An atmospheric bottoms fraction of crude oil (340 °C+) with an asphaltene content of 8.47 wt% and a sulfur content of 3.43 wt% was used in this thesis to evaluate its effects on high temperature corrosion and fouling of pure iron and 316 stainless steel. A surface temperature of 540 °C was chosen for this study, to approximate the

conditions of a delayed coker heat exchanger. The experiments were carried out using a stirred, batch-style fouling reactor that enabled the preferential resistive heating of a metallic wire, which was submerged in the test oil. The change in the fouling resistance (fouling factor) of the wire was measured with time. The behaviour of the fouling factor was found to be asymptotic with time, as the buildup of coke on the surface of the wire attenuated the surface corrosion reactions. This in turn reduced the amount of inorganic foulant being ejected into the foulant layer. The foulant was examined using SEM-EDX, XRD, TEM, FIB, and AES. It was determined to be a mixture of organic carbonaceous coke, interspersed with an inorganic phase, which was found to be predominantly the pyrrhotite phase (Fe(1-x)S) of iron sulfide. Initially it was observed that the buildup of a thin iron sulfide layer occurred almost instantaneously, and preceded the formation of any surface coke. This led to the hypothesis that the iron sulfide is actually catalytic toward the formation of coke, alluding to the fact that it is a strong catalyst of dehydrogenation and condensation reactions. The attenuation of the fouling factor with time was attributed to the reduction in the amount of iron sulfide being ejected into the foulant layer and erupting at the foulant-oil interface. Thiophene was also added to the oil bath to evaluate its effects on fouling. It was thought that the addition of a thermally

stable, surface-active solvent would both solubilize the asphaltenes and reduce the interaction of corrosive species with the surface of the metal by blocking adsorption sites. The compound was added to the oil bath at concentrations of 0.5, 1.3, and 5.7 vol%. Fouling behaviour was evaluated for 250, 1000, and 1400 minutes of exposure at temperature. Thiophene was found to be very effective at reducing both the fouling factor, and the amount of surface corrosion on 316 stainless steel at all exposure levels and times. Chapter 4, a review of MoS2 for lithium ion batteries, represents a seminal contribution to that field. At the time of its publication, there was a large debate in open literature regarding the lithiation mechanism and lithiation products of MoS2 during charge/discharge cycling. A thorough study of open literature, combined with a small number of my own experiments (shown in Appendix B), revealed evidence which helped to elucidate the lithiation mechanism. This work has begun to change what was the minority view at the time, into the majority view. MoS2 converts to lithium sulfide and molybdenum metal, and functions as a lithium sulfur battery after the first discharge cycle. Initially it was thought that the MoS2 functions as an intercalation electrode over its full voltage range of 0-3V vs Li/Li+. However, the MoS2 actually decomposes after lithiation, and never re-forms in subsequent cycles. The paper presented as Chapter

4 was instrumental in bringing about that paradigm shift, and remains extremely well-received by the scientific community.

This unique and comprehensive text considers all aspects of heat exchanger fouling from the basic science of how surfaces become fouled to very practical ways of mitigating the problem and from mathematical modelling of different fouling mechanisms to practical methods of heat exchanger cleaning. The problems that restrict the efficient operation of equipment are described and the costs, some of them hidden costs, that are associated with the fouling of heat exchangers are discussed. Some simple concepts and models of the fouling processes are presented as part of the introduction to the subject. Advice on the selection, design, installation and commissioning of heat exchangers to minimise fouling is given. A large part of the text is devoted to the use of chemical and other additives to reduce or eliminate the problem of fouling. Another large section is designed to give information on both on-line and off-line cleaning of heat exchangers. One of the difficulties faced by designers and operators of heat exchangers is anticipating the likely extent of fouling problems to be encountered with different flow streams. Another large section addresses the question and describes methods that have been used in attempting to define fouling potential. The book concludes with a chapter on how fouling information can be obtained using plant data, field tests and laboratory studies.

The First Law of Thermodynamics states that energy can neither be created nor destroyed. Heat exchangers are devices built for efficient heat transfer from one fluid to another. They are widely used in engineering processes and include examples such as intercoolers, preheaters, boilers and condensers in power plants. Heat exchangers are

becoming more and more important to manufacturers striving to control energy costs. Process Heat Transfer Rules of Thumb investigates the design and implementation of industrial heat exchangers. It provides the background needed to understand and master the commercial software packages used by professional engineers for design and analysis of heat exchangers. This book focuses on the types of heat exchangers most widely used by industry, namely shell-and-tube exchangers (including condensers, reboilers and vaporizers), air-cooled heat exchangers and double-pipe (hairpin) exchangers. It provides a substantial introduction to the design of heat exchanger networks using pinch technology, the most efficient strategy used to achieve optimal recovery of heat in industrial processes. Utilizes leading commercial software important to professional engineers designing heat exchangers Illustrates design procedures using complete step-by-step worked examples Provides details on how to develop an initial configuration for a heat exchanger and how to systematically modify it to obtain a final design Abundant example problems solved manually and with the integration of computer software Supercritical fluids behave either like a gas or a liquid, depending on the values of thermodynamic properties. This tuning of properties, and other advantageous properties of supercritical fluids led to innovative technologies. More than 100 plants of production size are now in operation worldwide in the areas of process and production technology, environmental applications, and particle engineering. New processes are under research and development in various fields. This book provides an overview of the research activities in the field of Supercritical Fluids in Germany. It is based on the research program "Supercritical fluids as solvents and reaction media" on the initiative of the "GVC-Fachausschuß Hochdruckverfahrenstechnik" (i.e. the German

working party on High Pressure Chemical Engineering of the Society of Chemical Engineers). This research program provided an immensely valuable platform for exchange of knowledge and experience. More than 50 young researchers were involved contributing with their expertise, their new ideas, and the motivation of youth. The results of this innovative research are described in this book. - This book provides an overview of the research activities in the field of Supercritical Fluids in Germany - Contains results of projects within the research program on "Supercritical fluids as solvents and reaction media" on the initiative of the German working party on High Pressure Chemical Engineering of the Society of Chemical Engineers. - More than 50 young researchers were involved in contributing with their expertise, their new ideas, and the motivation of youth.

Compact Heat Exchangers for Energy Transfer Intensification: Low-Grade Heat and Fouling Mitigation provides theoretical and experimental background on heat transfer intensification in modern heat exchangers. Emphasizing applications in complex heat recovery systems for the process industries, this book:Covers various issues related to low-grade hea

Supervision, condition-monitoring, fault detection, fault diagnosis and fault management play an increasing role for technical processes and vehicles in order to improve reliability, availability, maintenance and lifetime. For safety-related processes fault-tolerant systems with redundancy are required in order to reach comprehensive system integrity. This book is a sequel of the book “Fault-Diagnosis Systems” published in 2006, where the basic methods were described. After a short introduction into fault-detection and fault-diagnosis methods the book shows how these methods can be applied for a selection of 20 real technical components and processes as examples, such as: Electrical drives (DC,

AC) Electrical actuators Fluidic actuators (hydraulic, pneumatic) Centrifugal and reciprocating pumps Pipelines (leak detection) Industrial robots Machine tools (main and feed drive, drilling, milling, grinding) Heat exchangers Also realized fault-tolerant systems for electrical drives, actuators and sensors are presented. The book describes why and how the various signal-model-based and process-model-based methods were applied and which experimental results could be achieved. In several cases a combination of different methods was most successful. The book is dedicated to graduate students of electrical, mechanical, chemical engineering and computer science and for engineers.

Heat exchangers are a crucial part of aerospace, marine, cryogenic and refrigeration technology. These essays cover such topics as complicated flow arrangements, complex extended surfaces, two-phase flow and irreversibility in heat exchangers, and single-phase heat transfer.

This book presents the ideas and industrial concepts in compact heat exchanger technology that have been developed in the last 10 years or so. Historically, the development and application of compact heat exchangers and their surfaces has taken place in a piecemeal fashion in a number of rather unrelated areas, principally those of the automotive and prime mover, aerospace, cryogenic and refrigeration sectors. Much detailed technology, familiar in one sector, progressed only slowly over the boundary into another sector. This compartmentalisation was a feature both of the user industries themselves, and also of the supplier, or manufacturing industries. These barriers are now breaking down, with valuable cross-fertilisation taking place. One of the industrial sectors that is waking up to

the challenges of compact heat exchangers is that broadly defined as the process sector. If there is a bias in the book, it is towards this sector. Here, in many cases, the technical challenges are severe, since high pressures and temperatures are often involved, and working fluids can be corrosive, reactive or toxic. The opportunities, however, are correspondingly high, since compacts can offer a combination of lower capital or installed cost, lower temperature differences (and hence running costs), and lower inventory. In some cases they give the opportunity for a radical re-think of the process design, by the introduction of process intensification (PI) concepts such as combining process elements in one unit. An example of this is reaction and heat exchange, which offers, among other advantages, significantly lower by-product production. To stimulate future research, the author includes coverage of hitherto neglected approaches, such as that of the Second Law (of Thermodynamics), pioneered by Bejan and co-workers. The justification for this is that there is increasing interest in life-cycle and sustainable approaches to industrial activity as a whole, often involving exergy (Second Law) analysis. Heat exchangers, being fundamental components of energy and process systems, are both savers and spenders of exergy, according to interpretation.

Indeed, today "second generation" enhancement concepts are routing in the automotive and refrigeration industries to obtain lower cost, smaller heat exchanger size, and higher energy efficiency in system operation. And the aerospace, process, and power generation

industries are not far behind.

Presenting contributions from renowned experts in the field, this book covers research and development in fundamental areas of heat exchangers, which include: design and theoretical development, experiments, numerical modeling and simulations. This book is intended to be a useful reference source and guide to researchers, postgraduate students, and engineers in the fields of heat exchangers, cooling, and thermal management.

Deposition of amorphous silica (SiO_2) and calcium oxalate (CaOx) on the calandria tubes of juice evaporators cause serious processing problems in Australian cane sugar mills. The removal of these deposits by mechanical and chemical means is a time-consuming and costly experience. The cost of downtime and chemical cleaning can be several million dollars per year for the Australian sugar industry. The interactions between CaOx and SiO_2 have not been investigated previously because conventional studies only address fouling by individual components. The present work evaluates their interactions using two experimental approaches: batch tests for assessing kinetic and thermodynamic behaviour, and fouling-loop experiments for examining composite fouling behaviour under different operating conditions. These two approaches were employed both in the absence and in the presence of sugar to elucidate the effect of sugar on composite fouling mechanisms and to determine the controlling species responsible for composite fouling. The combined information obtained from both the batch and fouling-

loop tests in this study offer a unique insight into the mechanisms of composite fouling of CaOx and SiO2. Steam Generation from Biomass: Construction and Design of Large Boilers provides in-depth coverage of steam generator engineering for biomass combustion. It presents the design process and the necessary information needed for an understanding of not only the function of different components of a steam generator, but also what design choices have been made. Professor Vakkilainen explores each particular aspect of steam generator design from the point-of-view of pressure part design, mechanical design, layout design, process design, performance optimization, and cost optimization. Topics such as fuels and their emissions, steam-water circulation, auxiliary equipment, availability and reliability, measurements and control, manufacture, erection, and inspection are covered. Special attention is given to recovery boilers and fluidized bed boilers, and automated design and dimensioning calculation spreadsheets are available for download at the book's companion website. This book is intended for both design engineers and steam boiler operators, as well as those involved in plant management and equipment purchasing. Provides a complete overview of biomass steam boilers, including processes, phenomena, and nomenclature Presents a clear view of how biomass boilers differ from fossil fuel boilers Covers the most used types of large-scale biomass boilers, including recovery boilers, fluidized bed boilers, and auxiliary equipment Includes a companion website with spreadsheets, calculation examples, and automatic

calculation tools for design and dimensioning Scientific Essay from the year 2018 in the subject Physics - Thermodynamics, , language: English, abstract: This work is concerned with the effects of fouling on different fin tubes and exchangers cooled by air. During operation of heat exchangers layers of deposits or corrosive products may be formed and accumulated on heat exchanger surfaces over time. This leads to additional heat transfer resistance and constriction of fluid flow area. In consequence, the exchanged heat duty is badly affected. The loss of heat duty is extreme if local heat transfer coefficients are high at clean conditions. However, maintaining cooling effectiveness is paramount in most applications. As a remedy, surfaces must be regularly cleaned. Fin tubes are core elements in air cooled exchangers or condensers to transfer heat. Fin tube exchangers are characterized by a multitude of circular, elliptical or channel type core tubes with air-side finning. Generally, the process medium flows on the tube internal side with air as coolant on the external fin side. The report deals with air cooled heat exchangers and condensers under forced or natural draft in dry cooling applications with the focus on the effect of fin side fouling. Water spray injection into the cooling air flow is excluded. Consequently, the effect of fin side fouling layers will be assessed as well as the consequence for air flowrate and heat duty at different convection types. Special attention is given to the effect of fouling on the performance of dry air cooled condensers. Also, differences of forced, induced or natural draft dry cooling

applications will be covered.

This book comprises heat transfer fundamental concepts and modes (specifically conduction, convection and radiation), bioheat, entransy theory development, micro heat transfer, high temperature applications, turbulent shear flows, mass transfer, heat pipes, design optimization, medical therapies, fiber-optics, heat transfer in surfactant solutions, landmine detection, heat exchangers, radiant floor, packed bed thermal storage systems, inverse space marching method, heat transfer in short slot ducts, freezing an drying mechanisms, variable property effects in heat transfer, heat transfer in electronics and process industries, fission-track thermochronology, combustion, heat transfer in liquid metal flows, human comfort in underground mining, heat transfer on electrical discharge machining and mixing convection. The experimental and theoretical investigations, assessment and enhancement techniques illustrated here aspire to be useful for many researchers, scientists, engineers and graduate students.

This Brief stands as a primer for heat transfer fundamentals in heat transfer enhancement devices, the definition of heat transfer area, passive and active enhancement techniques and their potential and benefits and commercial applications. It further examines techniques and modes of heat transfer like single-phase flow and two-phase flow, natural and forced convection, radiation heat transfer and convective mass transfer.

With production from unconventional rigs continuing to escalate and refineries grappling with the challenges of

shale and heavier oil feedstocks, petroleum engineers and refinery managers must ensure that equipment used with today's crude oil is protected from fouling deposits Crude Oil Fouling addresses this overarching challenge for the petroleum community with clear explanations on what causes fouling, current models and new approaches to evaluate and study the formation of deposits, and how today's models could be applied from lab experiment to onsite field usability for not just the refinery, but for the rig, platform, or pipeline. Crude Oil Fouling is a must-have reference for every petroleum engineer's library that gives the basic framework needed to analyze, model, and integrate the best fouling strategies and operations for crude oil systems. Defines the most critical variables and events that cause fouling Explains the consequences of fouling and its impact on operations, safety, and economics Provides the technical models available to better predict and eliminate the potential for fouling in any crude system

The fouling of heat exchangers, reactors and catalysts remains one of the most urgent problems facing the process industries. Over the past ten years there has been limited research and investigation into the underlying mechanisms which give rise to this problem. For convenience, particularly in heat exchanger technology, the mechanisms involved have been subdivided into different subject areas. It is often the situation that individuals or groups of workers have concentra ted efforts in one or two of these specialist areas and there is a need to integrate the ideas across the whole spectrum of the subject. In addition, topics

such as adhesion and surface phenomena have not been properly taken into account up till now in the assessment of the fouling processes. For this reason it was considered essential that the recognised experts from around the world, who are actively concerned with research, development and design in the field, should meet and exchange ideas and experience. Such a meeting was held at Alvor, Portugal, in May 1987, sponsored by the NATO Advanced St~dy Institutes Programme. In order to obtain a common basis for the work of the Advanced Study Institute, the whole technological field was reviewed right from the basic concepts to the frontiers of present knowledge. Each invited contributor was asked to make an overall presentation covering his or her area of expertise.
Durch die gezielte Strukturierung von wärmeübertragenden Oberflächen, wie beispielsweise durch Dellen oder Rippen, kann die örtliche Turbulenz und damit die thermische Durchmischung gesteigert werden. Dies kann die Effizienz von Wärmeübertragern oder Bauteilkühlsystemen erheblich erhöhen. Derartige Oberflächenstrukturrierungen begünstigen jedoch das Partikelfouling, daher die Ablagerung suspendierter Partikel, wie z.B. Sand, Schlamm oder Korrosionsprodukte. Gegenstand dieser Arbeit ist die Entwicklung eines universellen, numerischen CFD-Verfahrens zur Vorhersage des partikulären Foulings auf strukturierten Oberflächen, speziell Dellenoberflächen. Das entwickelte Verfahren basiert auf einer Kombination des Lagrangian-Particle-Trackings zur Beschreibung der dispersen Phase (Foulingpartikel), sowie räumlich und

zeitlich aufgelöster Large-Eddy Simulation für die Berechnung der kontinuierlichen Phasen (Trägerfluid). Dieses Vorgehen ermöglicht nicht nur die Auswertung der infolge der Partikelablagerungen verminderten thermo-hydraulischen Effizienz, sondern auch die Untersuchung der Wechselwirkungen zwischen turbulenten Strömungsstrukturen und dem partikulärem Fouling. Dadurch kann gezeigt werden, dass die Verwendung von sphärischen Dellen als Oberflächenstrukturen nicht nur aus thermo-hydraulischer Sicht die optimale Wahl darstellt, sondern auch eine substantielle Verminderung des Partikelfoulings begünstigt. The application of structured heat transfer surfaces, such as dimples or ribs, increase the local turbulence and thus thermal mixing. This can improve the efficiency of heat exchangers or cooling systems significantly. However, structured surfaces are known to promote particulate fouling, hence the unwanted accumulation and deposition of suspended particles (e.g., silt, sludge or iron oxide). The scope of this work is the development of a universal numerical CFD method for the prediction of particulate fouling, especially on dimpled surfaces. The proposed approach is based on a combination of the Lagrangian point-particle tracking for the description of the disperse phase (fouling particles), and spatially and temporally resolved large-eddy simulations for the calculation of the continuous phase (carrier fluid). This approach allows not only the evaluation of the reduced thermo-hydraulic efficiency due to particle deposition, but also the investigation of the interaction between turbulent flow

structures and the particulate fouling. It can be shown that the usage of spherical dimples as surface structures is not only the optimal choice from a thermo-hydraulic point of view, but also favors a substantial reduction of particulate fouling.

For more than 50 years, the Springer VDI Heat Atlas has been an indispensable working means for engineers dealing with questions of heat transfer. Featuring 50% more content, this new edition covers most fields of heat transfer in industrial and engineering applications. It presents the interrelationships between basic scientific methods, experimental techniques, model-based analysis and their transfer to technical applications.

This book presents contributions from renowned experts addressing research and development related to the two important areas of heat exchangers, which are advanced features and applications. This book is intended to be a useful source of information for researchers, postgraduate students, academics, and engineers working in the field of heat exchangers research and development.

A heat exchanger is a device designed to efficiently transfer or ""exchange"" heat from one matter to another. When a fluid is used to transfer heat, the fluid could be a liquid, such as water or oil, or could be moving air. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The most well-known type of heat exchanger is a car radiator. In a radiator, a solution of water and ethylene glycol, also known as antifreeze, transfers heat from the engine to the radiator and then from the radiator to the ambient air flowing through it. This process helps to keep a car's engine from overheating.

For efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing resistance to fluid flow through the exchanger. The exchanger's performance can also be affected by the addition of fins or corrugations in one or both directions, which increase surface area and may channel fluid flow or induce turbulence.Heat Exchangers - Basics Design Applications offers comprehensive information on particular cases of heat exchangers. Beside the questions of thermodynamic basics, the book discourses numerous important issues, such as conceptions, design, operations, fouling and cleaning of heat exchangers. The book is not inevitably anticipated to be an elementary source of the knowledge in the area it covers, but moderately a guide while pursuing detailed solutions of specific technical problems which face engineers and technicians engaged in research and development in the fields of heat transfer and heat exchangers.

Fouling of Heat ExchangersElsevier

Two-phase flow heat exchangers are vital components of systems for power generation, chemical processing, and thermal environment control. The art and science of the design of such heat exchangers have advanced considerably in recent years. This is due to better understanding of the fundamentals of two-phase flow and heat transfer in simple geometries, greater appreciation of these processes in complex goemetries, and enhanced predictive capability through use of complex computer codes. The subject is clearly of great fundamental and practical importance. The NATO ASIan Thermal-Hydraulic Fundamentals and Design of Two-Phase Flow Heat Exchangers was held in Povoa de Varzim (near Porto), Portugal, July 6-17, 1987. participating in the organization of" the ASI were the Department of Mechanical Engineering and the Clean Energy Research Institute, University of Miami; Universidade do Porto; and the

Department of Mechanical Engineering, Aeronautical Eng ineer ing, and Mechanics, Rensselaer Polytechnic Institute. The ASI was arranged primarily as a high-level teaching activity by experts representing both academic and industrial viewpoints. The program included the presentation of invited lectures, a limited number of related technical papers and discussion sessions.

Comprehensive and unique source integrates the material usually distributed among a half a dozen sources. * Presents a unified approach to modeling of new designs and develops the skills for complex engineering analysis. * Provides industrial insight to the applications of the basic theory developed.

This classic text is an exploration of the practical aspects of thermodynamics and heat transfer. It was designed for daily use and reference for system design and for troubleshooting common engineering problems-an indispensable resource for practicing process engineers.