

Temp., T °C	Sat. press., P _{sat} kPa	Sat. liquid, v _f	Sat. vapor, v _g	Sat. liquid, u _f	Evap., u _{fg}	Sat. vapor, u _g	Sat. liquid, h _f	Evap., h _{fg}	Sat. vapor, h _g	Sat. liquid, s _f	Evap., s _{fg}	Sat. vapor, s _g
-40	51.25	0.0007053	0.36064	-0.036	207.42	207.38	0.00	225.86	225.86	0.00000	0.96869	0.96869
-38	56.86	0.0007082	0.32718	2.472	206.06	208.53	2.512	224.62	227.13	0.01071	0.95516	0.96588
-36	62.95	0.0007111	0.29740	4.987	204.69	209.68	5.032	223.37	228.40	0.02137	0.94182	0.96319
-34	69.56	0.0007141	0.27082	7.509	203.32	210.83	7.559	222.10	229.66	0.03196	0.92867	0.96063
-32	76.71	0.0007171	0.24706	10.04	201.94	211.97	10.09	220.83	230.93	0.04249	0.91569	0.95819
-30	84.43	0.0007201	0.22577	12.58	200.55	213.12	12.64	219.55	232.19	0.05297	0.90289	0.95586
-28	92.76	0.0007232	0.20666	15.12	199.15	214.27	15.19	218.25	233.44	0.06339	0.89024	0.95364
-26	101.73	0.0007264	0.18947	17.67	197.75	215.42	17.75	216.95	234.70	0.07376	0.87776	0.95152
-24	111.37	0.0007296	0.17398	20.23	196.34	216.57	20.31	215.63	235.94	0.08408	0.86542	0.94950
-22	121.72	0.0007328	0.15999	22.80	194.92	217.71	22.89	214.30	237.19	0.09435	0.85323	0.94758
-20	132.82	0.0007361	0.14735	25.37	193.49	218.86	25.47	212.96	238.43	0.10456	0.84119	0.94575
-18	144.69	0.0007394	0.13589	27.96	192.05	220.00	28.07	211.60	239.67	0.11473	0.82927	0.94401
-16	157.38	0.0007428	0.12550	30.55	190.60	221.15	30.67	210.23	240.90	0.12486	0.81749	0.94234
-14	170.93	0.0007463	0.11605	33.15	189.14	222.29	33.28	208.84	242.12	0.13493	0.80583	0.94076
-12	185.37	0.0007498	0.10744	35.76	187.66	223.42	35.90	207.44	243.34	0.14497	0.79429	0.93925
-10	200.74	0.0007533	0.099600	38.38	186.18	224.56	38.53	206.02	244.55	0.15496	0.78286	0.93782
-8	217.08	0.0007570	0.092438	41.01	184.69	225.69	41.17	204.59	245.76	0.16491	0.77154	0.93645
-6	234.44	0.0007607	0.085888	43.64	183.18	226.82	43.82	203.14	246.95	0.17482	0.76033	0.93514
-4	252.85	0.0007644	0.079889	46.29	181.66	227.94	46.48	201.66	248.14	0.18469	0.74921	0.93390
-2	272.36	0.0007683	0.074388	48.94	180.12	229.07	49.15	200.17	249.33	0.19452	0.73819	0.93271
0	293.01	0.0007722	0.069335	51.61	178.58	230.18	51.83	198.67	250.50	0.20432	0.72726	0.93158
2	314.84	0.0007761	0.064690	54.28	177.01	231.30	54.53	197.14	251.66	0.21408	0.71641	0.93050
4	337.90	0.0007802	0.060412	56.97	175.44	232.40	57.23	195.58	252.82	0.22381	0.70565	0.92946
6	362.23	0.0007843	0.056469	59.66	173.84	233.51	59.95	194.01	253.96	0.23351	0.69496	0.92847
8	387.88	0.0007886	0.052829	62.37	172.23	234.60	62.68	192.42	255.09	0.24318	0.68435	0.92752
10	414.89	0.0007929	0.049466	65.09	170.61	235.69	65.42	190.80	256.22	0.25282	0.67380	0.92661
12	443.31	0.0007973	0.046354	67.82	168.96	236.78	68.17	189.16	257.33	0.26243	0.66331	0.92574
14	473.19	0.0008018	0.043471	70.56	167.30	237.86	70.94	187.49	258.43	0.27201	0.65289	0.92490
16	504.58	0.0008064	0.040798	73.31	165.62	238.93	73.72	185.80	259.51	0.28157	0.64252	0.92409
18	537.52	0.0008112	0.038317	76.07	163.92	239.99	76.51	184.08	260.58	0.29111	0.63219	0.92330

$$v = 0.03 \frac{\text{m}^3}{\text{kg}}$$

$$v_f < v < v_g$$

Sat
liquid & vapor

$$x = \frac{v - v_f}{v_g - v_f}$$

$$v_g$$

$$v_g = v_g - v_f$$



Engineering Thermo Dynamic Data

KJ Lindholm-Leary



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Engineering Thermo Dynamic Data James Beverly Jones, Regina E. Dugan, 1996 **Thermodynamic Modeling and Materials Data Engineering** J.-P. Caliste, A. Truyol, Jack H. Westbrook, 2012-12-06 J P CALISTE A TRUYOL AND J WESTBROOK The Series Data and Knowledge in a Changing World exemplifies CODATA's primary purpose of collecting from widely different fields a wealth of information on efficient exploitation of data for progress in science and technology and making that information available to scientists and engineers A separate and complementary CODATA Reference Series will present Directories of compiled and evaluated data and Glossaries of data related terms The present book Thermodynamic Modeling and Materials Data Engineering discusses thermodynamic structural systemic and heuristic approaches to the modeling of complex materials behavior in condensed phases both fluids and solids in order to evaluate their potential applications It was inspired by the Symposium on Materials and Structural Properties held during the 14th International CODATA Conference in Chambéry France The quality of the contributions to this Symposium motivated us to present a coherent book of interest to the field Updated contributions inspired by Symposium discussions and selections from other CODATA workshops concerning material properties data and Computer Aided Design combine to highlight the complexity of material data issues on experimental theoretical and simulation levels Articles were selected for their pertinence in three areas Complex data leading to interesting developments and tools such as new developments in state equations and their applications prediction and validation of physical and energy data by group correlations for pure compounds modeling and prediction of mixture properties **Thermodynamic Processes 1** Salah Belaadi, 2020-02-19 Thermodynamic Processes 1 offers a comprehensive take on process engineering whereby technology transforms materials and energy production into various products The scientific methods required for designing such processes are the result of knowledge from a number of different disciplines As a result thermodynamics is the basic discipline in process engineering training The application of laws and concepts of thermodynamics is essential before the design and optimization of any process which allows downstream to control its reliability and validity This book offers a pragmatic approach through practical and varied examples chosen for their didactic and industrial interest Advanced Engineering Thermodynamics Rowland S. Benson, 2013-10-22 Advanced Engineering Thermodynamics Second Edition is a five chapter text that covers some basic thermodynamic concepts including thermodynamic system equilibrium thermodynamic properties and thermodynamic application to special systems Chapter 1 introduces the concept of equilibrium maximum work of thermodynamic systems development of Gibbs and Helmholtz functions thermodynamic system equilibrium and conditions for stability and spontaneous change Chapter 2 deals with the general thermodynamic relations for systems of constant chemical composition the development of Maxwell relations the derivatives of specific heats coefficients of h p T Clausius Clapeyron equations the Joule Thomson effect and application of van der Waals gas inversion curves to liquefaction system Chapters 3 and 4 describe

the thermodynamics of ideal gases ideal gas mixtures and gas mixtures with variable composition These chapters also discuss processes involving dissociation Lighthill ideal dissociating gas extension to ionization and real gas effects and characteristics of frozen and equilibrium flows Chapter 5 surveys the thermodynamics of elastic systems surface tension magnetic systems reversible electrical cell and fuel cell This chapter also provides an introduction to irreversible thermodynamics Onsager reciprocal relation and the concept of thermoelectricity This book will prove useful to undergraduate mechanical engineering students and other engineering students taking courses in thermodynamics and fluid mechanics

Thermodynamic Processes 2 Salah Belaadi, 2020-04-09 Thermodynamic Processes 2 is devoted to the study of equilibrium between phases in the case of the four changes of physical state fusion boiling or vaporization sublimation and allotropy or transition It also includes a section that addresses energy's relationship to the zero sum aspect of exergy and thermal cycles This second volume presents scientific and technical examples both theoretical and industrial which are the result of a careful selection accrued over more than three decades of teaching thermodynamics and in collaboration with the industry sector The didactic exercises and the practical problems are entirely dedicated to the understanding of this science and the potential applications for the industrial world This book is a tool for work and reflection essential for the student in training as well as the engineer or experienced researcher

Thermodynamic Measurement Techniques Mohammad Shamsuddin, 2024-07-18 This book offers various techniques for measurement of thermodynamic quantities of materials such as enthalpy free energy and entropy Techniques described herein include calorimetry chemical equilibria vapour pressure and electrochemical analysis The book covers general and solution thermodynamics in Chapters 1 and 2 respectively and highlights the significance of various thermodynamic quantities required for materials characterization and development in Chapter 3 The author goes on to discuss different thermodynamic measurement techniques in detail Chapters 4-8 together with a set of more than fifty worked out problems related to classical as well as solution thermodynamics and measurement techniques Chapter 9 Topics include but are not limited to the following The significance of various thermodynamic data required for selection and characterization of materials The physicochemical principles involved in various thermodynamic measurement and on the evaluation of thermodynamic data by phase diagram analyses The unique combination of calorimetry and chemical equilibrium for simultaneous determination of partial molar enthalpy and partial molar free energy of hydrogen in metals and alloys The special technique based on the combination of vapor pressure and electrical conductivity to study the effect of tellurium vapor pressure on the mode of conduction in polycrystalline cadmium telluride

Advances in Cryogenic Engineering Peter Kittel, 2012-12-06 The Albuquerque Convention Center was the venue for the 1993 Cryogenic Engineering Conference The meeting was held jointly with the International Cryogenic Materials Conference Walter F Stewart of Los Alamos National Laboratory was conference chairman Albuquerque is near Los Alamos National Laboratory which has been a significant contributor to the cryogenics community since the early days of the

Manhattan Project Albuquerque is also the home of the Air Force s Phillips Laboratory which has a lead role in developing cryocoolers The program consisted of 322 CEC papers more than a 30% increase from CEC 91 and 20% more than CEC 89 This was the largest number of papers ever submitted to the CEC Of these 249 papers are published here in Volume 39 of Advances in Cryogenic Engineering Once again the volume is published in two books This volume includes a cumulative index for the CEC volumes from 1975 1993 volumes 21 23 25 27 29 31 33 35 37 and 39 of Advances in Cryogenic Engineering The first 20 volumes are indexed in Volume 20 A companion cumulative index for the ICMC volumes volumes 22 through 40 appears in Volume 40 This is my first volume as editor I would not have been able to have done it without the assistance of the many reviewers Especially appreciated was the instruction manual left me by the previous editor Ron Fast

Nagra/PSI Chemical Thermodynamic Data Base 01/01 Wolfgang Hummel,Urs Berner,Enzo Curti,F. J. Pearson,Tres Thoenen,2002 The Nagra PSI Chemical Thermodynamic Data Base 01 01 is an encyclopedia of thermodynamic data recommended for environmental studies The data base focuses on elements commonly found as major solutes in natural waters and on actinides and fission products relevant for radioactive waste disposal projects It is the official chemical thermodynamic data base used in Swiss radioactive waste disposal projects The detailed discussion of every number recommended in this encyclopedia is the result of a multi man year project of the Paul Scherrer Institut PSI a Swiss National Lab The five authors of this work have many years of experience in research data base development and the application of thermodynamic data in environmental studies The data included for many elements are based on their reviews of the basic literature The data base also includes additional data selected by the authors from recommendations of other experts in ground water geochemistry and of the international data base project of the Nuclear Energy Agency NEA This report is indispensable for every scientist working in the field of environmental studies as the comprehensive source of information on the quality of the thermodynamic data governing particular problems in environmental geochemistry especially those concerned with the fate of hazardous substances This enables graduate students researchers and consultants as well as regulators and reviewers of scientific papers to assess the scientific basis of environmental modeling studies The encyclopedia can be used as a stand alone source of knowledge but ample references are provided for readers who wish to go beyond the level of discussion in the book An electronic version of the data base and a data base management program is available for download at our homepage <http://les.web.psi.ch/TDBbook.htm> **Select Thermodynamic Models for Process Simulation** Jean-Charles de Hemptinne,Jean-Marie Ledanois,2012 The selection of the most adequate thermodynamic model in a process simulation is an issue that most process engineer has to face sooner or later This book conceived as a practical guide aims at providing adequate answers by analysing the questions to be looked at The analysis first chapter yields three keys that are further discussed in three different chapters 1 A good understanding of the properties required in the process and their method of calculation is the first key The second chapter provides to that end in a synthetic manner the most

important equations that are derived from the fundamental principles of thermodynamics 2 An adequate description of the mixture which is a combination of models and parameters is the second key The third chapter makes the link between components and models both from a numerical parameterisation and physical molecular interactions point of view Finally 3 a correct view of the phase behaviour and trends in regard of the process conditions is the third key The fourth chapter illustrates the phase behaviour and makes model recommendations for the most significant industrial systems A decision tree is provided at the end of this chapter In the last chapter the key questions are reviewed for a number of typical processes This book is intended for process engineers who are not specialists of thermodynamics but are confronted with this kind of problems and need a reference book as well as process engineering students who will find an original approach to thermodynamics complementary of traditional lectures

Chemical Engineering Thermodynamics RAO,Y. V. C. Rao,1997 **Thermodynamic Properties of Cryogenic Fluids** Richard T. Jacobsen,Steven G. Penoncello,Eric W. Lemmon,2013-11-22 Practicing engineers and scientist will benefit from this book s presentation of the most accurate information on the subject The equations for fifteen important cryogenic fluids are presented in a basic format accompanied by pressure enthalpy and temperature entropy charts and tables of thermodynamic properties The book is supported by ICMPROPERS an interactive computer program for the calculation of thermodynamic properties of the cryogenic fluids that can be downloaded from the World Wide Web **Thermodynamic Properties of Helium, Nitrogen, and Helium-nitrogen Mixtures from 2400 to 9500 R for Pressures Between 14.696 and 3,000 Psia** Robert E. Wood,1968

Technical News Bulletin of the National Bureau of Standards ,1973 [Acyclic Hydrocarbons—Advances in Research and Application: 2012 Edition](#) ,2012-12-26 Acyclic Hydrocarbons Advances in Research and Application 2012 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Acyclic Hydrocarbons The editors have built Acyclic Hydrocarbons Advances in Research and Application 2012 Edition on the vast information databases of ScholarlyNews You can expect the information about Acyclic Hydrocarbons in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Acyclic Hydrocarbons Advances in Research and Application 2012 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at <http://www.ScholarlyEditions.com> **Thermodynamic Properties of Cryogenic Fluids** Jacob W. Leachman,Richard T Jacobsen,Eric W. Lemmon,Steven G. Penoncello,2017-07-30 This update to a classic reference text provides practising engineers and scientists with accurate thermophysical property data for cryogenic fluids The equations for fifteen important cryogenic fluids are presented in a basic format accompanied by pressure enthalpy and temperature entropy charts and tables of thermodynamic

properties It begins with a chapter introducing the thermodynamic relations and functional forms for equations of state and goes on to describe the requirements for thermodynamic property formulations needed for the complete definition of the thermodynamic properties of a fluid The core of the book comprises extensive data tables and charts for the most commonly encountered cryogenic fluids This new edition sees significant updates to the data presented for air argon carbon monoxide deuterium ethane helium hydrogen krypton nitrogen and xenon The book supports and complements NIST's REFPROP an interactive database and tool for the calculation of thermodynamic properties of cryogenic fluids Thermodynamics

Stephen R. Turns, 2006-03-06 Although the focus of this textbook is on traditional thermodynamics topics the book is concerned with introducing the thermal fluid sciences as well It is designed for the instructor to select topics and seamlessly combine them with material from other chapters Pedagogical devices include learning objectives chapter overviews and summaries historical perspectives and numerous examples questions problems and lavish illustrations Students are encouraged to use the National Institute of Science and Technology NIST online properties database **Handbook of**

Thermodynamic Diagrams Carl L. Yaws, 2013-10-22 Thermodynamic property data are important in many engineering applications in the chemical processing and petroleum refining industries The Handbook of Thermodynamic Diagrams series presents volume and enthalpy diagrams graphs for the major organic chemicals and hydrocarbons as well as the major inorganic compounds and elements The graphs arranged by carbon number and chemical formula cover a wide range of pressures and temperatures to enable engineers to determine quickly values at various points This volume covers inorganic compounds and elements *Magnesium Technology 2015* Michele Manuel, Alok Singh, Martyn Alderman, Neale

Neelameggham, 2016-12-26 The Magnesium Technology Symposium the event on which this collection is based is one of the largest yearly gatherings of magnesium specialists in the world Papers represent all aspects of the field ranging from primary production to applications to recycling Moreover papers explore everything from basic research findings to industrialization Magnesium Technology 2015 covers a broad spectrum of current topics including alloys and their properties cast products and processing wrought products and processing forming joining and machining corrosion and surface finishing ecology and structural applications In addition there is coverage of new and emerging applications *Catalogue for the Academic Year*

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