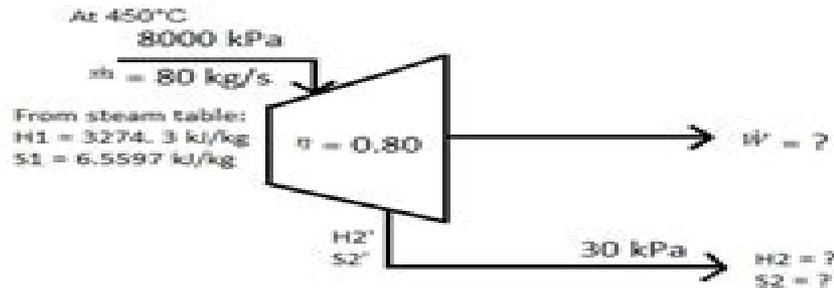


Introduction to Chemical Engineering Thermodynamics  
Problem Set

1. A turbine operates adiabatically with superheated steam entering at 450°C and 8,000 kPa with a mass flowrate of 80 kg/s. The exhaust pressure is 30 kPa and the turbine efficiency is 0.80. Determine the power output of the turbine and the enthalpy and entropy of the exhaust steam.

Given:



Required:

- a.  $\dot{W}$ , power output of the turbine
- b.  $H_2$ , enthalpy of exhaust stream
- c.  $S_2$ , entropy of exhaust stream

Solution:

From steam table under superheated steam, Table F.2, for inlet conditions:

$$H_1 = 3274.3 \frac{\text{kJ}}{\text{kg}}$$

$$S_1 = 6.5597 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

For discharge conditions:

$$H_2^L = 289.302 \frac{\text{kJ}}{\text{kg}}, H_2^V = 2625.4 \frac{\text{kJ}}{\text{kg}}$$

$$S_2^L = 0.9441 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}, S_2^V = 7.7695 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$$

If the expansion at 30 kPa is isentropic, then:  $S_2^L = S_1 = 6.5597 \frac{\text{kJ}}{\text{kg} \cdot \text{K}}$ . Steam with this entropy at 10 kPa is wet, yielding the equation:

$$S_2^L = S_2^L + x_2'(S_2^V - S_2^L)$$

Substituting the values:

$$6.5597 \frac{\text{kJ}}{\text{kg} \cdot \text{K}} = 0.9441 \frac{\text{kJ}}{\text{kg} \cdot \text{K}} + x_2' \left( 7.7695 \frac{\text{kJ}}{\text{kg} \cdot \text{K}} - 0.9441 \frac{\text{kJ}}{\text{kg} \cdot \text{K}} \right)$$

$$x_2' = 0.8228$$

This is the quality (fraction vapor) of the discharge stream at point 2'. The enthalpy  $H_2^L$  is also given by the equation:

$$H_2^L = H_2^L + x_2'(H_2^V - H_2^L)$$

Thus,

# Solved Problems In Chemical Engineering Thermodynamics

**Yijin Wang**



## **Solved Problems In Chemical Engineering Thermodynamics:**

**Chemical Engineering Thermodynamics Through Solved Problems** G. L. Pandey, J. L. Chaudhri, 1988 Chemical Engineering Thermodynamics G. N. Pande, J. L. Chaudhri, 2008 **Fundamentals of Chemical Engineering Thermodynamics** Themis Matsoukas, 2013 Fundamentals of Chemical Engineering Thermodynamics is the clearest and most well organized introduction to thermodynamics theory and calculations for all chemical engineering undergraduates This brand new text makes thermodynamics far easier to teach and learn Drawing on his award winning courses at Penn State Dr Themis Matsoukas organizes the text for more effective learning focuses on why as well as how offers imagery that helps students conceptualize the equations and illuminates thermodynamics with relevant examples from within and beyond the chemical engineering discipline Matsoukas presents solved problems in every chapter ranging from basic calculations to realistic safety and environmental applications *Chemical and Engineering Thermodynamics* Stanley I. Sandler, 1989 A revised edition of the well received thermodynamics text this work retains the thorough coverage and excellent organization that made the first edition so popular Now incorporates industrially relevant microcomputer programs with which readers can perform sophisticated thermodynamic calculations including calculations of the type they will encounter in the lab and in industry Also provides a unified treatment of phase equilibria Emphasis is on analysis and prediction of liquid liquid and vapor liquid equilibria solubility of gases and solids in liquids solubility of liquids and solids in gases and supercritical fluids freezing point depressions and osmotic equilibria as well as traditional vapor liquid and chemical reaction equilibria Contains many new illustrations and exercises **Chemical Engineering Thermodynamics** AHUJA, PRADEEP, 2008-12 This book offers a full account of thermodynamic systems in chemical engineering It provides a solid understanding of the basic concepts of the laws of thermodynamics as well as their applications with a thorough discussion of phase and chemical reaction equilibria At the outset the text explains the various key terms of thermodynamics with suitable examples and then thoroughly deals with the virial and cubic equations of state by showing the P V T pressure molar volume and temperature relation of fluids It elaborates on the first and second laws of thermodynamics and their applications with the help of numerous engineering examples The text further discusses the concepts of exergy standard property changes of chemical reactions thermodynamic property relations and fugacity The book also includes detailed discussions on residual and excess properties of mixtures various activity coefficient models local composition models and group contribution methods In addition the text focuses on vapour liquid and other phase equilibrium calculations and analyzes chemical reaction equilibria and adiabatic reaction temperature for systems with complete and incomplete conversion of reactants Key Features Includes a large number of fully worked out examples to help students master the concepts discussed Provides well graded problems with answers at the end of each chapter to test and foster students conceptual understanding of the subject The total number of solved examples and end chapter exercises in the book are over 600 Contains chapter summaries that review the major

concepts covered The book is primarily designed for the undergraduate students of chemical engineering and its related disciplines such as petroleum engineering and polymer engineering It can also be useful to professionals The Solution Manual containing the complete worked out solutions to chapter end exercises and problems is available for instructors

*Solutions Manual For Chemical Engineering Thermodynamics* Y. V. C. Rao,1998 This book is a very useful reference that contains worked out solutions for all the exercise problems in the book *Chemical Engineering Thermodynamics* by the same author Step by step solutions to all exercise problems are provided and solutions are explained with detailed and extensive illustrations It will come in handy for all teachers and users of *Chemical Engineering Thermodynamics* *Introductory Chemical Engineering Thermodynamics* J. Richard Elliott,Carl T. Lira,2012 In this book two leading experts and long time instructors thoroughly explain thermodynamics taking the molecular perspective that working engineers require This edition contains extensive new coverage of today's fast growing biochemical engineering applications notably biomass conversion to fuels and chemicals It also presents many new MATLAB examples and tools to complement its previous usage of Excel and other software *Introduction to Chemical Engineering Thermodynamics* Joseph Mauk Smith,2005 **Applied Chemical Engineering Thermodynamics** Dimitrios P. Tassios,2013-12-19 *Applied Chemical Engineering Thermodynamics* provides the undergraduate and graduate student of chemical engineering with the basic knowledge the methodology and the references he needs to apply it in industrial practice Thus in addition to the classical topics of the laws of thermodynamics pure component and mixture thermodynamic properties as well as phase and chemical equilibria the reader will find history of thermodynamics energy conservation intermolecular forces and molecular thermodynamics cubic equations of state statistical mechanics A great number of calculated problems with solutions and an appendix with numerous tables of numbers of practical importance are extremely helpful for applied calculations The computer programs on the included disk help the student to become familiar with the typical methods used in industry for volumetric and vapor liquid equilibria calculations **Numerical Problems in Thermodynamics and Kinetics of Chemical Engineering Processes** Dr. Stanisław Wroński,Ryszard Pohorecki,Jacek Siwiński,1998-01-01 This book was prepared in conjunction with the forthcoming book by the same authors *Thermodynamics and Kinetics of Chemical Engineering Processes* Both books were conceived as links between basic subjects such as mathematics physics physical chemistry and fluid mechanics and process calculations forming the final stage of chemical engineering education An understanding of the underlying principles and methods of solution is emphasized rather than purely computational skills *Engineering and Chemical Thermodynamics* Milo D. Koretsky,2004 Designed to support the way you learn Whether you learn best by applying knowledge assimilating information through visuals working equations or reading explanations of concepts Milo Koretsky's *Engineering and Chemical Thermodynamics* provides the support you need to develop a deeper and more complete understanding of thermodynamics and its application to real world problems Highlights An integrated presentation of molecular concepts with

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**Catalogue for the Academic Year** Naval Postgraduate School (U.S.), 1955

**Introduction to Chemical Engineering Thermodynamics** Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, 2001 Presents comprehensive coverage of the subject of thermodynamics from a chemical engineering viewpoint This text provides an exposition of the principles of thermodynamics and details their application to chemical processes It contains problems examples and illustrations to help students understand complex concepts

Open-Ended Problems James Patrick Abulencia, Louis Theodore, 2015-03-27 This is a unique book with nearly 1000 problems and 50 case studies on open ended problems in every key topic in chemical engineering that helps to better prepare chemical engineers for the future The term open ended problem basically describes an approach to the solution of a problem and or situation for which there is not a unique solution The Introduction to the general subject of open ended problems is followed by 22 chapters each of which addresses a traditional chemical engineering or chemical engineering related topic Each of these chapters contain a brief overview of the subject matter of concern e.g thermodynamics which is followed by sample open ended problems that have been solved by the authors employing one of the many possible approaches to the solutions This is then followed by approximately 40-45 open ended problems with no solutions although many of the authors solutions are available for those who adopt the book for classroom or training purposes A reference section is included with the chapter's contents Term projects comprised of 12 additional chapter topics complement the presentation This book provides academic industrial and research personnel with the material that covers the principles and applications of open ended chemical engineering problems in a thorough and

clear manner Upon completion of the text the reader should have acquired not only a working knowledge of the principles of chemical engineering but also and more importantly experience in solving open ended problems What many educators have learned is that the applications and implications of open ended problems are not only changing professions but also are moving so fast that many have not yet grasped their tremendous impact The book drives home that the open ended approach will revolutionize the way chemical engineers will need to operate in the future

**Thermodynamics with Chemical Engineering Applications** Elias I. Franses, 2014-08-25 Master the principles of thermodynamics and understand their practical real world applications with this deep and intuitive undergraduate textbook

**A Text Book of Engineering Thermodynamics** John Joseph Flather, 1915 *Announcement of the Course in Chemical Engineering, and of the Graduate Fellowships in Gas Engineering, Metallurgy, Paint and Varnish Manufacture, Pulp and Paper Manufacture* University of Michigan. Department of Chemical Engineering, 1916

**Thermodynamics and Heat Power, Ninth Edition** Irving Granet, Jorge Alvarado, Maurice Bluestein, 2020-11-05 The ninth edition of Thermodynamics and Heat Power contains a revised sequence of thermodynamics concepts including physical properties processes and energy systems to enable the attainment of learning outcomes by Engineering and Engineering Technology students taking an introductory course in thermodynamics Built around an easily understandable approach this updated text focuses on thermodynamics fundamentals and explores renewable energy generation IC engines power plants HVAC and applied heat transfer Energy heat and work are examined in relation to thermodynamics cycles and the effects of fluid properties on system performance are explained Numerous step by step examples and problems make this text ideal for undergraduate students This new edition Introduces physics based mathematical formulations and examples in a way that enables problem solving Contains extensive learning features within each chapter and basic computational exercises for in class and laboratory activities Includes a straightforward review of applicable calculus concepts Uses everyday examples to foster a better understanding of thermal science and engineering concepts This book is suitable for undergraduate students in engineering and engineering technology

**Problems in Chemical Thermodynamics with Solutions** Maka Aleksishvili, Shota Sidamonidze, 2002 The methods of chemical thermodynamics are effectively used in many fields of science and technology Mastering these methods and their use in practice requires profound comprehension of the theoretical questions and acquisition of certain calculating skills This book is useful to undergraduate and graduate students in chemistry as well as chemical thermal and refrigerating technology it will also benefit specialists in all other fields who are interested in using these powerful methods in their practical activities

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