

Thermodynamics - Example Problems

Problems and Solutions

1 Examining a Power Plant

Consider a power plant. At point 1 the working gas has a temperature of $T = 25^\circ\text{C}$. The pressure is 1bar and the mass flow is $\dot{m} = 2\text{kg/s}$. After point 1, the air enters a compressor, at which the pressure is increased to 6 bar. (This is point 2.) After this, the flow is heated to $T_3 = 700^\circ\text{C}$. (This is stage 3.) Afterwards, the flow goes through a turbine, at which the pressure is decreased to 1bar again. (This is stage 4.) The flow is then cooled to $T_1 = 25^\circ\text{C}$. We're now back in stage 1.

We assume that:

1. air behaves like a thermally and calorically perfect gas with $C_p = 1004\text{J/kg K}$, $R = 287\text{J/kg K}$ and $\gamma = 1.4$.
2. the isentropic efficiency of the compressor is 0.88.
3. the polytropic efficiency of the turbine is 0.85.

Answer the following questions.

1. Depict the evolution of the cycle in the $T - s$ plane.
2. Determine the net power.
3. Determine the heat received from the hot source.
4. Determine the thermal efficiency of the power plant.
5. Determine the Carnot efficiency associated with the present power plant and compare it with the previous result.
6. Verify the first principle.

1 Solution

1. Let's draw the $T - s$ graph. We start by drawing two lines of constant pressure. (This can be seen in the graph below.)

We now start at point 1. At this point the pressure and temperature are low. When we go to point 2, we don't go straight up, since the process is not isentropic. Instead, we go up and slightly right as well, until we reach the line $p = 6\text{bar}$. We then have found point 2.

The heating takes place under constant pressure. So from point 2 to point 3 we stay on the isobaric line $p = 6\text{bar}$. This goes on until we reach $T = 973\text{K}$. This is the position of point 3.

The turbine isn't isentropic either. So from point 3 we don't go straight down. Instead, we go down and a bit to the right as well, until we reach the line $p = 1\text{bar}$. This is point 4.

From point 4 we return to point 1. Since the cooling occurs at constant pressure, we do this without leaving the line $p = 1\text{bar}$.

Thermodynamics Example Problems And Solutions

Camilla Rothe



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Thermodynamics Problem Solving in Physical Chemistry Kathleen E. Murphy, 2020-03-23 Thermodynamics Problem Solving in Physical Chemistry Study Guide and Map is an innovative and unique workbook that guides physical chemistry students through the decision making process to assess a problem situation create appropriate solutions and gain confidence through practice solving physical chemistry problems The workbook includes six major sections with 20 30 solved problems in each section that span from easy single objective questions to difficult multistep analysis problems Each section of the workbook contains key points that highlight major features of the topic to remind students of what they need to apply to solve problems in the topic area Key Features Provides instructor access to a visual map depicting how all equations used in thermodynamics are connected and how they are derived from the three major energy laws Acts as a guide in deriving the correct solution to a problem Illustrates the questions students should ask themselves about the critical features of the concepts to solve problems in physical chemistry Can be used as a stand alone product for review of Thermodynamics questions for major tests Chemical Engineering License Problems and Solutions Dilip K. Das, Rajaram K. Prabhudesai, 2003-09-18 This is a review book for people planning to take the PE exam in Chemical Engineering Prepared specifically for the exam used in all 50 states It features 188 new PE problems with detailed step by step solutions The book covers all topics on the exam and includes easy to use tables charts and formulas It is an ideal desk Companion to DAS s Chemical Engineer License Review It includes sixteen chapters and a short PE sample exam as well as complete references and an index Chapters include the following topical areas material and energy balances fluid dynamics heat transfer evaporation distillation absorption leaching liq liq extraction psychrometry and humidification drying filtration thermodynamics chemical kinetics process control mass transfer and plant safety The ideal study guide this book brings all elements of professional problem solving together in one BIG BOOK Ideal desk reference Answers hundreds of the most frequently asked questions The first truly practical no nonsense problems and solution book for the difficult PE exam Full step by step solutions are included **Modern Engineering Thermodynamics - Textbook with Tables Booklet** Robert T. Balmer, 2011-01-03 Modern Engineering Thermodynamics Textbook with Tables Booklet offers a problem solving approach to basic and applied engineering thermodynamics with historical vignettes critical thinking boxes and case studies throughout to help relate abstract concepts to actual engineering applications It also contains applications to modern engineering issues This textbook is designed for use in a standard two semester engineering thermodynamics course sequence with the goal of helping students develop engineering problem solving skills through the use of structured problem solving techniques The first half of the text contains material suitable for a basic Thermodynamics course taken by engineers from all majors The second half of the text is suitable for an Applied Thermodynamics course in mechanical engineering programs The Second Law of Thermodynamics is introduced through a basic entropy concept providing students a more

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