(*Continued from page 174*)

axial direction x.

It is often desirable to calculate the temperature distribution in a complex structure formed by joining members having good thermal conductivity. Frequently, such a structure will resemble a system of fins connected in series. In order to take advantage of this similarity, analytical expressions have been derived and are given below for two, three, and four fins in series. Each fin

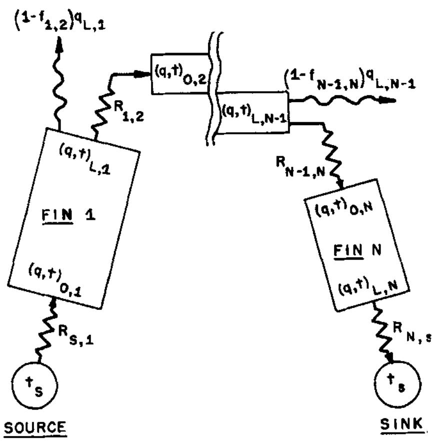

Fig. 1. Illustration of nomenclature.

may have its own surface conditions, axial conductance, and internal heat generation. In addition, there can be thermal resistances and/or heat losses between fins.

The nomenclature used is illustrated in Figure 1. There, fin N is located in opposition to fin 1 to emphasize that even heat transfer between unconnected fins may be included, if a little ingenuity is exercised. (In this regard, the section on Plate Fin with Different Conditions at Each Surface is relevant.) Thus, useful solutions can be found for a large variety of problems which would normally justify the use of extensive computational equipment.

BASIC EQUATIONS

As shown by Jakob (*1*), the temperature distribution in a fin may be expressed as

$$\theta = Me^{-mx} + Ne^{mx} + [q'''/(km^2)] \quad (1)$$

(*Continued on page 178*)

(*Continued from page 2*)

certainly be more exact than the graphical procedures described. In fact, the failure of the author to describe numerical procedures is the main fault in this book.

In general, I would say that this book is a valuable addition to the library of any student of thermodynamics mainly because of the thoroughness with which it treats the classical theories of solutions. Because it is so cursory in its treatment of fundamentals, it must be recommended as a supplement to a standard text, rather than as a replacement. Its value to researchers in the field is more limited because it is simply too short to treat modern advances with the thoroughness they deserve.

IRVING F. MILLER
POLYTECHNIC INSTITUTE OF BROOKLYN

Equilibrium Thermodynamics, J. Coull and E. B. Stuart, Wiley, New York (1964). 469 pages.

The presentation of classical thermodynamics given by the authors differs from the normal presentation in three respects. First, to quote the authors, "Our method of presentation of material is based on the spiral technique wherein the various topics are presented early in the book and are developed in depth as the student progresses." Second, "Detailed references to equipment have been largely omitted, for we feel that the engineering application of equilibrium thermodynamics should be at an analytical level. We have brought in details of application not in equipment, but in the determination of thermodynamic properties and equilibrium analysis." Third, the authors have included a chapter on the third law, which contains a brief discussion of microscopic considerations, and an introductory chapter on nonequilibrium thermodynamics.

These last two points are certainly noteworthy. It is refreshing to encounter a complete chapter (Chapter 6, 35 pages) entitled "The Evaluation of the Thermodynamic Properties from Fundamental Data." The authors clearly inform the reader of the purpose of the chapter, and of the desirability of making such calculations. This section is well illustrated with examples and includes the standard methods of calculation from P-V-T data, and also a discussion of generalized properties. Although the presentations of microscopic considerations and nonequilibrium thermodynamics are admittedly brief, the former is sufficient to lead the reader into the consideration of group-contribution methods, and both sections should serve to whet the appetite of the reader and lead him to pursue these topics further.

Although the method of presentation is obviously based upon the authors' experence in teaching, it is in the use of the *spiral technique* of presentation that the reviewer believes the student will encounter a problem. While the idea is appealing to one already familiar with thermodynamics, the use of this technique may well represent a sizeable hurdle for the beginning student, particularly in the initial portion of the book where possible difficulties are most noticeable. To illustrate this point, it is worth listing the topics presented in Chapter 1 (42 pages): traditional introductory material such as the definition of a system, the surroundings, heat, work, etc.; the definition of internal energy and a statement of the first law for a closed system; a definition of entropy (as an extensive property associated with thermal energy) and a brief statement of the second law; the definition of enthalpy, the Gibbs function, and the Helmholtz free energy, their general differential equations, and the Maxwell relations derived therefrom; the definitions of a property and of partial molar properties; the criteria of equilibrium and of a spontaneous process; the concept of lost work; the relation of entropy to probability; and an introduction to irreversible thermodynamics. While each of these topics is fully developed in subsequent chapters, at the end of this chapter the reader is overwhelmed.

The authors then continue with the same technique in Chapter 2 in which the relationships for various types of processes are presented for closed systems (in general and for ideal gases) before the first law is covered in detail in Chapter 3. It would seem that this portion of the book would be particularly difficult for a beginning student, leaving him lost, rather than with the intended clear sense of the purpose of the book.

Also to be noted is the statement on the jacket of the book that it "supplies the needs of the core curriculum undergraduate course in classical thermodynamics." While the book is well suited to a course for chemical engineering students, it does not actually supply the needs of a core course; indeed, the treatment of the first law should be supplemented in any case. In discussing the first law the authors present the equations for closed systems, steady-flow open systems, and nonsteady open systems, but the treatment of the latter is extremely brief. Actually, there are

(*Continued on page 179*)

(*Continued from page 178*)

nected, simultaneous Equations (6) and (7) are still valid. Since

$$t_{L,2} - t_{0,3} = R_{2,3}q_{0,3};\ \ q_{0,3} = f_{2,3}q_{L,2};$$

and $$t_{L,3} - t_s = R_{3,s}q_{L,3}$$

Equations (4) and (5) may be used to write two additional simultaneous equations:

$$t_{L,2} = G_2 f_{1,2}q_{L,1} - F_2 q_{L,2} + B_2 = R_{2,3}q_{0,3} + t_{0,3} = R_{2,3}q_{0,3} + F_3 q_{0,3} - G_3 q_{L,3} + B_3 = (R_{2,3} + F_3) f_{2,3}q_{L,2} - G_3 q_{L,3} + B_3 \qquad (10)$$

$$t_{L,3} = G_3 q_{0,3} - F_3 q_{L,3} + B_3 = G_3 f_{2,3}q_{L,2} - F_3 q_{L,3} + B_3 = R_{3,s}q_{L,3} + t_s \qquad (11)$$

The unknowns in Equations (6), (7), (10), and (11) are $q_{0,1}$, $q_{L,1}$, $q_{L,2}$, and $q_{L,3}$. Use of determinants gives

$$q_{L,1} = \{\{(F_1 + R_{S,1})(B_2 - B_1) + G_1(B_1 - t_S)\}\{[F_2 + f_{2,3}(F_3 + R_{2,3})][F_3 + R_{3,s})] - f_{2,3}G_3^2\} + G_2(F_1 + R_{S,1})[(B_3 - B_2)(F_3 + R_{3,s}) + G_3(t_s - B_3)]\}/\{\{-[F_1 + R_{S,1}][F_1 + f_{1,2}(F_2 + R_{1,2})] + G_1^2\}\{[F_2 + f_{2,3}(F_3 + R_{2,3})][F_3 + R_{3,s}] - f_{2,3}G_3^2\} + f_{1,2}G_2^2(F_1 + R_{S,1})(F_3 + R_{3,s})\} \qquad (12)$$

$q_{0,1}$ can then be found from Equation (6), $t_{L,1}$ and $q_{L,2}$ from Equation (7), $t_{L,2}$ and $q_{L,3}$ from Equation (10), and $t_{L,3}$ from Equation (11).

FOUR FINS IN SERIES

When four fins 1, 2, 3, and 4 are connected, simultaneous Equations (6), (7), and (10) are still valid. Since

$$t_{L,3} - t_{0,4} = R_{3,4}q_{0,4};\ \ q_{0,4} = f_{3,4}q_{L,3};$$

and $$t_{L,4} - t_s = R_{4,s}q_{L,4}$$

Equations (4) and (5) may be used to write two additional simultaneous equations:

$$t_{L,3} = G_3 f_{2,3}q_{L,2} - F_3 q_{L,3} + B_3 = R_{3,4}q_{0,4} + t_{0,4} = R_{3,4}q_{0,4} + F_4 q_{0,4} - G_4 q_{L,4} + B_4 = (R_{3,4} + F_4) f_{3,4}q_{L,3} - G_4 q_{L,4} + B_4 \qquad (13)$$

$$t_{L,4} = G_4 q_{0,4} - F_4 q_{L,4} + B_4 = G_4 f_{3,4}q_{L,3} - F_4 q_{L,4} + B_4 = R_{4,s}q_{L,4} + t_s \qquad (14)$$

The unknowns in Equations (6), (7), (10), (13), and (14) are $q_{0,1}$, $q_{L,1}$, $q_{L,2}$, $q_{L,3}$, and $q_{L,4}$. Use of determinants gives

(*Continued on page 180*)

(*Continued from page 177*)

only six examples in the chapter dealing with the first law; five are steady-flow systems, and the sixth, while dealing with nonsteady flow, is a simple mass balance, not an application of the first law. Nineteen pages at the end of this chapter are devoted to gas dynamics, but no qualitative discussion of the behavior of a fluid in a nozzle is given, the significance of stagnation properties is not emphasized, and shock waves are discussed with no mention of the Fanno or Rayleigh lines. The authors stated their intention of de-emphasizing equipment, but the presentation of gas dynamics would benefit by the discussion of the behavior of a fluid in a nozzle, for it is from this discussion that the student gains a qualitative understanding of the necessary existence of a shock wave.

In addition to the virtual omission of the nonsteady flow system from the first law presentation, one other point detracts from the value of this book for a core course. Three excellent chapters (115 pages) are included which deal with solutions and phase equilibrium on multicomponent systems. The authors stress the use of the Gibbs function as the criterion for the existence of a stable phase, and the conditions for phase equilibrium are clearly illustrated through the use of free-energy diagrams showing the equality of the Gibbs function in phase equilibrium and the concept of the Gibbs function as a potential in nonequilibrium situations. This discussion is extremely valuable for the chemical engineer, however, the emphasis on separation processes here would appear to be a defect if the book is to be used in a core course.

Two minor omissions which are certainly not specific to this book are worth mention. First, the Gibbs-Duhem equation is first presented without the terms which account for the effects of temperature and pressure, but the limitations in applying this equation to binary phase equilibrium are not clearly stated. Second, there is a section dealing with simultaneous reaction equilibria, but thre is no discussion of the method to be used to determine the number of reactions to be considered for a system with a given number of species. These two points would certainly need to be clarified by an instructor.

Clarification would also seem warranted on two further points. In a short section on enthalpy-concentration diagrams and their application, the authors seem to have sacrificed clarity for the sake of brevity. Further, a property is defined in terms of a line integral and the use of Green's theorem. While this definition is certainly completely rigorous, it is probably beyond the mathematical capability of a normal college junior.

In conclusion, it should be noted again that the book has many good points, and that the stress on topics of interest to chemical engineers makes the book suitable for a thermodynamics course for this group. However, this same stress and the treatment of the first law would seem to make the book unsuitable for a core curriculum course. In addition, it seems to the reviewer that the *spiral technique*, while admirable in principle, would cause more problems than it solves.

R. V. Mrazek
Oregon State University