



FIGURE 3. The perturbation solution, δ , (a) in comparison to the classical, δ_0 , (b) and cubic, f , (b) solutions ($K_2 = 0.5$ and $t = 1$ unless otherwise indicated).

limited sense that the profile is thicker and higher on the wall relative to the classical profile (see Figure 3).

The perturbation and analysis do interestingly exercise development of insight, are qualitatively rewarding, and introduce perturbation ideas with a minimum of mathematical complexity. Eq. (7) produces a more realistic shape (without ripple), but a better model is needed with realistic general shape as well as details (ripple).

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NOMENCLATURE

t	=	time
δ	=	film thickness
y	=	horizontal distance from wall into the film
z	=	distance down the film
x	=	dimensionally modified distance
	=	$z \eta_0 / \rho g$
ρ	=	density
g	=	acceleration of gravity
η	=	viscosity for film interior
η_0	=	viscosity at the outer edge of the film
K_1	=	proportionality of viscosity to distance from outer edge of the film
K_2	=	$K_1/2$

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ChE book reviews

THE LABORATORY MICROCOMPUTER

by James W. Cooper

John Wiley & Sons, Somerset, NJ 08873, 1984, \$29.00

Reviewed by
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The subtitle of this book is *Programming in Pascal and MC68000 Assembly Language on the IBM System 9000*. The first two chapters provide the "introduction" to the System 9000. By "introduction," I mean a discussion of the operating system, file handling and the system editor! Chapters eleven and twelve are actually part of the introduction as well, since a partial review of the system library functions and a brief discussion of the display screen and console box are presented. Chapters three through ten provide an introduction to Pascal. The second half of the book deals with assembly language programming on the MC68000, the microprocessor used in the System 9000. Nine chapters are devoted to assembly language programming with one of those nine describing how to use the assembler on the System 9000. The last chapter in the book provides several Pascal and assembly language programs for drawing diagonal lines on the graphics display and one for reading in and displaying a 16K plot.

In the Preface the author states that "This book gives the scientist a basic introduction to Pascal, shows how to program this computer system, and gives a brief introduction to the assembly language of the Motorola 68000. . . ." I agree with two of the three statements. It is a basic introduction to Pascal and it is certainly a brief introduction to assembly language programming on the MC68000, but I seriously doubt that a scientist could effectively ". . . program this computer system" with the information provided in this book. Having seen the documentation IBM provides for the 9000 and having seen firsthand the difficulty several of our better students have had learning to program the System 9000 over the course of an entire semester, I have some appreciation for the effort involved in using the System 9000 in a laboratory environment.

The chapters devoted to Pascal are probably adequate to become acquainted with the language provided one has had prior programming experience. I would not recommend this text to a novice. The author provides a number of examples in the form of sample programs which are useful; but, in my opinion, it would be much better if he also provided exercises.

The MC68000 is a powerful microprocessor, but it is relatively complicated (compared to, say, the 6502) to program and use effectively as a laboratory instrument. In my opinion the brief introduction to MC68000 assembly language programming in chapters 14 to 21 is inadequate, even for someone who has had experience. The addressing modes are one of the most important and powerful features provided with the MC68000 instruction set. Yet to spend only one short chapter discussing the addressing modes and to provide virtually no practice exercises is extraordinary. Assembly language programming for 16 (and larger) bit processors gets to be cumbersome without the use of an assembler. ASM, the assembler provided with the System 9000, is a crucial part of the system and also deserves more than one chapter if it is to be learned effectively. Again, practice exercises would be very helpful.

Although the author does not suggest it specifically, it seems that this book might better be described as an adjunct to the documentation provided with the System 9000. The eclectic approach used in the book should help to keep the many details in the system documentation in perspective and, at the same time, provide an easier path toward getting the System 9000 doing something useful. □

LETTER TO THE EDITOR

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calculations for multicomponent aqueous systems containing volatile, weak electrolytes and other gases. To solve the equations of phase equilibrium, we use the method of Nakamura *et al* [3] to calculate fugacity coefficients in the vapor phase; for the liquid phase, we use Henry's constants and an extension of the theory for electrolyte solutions developed by Pitzer [4] to describe the temperature and concentration dependence of activity coefficients. A sophisticated numerical technique is used to solve the many simultaneous equations of equilibrium.

3. *Gas-Hydrate Phase Equilibria* presents a program for calculating the conditions of pressure, temperature and gas composition required for formation of hydrates. Gas hydrates are formed when water and light gases (*e.g.*, natural gases, refrigerants, oxygen, nitrogen) are at equilibrium at low temperatures and high pressures. Gas molecules become trapped in cavities (or cages) contained in the crystalline lattice structure formed by water molecules; the trapped gas molecule stabilizes the lattice. A quantitative understanding of conditions for hydrate formation is necessary, for example, to design gas production from underground fields of natural-gas hydrates, or to control sea-water desalination plants

where hydrates are used to separate water from salt. Hydrate-formation is particularly important in the transportation of natural gas, where hydrates can clog pipelines. In this case study, we use a modified van der Waals-Platteeuw [5] framework to estimate hydrate-formation conditions. Fugacities in the vapor phase are computed from the Chueh-Prausnitz [6] modification of the Redlich-Kwong equation of state.

4. *Isothermal Flash Calculations for Multicomponent Mixtures of Organic Liquids Using UNIFAC* combines the UNIFAC method [7] for establishing activity coefficients with a step-limited Newton-Raphson routine to assist the user in performing isothermal flash calculations for a wide variety of mixtures of organic liquids, containing up to 10 components. We use an isothermal flash calculation to obtain the pressure (or temperature) that produces the optimum separation of two hydrocarbons from a multicomponent stream. The program includes a data bank with group surface areas, group volumes and group-group interaction parameters as required to calculate activity coefficients with UNIFAC.

5. *Estimation of Activities of Solvents in Polymer Solutions Using UNIFAP*, uses an extension of the UNIFAC method for calculation of liquid-phase activities of solvents in polymer solutions. In polymer production, these activities are required to design devolatilization equipment, necessary to recover the solvent from the polymer solution by evaporation. UNIFAP [8] is a group-contribution method that can be used to estimate vapor-liquid equilibria for a variety of polymer mixtures where no experimental mixture data are available. The computer program includes a data bank which contains the pertinent group parameters.

Copies of these case studies are available from J. M. Prausnitz (Department of Chemical Engineering, University of California, Berkeley, California 94720). Magnetic tapes for computer programs (written in FORTRAN IV) are available for purchase. These tapes are 9 track at 1600 bpi, in EBCD with 80-character (card-image) record.

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