**ChE book review**

## *Boundary Element Methods in Transport Phenomena*

by P. A. Ramachandran

*Published by Computational Mechanics, Inc., 25 Bridge Street, Billerica, MA 01821; 424 pages, $160 (1993)*

***Reviewed by***
**Bruce A. Finlayson**
*University of Washington*

The boundary element method solves an integral form of a differential equation. This method has the marvelous advantage that for a linear problem the entire solution is determined from the boundary conditions. This changes a three-dimensional problem into a two-dimensional problem, or a two-dimensional problem into a one-dimensional problem; both reductions in order provide significant computational savings. The reduction of dimensionality is useful if one wants only a few features of the solution, such as the value of the function at a few points, or the integrated flux. If one wants the solution everywhere (say, for contour plotting), then the computational cost goes up, and this may be why no contour plots are presented in the book. Multiple equations are also limiting, since the equations must be handled separately, leading to iterations that may not converge.

The disadvantage of the boundary element method is that nonlinear problems still require that the solution be represented everywhere, usually using finite elements throughout the whole domain. This feature destroys the chief advantage of the method, the reduction of dimensionality. The author argues that one does not need to introduce approximations at an early stage, but approximations are finally introduced, and if they affect the result it doesn't matter when they are introduced.

The first chapter carefully develops the differential equations and boundary conditions that are needed to solve transport problems, including fluid flow and mass and heat transfer. This is carefully done, and the treatment is concise.

The second chapter shows how the use of a weighting function plus one integration by parts can lead to a weighted residual method (like Galerkin); with two integration by parts the boundary element method is obtained. The weighting function can be a Green's function, in which case the method is the "Fundamental Solution Method," or the boundary integral method.

The book (which has a total of eleven chapters) is very clearly written, with lots of simple examples. Fundamental Solution Methods and Green's Functions are clearly presented, with lots of details carefully attended to. The Laplacian operator is clearly important, but chapters deal with extensions involving time derivatives, one-, two-, and three-dimensional problems, the Poisson Equation, heat and mass transfer applications, and application to fluid flow. Most of the problems are simple; more complicated solutions are given in tables, which is not a clear way to present material unless it is to be used for checking computer code. A computer diskette is provided, but the reviewer did not review it since it is not in Macintosh format (it also uses the old 5 1/4" format).

There are some minor errors: reference is made to the "Burger" equation; the person's name was Burgers. On page 153 the claim is made that the "quadratic" method for integrating ordinary differential equations does not lead to oscillations regardless of the step size—that is false.

The author makes the claim that the boundary element method will become the most widely used numerical method for engineering analysis in the 21st century. This reviewer believes that won't happen for nonlinear problems, and most problems are nonlinear. In fact, the book is deficient in that hard problems are not presented, even to whet the reader's appetite. The book does not usually demonstrate convergence with mesh refinement, which is a standard required of first-rate numerical journals, and this author believes that is essential. Detailed equations are given for constant, linear, or quadratic elements, but little guidance is given when to use which ones.

Despite these minor defects, overall the book is excellent. The careful, concise treatment of both Green's functions and boundary element methods will make it useful for anyone doing analysis of transport problems, or anyone who wants to learn about Green's functions. This reviewer believes that reviewing a book is only worthwhile if he can learn something. He did. ❐

**ChE book review**

## *HAZARDOUS WASTE MANAGEMENT*, 2nd ed.

by Charles A. Wentz

*Published by McGraw-Hill Book Company, NY (1995)*

***Reviewed by***
**Ralph H. Kummler**
*Wayne State University*

At Wayne State University, we used the first edition of *Hazardous Waste Management* by Charles A. Wentz in the developmental stages of our program. We viewed it as an excellent undergraduate and graduate introductory overview to the hazardous waste management (HWM) field. Our civil engineering curriculum also used the text for their environmental engineering course on landfill disposal techniques.

As our HWM program developed, we began taking in

*Continued on page 61.*