LETTERS TO THE EDITOR

COMMENTS ON "A FINITE DIFFERENCE TREATMENT OF DIFFERENTIAL EQUATION SYSTEMS WITH WIDELY DIFFERING TIME CONSTANTS"

In a recent paper,[1] Dalton and Gamble proposed a matrix technique for use in solving the large number of coupled first-order differential equations that necessarily occur in fission burnup calculations. The purpose of this brief comment is to discuss the applicability of another readily available, standardized numerical technique for performing the same calculation and to discuss the usefulness of elementary matrix methods for the numerical solution of coupled sets of first-order nonlinear differential equations.

We have developed a short program that uses the DGEAR subroutine from the International Mathematical and Scientific Library (IMSL) to solve the same system of differential equations as Ref. 1. This algorithm, developed by Gear[2] and improved by Hindmarsh,[3] is especially useful for obtaining solutions to coupled sets of "stiff" differential equations. While it is true that all numerical integration techniques require a regularity constraint on the difference interval of the independent variable, the Gear algorithm employs a variable step size routine, which optimizes the time step length and preserves the convergence of the solution, thus minimizing the required computer time.[4]

Using the same initial time increments as the examples discussed in Ref. 1, $t = 10$ min, 20.8 h, and 8.4 days, it was found that the DGEAR subroutine accurately predicts the steady-state as well as the transient concentrations of ^{238}U, ^{239}U, ^{239}Np, and ^{239}Pu found in Ref. 1. Not only is the DGEAR subroutine simple to use and numerically stable for this type of problem, it requires <0.01 min central processing unit time on an AMDAHL 470/V7 mainframe.

A similar but more complicated problem involving the fuel dynamics of ^{235}U and ^{238}U was solved using the DGEAR algorithm by Chang et al.[5]

Stiff sets of differential equations can be easily solved by a standard algorithm like DGEAR with fewer required manipulations. Moreover, the **[C]** matrix technique might not handle nonlinear systems efficiently, since an expensive iterative algorithm must be employed to give accurate results.

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REPLY TO "COMMENTS ON 'A FINITE DIFFERENCE TREATMENT OF DIFFERENTIAL EQUATION SYSTEMS WITH WIDELY DIFFERING TIME CONSTANTS' "

Chung et al.[1] are quite correct that a variable size time step integration procedure can allow one to efficiently calculate the transients of short-lived members in a family of differential equations. A major advantage of the **C** matrix method is that it allows one to include a whole library of short-lived members, while using the steady-state values of the short-lived members. When using large time steps, one avoids the tedium of calculating the buildup of each of the short-lived members.

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REFERENCE

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