☐ Most of the content of this part of the course consists of (a) definitions of and procedures for measuring and estimating the energy-related variables that characterize chemical process systems—heat capacities, latent heats of phase change, solution, and mixing, and heats of reaction, formation, and combustion; (b) procedural and computational algorithms for calculating internal energy and enthalpy changes associated with transitions from one system state to another; and (c) procedures for solving the first law equation for unknown energy flows or changes in state in various unit processes. The sequence of the information flow is suggested in Figure 2.

TRANSIENT BALANCES

Most stoichiometry textbooks contain a chapter on transient system balances. A key concept here is that of a **derivative.** While students in the course can differentiate functions on demand, they have no physical or intuitive understanding of derivatives, in part because most mathematics professors seem to fear that they would harm their reputations by putting applications in the elementary calculus sequence. Covering transient balances in the stoichiometry course could help the students make significant progress toward this understanding; unfortunately, the course almost never gets to transient balances and most introductory transport courses take the underlying knowledge structure of this topic for granted.

AFTERWORD

Once a knowledge structure has been defined, the next logical step is to consider how it can best be transferred into students' brains. I believe that for stoichiometry there are two keys:

1. *Provide explicit instruction and lots of drill in basic problem-solving procedures,*

   especially the systematic use of the flow chart coupled with informal degree-of-freedom analysis to organize the solutions of material and energy balance problems.

2. *Establish an active, cooperative learning environment.*

   Have students work in teams on problems in class and on the homework, identifying conceptual and procedural sticking points and finding out how to get past them, teaching and learning from one another.

For specific ideas about how to accomplish these tasks, see Reference 1.

REFERENCES

1. Felder, R.M., "Stoichiometry Without Tears," *Chem Engr. Ed.,* **24**(4), 188 (1990) ☐

ChE letter to the editor

Dear Editor:

Due to an unfortunate oversight, the article on the Markovian approach to chemical kinetics (*CEE,* **27**, 42-43) does not discuss the importance of choosing properly the duration of a stage for the sake of acceptable numerical accuracy. In any discrete approximation to a continuous phenomenon, the time increment in the former must be sufficiently small, and Markov chains are no exception.

In the numerical example of the article, the stage width of 0.001 minutes is one appropriate choice, when 75% of species A at a given time decompose to B and 5% of species B at a given time decompose to species A in one minute. With this choice, the Markov formulation

$$\begin{pmatrix} A(n+1) \\ B(n+1) \end{pmatrix} = \begin{pmatrix} 0.99925 & 5.0\,e-5 \\ 7.5\,e-4 & 0.99995 \end{pmatrix} \begin{pmatrix} A(n) \\ B(n) \end{pmatrix}$$

and the integral rate equations

$$A(t) = 0.075 + 0.925 \exp(-8.0\,e-4\,t)$$
$$B(t) = 1.125 - 0.925 \exp(-8.0\,e-4\,t)$$

agree to at least a four-decimal accuracy when t=n=stage number, as shown in the tabulation. Steady state conditions are reached essentially at n = 10000.

The author regrets the omission of this material, and wishes to thank Dr. Alan M. Lane at the University of Alabama, Tuscaloosa, for drawing it to his attention.

n	A(n)		B(n)	
	Markov	Rate Eq.	Markov	Rate Eq.
1	0.9993	0.9993	0.2007	0.2007
10	0.9926	0.9926	0.2074	0.2074
1000	0.4905	0.4906	0.7095	0.7094
5000	0.0919	0.0919	1.1081	1.1081
10000	0.0753	0.0753	1.1247	1.1247
inf.	0.075	0.075	1.125	1.125

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