in any fluid condition (i.e., saturated liquid, subcooled liquid, etc). Antoine's equation is used to obtain the saturated temperatures and pressures of both components, and the x-y equilibrium curve is obtained assuming ideal behavior. Optional consideration of a variety of non-ideal descriptions of the equilibrium curve is also possible.

Routines are included which calculate the diameter and height of the distillation column for each case study in order to produce the scaled diagram described earlier, including the correct number of bubble-cap trays, a total condenser, reboiler, and the location of the feed tray. This is achieved by following the recipe outlined in Treybal [4].

Some interesting aspects of column design with regard to the economics involved are also incorporated by allowing the preparation of a graph showing the relationship between a given reflux ratio and the total cost involved, considering both capital costs and estimated running costs over the expected lifetime of the column. The minimum of this parabolic curve allows the estimation of an optimum reflux ratio for the most cost-effective operation of the column.

SUMMARY

The implementation of the computer graphics package described has proved to be of considerable assistance in the teaching of staged operations. Instructors benefit from the increased quantity and complexity of problems which can be investigated in the alloted time, and students welcome this novel and easy-to-use tool which makes completing their assignments so much less onerous. □

ACKNOWLEDGMENTS

M. G. would like to thank C. D. Naik and G. Charos for many helpful discussions. It is a pleasure to thank the Gas Research Institute for practical support of this work.

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ChE letters

More on Tubular Flow Reactors

Dear Editor:

Professor Asfour's two improvements (*CEE* XIX, 2, 84, 1985) to the original design of a tubular flow reactor using crystal violet dye and sodium hydroxide reactants (Hudgins and Cayrol, *CEE* XV, 1, 26, 1981) are timely ones. This experiment, to judge from a recent survey (E. O. Eisen, "Teaching of Undergraduate Reactor Design," AIChE Meeting, San Francisco, Nov. 1984), is now incorporated into several reaction engineering laboratory courses in North America.

I welcome the occasion of the Asfour article to suggest several additional improvements that arise out of our experience since 1981.

First, I concur with the footnote in the Asfour paper. Tygon tubing is an unhappy choice for the tubular reactor. In our experience, clear Tygon tubing darkens within a few hours' use to a permanent deep violet. This obscures the pleasing axial color change that is one of the main attractions of the experiment. Polyethylene tubing, though translucent rather than transparent, resists the crystal violet dye for a much longer time.

Calculating the reactor volume can be a problem. Certainly, the nominal value of the inside diameter of the tubing is not sufficiently accurate. Some students have improved on this value by trying to fit the tubing using indexed drill bits. Because of the flexibility of the tubing, however, it is not certain that the cross-sectional area remains undistorted when the tubing is wound on the large spool. Weighing the spool with the reactor tubing empty and then filled with water appears to be the most rigorous way to obtain the volume.

In both of the above *CEE* articles, the spool is shown mounted on its side. This has proven to be an unfortunate method of mounting since bubbles often enter the reactor tubing (perhaps from the mixer pump), become trapped in the coils of the tubing, and grow. An effective remedy is to remount the spool with axis perpendicular to the lab bench and flow spiralling upward. Of course, this does not eliminate bubbles but does prevent their retention and growth sometimes to several percent of the total reactor volume.

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Another important refinement is to modify the impeller in the "mixer" which is a small centrifugal pump that blends together the reactant streams entering the reactor tube. In our particular reactor geometry, the impeller of the pump sent rapid pressure pulses back to the dye rotameter causing violent fluctuations of the bead in the dye rotameter. Our solution was to replace the impeller blade with a flat disc. The rotation of the disc generates sufficient shear to blend the streams.

R. R. Hudgins
University of Waterloo

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these packages. To this end an increased student awareness and familiarity with these facilities can only be beneficial. □

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2. Annual Research Meeting, Bath, 4 April 1984. Heat Transfer, Catalysis and Catalytic Reactors, 247. Heavy Oil Cracking. S. Acey, J. C. K. Lee, J. R. Walls.

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to bad habits as soon as they stop writing regularly.

The feedback from the students has been extremely positive. They fully enjoy the opportunity to work on what they regard as their own problems. We have not come across a course which puts so much demand on the students but receives so few complaints. (The actual lab work extends well over the regular six hours per week scheduled in addition to the time required for report writing and preparing oral reports.)

The support from industry has also been encouraging. We continually receive financial aid and equipment donations as well as new ideas for experiments. In the next year we expect to receive an industrial scale CVD reactor, a spin coating apparatus and an experiment to perform membrane separation of gasses. Our lab course would not have been so successful without this continued support. □

ACKNOWLEDGMENTS

We would like to thank our industrial supporters—Chevron, Kelco, Eastman Kodak, and Komax—for their donations of equipment, materials, information, and money. Finally, we are indebted to the AMES department technical support staff—Joe Robison, Paul Engstrom, Ray Hummer, and Jon Haugdahl—for their continued help and understanding (both with students and instructors!).

REVIEW: Cost Engineering
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other new topics added to the first edition such as an analysis of overtime costs, information on rework costs, and the handling of back charges. These topics are illustrated by actual industrial examples. Additional new information on bulk material control, monitoring construction field labor overhead, labor productivity, and forecasting direct labor are illustrated with other industrial examples. The chapter on contingency estimating and its application to cost control has been rewritten to reflect recent developments. The treatment of estimate types and accuracies likewise has been updated. Because of the omnipresent computer, an introduction to computerized estimating has been added since the first edition. Advice is provided on how to go about computerizing routine estimating tasks.

This edition is the first book in a planned series of about 20 which concern cost engineering and related topics. Of the twenty, six have already been published. This series will cover the whole gamut of cost engineering topics for the student and for the practicing cost engineer. □