Communications to the Editor

A Note on the Locus of the Maximum of a Distillation Line

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In a recent paper (*1*) Lee and Kammermeyer point out that it would be desirable to derive a theoretical equation for the locus of the point of maximum concentration of the intermediate component in a distillation at total reflux for a ternary system of constant relative volatilities. The following note is a solution to this problem.

With subscripts 1, 2, and 3 referring to the components in increasing order of relative volatility, the composition in the still may be given by X_{1s}, X_{2s}, and X_{3s}. The composition of the vapor rising from the *n*th plate is equal to the composition of the liquid falling from the plate above and is given by Y_1, Y_2 and Y_3 in the following modified forms of Fenske's equation. In these equations the still is considered as the first plate.

$$\log Y_2 = n \log\left(\frac{\alpha_2}{\alpha_3}\right) + \log\left(\frac{X_{2s}}{X_{3s}}\right) + \log Y_3 \qquad (1)$$

$$\log Y_2 = n \log\left(\frac{\alpha_2}{\alpha_1}\right) + \log\left(\frac{X_{2s}}{X_{1s}}\right) + \log Y_1 \qquad (2)$$

Although Equations (1) and (2) have a real meaning only for integral values of *n* (for columns composed of theoretical plates), it is convenient for the present purpose to consider *n* as a continuous variable. As fractional theoretical plates frequently occur in design calculations this assumption introduces no new concept. Concentrations in a packed tower do, of course, change smoothly.

At the maximum concentration of Y_2,

$$\frac{d \log Y_2}{d\,n} = 0$$

Therefore when (1) and (2) are differentiated with respect to *n*, the still composition being constant,

$$\frac{d \log Y_3}{d\,n} = -\log\left(\frac{\alpha_2}{\alpha_3}\right) \qquad (3)$$

and

$$\frac{d \log Y_1}{d\,n} = -\log\left(\frac{\alpha_2}{\alpha_1}\right) \qquad (4)$$

If (3) is divided by (4) the result is

$$\frac{d \log Y_3}{d \log Y_1} = \frac{Y_1}{Y_3} \cdot \frac{dY_3}{dY_1} = \frac{\log\,(\alpha_2/\alpha_3)}{\log\,(\alpha_2/\alpha_1)} \qquad (5)$$

But $Y_3 + Y_2 + Y_1 = 1$

Therefore $dY_3 + dY_2 + dY_1 = 0$

at the maximum of Y_2, $dY_2 = 0$

$$\text{Therefore } \frac{dY_3}{dY_1} = -1 \qquad (6)$$

If (6) is substituted in (5) the following equation for the locus of the maximum is obtained,

$$Y_3 = \frac{\log\,(\alpha_2/\alpha_1)}{\log\,(\alpha_3/\alpha_2)} \cdot Y_1 \qquad (7)$$

As was foreseen by Lee and Kammermeyer, this is the equation of a straight line passing through the origin. Although Equation (7) represents the dotted lines drawn by Lee and Kammermeyer in their Figures 1 and 2, it is not of the same form as the empirical equation which they suggest.

LITERATURE CITED

1. Lee, Kwo-Tseng, and Karl Kammermeyer, *Chem. Eng. Progr. Symposium Series*, **49**, No. 6, 99 (1953).

Commencement

Following are some of the comments received by the editor on the first issue of the Journal. Suggestions in these and other letters are much appreciated.

I have just had an opportunity to examine my copy of Vol. 1, No. 1, of the A.I.Ch.E. Journal, and I want to congratulate you on its appearing and to wish you the best of success in this new venture.

Personally, moreover, I want to felicitate you on your consistency in the application of the A.I.Ch.E. recommended system of nomenclature and abbreviations, and in general on the typographical standards exhibited throughout the pages.

THOMAS H. CHILTON
Wilmington, Delaware

Last evening I received a copy of the first issue of the A.I.Ch.E. Journal. I think it is splendid and I want to thank you and Van for an excellent job. . . .

J. H. RUSHTON
Chicago, Illinois

My hearty congratulations on the splendid first number of the A.I.Ch.E. Journal. It shows every evidence of painstaking and highly competent editorial planning and execution. In my opinion the new Journal, which has been needed for a long time, will very soon become recognized throughout the world as the leader in its field. . . .

W. B. VAN ARSDEL
Albany, California

The first issue of the A.I.Ch.E. Journal arrived this morning. Let me extend my congratulations and good wishes for the excellent job in getting together the first issue. . . .

ROBERT YORK
St. Louis, Missouri

Would you please accept my hearty congratulations for your great success in the first issue of A.I.Ch.E. Journal? I was very happy to see another excellent publication of the Institute. . . .

CHEN-JUNG HUANG
Beaumont, Texas

You and your staff are to be congratulated on the A.I.Ch.E. Journal. . . .

H. TEN BROEK
Queens Village, New York

The long-awaited debut of the A.I.Ch.E. Journal materialized in fine style. The maiden issue is certainly most impressive and I'd like to add my congratulations to you and your staff. It will certainly provide plenty of grist for any one's mill. . . .

MARCEL BOGART
New York, New York