$$\alpha_{12} = \frac{P_1^*}{P_2^*} = 1 + \frac{P_1^* - P_2^*}{P_2^*} \quad (4)$$

We may estimate the change in vapor pressure with temperature from the Clapeyron Equation

$$\frac{dP}{dT} = \frac{\Delta H}{T\Delta V} = \frac{\Delta H}{T(V_{gas} - V_{liq})} \quad (5)$$

and making the usual assumption that $V_{gas} >> V_{liq}$ and that the ideal gas law applies to the vapor,

$$\Delta V = V_{gas} = \frac{RT}{P} \quad (6)$$

applying Eq. (6) to Eq. (5) we get

$$\frac{dP}{dT} = \frac{\Delta H}{T} \cdot \frac{P}{RT} \quad (7)$$

and if we may approximate dP/dT with $\Delta P/\Delta T$ over the small temperature range involved

$$\frac{dP}{dT} = \frac{\Delta P}{\Delta T} = \frac{\Delta H \cdot P}{RT^2} \quad (8)$$

and further that

$$\Delta P = \frac{\Delta T}{T} \cdot \frac{P\Delta H}{RT} \quad (9)$$

Now the ΔP is the change in vapor pressure with a change in temperature of ΔT and may be applied to either component in Eq. (4) above in which the $P_1^* - P_2^*$ may be identified with the ΔP in Eq. (9). Thus combining Eq. (4) with Eq. (9)

$$\alpha_{12} = 1 + \frac{\Delta P}{P_2^*} = 1 + \frac{\Delta T}{T} \cdot \frac{\Delta H}{RT}\frac{P}{P_2} = 1 + \frac{\Delta T}{T}\frac{\Delta H}{RT} \quad (10)$$

since P_1 and P_2 are the same as P from *normal* boiling points, or for boiling points known at any other fixed pressure.

The ratio $\Delta H/T$ is Trouton's constant which is often taken as 21 cal/(gmole)(K) at 1 atmosphere. Also since R = 1.987 cal/gmole(K) we arrive at

$$\alpha_{12} = 1 + \frac{\Delta T}{T} \cdot \frac{21}{1.987} = \boxed{1 + \frac{10.6\ \Delta T}{T} = \alpha_{12}} \quad (11)$$

In Eq. (11) the temperatures must all be on the same absolute scale, Kelvin or Rankine.

The constant 10.6 is subject to experimental confirmation since Trouton's constant is not a fixed number but depends on the substances and the temperature level at which they boil.

The constant appears to lie between 10 and 13 for many of the close boiling pairs I have checked it on. For the isomeric xylenes it is 12.

Also it is 17 to 20 for the system ($O_2 + N_2$) at 1 atm. The temperature range is probably too large (ΔT = 13°C), or the temperature is too low (77 and 90K) for Trouton's constant to hold. The α range is 3.7 to 4.2 at 1 atm and at 5 atm the mean α = 2.6.

NOMENCLATURE

α_{ij} = relative volatility of i with respect to j
p_i = partial pressure of i
P^* = vapor pressure of i
P = total pressure
R = gas constant
T = absolute temperature °R or K
ΔT = difference in boiling points at a fixed P
ν_i = volatility of i (Eq. 2)
x_i = mole fraction of i in the liquid □

ChE book reviews

TWO PHASE FLOW AND HEAT TRANSFER: CHINA-US PROGRESS

by Xue-jun Chen, and T. Nehat Veziroglu
Hemisphere Press, 785 pgs, $175 (1985)

Reviewed by
A. E. Dukler
University of Houston

In 1984, a small conference in Xian China on two phase flow and heat transfer was attended by about forty Chinese researchers, ten US researchers, and four researchers from other countries. The conference was organized to stimulate interaction between the Chinese and US community working on this subject, as has been the purpose of many other such conferences. This volume contains the 49 papers presented at that meeting.

Of the thirteen papers presented by US participants, ten were essentially review papers (pressure drop, burnout, critical flow, heat exchanger design, etc). These vary greatly in quality and completeness. In many cases more complete reviews can be found elsewhere, in some cases by the same authors.

The papers presented by Chinese investigators were, in the most part, reports on work in progress which was largely experimental and which were concerned with global characteristics of the flow (pressure gradient, Nusselt number, flow patterns, burnout conditions, etc.). These papers contribute little to a knowledge of the basic mechanisms underlying these processes, although in some cases the new data are of interest.

The individual papers appear to be unedited and the book consists of direct reproduction of each paper as prepared by the author. Thus the type and graphics differ in each paper. There is a very complete index. □