NOTATION

C_E = concentration at coalescer input
C_s = concentration at coalescer output
dg^* = experimental value of the diameter of the drop formed as defined by equation (1*a*)
d_g = diameter of the drop formed
dg_1 = diameter of the drop still attached to the sphere
d_p = diameter of packing element
d_E = average microdrop size
g = gravitational acceleration
U = mass velocity (dispersion flow rate/column section)
U_c = critical velocity
U_f = water velocity

Greek Letters

δ = diameter of the circle at the constriction point as defined by Equation (1*b*)
γ_i = interface tension
$\Delta\rho$ = density difference between the two phases
Δp = pressure difference at the poles of the coalescer
σ = standard deviation
ν_f = kinematic viscosity of continuous phase

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Vapor-Liquid Equilibrium Measurements Through Vapor-Adsorption Chromatography

ARMGARD EVERETT and RIKI KOBAYASHI

Department of Chemical Engineering
Rice University
Houston, Texas

Further understanding of the application of perturbation chromatography as applied to gas-adsorption systems enables one to study vapor-liquid equilibria at finite concentrations. The generalized relations for the determination of gas adsorption on arbitrary adsorbents using the principles of perturbation chromatography were developed by Gilmer and Kobayashi (1965). Perturbation chromatography has been successfully applied to study the adsorption of gas mixtures on several adsorbents (Gilmer and Kobayashi, 1964; Haydel and Kobayashi, 1967; Masukawa and Kobayashi, 1969).

Adsorption chromatography was used by Masukawa et al. (1968) to show that the dew point could be viewed as a limiting condition of gas adsorption. They introduced the hypothetical perfect gas perturbation to obtained adsorbed phase properties (Masukawa and Kobayashi, 1968*a*). They also showed that the condensed state could be defined within very narrow limits, that is, tens of Angstrom units. Kobayashi and Carnahan (1975) defined the dew point in explicit Gibbsian terms and used the earlier measurements of Masukawa and Kobayashi (1968*b*) as an example of the mixture dew point definition.

Through careful selection of a homogeneous adsorbent for a given type of adsorbate, Porapak P, for the methane-*n*-butane system, the authors have found that the K value for adsorbent, defined by

$$K_i = \frac{y_i}{x_i} \tag{1}$$

where y_i is the mole fraction of component i in the elution gas phase, and x_i is the mole fraction of the adsorbate in the adsorbed phase, is essentially independent of the pressure, Figure 1. From the determination of the K value for the components in a mixture by methods described earlier (Masukawa and Kobayashi, 1969), from determination of the very onset of condensation from the detector signal, Figure 2, and from the behavior of the adsorption isotherm, Figure 3, it has been found possible to determine the vapor-liquid equilibrium constants for the components in the mixture (Everett, 1977). Similar results were obtained at 255.37° and 244.26°K (0° and −20°F) for the methane-3 mole % *n*-butane mixtures and for a methane-5 mole % *n*-butane mixture at 266.48°, 255.37°, and 244.26°K (+20°, 0°, and −20°F). The V-L-E K values determined by classical methods at 255.37°K (−20°F) are also shown on Figure 1 and found to agree quite satisfactorily with the V-L-E K values determined by adsorption chromatography.

A precise method for determining vapor-liquid equilibria as a limiting case of gas-adsorption chromatography is presented. The small, radioactive samples were injected into the flowing system in the gaseous state with a six-port injection and column bypass switching valves (model CV-H Pax from the Valco Instruments Co., Houston, Texas) with special rotors for low temperature work. If

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Armgard Everett is with Ethyl Corporation, P.O. Box 472, Pasadena, Texas 77501.

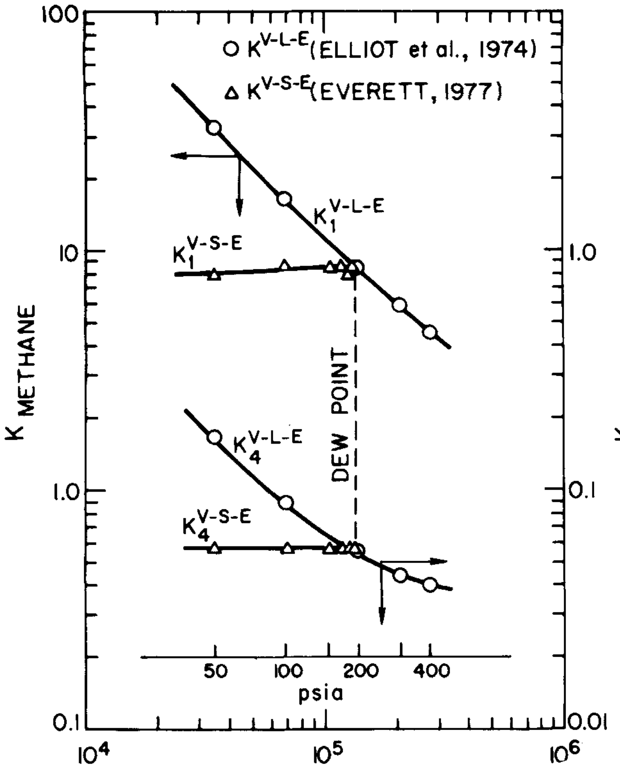

Fig. 1. K values for V-L-E and V-S-E C_1-n-C_4-porapak P at 255.37°K (0°F).

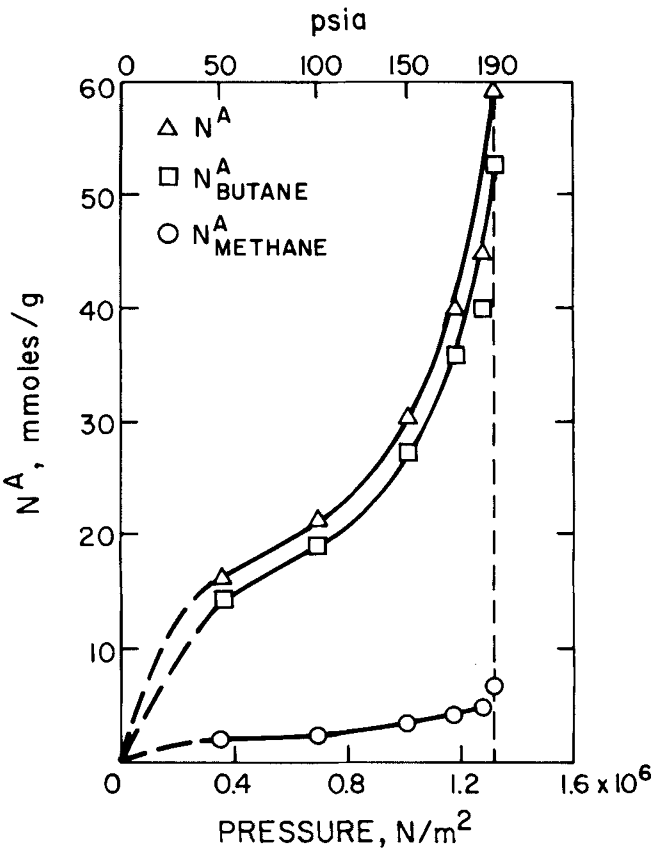

Fig. 3. Total absorption vs. pressure at 255.37°K (0°F) and 5% *n*-butane concentration.

necessary, the radioactive *n*-butane to be injected was diluted with methane to keep the radioactive compound, for example, *n*-butane, in the gaseous state. Under the present state of the art, the method should be applicable to mixtures whose components possess relative volatilities less than 100 and where adsorbate-adsorbent interactions do not cause special orientation effects at the gas-liquid interface.

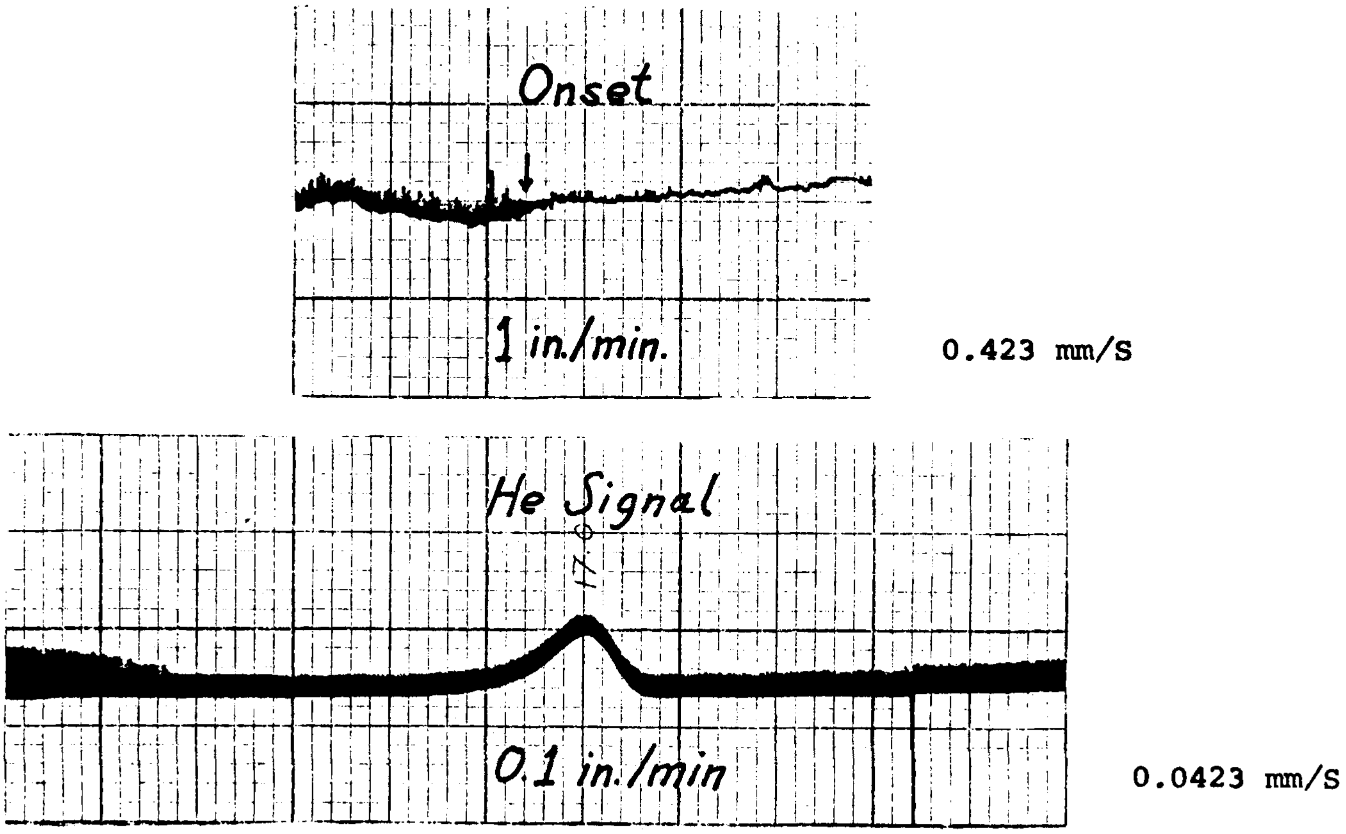

Fig. 2. TC cell signal at the dew point.

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cik June 28, 1978