Calorimeter

The Gibbs-Helmholtz equation provides a relationship between excess Gibbs energy and heats of mixing as follows,

$$\left.\frac{\partial\left(\frac{\tilde{G}^E}{T}\right)}{\partial\left(\frac{1}{T}\right)}\right|_P = \tilde{H}^E$$

Assuming an excess Gibbs energy model of the following form (Wilson Equation)

$$\frac{\tilde{G}^E}{RT} = -x_1 \ln(x_1 + Ax_2) - x_2 \ln(x_2 + Bx_1)$$

and Arrhenius-type dependence of the parameters A and B, that is,

$$A = C_A \exp\left(-\frac{D_A}{T}\right)$$

and

$$B = C_B \exp\left(-\frac{D_B}{T}\right)$$

Use the calorimeter to determine the parameters A and B (or, equivalently, C_A, C_B, D_A, and D_B) by collecting heat of mixing data at well-selected composition and temperature points for the ethanol-n-heptane binary system. You must do a minimum of one composition and four temperatures to determine these parameters.

Using these results, develop a pressure-swing distillation system with one column at 1 atm and a second column at 1 psi that will produce 99% pure ethanol with 90% ethanol recovery from an initial equimolar mixture of ethanol and n-heptane. Determine the number of equilibrium and actual stages assuming Murphree vapor efficiency of 0.71 in each column, feed points, and column diameters assuming a saturated liquid feed flow rate of 1000 kg/hr. Assume a reflux ratio of 1.3 in each column.