Chemistry 4114: Homework

26-1 b. Mobile Phase – the material that carries the solute down the length of the separation column.

c. Stationary Phase – the phase in a separation with which solutes have different interactions, allowing for separation of the solutes.

h. Plate Height – a measure of the efficiency of a separation, calculated by dividing the length of the separation column by the number of theoretical plates.

i. Longitudinal diffusion – solute diffusion in a chromatographic separation in which the solute moves away from regions of high concentration along the direction of the long axis of the separation column

j. Eddy diffusion – the presence of multiple flow paths for an analyte in a separation column leads to different times of arrival of the solutes at the end of the separation column.

26-8

$$N = 16\left(\frac{t_r}{W}\right)^2$$

Measure the retention time (t_r) and the width (W) at the base of the peak to calculate the number of theoretical plates.

26-10 Looking at the contributions to the efficiency (H) of a separation, the minimum is due to the longitudinal diffusion term. This is due to the inverse relationship between H and the mobile phase velocity for longitudinal diffusion. The longitudinal diffusion is due to simple diffusion within the mobile phase of a separation. Diffusion in a condensed phase (e.g. a liquid) is much slower than in a gas phase; consequently, solutes are dispersed less during the same amount of time in a liquid than they are in a gas.

26-12 a. Use the equation from 26-8, and the data in the table to find:

A: N=2775
B: N=2472
C: N=2363
D: N=2523

b. the Average N = 2533
the standard deviation is 200

c. $H = \frac{L}{N}$ = 0.0097

26-13 a. $k' = \frac{t_r'}{t_m}$

A: $k' = \frac{5.4 - 3.1}{3.1} = 0.74$

B: 3.29

C: 3.55

D: 5.97

b. $K = \frac{k' V_m}{V_S}$

A: 6.2

B: 27

C: 30

D: 50

26-14 a. $R_s = \frac{t_{R,A} - t_{R,B}}{\frac{1}{2}(W_A + W_B)} = \frac{14.1 - 13.3}{\frac{1}{2}(1.07 + 1.16)} = 0.717$

b. $\alpha = \frac{k'_C}{k'_B} = \frac{3.55}{3.29} = 1.08$

c. $R_s = \left(\frac{\alpha - 1}{\alpha}\right)\left(\frac{k'}{1 + k'}\right)\frac{\sqrt{N}}{4}$

Using this equation, and results from previous questions, the required value of N to achieve a resolution of 1.5 can be determined.

$$1.5 = \left(\frac{1.08 - 1}{1.08}\right)\left(\frac{3.55}{1 + 3.55}\right)\frac{\sqrt{N}}{4}$$

N = 10799.5

From before, H = 0.00975

Because $H = \frac{L}{N}$, L =HN, L = 105.3 cm d.

$$\frac{(t_r)_1}{(t_r)_2} = \frac{(R_s)_1^2}{(R_s)_2^2}$$

$$\frac{14.1}{(t_r)_2} = \frac{0.717^2}{1.5^2}$$

t_r = 62 minutes