Answer on the question #66666, Chemistry / Other

Question:
Plot the HETP versus the flow rate for following data:

Flow Rate (mL/min)
1) 120.2
2) 90.3
3) 71.8
4) 62.7
5) 50.2
6) 39.9
7) 31.7
8) 26.4

HETP (cm/plate)
1) 0.3154
2) 0.2343
3) 0.2248
4) 0.2378
5) 0.2274
6) 0.2991
7) 0.3206
8) 0.3503

(1) Identify on the graph the optimum flow rate, longitudinal diffusion, mass transfer

(2) Show a theoretical profile of Eddy diffusion on the same graph

Answer:

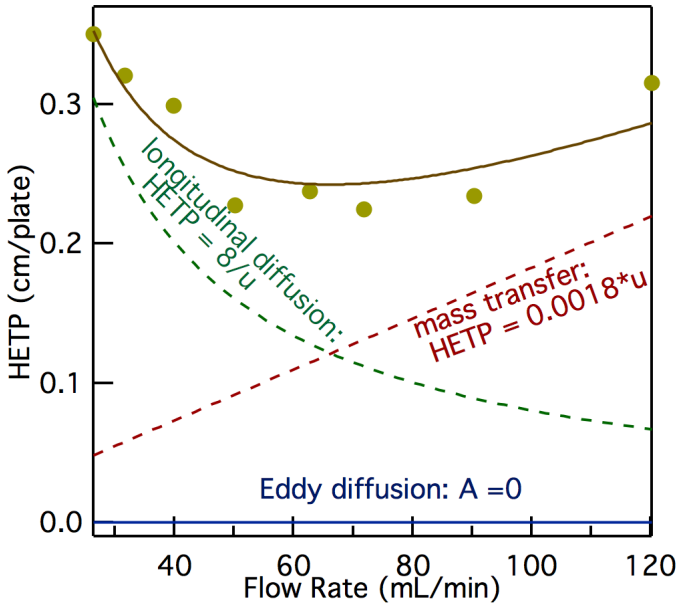

Figure 1: HETP dependence on flow rate. Points represent experimental data, full dark goldenrod line is the fit to Van Deemter equation. Green dash and firebrick dash lines represent longitudinal diffusion and mass transfer terms. Blue solid line shows Eddy diffusion level.

The data were fitted to Van Deemter equation:

$$HETP = A + \frac{B}{u} + C \cdot u,$$

where A is Eddy diffusion term, B is the longitudinal diffusion term, C is mass transfer term and u is the flow rate. Given poor quality of data, we had to restrict A coefficient to be non-negative.

Resulting equation is:

$$HETP = 7 \cdot 10^{-18} + \frac{8}{u} + 0.0018 \cdot u$$

Thus, optimum flow rate is:

$$F_{opt} = \sqrt{\frac{B}{C}} = \sqrt{\frac{8}{0.0018}} = 66.7\ mL/min.$$

Longitudinal diffusion and mass transfer terms are 8±2 and 0.0018±0.0007, respectively. Eddy diffusion term was estimated to be statistically negligible (7e-18±0.09).