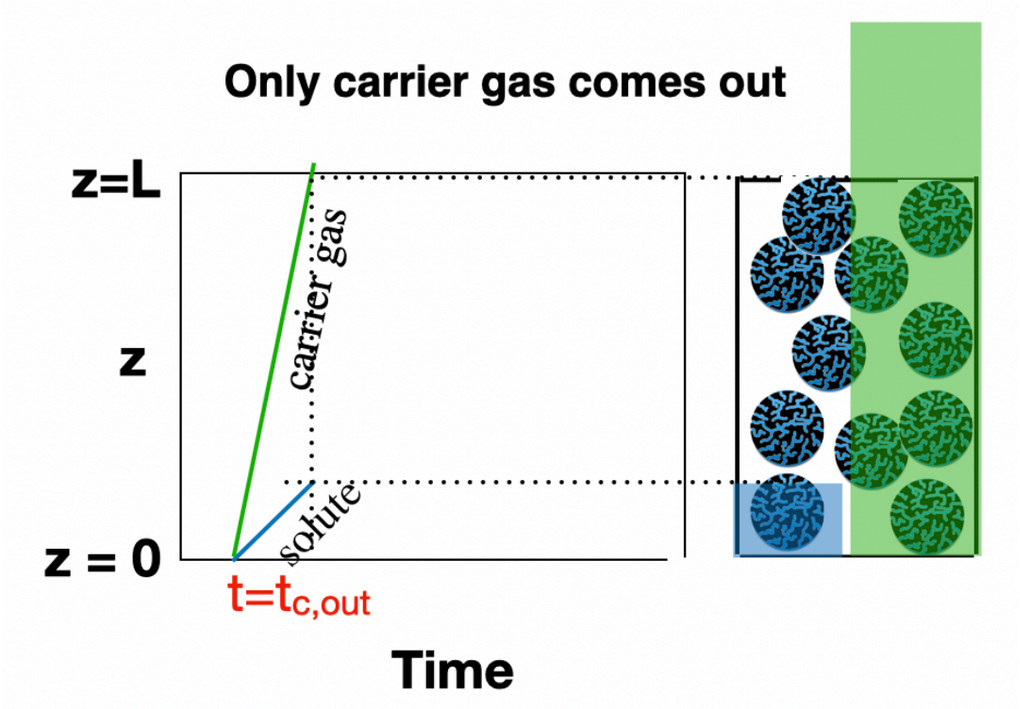
Review quiz

In the context of solute transport, which part has nearly zero velocity?



A) Solute in inter-particle void

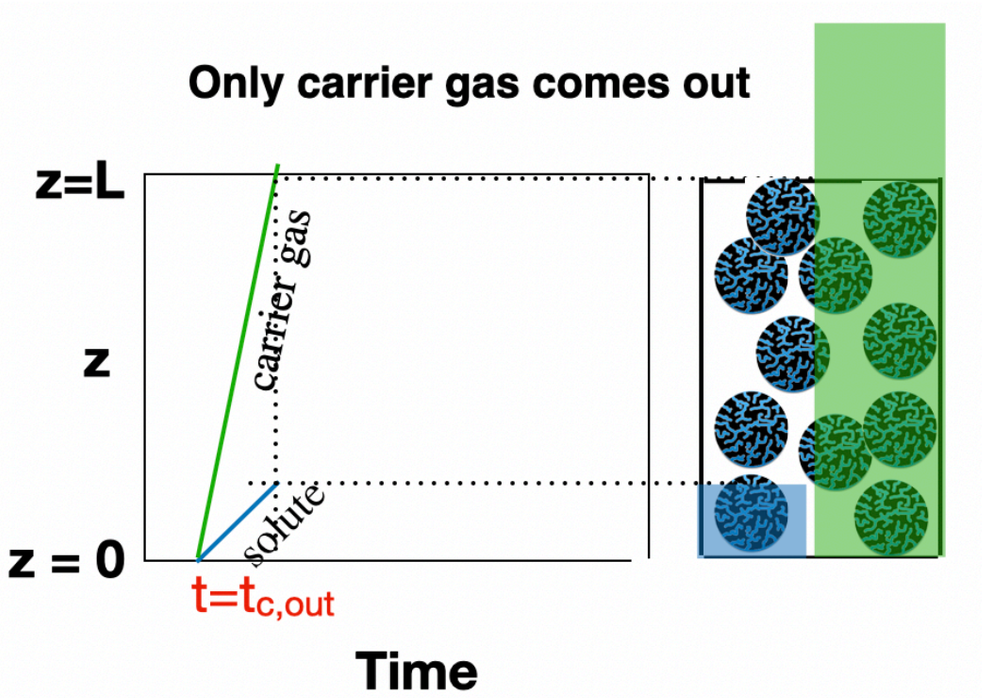
B) Solute inside the particle

C) Carrier gas

D) Solute at column inlet

Review quiz

What is the purpose of reducing solute velocity in a packed column?



A) To increase system pressure

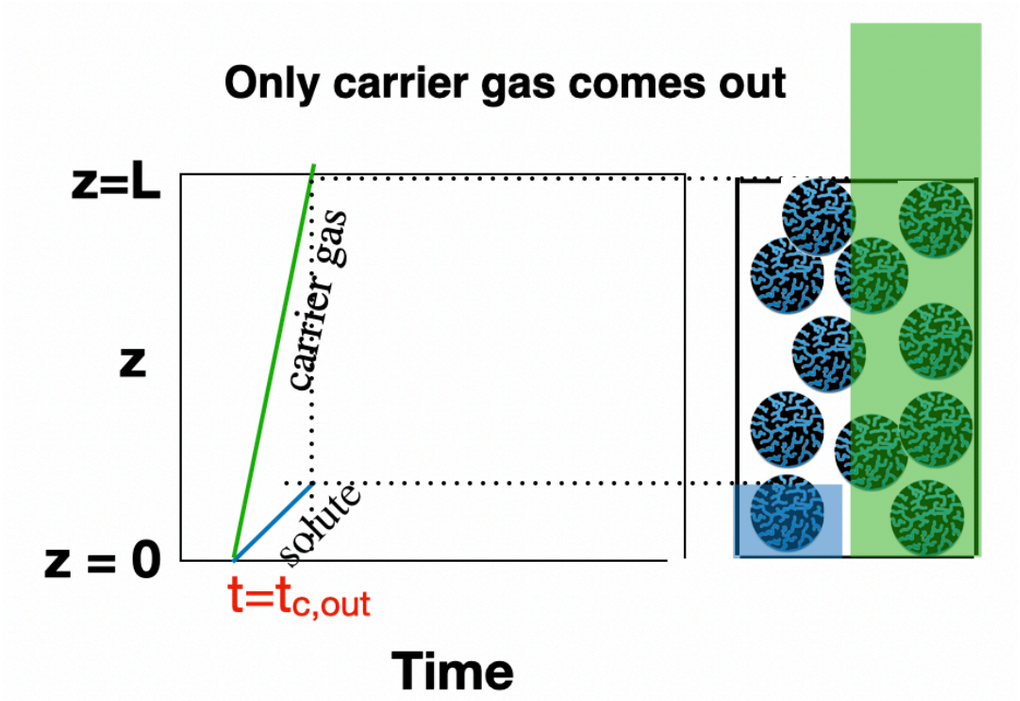
B) To allow for better separation

C) To maximize temperature gradients

D) Not correct. Solute velocity is same as carrier.

Review quiz

Why is the average velocity of solute in a packed column generally lower than the interstitial velocity?



A) Solute molecules have a lower mass

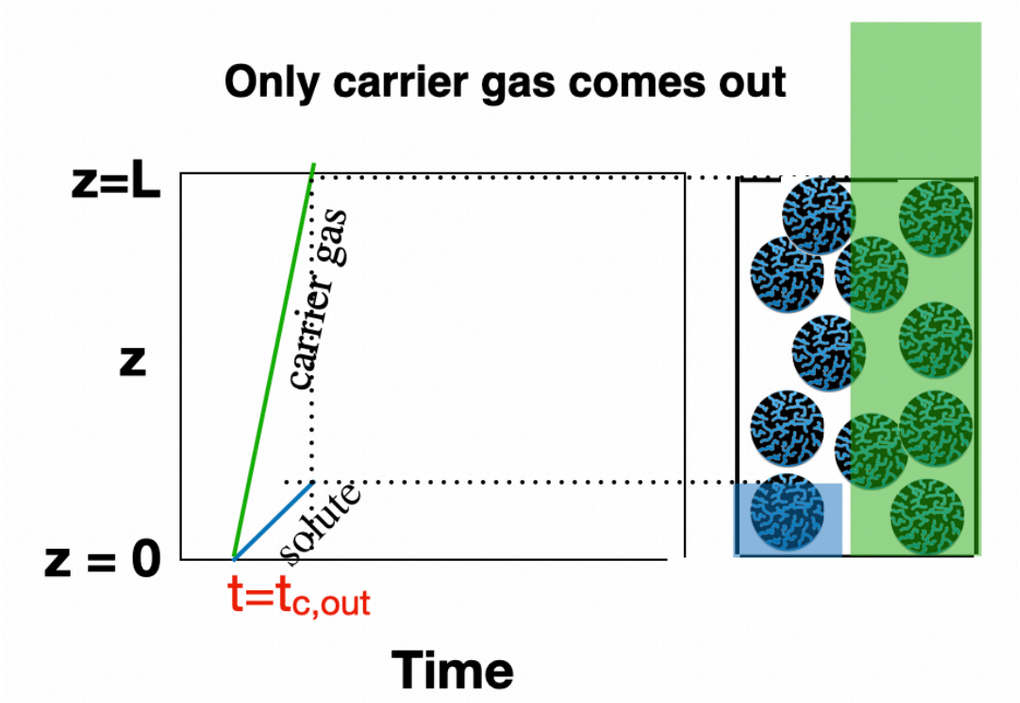
B) Most solute remains in the carrier gas phase

C) Some solute diffuses into particles where velocity is negligible

D) Interstitial velocity is affected by temperature only

Review quiz

If the porosity ε_p of adsorbent pellets increases, what is the most likely impact on solute velocity?



A) It will increase due to less adsorption

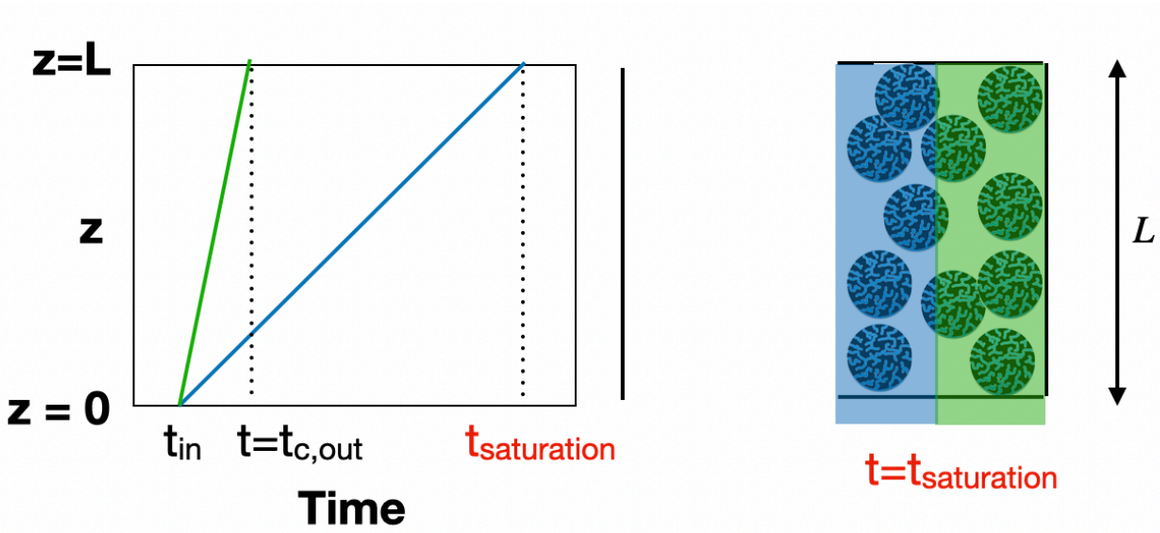
B) It will decrease due to increased diffusive volume

C) It will stay constant because porosity doesn't affect transport

D) It will oscillate due to alternating flow patterns

Review quiz

You have two trying to separate a mixture of helium and krypton in porous carbon packed bed. Which component will come out first



A) Helium

B) Krypton

C) It depends on temperature of bed.

D) It depends on velocity of mixture.

In class exercise problem

You need to design an adsorption process to purify air from traces of hydrocarbon contaminants using a 2.0-meter-long adsorbent column. Air does not absorb at all.

a) Calculate the interstitial velocity of solute.

b) Calculate the average velocity of solute.

c) Calculate the breakthrough time in minutes.

d) How long can you use the adsorbent column in a single cycle for efficient separation.

$\varepsilon_e = 0.50$ $\varepsilon_p = 0.50$ $K_d = 0.5$ $\rho\frac{dq}{dc} = 10$ $A_c = 1\ \mathrm{m}^2$

Amount of hydrocarbon in feed (inlet) air = 1 %

Feed air flow rate = 1 m^3 /minute

In class exercise problem

$\varepsilon_e = 0.50$ $\varepsilon_p = 0.50$ $K_d = 0.5$ $\rho\frac{dq}{dc} = 10$ $A_c = 1\ \text{m}^2$

Amount of hydrocarbon in feed (inlet) air = 1 %

Feed air flow rate = 1 m^3 /minute

Flowrate of hydrocarbon = $Q_h = 1 * 0.01$ m^3/minute

$$v_{inter} = \frac{Q_h}{A_c \varepsilon_e} = \frac{0.01}{1 * 0.5} = 0.02 \text{ m/min}$$

$$u_s = \frac{v_{inter}}{1 + \left(\frac{1-\varepsilon_e}{\varepsilon_e}\right) * \left(K_d \varepsilon_p\right) + \left(\frac{1-\varepsilon_e}{\varepsilon_e}\right) * \left(1-\varepsilon_p\right) * \rho\left(\frac{\Delta q}{\Delta c}\right)}$$

$$\Rightarrow u_s = \frac{0.02}{1 + 0.25 + 0.5 * 10} = 0.0032 \text{ m/minute}$$

$$Breakthrough\ \ time = t_{saturation} - t_{in} = \frac{L}{u_s} = 625 \text{ minutes}$$