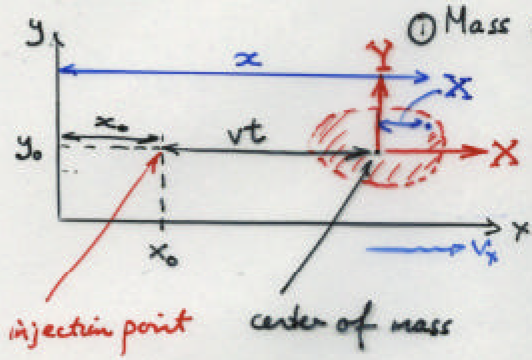
5.6.6 3-D Flow field – Slug Injection

$$C(x,y,z,t) = \frac{\overset{(C_0 \times \text{volume})}{M}}{8(\pi t)^{3/2}\sqrt{D_x D_y D_z}} \exp\left\{ - \frac{(x-(x_0+Vt))^2}{4D_x t} - \frac{(y-y_0)^2}{4D_y t} - \frac{(z-z_0)^2}{4D_z t} \right.$$



① Mass of injection at location x_0, y_0, z_0

② Moves downstream @ velocity V

③ At time, t, center of mass at $x = x_0$

Note coordinates: $x_0 + vt + X = x$

or $X = x - (x_0 + $

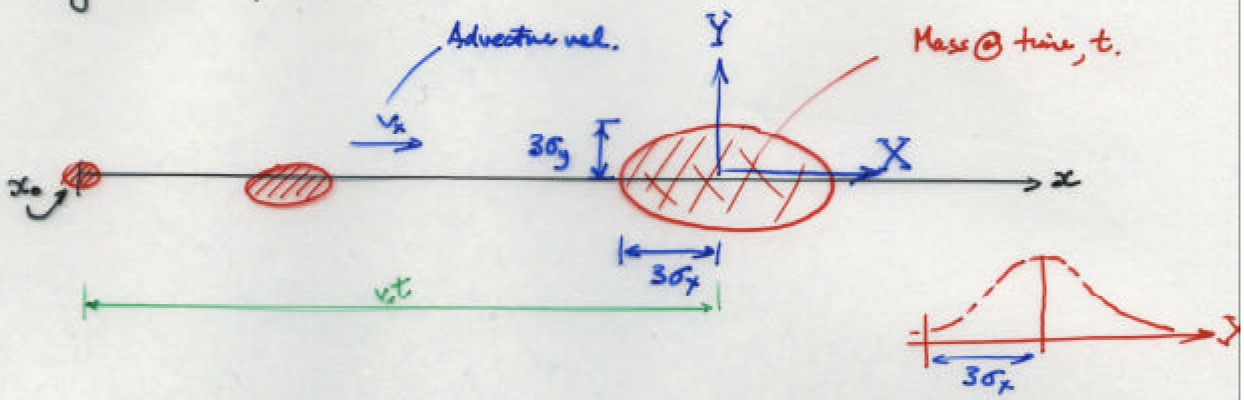
∴ resubstitute into (1)

$$C = \frac{M}{8(\pi t)^{3/2}\sqrt{D_x D_y D_z}} \exp\left\{ - \frac{X^2}{4D_x t} - \frac{Y^2}{4D_y t} - \frac{Z^2}{4D_z t} \right\}$$

Max concentration; set $X = Y = Z = 0$

$$C_{max} = \frac{M}{8(\pi t)^{3/2}\sqrt{D_x D_y D_z}}$$

Note downgradient form:



Zone consisting of 99.7% of Mass

contained in the 3-D ellipsoid of

dimensions:

$$3\sigma_x = 3\sqrt{2D_x t} = 3(2D_x t)^{1/2} \text{ etc.}$$
$$3\sigma_y = 3\sqrt{2D_y t}$$
$$3\sigma_z = 3\sqrt{2D_z t}$$

∴ (1) Measure ellipsoid in field

and (2) evaluate D_x etc.

Preferable method since includes large scale heterogeneity