Solving Differential Material Balances

Procedure

1.   Draw a diagram of the system, labeling all flow directions and boundary conditions.

2.   Select a representative differential volume element.

3.   Perform a material balance around that volume element, resulting in an equation for flux in terms of system geometric parameters.

4.   Write an appropriate flux equation, resulting in a differential equation for concentration.

5.   Solve

Steady-state systems

Flux and concentration *are not* functions of time.

If flux can be expressed in one spatial dimension (preferred!), then an ordinary differential equation results.

If flux must be expressed in 2-3 spatial dimensions, then a partial differential equation results.

Unsteady-state systems

Flux and concentration *are* functions of time.

A partial differential equation always results (with spatial and time dimensions).