**Transient Balances**

**(Time-dependent Behavior)**



The accumulation term always involves a derivative: 

**Example:** total mass





,



How do you solve a simple ordinary differential equation (ODE)?

**SEPARATE and INTEGRATE**

**A. Separate** means put one variable on left side and the other variable on the right side.

Example: 

Split the *dy* and the *dt* (like a quotient), and put *dt* on the RHS. Also put all terms with a *y* on the LHS, and all terms with a *t* or *dt* on the RHS.





**B. Integrate** both sides between limits that correspond to each other.





Example:  at *t* = 0, *y* = *y0*; at *t* = *tf*, *y* = *yf*

Separate: 



Integrate: 

or , or 



**Example: Air Quality in Utah Valley**

Let = mass concentration of pollutants (kg of pollutants/m3)

* Assume valley is a vessel
* Wind comes along
* Perfectly mixed ()



Species balance on “p”:









So the balance becomes:









Now **Separate:**





Now **Integrate:**











**Consistency of units**

In the balance equation, each term must have the same units! (We talked about this before)

Species mass balance: