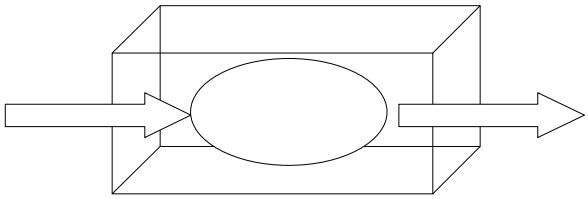
Box Model

- Introduction
- Steady-state Box Model Formula
- Application to Pollution Control

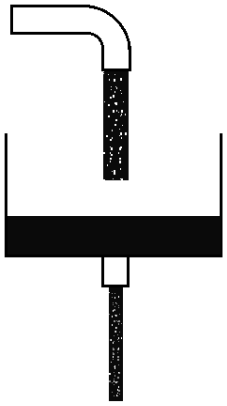
Box Model, Reservoir Model, Budget Model

A defined system receives something (input or source) and simultaneously has this stuff removed (output or sink).



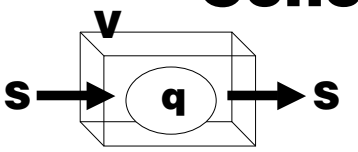
Steady-state: when the source rate = sink rate, resulting in a constant amount or concentration of material inside the box

Source rate = Sink rate



Source rate > Sink rate

Steady-state Box Model Concentration



$$q = \frac{S\tau}{V}$$

V = volume of box

S = source rate = sink rate at steady-state

τ = residence time ("tau")

q = steady-state concentration of pollutant in the box

Air Pollution Sources and Sinks

- **Sources: origin of pollution**
  - → **Direct emission**
  - → **Winds**
  - → **Chemical processes**
  - → **Resuspension**
- **Sinks: removal processes**
  - → **Winds**
  - → **Chemical processes**
  - → **Deposition**

Residence Time

- τ = average period of time a molecule of an air pollutant stays inside a box before it is removed by some sink process
- Controlled by sinks:

  → More efficient sink process → smaller residence time

Pollution Control Analysis

Reduction of ambient, steady-state air pollution concentration achieved by:

- **Decreasing S**
  - → **Easy to eliminate source or decrease source rate**
- **Decreasing τ**
  - → **Somewhat more difficult to add more sink processes or increase sink efficiency**
- **Increasing V**
  - → **Most difficult—how does one add on volume?**