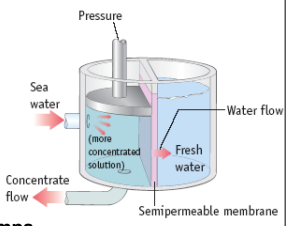
Reverse Osmosis: Water Desalination



Water desalination plant in Tampa

Overview of Chapter 15: Kinetics

Rates of Reactions

Effects on reaction rates:

- Temperature effects
- Concentration effects
- Effects of catalysts

Integrated Rate Laws

Reaction Mechanisms

Today's questions to consider:

- What is meant by reaction rate?
- What are the units for rates?
- How do we measure reaction rates?

Today's Topics

- Defining rate equations
- Initial rate
- Average rate
- Instantaneous rate

Chemical Kinetics

- Thermodynamics tells us if a reaction is product- or reactant-favored.
- Thermodynamics gives us no info on how fast reaction goes from reactants to products.
- Kinetics is the study of reaction rates and their mechanisms (the way the reaction proceeds).

Reaction Mechanisms

The sequence of events at the molecular level that control the speed and outcome of a reaction.

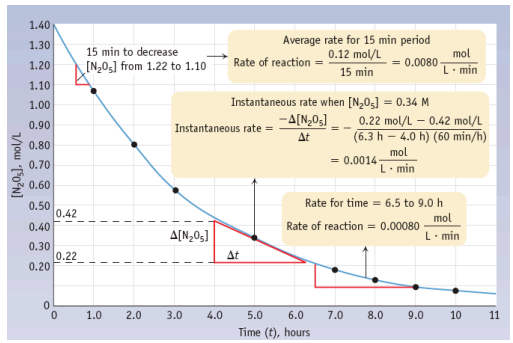
Example: Bromine from biomass burning destroys stratospheric ozone.
(from R.J. Cicerone, *Science*, volume 263, page 1243, 1994.)

Step 1: $Br + O_3 \text{ ---> } BrO + O_2$
Step 2: $Cl + O_3 \text{ ---> } ClO + O_2$
Step 3: $BrO + ClO + \text{light} \text{ ---> } Br + Cl + O_2$
NET: $2\ O_3 \text{ ---> } 3\ O_2$

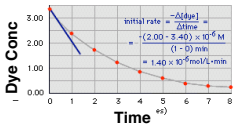
Reaction Rates

- Reaction rate = change in concentration of a reactant or product with time
- Rate units = concentration / time
- Types of rates
  - initial rate
  - average rate
  - instantaneous rate

Determining a Reaction Rate



Determining a Reaction Rate



Blue dye is oxidized with bleach.

The rate (the change in dye concentration with time) can be determined from the plot.

Following reaction progress

For the reaction

$$2N_2O_5 \text{ --> } 4NO_2 + O_2$$

we can follow the progress by monitoring:

- the rate of formation of NO_2
- the rate of formation of O_2 , and/or
- the rate of disappearance of N_2O_5

Factors Affecting Rates

1. Concentrations
2. Physical state of reactants and products
3. Temperature
4. Catalysts