

Problem 1

A 45000L office has a humidifier that emits 1.24 g/min water vapor. A single vent allows 250 L/min flow of air having 40% relative humidity to flow into the office. A stream of moister air exits the room. The room and both inlet and exiting streams have a temperature of 295K and a pressure of 745 mm Hg. The office has a fan and can be considered well-mixed.

Information:

Vapor Pressure, $p_w^*(295K) = 19.66 \text{ mm Hg}$

$R = 62.36 \text{ L mmHg/molK}$

$M_w = 18.0 \text{ g/mol}$

$PQ = nRT$

$P_i = c_iRT$

- What is the volumetric flowrate of air exiting this office when the humidifier is operating?
- What is the relative humidity of the air in the office?
- If the humidifier were suddenly stopped, how much time would pass before the relative humidity in the room decreases to 50%?

Problem 2

A stream of 75 L/min containing 120 mM K^+ and 30 mM SO_4^{2-} is needed. Three streams are available to generate this stream:

Stream A: 200 mM KCl

Stream B: 50 mM K_2SO_4

Stream C: Water

A 5000 liter tank is to be used (at its capacity) to combine these three streams in the correct proportion to generate the desired flowrate and composition as a product “P” stream. All the streams have a density close to 1.0 g/mL. (Note: we do not care about the presence of Cl^-)

- What flowrate of each of the three streams is needed to accomplish the desired concentrations for the P stream?
- The process is operating at steady-state when the pump introducing the 200 mM KCl solution into the tank (A) suddenly stops.
 - How much time passes before the K^+ concentration in P stream falls from 120 mM to 90 mM?
 - How much time passes before the K^+ concentration in P stream falls from 120 mM to 80 mM?
 - What is the SO_4^{2-} concentration at the time found in part i) (that is, when the K^+ concentration is 90 mM)?