Chemical Engineering 4310
Fall Semester, 2005
Homework Assignment #2
Chapters 3and 4
(For return in marked box in hall of 2nd floor
Chemical Sciences by noon on Friday, September 29)

Work problems 3-15, 3-21, 3-22, 3-25, 3-29, 3-30 and 4-10 in the text

1. We want to evaluate the usage of nitrogen in the MTU Unit Operations laboratory. We are concerned that if a release of nitrogen occurs the oxygen level will be reduced below the 19.5% allowed by OSHA. The laboratory has a floor area of 4,800 ft^2 and a volume of 74,300 ft^3. The ventilation rate is 1 ft^3 /min for each ft^2 of laboratory floor space.
   a. In the past we used a gas cylinder to supply the nitrogen. This is a K-cylinder, with a volume of 1.76 ft^3. The nitrogen in a full cylinder is pressurized to 2,500 psig. Nitrogen behaves as an ideal gas under these conditions.
      Calculate the concentration of oxygen in the room if the cylinder fails catastrophically. Assume that the nitrogen released by the cylinder displaces the air in the lab.
      Is the oxygen concentration acceptable for this case?
   b. We currently supply nitrogen from a small nitrogen plant. The plant is capable of producing 19.3 SCFM of nitrogen. Estimate the concentration of oxygen in the lab due to this continuous release of nitrogen. Is this acceptable? What about the local concentration around the vicinity of the leak?

2. Spill containment should be provided when transporting chemicals in a laboratory.
   A 2-liter bottle of tetrahydrofuran (THF) (C_4H_8O) must be transported from a laboratory storage cabinet to a hood. If an accident occurs and the container is broken, the THF will form an evaporating pool resulting in a vapor concentration within the lab.
   Consider two accident scenarios:
   A. The THF is transferred without any containment. Assume that upon breakage of the container a pool of 1-cm depth is formed. Estimate the vapor concentration in the laboratory in ppm.
   B. The THF is transferred using a tray with dimensions of 15-cm x 15-cm. If the container breaks, a pool will form completely within the container. Estimate the vapor concentration in the laboratory in ppm.
   C. Compare the two values. Based on the equations, how does the vapor concentration scale with the area of the pool, i.e. linear, quadratic, etc? What recommendation can you make with respect to the size of the tray?

   Assume that the temperature is 25°C and the pressure is 1atm. Also assume a ventilation rate of 0.5 m^3/s in the laboratory.

   For THF the following properties are available:

MW:	72.12
Vapor Pressure:	114 mm Hg
Liquid density:	888 kg/m^3
TLV-TWA:	200 ppm