OCEN 475/689
Environmental Fluid Mechanics
Problem Set #1: Introduction, concentration, and diffusive flux

Date distributed : 1.20.2011
Date due : 1.27.2011 at 1:50 p.m.

Return your solution either in class or in my mail box (8th Floor, CE/TTI) by the date shown above. Please show all your work and follow the rules outlined in the course syllabus.

1 Email

Please set up your Texas A&M University NEO email so that you will receive emails I send to the class in a timely manner.

2 Newspaper Research

Find an example of a news article that deals with transport of a passive substance (dissolved or suspended substance or chemical) in a situation that demonstrates the application of concepts from environmental fluid mechanics. You may choose a newspaper or web article, and the event should have occurred in the last 10 years. Attach a copy of the article and write a short paragraph describing its relationship to environmental fluid mechanics. Be sure to use proper grammar and your best writing skills when writing your summary paragraph.

3 Definitions

Write a short, qualitative definition of the following terms:

- Concentration
- Mass fraction
- Diffusion
- Chemical transport
- Fick’s law
- Mass flux
4 Concentrations in Water

A student adds 1.0 mg of a stock Rhodamine WT solution to 100.0 ml of water at 20°C. Rhodamine WT solution is a mixture that contains a 20% mass fraction of pure Rhodamine WT in water. Assuming the solution is dilute so that we can neglect the equation of state of the solution, compute the concentration of Rhodamine WT in the mixture in units of mg/l, mg/kg, ppm, and ppb. Be sure to report the correct number of significant figures for each calculation.

5 Concentrations in Air

Air is a mixture of gasses containing a mass fraction of 21.7% oxygen gas (O\textsubscript{2}). For air with a density of 1.227 kg/m\textsuperscript{3}, compute the concentration of oxygen in the units of mg/l, mg/kg, mol/l, and ppm.

6 Diffusive and Mass Fluxes

Aluminum dissolves into a well from a plate at the bottom of the well. No other source of aluminum exists, so that aluminum can only enter through the bottom. The concentration of aluminum near the bottom of the well is given by \( C_{Al} = (7/3)z \), where \( z \) is the height above the bottom of the well in meters and \( C_{Al} \) is the concentration of aluminum in ppb.

1. Compute the diffusive flux of aluminum at \( z = 0 \) assuming a one-dimensional model (this assumes that the aluminum concentration does not depend on lateral position in the well).

2. Compute the mass flux of aluminum into the well at \( z = 0 \) if the plate diameter is 1.5 meters.

For both calculations, use the molecular diffusion coefficient for aluminum in water (choose a diffusion coefficient for a similar weight metal if you cannot find the diffusion coefficient of Al).