Ch.E. 375, W, '09 - Assignment Ten
Computer Tools/Skills in Chemical Engineering

Course web site: http://courses.washington.edu/checomp/
Course mailman (send e-mail to entire class): cheme375a_wi09@u.washington.edu
e-book: http://faculty.washington.edu/finlayso/ebook/

Reading: Ch. 11, Convection and Diffusion, pp. 209-211, Table 11.2, 214-217

Class: Review homework
Convective diffusion equation, added in Comsol; example
Flow past a sphere
Fluid mechanics and its impact on baseball

Assignment Ten

Consider the device used in Assignment Nine. The flow will be reversed, though, coming in the right and going out on the left-hand side. Change your model to do this. Use a constant velocity of –0.1 cm/sec on each boundary on the right-hand side and p = 0 on the left-hand side. For each of the steps below, note the number of elements and the degrees of freedom used in each calculation.

1. Create the mesh from scratch; then refine it once. Solve the flow problem
2. Add the convective diffusion equation to your model. Set the diffusivity to 10^{-4} cm^2/sec. Put in u and v into the boxes for velocity. Set the concentration to 1, 0, 1, 0 from top to bottom on the right-hand side.
3. Go to Solver/Solver Manager. Click on Store solution (to save the flow solution). Then click both the Use Stored Solution buttons; change to Solve For and select only the convective diffusion equation.
4. Solve and plot the concentration at the exit (left-hand side).
5. Use Physics/Subdomain and click on Artificial Diffusion/Petrov-Galerkin
6. Resolve; plot the concentration at the exit.
7. Change the diffusivity to 10^{-5} cm^2/sec and solve; plot the exit concentration. If it isn't smooth, refine the mesh once and resolve. Continue thus until the solution is smooth or you reach 'out of memory' error.

Questions to answer:

1. Is the output well mixed?
2. How does this change when the diffusivity changes from 10^{-4} cm^2/sec to 10^{-5} cm^2/sec?
3. What is the Peclet number at the exit, defined as the average velocity times height divided by the diffusivity. Remember Peclet numbers below 1000 are manageable, those above 1000 are difficult and require small finite elements, i.e. a large number of elements.
4. Describe in words what happens to the concentration at the outlet when you refine the mesh; when the Peclet number increases.
5. If you wanted better mixing, what would you do?