

ChE 400 Applied Chemical Engineering Calculations
Fall 2008
Project
Due 18/11/08

General Comments

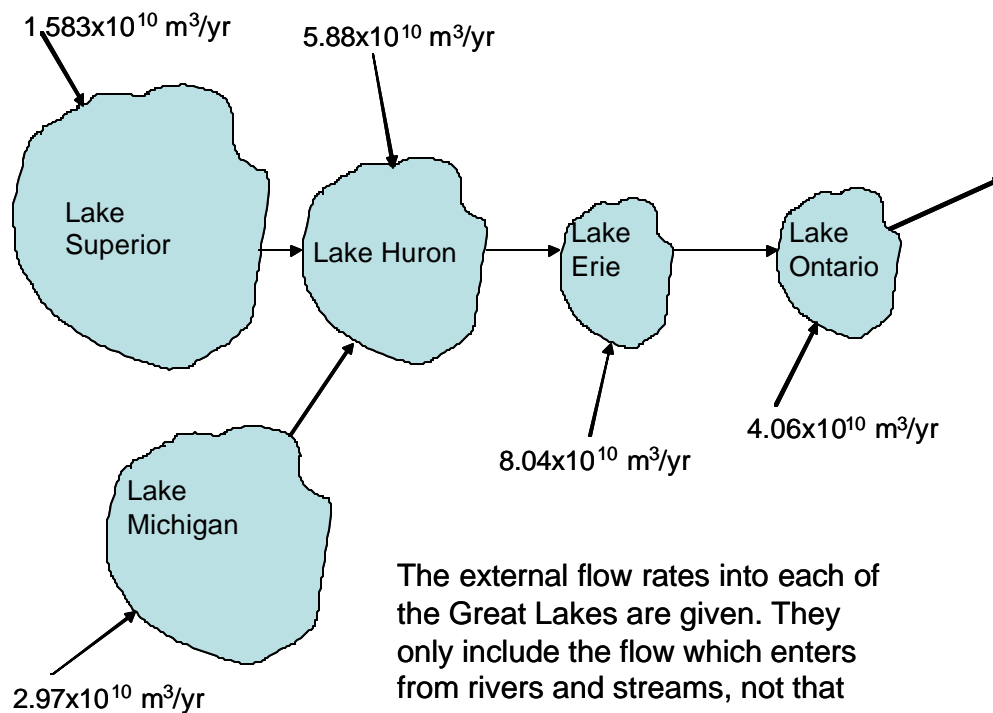
1. As explained in the syllabus you will need to write a report in the format of a technical memorandum about your project. Examples of how to write technical memos are given in the web: <http://www.ent.ohiou.edu/~valy/techwrite.html>
2. The project counts for 15% of your grading. So plan in advance to work in the project.
3. I will be evaluating the creativity of the groups in the project. To encourage that I will be giving extra credits of 5% according to my judgment of what I consider a creative solution in addition to what is asked in the project.
4. You are required to fill out the self and peers assessment form but it won't be considered part of your project grade. According to the engineering code of ethics, you should provide a thoroughly honest evaluation of yourself as well as your team members. Each team member **must** turn in this evaluation the **day the project is due**. The evaluation is confidential. The evaluation sheet is available on the web: <http://www.ent.ohiou.edu/che/che400/Assignments.htm> I will give you feedback on your "self and team" performance the day of the final exam or through e-mail.
5. A general rubric for the project is posted in the web: <http://www.ent.ohiou.edu/che/che400/Assignments.htm>
6. There won't be an extension on the date of the project. It is your responsibility to manage the time in advance to ask questions if necessary. Do not wait until the afternoon before the project is due.
7. You are expected to present the project in an organized way as a Chemical Engineer must do (some guidelines are given in the course syllabus). I will reserve the right of no grading material that is not clearly explained and understandable.
8. The group members have been chosen randomly. The team members are posted on the web: <http://www.ent.ohiou.edu/che/che400/Assignments.htm>

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Description

Spill of Heptachlor in Great Lakes

You are the process engineer of a manufacturing company that produces Heptachlor. Your company is going to ship some of the product to Canada through Lake Superior. In order to do that, EPA has requested an emergency plan that explains what you would do in case of a large spill of the product in Lake Superior. The pollution of Lake Superior by this contaminant will also affect the other great lakes because they are connected together as shown in the diagram given below.



The external flow rates into each of the Great Lakes are given. They only include the flow which enters from rivers and streams, not that which flows from one lake to the other.

The pollutant will not only affect the water quality (the concentration of pollutant may be higher than the EPA water quality standards, due to its spill) but also will affect the fish population (f) in all the lakes. The growth of the fish population in all the lakes is the same, and is given by:

$$\text{population growth rate} = f \left(1 - \frac{f}{60000} \right) \text{ in fish/yr km}^3$$

The death rate by natural causes as well as fishing in all the lakes is the same and is given by:

$$\text{death rate} = f \left(1 - \frac{f}{60000} \right)^{\frac{14600}{f}} \text{ in fish/yr km}^3$$

Heptachlor kills fish at a rate given by the expression

$$\text{chemical death rate} = 0.04f \exp\left(-\frac{1}{c}\right) \text{ in fish/yr km}^3$$

where c is the concentration of Heptachlor in $\mu\text{g/l}$.

If the maximum amount that you will ship is $1\text{E}6$ ton of the product, develop a plan for the case of a spill of this magnitude considering the two following alternatives: (1) No collection of the product, (2) Immediate collection of part of the product. For the comparison of the two alternatives you should discuss as minimum (you are expected to use your creativity to include more topics of discussion):

1. The profile of concentration pollutant in all the lakes as a function of time
2. How long should you wait to bring the concentration of pollutant to the EPA water quality standard in each of the lakes
3. What's the maximum concentration of pollutant in all the lakes?
4. What would be the effect of pollutant in the fish population with time?
5. Determine the time required for the fish population to return to 99% of its original value.
6. What alternative would you propose to EPA as a solution in case of a spill?

Additional information:

1. The Immediate collection of part of the product is based on the solubility of the product in water. Use this property to sketch a filtration procedure to collect part of the product. Over what volume of the lake will you filter your product (use a reasonable statement and justify it). What would be the surface area occupied by the pollutant in this volume? Assumed that you will be able to collect 90% of the mass of pollutant that didn't dissolve in your chosen volume.
2. No all the information required for the solution of the problem is given, you will need to do your own literature search to find out the needed information.
3. You must obtain as minimum ODEs (choose your assumptions accordingly). You must justify all the assumptions, if necessary use literature data to support your statement.
4. You must discuss the implications of your assumptions on your solutions.
5. You must develop your own program using Matlab and the most appropriate of the techniques explained in class to solve for the problem. You can't use built in ODE solvers available in Matlab.
6. All the discussion topics suggested above for each of the alternatives must be coming from your program output as much as possible.