

# Unit Operations/Water & Wastewater

## ESR 410/510 - CE 474/574

### Midterm Exam REVIEW

Here are topics to be familiar with and ideas for questions I might ask. I will NOT ask you to perform lengthy or complex calculations. However I will ask you to perform simple calculations that demonstrate you understand the fundamental concepts we have been trying to master. The exam will try to cover things we have talked about in class but which are not always covered on the Design Assignments.

1. Know the main categories of pathogens and their basic characteristics, such as size and the properties that are relevant to choosing a disinfection method.
2. Know the most important disinfection by-products (DBPs) and what makes the problem better or worse.
3. As for **basic chemistry**, nothing too complex, but there are a few basic skills you should be able to demonstrate. Be able to do basic unit conversions (such as mg/L to mol/L or meq/L); be able to convert from mol/L or meq/L to mg/L as  $\text{CaCO}_3$  (for example when expressing hardness or alkalinity "as  $\text{CaCO}_3$ "; see for instance p. 97, and pp. 458-459 in text.) Also be able to calculate the alkalinity if I give you a simple chemical analysis that includes the pH and the concentration of carbonate or bicarbonate. Finally, be able to define the total hardness of a water if I give you a lab analysis. (For instance if I give you a list of concentrations in mg/L from the lab, be able to put them into units of eq/L or mg/L as  $\text{CaCO}_3$  and then sum them to get total hardness)
4. If I give you information about a desired "log-X" level of disinfection for a particular type of organism, be able to use Ct tables to calculate something like the required contact time.
5. Be able to perform calculations like the total amount of a chemical needed daily by a given water treatment plant if you are given info about the dose of chemical used per liter.
6. For the unit operations we have studied (e.g., clarifiers, filters), be able to calculate the minimum required surface area to satisfy a particular flow requirement subject to the design guidelines given in the text. Know where to quickly find such tables of guidelines.
7. Don't expect to see any detailed calculations on clarifier efficiency or head loss in a sand bed, but I might ask some general questions about the characteristics or operating properties of clarifiers and filters.
8. For softening, I would not expect any detailed calculations, but you should be able to do something like figure out the total mass of  $\text{CaCO}_3$  precipitated if you knew the total hardness and the basic softening reaction. (I'd keep something like this limited to just calcium removal and not Mg since you have not had a chance to get through the Design Assignment yet.) Also, be aware of the basic chemical reactions involved in the softening process. Can you calculate the residual concentration of  $\text{Ca}^{2+}$  after lime precipitation if I gave you the carbonate concentration? (Hint, think solubility product).