

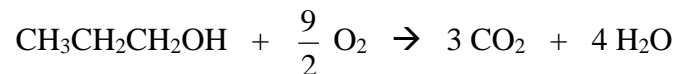
ENV 4001: ENVIRONMENTAL SYSTEMS ENGINEERING

Fall 2021
Problem set #3
Complete by Wednesday, September 22

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Civil & Environmental Eng.
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This problem set will not be collected or graded. Your reward for completing this problem set is that it is essential for learning the course material and passing the quizzes and final exam.

1. Answer problems 5.6, 5.16, 5.19, 5.21, 5.27, 5.29, 5.33 (first part only), and 5.46 in your text book. Hint: the answer to problem 5.5 is given on page 660.
2. A large amount of propanol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$) was spilled into a lake. Before the spill, the concentration of dissolved oxygen in the lake was 9.2 mg/L. The concentration of propanol in the lake just after the spill was 3.0 mg/L. After the spill, propanol was degraded aerobically by bacteria in the lake. The stoichiometry of the propanol degradation is given by the following (approximately):



Five days after the spill occurred, the concentration of oxygen in the lake was measured and found to be 5.6 mg/L. Given this information, answer the following.

- a. What is the theoretical oxygen demand of 3.0 mg/L propanol? Report your answer in units of mg/L of oxygen.
- b. What is the BOD_5 of the propanol spilled in the lake?
- c. Estimate/calculate the first-order rate constant, k , for the biodegradation of propanol. You will need to make an assumption to solve this problem; state it clearly.
- d. Estimate/calculate the concentration of oxygen that will remain 10 days after the spill occurs. (You can ignore re-aeration from the atmosphere.)

3. You have just been hired to respond to an emerging problem in a nearby city, and you have to act fast. Sixteen days ago, something was spilled into a pond in the town. Nobody knows exactly what was spilled, or how much. However, the spilled chemical appears to be using up the dissolved oxygen in the pond. The following data have been made available to you:

Time elapsed since the spill occurred (days)	Concentration of dissolved oxygen in the pond (mg/L)
=====	=====
0	9.25
5	6.91
10	5.39
15	4.39

The city needs to decide if some sort of engineering action is necessary. They need your expertise to help them make this decision before the pond life dies off from oxygen deprivation.

- Based on the data above, estimate the values of L_0 and k for this spill. Be sure to specify the units. Hint: the algebra is messy but do-able.
 - In a few sentences, describe what “ L_0 ” means.
 - If we ignore replenishment of oxygen from the atmosphere, then how low will the oxygen concentration eventually become? In other words, what will be the dissolved oxygen concentration after all the spilled contaminant has been degraded?
 - A critical oxygen concentration for some of the species that live in the pond is 3.50 mg/L. Considering that the spill occurred 16 days ago, how much more time does the city have until the oxygen concentration sinks below that critical level?
 - What is your expert recommendation to the city? Is the pond imminently threatened, or can the city relax and stop worrying?
4. Look up two of the Sustainable Development Goals that seem like they would be particularly relevant for ENV 4001. Write down the number and the title (e.g., Goal 4, “Quality Education”) of these two SDGs. Then, look up the brief description of these two goals and write those down too (e.g., “Ensure inclusive and quality education for all and promote lifelong learning”). Try to memorize the numbers, the names of the goals, and the brief description of the goals.