

ENGS-43, Winter 2012
ENVIRONMENTAL TRANSPORT & FATE

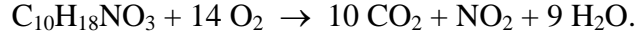
HOMEWORK #1

Assigned: Friday 6 January 2012

Due: 11:15am Friday 13 January 2012

1. (10 points) Consider the so-called dead-zone off the Mississippi River Delta in the Gulf of Mexico (<http://serc.carleton.edu/microbelife/topics/deadzone/>). The chief problem is excessive nitrogen and phosphorus runoff from agriculture in the watershed of the Mississippi River. From the facts of the situation, cite two possible types of remedial actions for each of the three possible approaches (management at the source, along the path and at the receptor level), for a total of six possible remedial actions. A couple of lines on each action constitutes a sufficient answer.

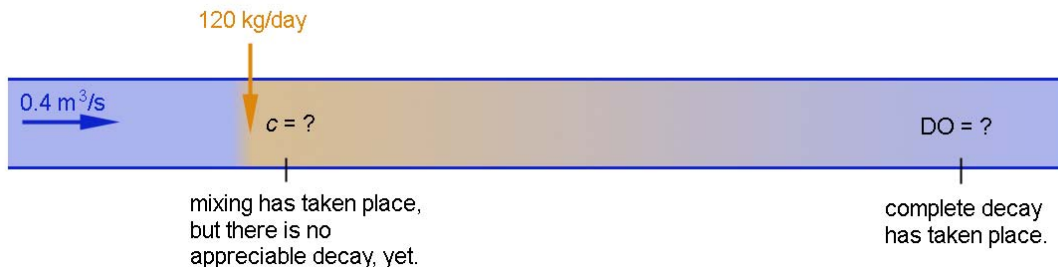
2. (10 points) A certain pre-treated sewage consists of organic material with average chemical formula $C_{10}H_{18}NO_3$, which slowly decays in several biological and chemical steps that can be summed as the net chemical reaction:



If 120 kg/day of this type of sewage is continuously discharged in a small stream carrying $0.4 \text{ m}^3/\text{s}$ of water with 9.3 mg/L of dissolved oxygen upstream, determine

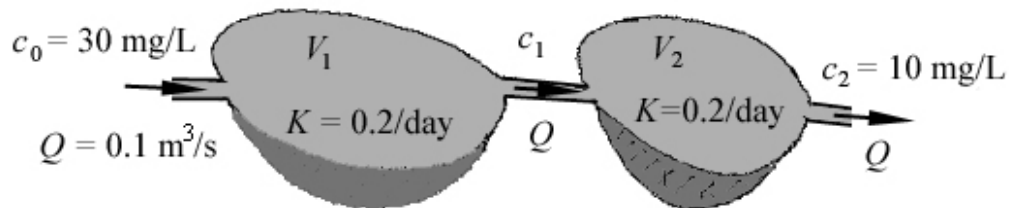
(a) (4 points) the pollutant concentration in the stream shortly downstream of the discharge (assume nearly immediate vertical and transverse mixing across the stream but no appreciable decay, yet), and

(b) (6 points) the ultimate concentration of dissolved oxygen (in mg/L) in the water further downstream after total degradation of the pollutant?

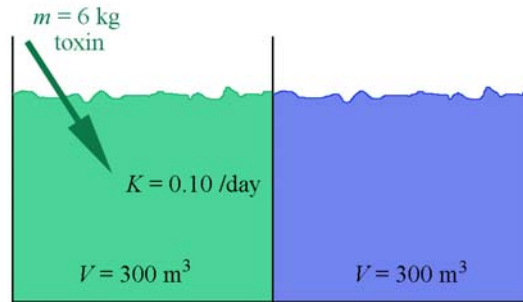


3. (10 points) A 200-m^3 swimming pool has been overly chlorinated by accidentally dumping an entire container of chlorine, which amounted to 500 grams. This creates a chlorine concentration well in excess of the 0.20 mg/L that was the objective at the time. With which volumetric rate (in L/min) of freshwater should the pool be flushed to decrease the concentration to the desired level in 36 hours? You may assume that the chlorine does not degrade chemically during those hours.

4. (10 points) A two-lagoon system (see sketch below) is being designed to accommodate an input flow of $0.10\text{ m}^3/\text{s}$ of a biodegradable pollutant with concentration of 30 mg/L . The pollutant decomposition rate in each lagoon will be 0.2 /day . The effluent from the second lagoon must have a pollutant concentration not exceeding 10 mg/L . Assuming complete mixing in each lagoon and deciding on an optimal volume partitioning between the two lagoons (for you to define – be practical), determine the necessary volume of water in each lagoon. Is there a real advantage in using two lagoons instead of one?



5. (10 points) You are working for a chemical manufacturing plant, which has two adjacent pools of water (300 m^3 each) for the continuous processing of certain contaminated wastes. One day, 6 kg of a toxic substance is accidentally dropped in one of the pools, and that pool must be temporarily shut down. You know that in the presence of the other contaminants, this toxin decays at a rate of 0.10 per day, and that it will be legal and safe to resume operations when the toxin concentration has fallen below 0.5 mg/L .



You have two options: (1) to wait for the toxin concentration in the contaminated pool to drop to the legal level, while keeping the other pool in operation, and (2) to shutdown the other pool, remove the partition separating the two pools thereby diluting the contaminant, and wait until the concentration of the mixture has dropped to the legal level. The shut-down cost is $\$125$ per pool per day. Which option is more economical?