Mass Balance–PFR with Reactive Pollutant

CENG 340–Introduction to Environmental Engineering
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In Class: September 30, 2013

Preface: Biological Oxygen Demand (BOD) represents the potential effect of biodegradable organic carbon on oxygen depletion in natural and engineered systems.

Problem Statement: The concentration of BOD in a river just downstream of a sewage treatment plant's effluent pipe is 75 mg/L. If the BOD is destroyed through a first-order reaction with a rate constant equal to 0.05 day^{-1} what is the BOD concentration 50 km downstream. The velocity of the river is 15 km/day, and you can assume that the river behaves like a plug flow reactor.

Step 1:

Draw a mass balance diagram, ***draw and label the appropriate control volume for analyzing a PFR***, and label your diagram with given information and unknowns.

Step 2:

Write a general mass balance equation:

Step 3:

Determine whether there is flow in and out of the control volume, and whether reactions occur or if conservative.

Step 4:

Rewrite the mass balance equation based on your answer in Step 3, and solve for C_{BOD} 50 km downstream: