Assignment 12

The next two assignments will be based on the following scenario.

The conditions are as follows:

1. **Labeled Questions (1-5):**
   - Oxygen diffuses through the walls of fish containers and oxidizes many fish species. One such species is the zebrafish. The zebrafish, Danio rerio, is a small, easy-to-handle, and relatively inexpensive fish species, making it a popular choice for scientific research. It has been shown that oxygen consumption can have a significant impact on the health and well-being of the fish. The zebrafish are kept in a water tank containing 100 liters of water. The oxygen concentration in the tank is 8 mg/L. The fish consume oxygen at a rate of 0.05 mg/L/day. The tank is kept at a constant temperature of 25°C. Please answer the following questions:

   a. **Choose the correct boundary condition:**
      - Option A: $C_1 = 8$ mg/L at $r = 0$
      - Option B: $C_2 = 8$ mg/L at $r = 0$
      - Option C: $C_3 = 8$ mg/L at $r = 0$
      - Option D: $C_4 = 8$ mg/L at $r = 0$

   b. **Identify the correct concentration profile of O2 in the container material:**
      - Option A: $C_5 = 8$ mg/L at $r = 0$
      - Option B: $C_6 = 8$ mg/L at $r = 0$
      - Option C: $C_7 = 8$ mg/L at $r = 0$
      - Option D: $C_8 = 8$ mg/L at $r = 0$

   c. **Calculate the total amount of oxygen required to maintain the fish in the container:**
      - Option A: 0.2778 mg/L.
      - Option B: 0.1935 mg/L.
      - Option C: 0.2358 mg/L.
      - Option D: 0.3819 mg/L.

   d. **Calculate the rate of change of O2 (Given: 10% of Sodium bicarbonate is consumed in 1 year):**
      - Option A: $2.56 \times 10^{-2}$ mol/L·day/s
      - Option B: $8.6 \times 10^{-2}$ mol/L·day/s
      - Option C: $7.5 \times 10^{-2}$ mol/L·day/s
      - Option D: $9.3 \times 10^{-2}$ mol/L·day/s

   e. **Relation between inner (i) and outer (o) radii of the cylinder:**
      - Option A: $i = 0.05$
      - Option B: $i = 0.1$
      - Option C: $i = 0.3$
      - Option D: $i = 0.2$

2. **Analytical Solutions:**
   - Please refer to the provided analytical solutions for further assistance.

3. **Hints:**
   - Consider the following hints for solving the problem:
   - **HINT 1:** Use the Ficks law to calculate the diffusion coefficient.
   - **HINT 2:** The boundary condition at the tank wall is crucial for the solution.
   - **HINT 3:** The rate of oxygen consumption is directly related to the fish population.

4. **Submission:**
   - Submit your answers by 11:59 PM on the due date.

5. **Grading:**
   - The assignment will be graded on the accuracy of your answers and the clarity of your explanations.

6. **Feedback:**
   - Feedback will be provided within 1 week of submission.

7. **Further Reading:**
   - Please refer to the provided readings and resources for a deeper understanding of the topic.

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**Date:** 2020-04-02, 12:59 IST

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**Note:** This assignment is due in 1 week.