Reactor Analysis with First-Order Reaction Kinetics

CEEG 340–Introduction to Environmental Engineering

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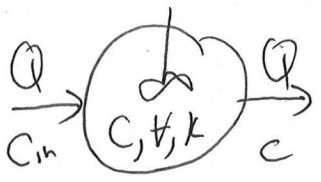
CMFR–The Monster Equation Cont.

A small well-mixed pond (V = 500 m^3) is contaminated with polyfluoroalkyl substances (PFAS), concentraton = 0.01 μg/liter. In addition a stream that enters and exits the pond (Q = 50 $\frac{m^3}{day}$) is contaminated with 10 μg/liter of PFAS due to contamination of flame retardants. PFAS biodegrades very slowly, and has a reaction rate coefficient, k = 0.003 day^{-1}.

1. What is the steady state concentration of PFAS?

$$C_{ss} = \frac{C_{in}}{1+k\theta}$$



$$\theta = \frac{V}{Q} = \frac{500 m^3}{\frac{50 m^3}{day}} = 10 \text{ day}$$

$$C_{ss} = \frac{10 \mu g/L}{1 + 0.003 \times 10} = 9.7 \mu g/L$$

$$\boxed{C_{ss} = 9.7 \mu g/L}$$

2. Now assume the the starting concentration of PFAS in the pond, C(0) = 100 mg/L. What is the steady state concentration of PFAS?

$$\boxed{C_{ss} = 9.7 \mu g/L}$$

$C_{ss} \neq f(C(0))$