# LSN 32 In Class—Microbial Growth, Reaeration, and Energy Recovery

CEEG 340–Introduction to Environmental Engineering

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## Monod Kinetics–From Last Lecture

The growth rate of a bacterium has been characterized and obeys the following mixed-order relationship, according to the Monod Model:

$$\mu = \frac{24 \times \mathrm{S}}{6 + \mathrm{S}}$$

1. Given S = 600 mg/L, calculate $\mu$ twice: (1) using the Monod Model, and (2) using the simplified zero-order model derived in class.

(1) $\mu = \frac{24 \times 600}{6 + 600} = 24 \frac{1}{\text{TIME}}$

(2) $\mu = \mu_{MAX} = 24 \frac{1}{\text{TIME}}$

2. Given S = 0.006 mg/L, calculate $\mu$ twice: (1) using the Monod Model, and (2) using the simplified first-order model derived in class.

(1) $\mu = \frac{24 \times 0.006}{6 + 0.006} = 0.02 \frac{1}{\text{TIME}}$

(2) $\mu = \frac{\mu_{MAX}}{K_S} S = \frac{24}{6} \times 0.006 = 0.02 \frac{1}{\text{TIME}}$

## Reaeration

Microorganisms deplete BOD and oxygen (DO) at the same time. To make sure microorganisms have sufficient oxygen in secondary treatment oxygen is supplied through aeration systems, such as bubble diffusers and mixing.

Given a Henry's constant, $k_H = 1.36\times10^{-3} \frac{\text{mole}}{\text{L}\bullet\text{atm}}$ at 20 $^0$C, determine the saturation concentration of oxygen, D.O.$_{sat}$

$P_{O_2} = 0.20\,ATM$ $\quad K_H = \frac{[O_2]_{(aq)}}{P_{O_2}}$

$[O_2]^{SAT}_{(aq)} = K_H \times P_{O_2}$

$= 1.36\times10^{-3} \frac{MOLE}{L\cdot ATM} \times 0.20\,ATM = 2.72\times10^{-4} \frac{MOLE}{L}$

$[O_2]^{SAT}_{(aq)} = 2.72\times10^{-4} \frac{MOLE}{L} \times 32 \frac{g}{MOLE} \times 1000 \frac{mg}{G} = 8.7\,mg/L$

$[O_2]^{SAT}_{aq} = 8.7\,mg/L$ ; $D.O_{SAT} = 8.7\,mg/L$

Given a saturation concentration, D.O.$_{sat}$ = 8.7 mg/L, calculate the dissolved oxygen deficit, D, for a CMFR with a D.O. concentration of 5 mg/L.

$D = D.O._{SAT} - D.O.$

DEFICIT

$D = 8.7 - 5 = 3.7$

$D = 3.7\,mg/L$

Given an aeration system with a first order reaeration coeffienct, $k_2 = 0.3$ day$^{-1}$, calculate the time it takes to raise D.O. to 8 mg/L. Assume no BOD is being degraded while reaeration is occuring.

$C \equiv D.O.$

$\frac{dD}{dt} = -K_2 D$ ; $\frac{dC}{dt} = K_2 C$

$D = D_0 e^{-k_2 t}$

$D@t = 8.7 - 8 = 0.7\,mg/L$

$0.7 = 3.7 e^{-0.3t}$ $\quad \frac{\ln \frac{0.7}{3.7}}{-0.3} = t$

$t = 5.5\,h$