1. Given:

A wastewater stream having a flow rate of 1.25 MGD and an initial soluble BOD concentration of 275 mg/L needs to be treated so the effluent soluble BOD concentration is no greater than 25 mg/L.

Required:

Determine the reactor volume (gal) that would be needed if it is operated as a CSTR.

a. Find the specific growth rate ($\mu$) in 1/day.

b. Find the reactor volume (gal).

Hint: See example in Biological Treatment Processes notes.

2. Given:

Wastewater from a food processing operation having a substrate (BOD) concentration of 1,500 mg/L and flow rate of 10 m$^3$/h is treated in a reactor. The reactor has a volume of 300 m$^3$ and is equipped with an agitator to keep the fluid well-mixed. For the treatment process, $\mu_{\text{max}}$ is 0.05 h$^{-1}$ and $K_s$ is 50 mg/L. The federal limit for BOD discharge is 30 mg/L.
Required:

a. Determine the concentration in the effluent from the process.
Hint: Use the Monod equation 2a.

b. Can this effluent be discharged to the stream?

b. If you cannot discharge the effluent to the stream, what can you do?

3. Given:

The WWTP in problem 4 on homework 2 (equalization tank design) had an average influent flow rate of 0.400 m³/s with a maximum BOD₅ concentration of 400 mg/L. Effluent from the treatment plant must meet U.S. federal standards of 30.0 mg BOD₅/L and 30.0 mg TSS/L. Primary clarifiers remove 32% of the BOD₅ from the incoming wastewater prior to the activated sludge process.

Required:

Determine the cell residence time, hydraulic retention time, and aeration tank volume required to treat the wastewater using a completely mixed activated sludge process. Assume typical values for the activated sludge parameters and an MLVSS (cell concentration, X) in the reactor of 2,000 mg/L. Also assume the BOD₅ content of the suspended solids in the system effluent is 63% of the total solids concentration.

Note: The suspended solids in the effluent, which are primarily microbial sludge, contain a substantial amount of BOD₅. The effluent from the clarifier contains both suspended solids (TSS) and unused substrate (soluble BOD₅). The BOD₅ content of the suspended solids must be taken into account when determining the allowable concentration of unused substrate in the effluent.

a. Calculate the cell residence time (θₑ) in days.
Hint: Use the Activated Sludge Design equation (Eq. 13) from the Biological Treatment
Processes lecture to calculate the cell resistance time.

b. Calculate the hydraulic retention time (θ) in days.
Hint: Use the Activated Sludge Design equation (Eq. 11) from the Biological Treatment Processes lecture.

c. Calculate the reactor volume in m³.