A conventional activated sludge process treats 3785 m$^3$/d of wastewater, containing 250 g/m$^3$ BOD$_5$, and produces an effluent containing 20 g/m$^3$ BOD$_5$. The nominal detention time in the aeration basin excluding the return activated sludge flow is six hours and the mixed liquor suspended solids (MLSS) concentration is 3000 g/m$^3$. Determine the following:

a) aeration basin volume (m$^3$).
b) F/M ratio (d$^{-1}$).
c) Specific substrate utilization rate (d$^{-1}$).
d) Substrate removal efficiency (%).
a) The detention time is given as 6 h to substitute in the definition of it as follows:
\[ \tau = \frac{V}{Q} \rightarrow V = (\tau)(Q) = (6 \text{ h}) \left( 3785 \frac{m^3}{d} \right) \left( \frac{1 \text{ d}}{24 \text{ h}} \right) = 946.25 \text{ m}^3 \]

b) \( F/M \) ratio is calculated using the following equation:
\[ F/M = \frac{QS_i}{XV} = \frac{\left( 3785 \frac{m^3}{d} \right) \left( 250 \frac{g}{m^3} \right)}{\left( 3000 \frac{g}{m^3} \right) \left( 946.25 m^3 \right)} = 0.33 \frac{g \text{ BOD}_5}{g \text{ TSS. d}} \]

c) \( U \) is calculated using the following equation:
\[ U = \frac{Q(S_i - S_e)}{XV} = \frac{\left( 3785 \frac{m^3}{d} \right) \left( 250 \frac{g}{m^3} \right) - 20 \frac{g}{m^3}}{\left( 3000 \frac{g}{m^3} \right) \left( 946.25 m^3 \right)} = 0.31 \frac{g \text{ BOD}_5}{g \text{ TSS. d}} \]

d) Treatment efficiency is calculated using the following equation:
\[ E(\%) = \frac{C_i - C_e}{C_i} \times 100 \]
\[ E(\%) = \frac{\left( 250 \frac{g}{m^3} - 20 \frac{g}{m^3} \right)}{\left( 250 \frac{g}{m^3} \right)} \times 100 = 92\% \]