Problem 4-10 Integrated Michaelis-Menten equation; $c_{S0} >> K_M$; substrate conversion

The action of pepsin on 1-carboxy-1-glutamyl tyrosin (substrate S) at the temperature of 38 °C and pH = 4 is characterized by the kinetic parameters

$$K_M = 1.73 \cdot 10^{-4} \text{ mol dm}^{-3} \quad \text{a} \quad \upsilon_{max} = 9.2 \cdot 10^{-7} \text{ mol dm}^{-3} \text{ s}^{-1}.$$

Calculate the percentage of the substrate converted after 10 hours from the beginning of the reaction in case that the initial concentration of the substrate was 0.8 mol dm^{-3}.

[4.14 %]

Solution:

$\tau = 10$ h , $c_{S0} = 0.8$ mol dm^{-3}

$c_{S0} = 0.8$ mol dm^{-3} >> $K_M = 1.73 \cdot 10^{-4}$ mol dm^{-3}

$\upsilon_{max} = 9.2 \cdot 10^{-7}$ mol dm^{-3} s^{-1}

$\alpha = ?$

$$r = \frac{\mathrm{d}c_P}{\mathrm{d}\tau} = \frac{\upsilon_{max} \cdot c_S}{K_M + c_S} \cong \frac{\upsilon_{max} \cdot c_S}{c_S} = \upsilon_{max}$$

$$c_{S0} \cdot \frac{\mathrm{d}\alpha}{\mathrm{d}\tau} = \upsilon_{max} \quad \text{- zero-order kinetics}$$

$$c_{S0} \cdot \alpha = \upsilon_{max} \cdot \tau$$

$$\alpha = \frac{\upsilon_{max} \cdot \tau}{c_{S0}} = \frac{9.2 \cdot 10^{-7} \cdot 10 \cdot 3600}{0.8} \qquad \left[\frac{(\text{mol dm}^{-3} \text{ s}^{-1}) \cdot \text{s}}{\text{mol dm}^{-3}} = 1 \right]$$

$\alpha = 4.14 \cdot 10^{-2}$.....4.14 %