Problem 16-02 Gibbs adsorption isotherm

The surface tension of the diluted aqueous hexanol solutions at the temperature of 26.5 °C can be expressed as a linear function of alcohol concentration in the bulk phase

$$\gamma = 0.0716 - 6.8 \cdot c_2$$

where γ is the surface tension (N m^{-1}) and c_2 is the concentration in mol dm^{-3}. Calculate the relative adsorption with respect to water as a solvent, $\Gamma_{2,1}$, in a solution of concentration $6 \cdot 10^{-4}$ mol dm^{-3}. Is it possible to say that hexanol is a surface active substance?

[$\Gamma_{2,1} = 1.637 \cdot 10^{-6}$ mol m^{-2} > 0 - hexanol is a surface active substance]

Solution:

$T = 299.65$ K

$c_2 = 6 \cdot 10^{-4}$ mol dm^{-3}

$$\Gamma_{2,1} = -\frac{c_2}{\boldsymbol{R}T} \cdot \left(\frac{\mathrm{d}\gamma}{\mathrm{d}c_2} \right)_{T,\,p}$$

$$\gamma = 71.6 - 6.8 \cdot c_2$$

$$\left(\frac{\mathrm{d}\gamma}{\mathrm{d}c_2} \right)_{T,\,p} = -6.8 \text{ (N m}^{-1}\text{) (mol dm}^{-3}\text{)}^{-1}$$

$$\Gamma_{2,1} = -\frac{6 \cdot 10^{-4}}{8.314 \cdot 299.65} \cdot (-6.8) = 1.637 \cdot 10^{-6} \text{ mol m}^{-2}$$

$$\left[\frac{(\text{mol dm}^{-3})}{(\text{N m mol}^{-1}\text{ K}^{-1}) \cdot \text{K})} \cdot (\text{N m}^{-1}) \cdot (\text{mol dm}^{-3})^{-1} = \text{mol m}^{-2} \right]$$