Problem 14-09 Kelvin equation – vapour pressure above a drop

A liquid with molar mass M = 260 g mol^{-1}, density 0.855 g cm^{-3}, and surface tension 35 mN m^{-1}, was dispersed into air in the form of small droplets. Calculate the size of drops if you know that the vapour pressure above the drops is 16.8 kPa, whereas the equilibrium vapour pressure above this liquid with the planar surface has the value of 16.54 kPa, both at the temperature of 31 °C.

[r = 0.54 μm]

Solution:

γ = 35 mN m^{-1} = 0.035 N m^{-1}

t = 31°C

p_r^s = 16.8 kPa

p_∞^s = 16.54 kPa

M = 260 g mol^{-1} = 0.260 kg mol^{-1}

ρ = 0.855 g cm^{-3} = 855 kg m^{-3}

$$r = \frac{2 \cdot \gamma \cdot M}{RT \cdot \rho \cdot \ln\left(\frac{p_r^s}{p_\infty^s}\right)} = \frac{2 \cdot 0.035 \cdot 0.260}{8.314 \cdot (31 + 273.15) \cdot 855 \cdot \ln\frac{16.8}{16.54}} = 5.397 \cdot 10^{-7}\ \text{m} = 0.54\ \mu\text{m}$$