Fiber Drawing Modeling Quiz

Solutions

1.) $u_{x=L} = \frac{U_L}{L} \ln DR = \frac{1000\,cm/sec}{300\,cm} \ln(75) = 14.4 \frac{1}{sec}$

2.) $\sigma_{max} = \sigma_{x=L} = 3\mu u_{x=L} = 3\left(4{,}000 \frac{dyne\cdot sec}{cm^2}\right) 14.4 \frac{1}{sec} = 1.72\times10^5 \frac{dyne}{cm^2}$

3.) $F = \pi R_L^2 \sigma_{max} = 3.14\left(5^{-3}\,cm\right)^2 \left(1.72\times10^5 \frac{dyne}{cm^2}\right) = 13.5\,dyne$

4.) Internal effects are of importance when:

$$\frac{\rho U_L L}{3\mu \ln DR} = 1 \qquad \text{assuming } \rho = 1$$

Rearranging, we find $L^* = \frac{3\mu \ln(DR)}{\rho U_L} = \frac{3\left(4{,}000 \frac{dyne\,sec}{cm^2}\right)\ln(75)}{\left(1\,g/cm^3\right)\left(1000\,cm/sec\right)} = 51.8\,cm$

5.) Increasing the draw ratio would increase the modulus and tensile strength of the fiber. Doing so would likely make the fiber more brittle to impact. Decreasing the draw ratio could result in the onset of draw resonance.