

15.15 This problem gives us the tensile strengths and associated number-average molecular weights for two polyethylene materials and then asks that we estimate the \bar{M}_n that is required for a tensile strength of 140 MPa. Equation 15.3 cites the dependence of the tensile strength on \bar{M}_n . Thus, using the data provided in the problem statement, we may set up two simultaneous equations from which it is possible to solve for the two constants TS_∞ and A . These equations are as follows:

$$90 \text{ MPa} = TS_\infty - \frac{A}{20,000 \text{ g/mol}}$$

$$180 \text{ MPa} = TS_\infty - \frac{A}{40,000 \text{ g/mol}}$$

Thus, the values of the two constants are: $TS_\infty = 270 \text{ MPa}$ and $A = 3.6 \times 10^6 \text{ MPa-g/mol}$. Solving for \bar{M}_n in Equation 15.3 and substituting $TS = 140 \text{ MPa}$ as well as the above values for TS_∞ and A leads to

$$\begin{aligned} \bar{M}_n &= \frac{A}{TS_\infty - TS} \\ &= \frac{3.6 \times 10^6 \text{ MPa-g/mol}}{270 \text{ MPa} - 140 \text{ MPa}} = 27,700 \text{ g/mol} \end{aligned}$$