Solutions

2.1

- $V/A = a^3/(6a^2) = a/6 = 60/6 = 10$ mm = **1.0** cm.
- $t = B(V/A)^2 = 2.0 \times 1.0^2 = \mathbf{2.0}$ min.

2.2

- $D/6 = 1.2 \times 10$, so $D = \mathbf{72}$ mm.
- $t = B(V/A)^2 = 2.0 \times 1.2^2 = \mathbf{2.88}$ min.

2.3

- $\varepsilon = \ln(A_0/A_f) = \ln(64/49) = \mathbf{0.267}$.
- $\bar{Y} = K\varepsilon^n/(n+1) = 500 \times 0.267^{0.2}/1.2 = \mathbf{320}$ MPa.
- $\sigma_d = \bar{Y}\varepsilon = 320 \times 0.267 = \mathbf{85.5}$ MPa.
- $F = \sigma_d A_f = 85.5 \times \pi \times 3.5^2 = \mathbf{3.29}$ kN.

3.1

- Set $\sigma_d = K\varepsilon^{n+1}/(n+1)$ equal to $K\varepsilon^n$: $\varepsilon/(n+1) = 1$, so $\varepsilon = n + 1$.
- $\varepsilon = 1.2$: reduction $= 1 - A_f/A_0 = 1 - e^{-1.2} = \mathbf{69.9}\%$.
- Friction and redundant work raise the real drawing stress, so passes are kept to about 20 to 45% reduction.

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