ME3210 Spring 2016 HW3 Solution

5.12

Hot tearing is a result of tensile stresses that develop upon contraction during solidification in molds and cores if they are not sufficiently collapsible and/or do not allow movement under the resulting pressure during shrinkage.

5.20

Preheating the mold in permanent-mold casting is advisable in order to reduce the chilling effect of the metal mold which could lead to low metal fluidity and the problems that accompany this condition. Also, the molds are heated to reduce thermal damage which may result from repeated contact with the molten metal. Considering casting removal, the casting should be allowed to cool in the mold until there is no danger of distortion or developing defects during shakeout. While this may be a very short period of time for small castings, large castings may require an hour or more.

5.27

After solidification, shrinkage continues until the casting cools to room temperature. Also, due to surface tension, the solidifying metal will, when surface tension is high enough, not fully conform to sharp corners and other intricate surface features. Thus, the cast shape will generally be slightly different from that of the pattern used.

5.35

Draft is provided to allow the removal of the pattern without damaging the mold. If the mold material is sand and has no draft, the mold cavity is likely to be damaged upon pattern removal, due to the low strength of the sand mold. However, a die made of high-strength steel, which is typical for permanent-mold castings, is not at all likely to be damaged during the removal of the part; thus smaller draft angles can be employed.

5.59

For the same length and cross sectional area (thus the same volume), and the same casting conditions, the same C value in Eq. (5.11) on p. 205 on p. 205 should be applicable. The surface area and volume of the round casting is

$$A_{\text{round}} = 2\pi rl + 2\pi r^2 = 0.613 \text{ m}^2$$

$$V_{\text{round}} = \pi r^2 l = 0.0353 \text{ in}^2$$

Since the cross-sectional area of the ellipse is the same as that for the cylinder, and it has a major and minor diameter of a and b, respectively, where $a = 3b$, then

$$\pi ab = \pi r^2$$

$$3b^2 = r^2 \quad \rightarrow \quad b = \sqrt{\frac{(0.15)^2}{3}}$$

or $b = 0.0866$ m, so that $a = 0.260$ m. The surface area of the ellipse-based part is (see a basic geometry text for the area equation derivations):

$$A_{\text{ellipse}} = 2\pi ab + 2\pi\ell\sqrt{a^2 + b^2} = 0.75 \text{ in}^2$$

For the same volume, $\dfrac{T_{\text{round}}}{T_{\text{ellipse}}} = \left(\dfrac{A_{\text{ellipse}}}{A_{\text{round}}}\right)^2 = 1.5$

5.61

The force exerted by the molten metal is the product of its cross-sectional area at the parting line and the pressure of the molten metal due to the height of the sprue. Assume that the sprue has the same height as the cope, namely, 15 in. The pressure of the molten metal is the product of height and density. Assuming a density for the molten metal of 500 lb/ft^3, the pressure at the parting line will be $(500)(15/12) = 625$ lb/ft^2, or 4.34 psi. The buoyancy force is the product of projected area and pressure, or $(625)(\pi)(9/12)^2 = 1100$ lb. The net volume of the sand in each flask is

$$V = (20)(20)(15) - (0.5)\left(\frac{4\pi}{3}\right)(9)^3$$

or $V = 4473$ in^3 $= 2.59$ ft^3. For a sand density of 100 lb/ft^3, the cope weighs 454 lb. Under these circumstances, a clamping force of $1100 - 259 \approx 850$ lb is required.