Stress and Temperature Effects

8.28 This problem asks that we determine the total elongation of a low carbon-nickel alloy that is exposed to a tensile stress of 70 MPa (10,000 psi) at 427°C for 10,000 h; the instantaneous and primary creep elongations are 1.3 mm (0.05 in.).

From the 427°C line in Figure 8.31, the steady state creep rate $\dot{\varepsilon}_s$ is about $4.7 \times 10^{-7}\ h^{-1}$ at 70 MPa. The steady state creep strain, ε_s, therefore, is just the product of $\dot{\varepsilon}_s$ and time as

$$\varepsilon_s = \dot{\varepsilon}_s \times (\text{time})$$

$$= \left(4.7 \times 10^{-7}\ h^{-1}\right)(10{,}000\ h) = 4.7 \times 10^{-3}$$

Strain and elongation are related as in Equation 6.2; solving for the steady state elongation, Δl_s, leads to

$$\Delta l_s = l_0 \varepsilon_s = (1015\ mm)\left(4.7 \times 10^{-3}\right) = 4.8\ mm \quad (0.19\ in.)$$

Finally, the total elongation is just the sum of this Δl_s and the total of both instantaneous and primary creep elongations [i.e., 1.3 mm (0.05 in.)]. Therefore, the total elongation is 4.8 mm + 1.3 mm = 6.1 mm (0.24 in.).