Solution to Problem 241Ea

The planar flow close to the stagnation point on any bluff cylindrical body has a potential flow solution that yields a velocity, U, outside the boundary layer that is proportional to the distance x , from the stagnation point given by

$$U = Ax$$

This is one of the family of $U(x)$ among the Falkner-Skan laminar boundary layer solutions which since the half-angle $\theta = \pi/2$ the value of m is

$$m = \frac{\theta}{\pi - \theta} = 1$$

From the Falkner-Skan graph we find that

$$\eta_{0.99} = 1.2$$

and therefore the 99% boundary layer thickness, $\delta_{0.99}$, is obtained from

$$\eta_{0.99} = \delta_{0.99} \left(\frac{U}{4\nu x} \right)^{1/2} = \delta_{0.99} \left(\frac{Ax}{4\nu x} \right)^{1/2}$$

so that

$$\delta_{0.99} = \eta_{0.99} \left(\frac{4\nu}{A} \right)^{1/2} = 2.4 \left(\frac{\nu}{A} \right)^{1/2}$$

Note that the thickness is constant and independent of distance, x, from the stagnation point.