

1.82 Oil (absolute viscosity = 0.0003 lb-s /ft², density = 50 lbfm/ft³), flows in the boundary layer, as shown in Fig. P1.82. The plate is 1 ft wide perpendicular to the paper. Calculate the shear stress at the plate surface.

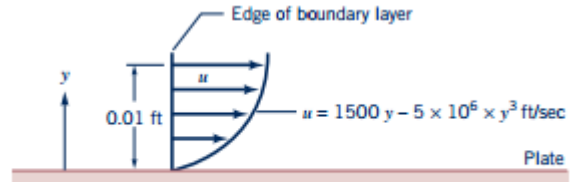


Figure P1.82

SOLUTION:

Assuming
a newtonian fluid,
the shear stress on
the plate by the oil
is

$$\tau = \mu \left(\frac{du}{dy} \right)_{y=0}$$

Now

$$u = \frac{1500}{\text{sec}} y - \frac{5 \times 10^6}{\text{sec} \cdot \text{ft}^2} y^3$$

and

$$\frac{du}{dy} = \frac{1500}{\text{sec}} - \frac{15 \times 10^6}{\text{sec} \cdot \text{ft}^2} y^2$$

so

$$\left(\frac{du}{dy} \right)_{y=0} = \frac{1500}{\text{sec}}$$

and

$$\tau = \left(\frac{0.0003 \text{ lb} \cdot \text{sec}}{\text{ft}^2} \right) \left(\frac{1500}{\text{sec}} \right)$$

$$\tau = 0.45 \text{ lb/ft}^2$$