

7.19

7.19 One type of viscometer consists of an open reservoir with a small diameter tube at the bottom as illustrated in Fig. P7.19. To measure viscosity the system is filled with the liquid of interest and the time required for the liquid level to fall from level  $H_i$  to  $H_f$  is determined. Use dimensional analysis to obtain a relationship between the viscosity,  $\mu$ , and the draining time,  $\tau$ . Assume that the other variables involved are the initial head,  $H_i$ , the final head,  $H_f$ , the tube diameter,  $D$ , and the specific weight of the liquid,  $\gamma$ .

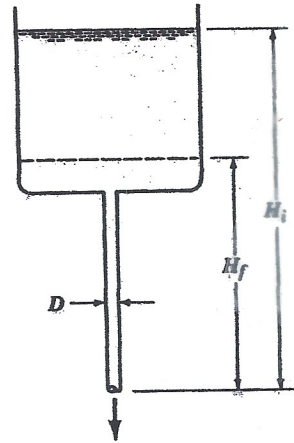


FIGURE P7.19

$$\tau = f(D, H_i, H_f, \mu, \gamma) = \text{draining time}$$

$$F(\tau, D, H_i, H_f, \mu, \gamma) = 0$$

$$T \quad L \quad L \quad L \quad FL^{-2}T \quad FL^{-3}$$

$$n = 6$$

$$m = 3$$

by inspection  $\pi_1 = \tau \gamma D / \mu = T (FL^{-3}) L / FL^{-2}T = F^0 L^0 T^0$

$$r = n - m = 3$$

$$\pi_2 = H_i / D$$

$$\pi_3 = H_f / D$$

$$\tau \gamma D / \mu = f(H_i / D, H_f / D)$$

for fixed geometry:  $\frac{\tau \gamma D}{\mu} = \text{constant} = K$

$$\mu = \tau \gamma D / K$$

$$= K' \gamma \tau$$

$$K' = D / K$$

= constant for fixed geometry