resulting velocity distribution. The fluid is at rest far from the cylinder. [HINT: the cylinder does not induce any radial motion.]

Fig. P4.94

Solution: We already have the useful hint that $v_r = 0$. Continuity then tells us that $(1/r)\partial v_\theta/\partial\theta = 0$, hence v_θ does not vary with θ. Navier-Stokes then yields the flow. From Eq. D.6, the tangential momentum relation, with $\partial p/\partial\theta = 0$ and $v_\theta = f(r)$, we obtain Eq. (4.139):

$$\frac{1}{r}\frac{d}{dr}\left(r\frac{dv_\theta}{dr}\right) = \frac{v_\theta}{r^2}, \quad \text{Solution:} \quad v_\theta = C_1 r + \frac{C_2}{r}$$

$$\text{As } r \to \infty, \ v_\theta \to 0, \quad \text{hence } C_1 = 0$$

$$\text{At } r = R, \ v_\theta = \Omega R = \frac{C_2}{R}; \ C_2 = \Omega R^2; \ \text{Finally,} \quad v_\theta = \frac{\Omega R^2}{r} \qquad \textit{Ans.}$$

Rotating a cylinder in a large expanse of fluid sets up (eventually) a *potential vortex flow*.

***P4.95** Two immiscible liquids of equal thickness h are being sheared between a fixed and a moving plate, as in Fig. P4.95. Gravity is neglected, and there is no variation with x. Find an expression for (a) the velocity at the interface; and (b) the shear stress in each fluid. Assume steady laminar flow.

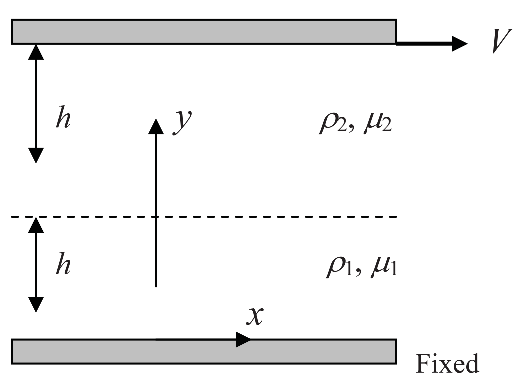

Fig. P4.95