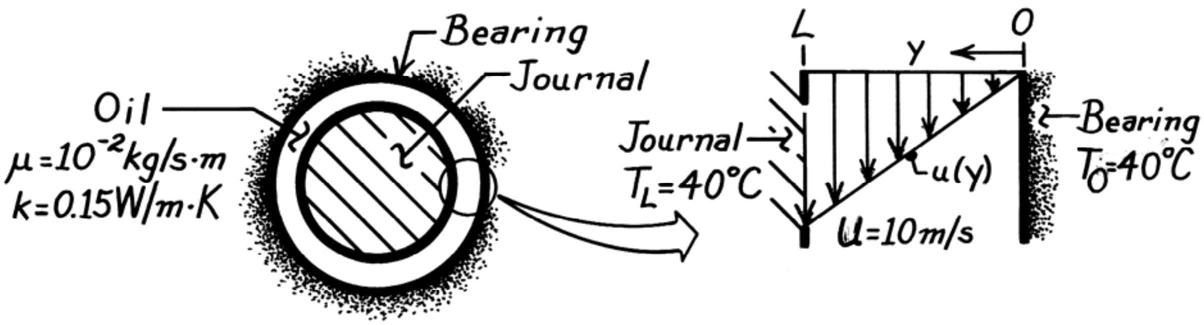
PROBLEM 6S.2

KNOWN: Oil properties, journal and bearing temperatures, and journal speed for a lightly loaded journal bearing.

FIND: Maximum oil temperature.

SCHEMATIC:



ASSUMPTIONS: (1) Steady-state conditions, (2) Incompressible fluid with constant properties, (3) Clearance is much less than journal radius and flow is Couette.

ANALYSIS: The temperature distribution corresponds to the result obtained in the text Example on Couette flow,

$$T(y) = T_0 + \frac{\mu}{2k}U^2\left[\frac{y}{L} - \left[\frac{y}{L}\right]^2\right].$$

The position of maximum temperature is obtained from

$$\frac{dT}{dy} = 0 = \frac{\mu}{2k}U^2\left[\frac{1}{L} - \frac{2y}{L^2}\right]$$

or, $\qquad y = L/2.$

The temperature is a maximum at this point since $d^2T/dy^2 < 0$. Hence,

$$T_{max} = T(L/2) = T_0 + \frac{\mu}{2k}U^2\left[\frac{1}{2} - \frac{1}{4}\right] = T_0 + \frac{\mu U^2}{8k}$$

$$T_{max} = 40^\circ C + \frac{10^{-2}\,kg/s\cdot m\,(10\,m/s)^2}{8\times 0.15\ W/m\cdot K}$$

$$T_{max} = 40.83^\circ C.$$ <

COMMENTS: Note that T_{max} *increases* with *increasing* μ and U, *decreases* with *increasing* k, and is *independent* of L.