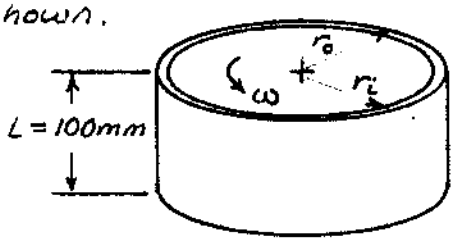
Problem 8.19

Given: Sealed journal bearing rotating as shown.



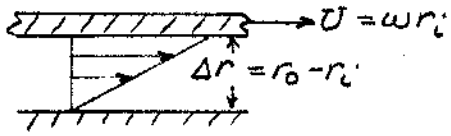
$r_o = 26\,mm$, $r_i = 25\,mm$

Gap contains oil in laminar motion with linear velocity profile.

$\omega = 2800\,rpm$ and Torque, $T = 0.2\,N\cdot m$

Find: (a) Viscosity of oil
(b) Will torque increase or decrease with time? Why?

Solution: "Unfold" bearing since gap is small, and consider as flow between parallel plates. Apply Newton's law of viscosity.



Basic equation: $\tau_{yx} = \mu \frac{du}{dy}$

Assumption: Linear velocity profile

Then $\tau_{yx} = \mu \frac{U}{\Delta r} = \frac{\mu \omega r_i}{\Delta r}$

and

$$T = r_i \left(2\pi r_i L \tau_{yx}\right) = 2\pi r_i^2 L \tau_{yx} = \frac{2\pi \mu \omega r_i^3 L}{\Delta r}$$

Solving, $\mu = \frac{\Delta r\, T}{2\pi \omega r_i^3 L}$

$$\mu = \frac{1}{2\pi} \times 0.001\,m \times 0.2\,N\cdot m \times \frac{min}{2800\,rev} \times \frac{1}{(0.025)^3 m^3} \times \frac{1}{0.1\,m} \times \frac{rev}{2\pi\,rad} \times 60\,\frac{s}{min}$$

$$\mu = 0.0695\,N\cdot s / m^2$$

μ

Bearing is sealed, so oil temperature will increase as energy is dissipated by friction. For liquids, μ decreases as T increases. Thus torque will <u>decrease</u>, since it is proportional to μ.