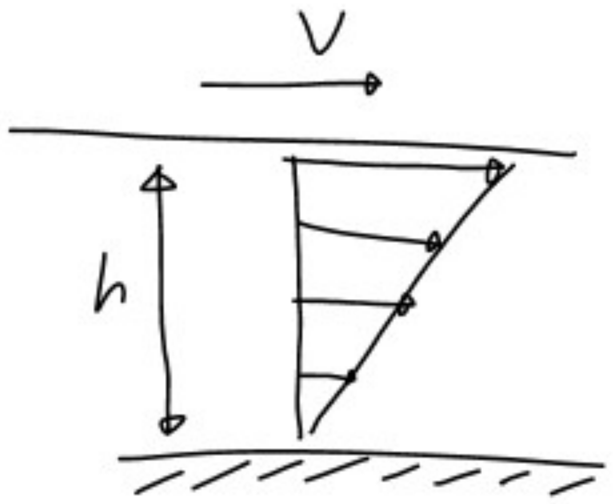
Journal Bearing

Why not use a ball bearing?

Types of lubrication

- Hydrodynamic
  - Fluid film from rotation
- Hydrostatic
  - High pressure oil or air
- Elastohydrodynamic
- Boundary
- Solid Film

Hydrodynamic Bearings



$$\tau = \frac{F}{A} = \mu \frac{du}{dy}$$

$$\tau = \mu \frac{V}{h} = \frac{2\pi r \mu N}{c}$$

N rev/s

c radial clearance

$$T = \frac{4\pi^2 r^3 l \mu N}{c}$$

$$P = \frac{W}{2rl}$$

W radial force

P pressure

$$T = fWr$$
$$= 2r^2 f l P$$

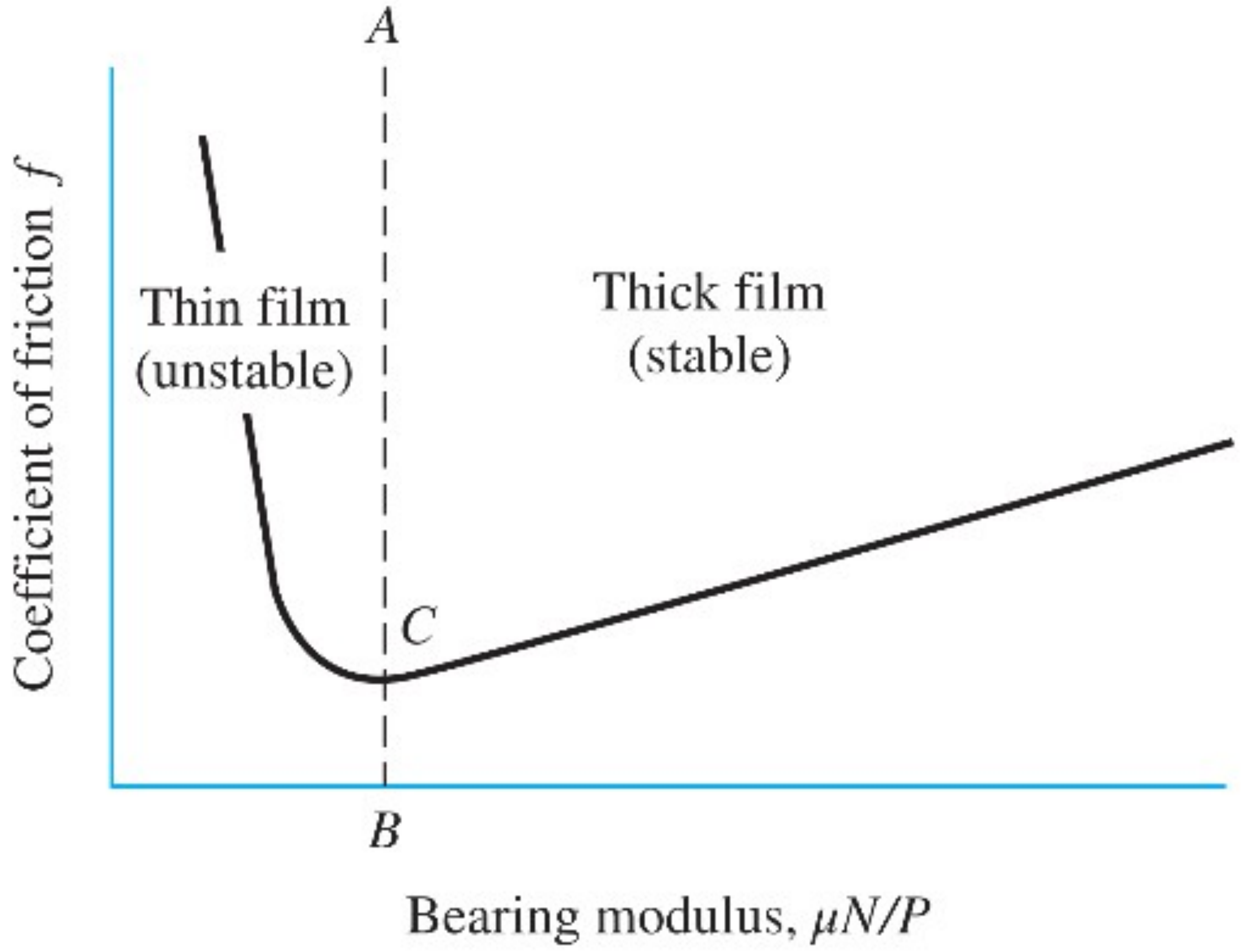
f coefficient of friction

$$f = 2\pi^2 \frac{\mu N}{P} \frac{r}{c}$$

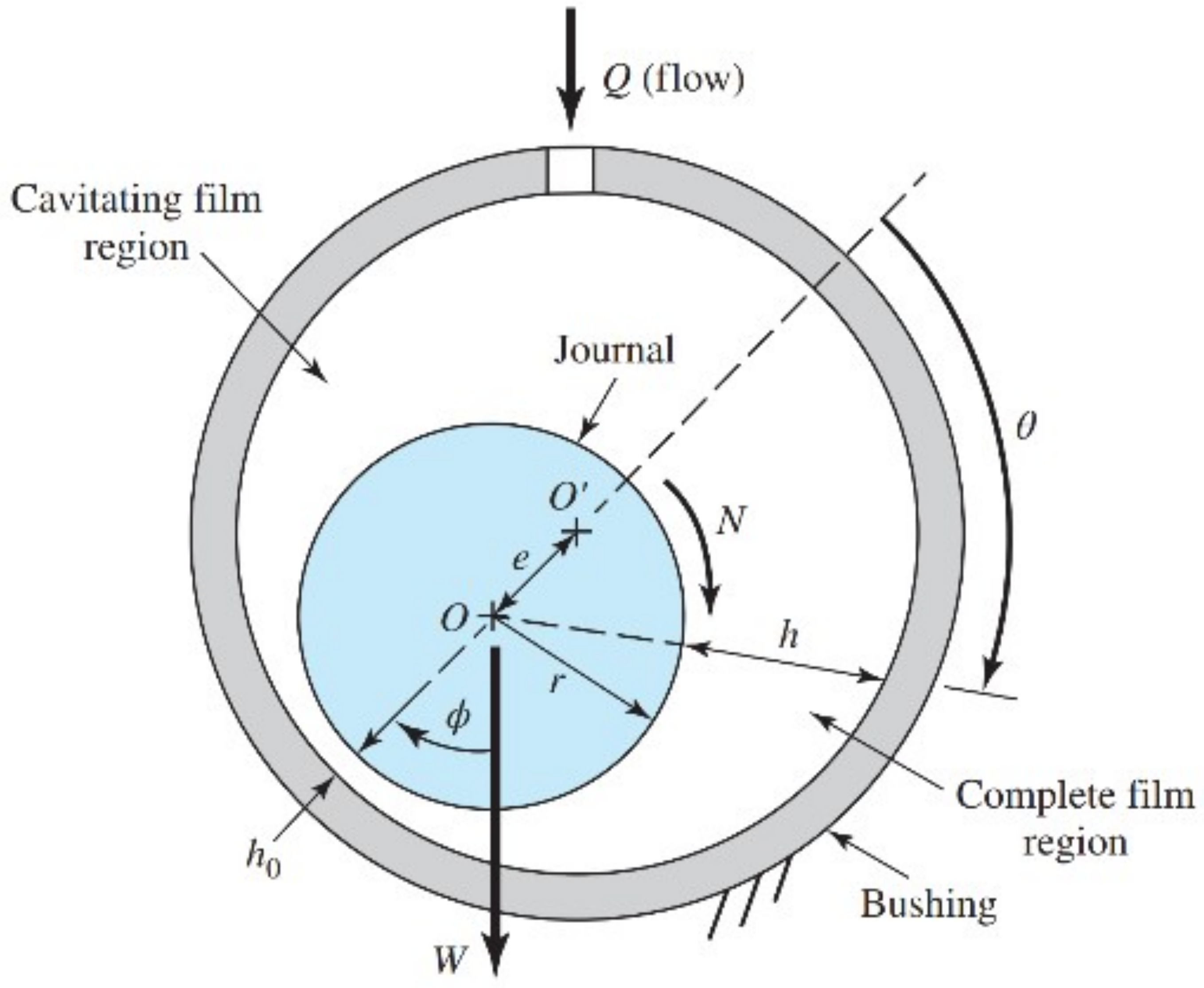
Sommerfeld Number $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$

r/c radial clearance ratio

$$f \frac{r}{c} = 2\pi^2 S$$



$$\frac{\mu N}{P} \geq 1.7\times10^{-6}$$ for thick film



$h = c + e\cos\theta$

$\varepsilon = e/c$ eccentricity ratio

$\varepsilon = 0$ centered

$\varepsilon = 1$ touching

Trumpler Criteria

$h_0 \geq 0.0002 + 0.00004d$ $\quad d$ in inches

$T_{max} \leq 250°F$

$\frac{W_{st}}{lD} \leq 300 psi$ $\quad W_{st}$ stationary load

$n_d \geq 2$

Relations between variables

Fig 12-15 — 12-21

A full journal bearing has a journal diameter of 25 mm, with a unilateral tolerance of −0.03 mm. The bushing bore has a diameter of 25.03 mm and a unilateral tolerance of 0.04 mm. The l/d ratio is 1/2. The load is 1.2 kN and the journal runs at 1100 rev/min. If the average viscosity is 55 mPa · s, find the minimum film thickness, the power loss, and the side flow for the minimum clearance assembly.

$$N = 1100\ \frac{rev}{min}\ \frac{1\ min}{60\ s} = 18.3\ \frac{rev}{s}$$

$$l/d = 1/2$$

$$\mu = 55\ mPa\ s$$

$$c = \frac{25.03 - 25}{2} = 0.015\ mm$$

$$P = \frac{W}{2rl} = \frac{1.2\ kN}{2\left(\frac{25\ mm}{2}\right) 12.5\ mm} = 3.84 \times 10^{-3} \frac{kN}{mm^2} = 3.84 \times 10^{6}\ Pa$$

$$S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$$

$$= \left(\frac{12.5\ mm}{0.015\ mm}\right)^2 \frac{55\ mPa\ s\ 18.3 \frac{rev}{s}}{3.84 \times 10^{6}\ Pa}$$

$$= 182\ \frac{mPa\ rev}{Pa}\ \frac{1\ Pa}{1000\ mPa} = 0.182$$

$$\frac{l}{d} = \frac{1}{2} = \frac{l}{25\ mm} \Rightarrow \frac{25\ mm}{2} = l = 12.5\ mm$$

Fig 12-15 $\quad 0.3 = \frac{h_0}{c} \Rightarrow 0.3c = h_0$

$$0.3 \cdot 0.015\ mm = \boxed{0.0045\ mm}$$

Fig 12-17

$\frac{r}{c} f = 5.25 \Rightarrow f = 5.25 \frac{c}{r} = 5.25 \frac{0.015\ mm}{12.5\ mm} = 0.0063$

$T = fWr = 0.0063 \cdot 1.2 KN \cdot 12.5 mm = 0.0945\ KN\text{-}mm = 0.0945\ N\text{-}m$

$P = TN = 0.0945\ Nm\ 18.3 \frac{rev}{s} \frac{2\pi\ rad}{1\ rev} = 10.9 \frac{Nm}{s} = \boxed{10.9\ W}$

$\frac{1000\ N}{1\ KN} \frac{1\ m}{1000\ mm}$