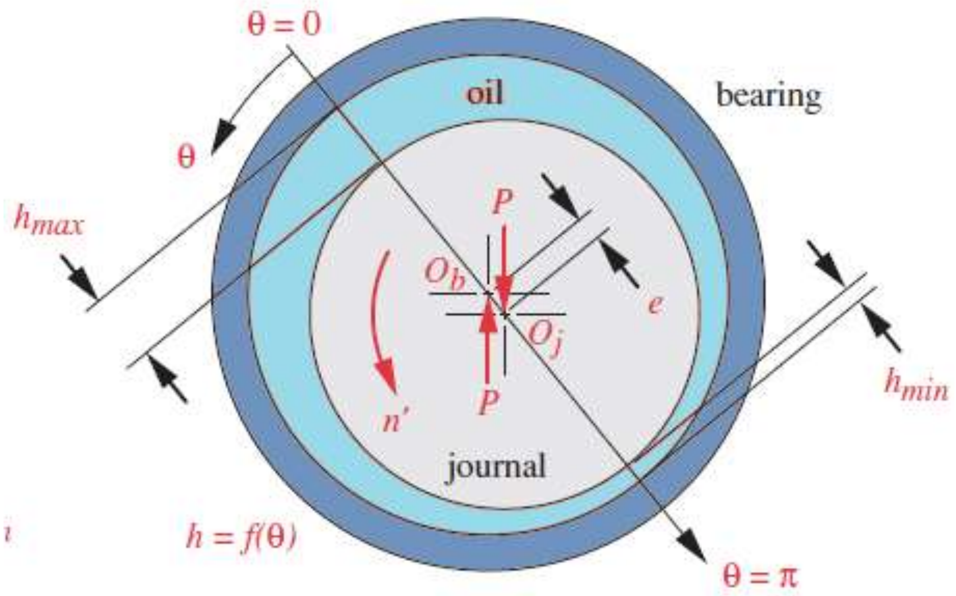
Lecture - 7

Hydrodynamic Lubrication

By

Prof. M. Naushad Alam

MACHINE DESIGN II
MEC 3110



MECHANICAL ENGINEERING DEPT.
A.M.U. ALIGARH

DESIGN CHARTS FOR HYDRODYNAMIC BEARINGS

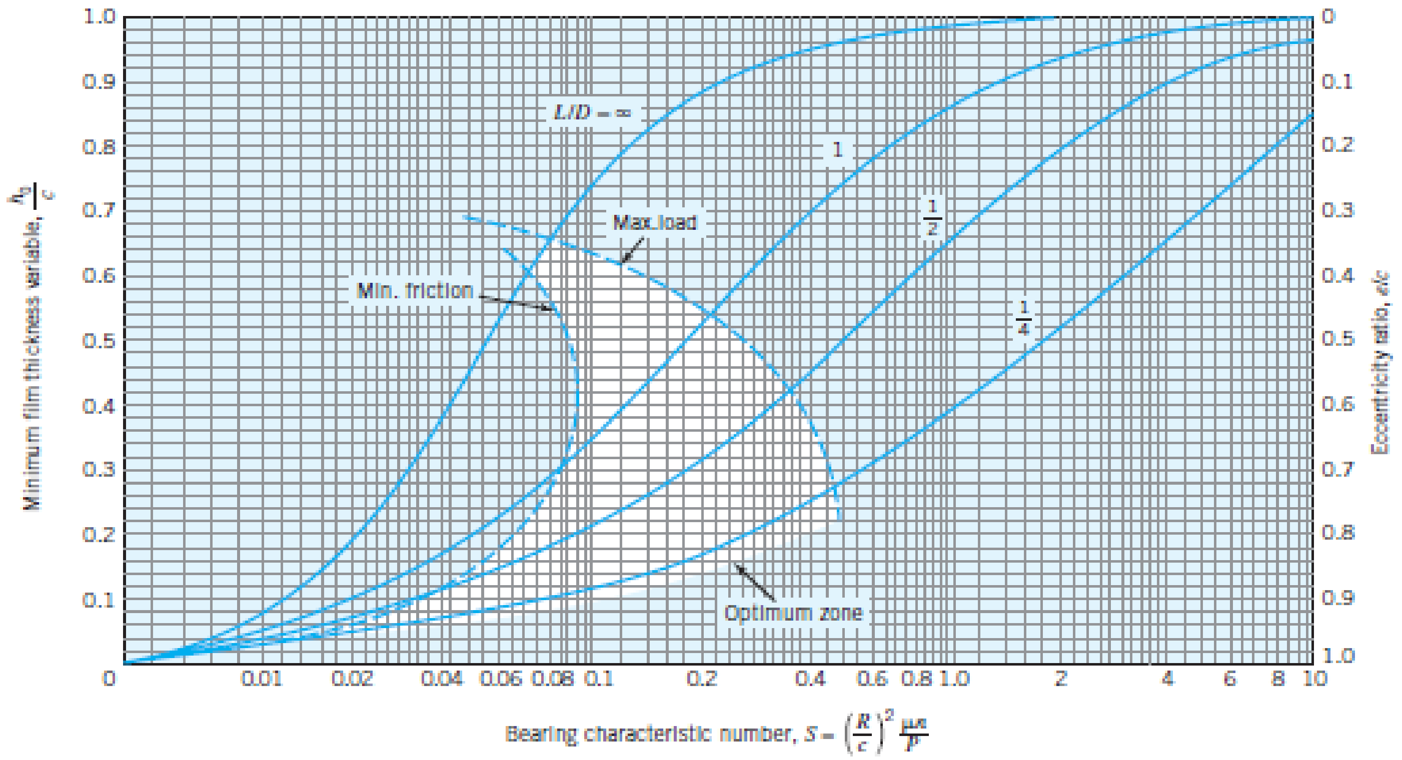
- Raimondi and Boyd charts are **plots of** ***dimensionless bearing parameters*** as functions of *the* ***dimensionless bearing characteristic number***, or Sommerfeld variable, S.
- Raimondi and Boyd charts apply to partial bearings (which extend around only 60°, 120°, or 180° of the journal circumference) and to thrust bearings.

$$\text{Bearing characteristic number, } S = \left(\frac{R}{c}\right)^2 \frac{\mu n}{P}$$

The S scale on the charts is logarithmic except for a linear portion between 0 and 0.01.

Raimondi and Boyd charts

- **Raimondi** and **Boyd** have obtained computerized solutions for ***Reynolds equation***, and reduced them to chart form.
- These charts provide accurate solutions for bearings of all proportions.
- Selected charts are shown in the Figures.



Problem

- A journal of a stationary oil engine is 80 mm in diameter. and 40 mm long. The radial clearance is 0.060mm. It supports a load of 9 kN when the shaft is rotating at 3600 rpm. The bearing is lubricated with SAE 40oil supplied at atmospheric pressure and average operating temperature is about 65oC. Using Raimondi- Boyd charts analyze the bearing **Data:** d = 80 mm; l =40 mm; c = 0.06 mm; F = 9kN;

- **Data Given:**

  n = 3600rpm = 60 rps;

  SAE 40 oil;

  T_o = 65oC;

  Assuming that it is working under steady state condition.

Solution

Analysis:

1. p= F / ld

   = 9 x1000 /40 x 80 = 2.813 MPa

2. μ = 30 cP at 65oC for SAE 40 oil from Fig. 2.3a.

3. $$S=\left(\frac{r}{c}\right)^2\left(\frac{\mu n}{p}\right)$$

$$=\left(\frac{40}{0.06}\right)^2\left(\frac{30\times10^{-3}\times60}{2.813\times10^6}\right)=0.284$$

4. For S = 0.284 and l/d = ½,

$h_o / c = 0.38$

For $\varepsilon = e / c = 0.62$ from Fig.6.

$h_o = 0.38 x c$

$= 0.382 x 0.06$

$= 0.023 mm = 23 \mu m$

$e = 0.62 x c$

$= 0.62 x 0.06 = 0.037$ mm

5. (r /c) f = 7.5,
   for S = 0.284 and l /d = ½ from Fig.2.11a.
   f = 7.5 x (c / r) = 7.5x (0.06/40) = 0.0113

6. Φ = 46o, for S = 0.284 for l /d = ½ from Fig.2.9a.

7. (Q / r c n l) = 4.9, for S = 0.284 for l /d = ½ from Fig.2.12a.
   Q = 4.9 r c n l = 4.9 x 0.04 x 0.00006 x 60 x 0.04
   = 2.82x10-5 m3/s
   = 28.2 cm3 /s

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8. $(Q_s / Q) = 0.75$, for $S = 0.284$ for $l / d = ½$ from Fig.2.13a.

   $Q_s = 0.75\ Q = 0.75 \times 28.2 = 21.2\ cm^3 /s$

9. $(p / p_{max}) = 0.36$, for $S = 0.284$ for $l / d = ½$ from Fig.2.14a.
   $p_{uma} = p /0.36 = 2.813 / 0.36 = 7.8$ MPa

10. $\theta_{pox} = 61.5^o$ and $\theta_{puma} = 17.5^o$, for $S = 0.284$ for $l / d = ½$ from Fig.2.15a.

. **Temp-Viscosity Chart**

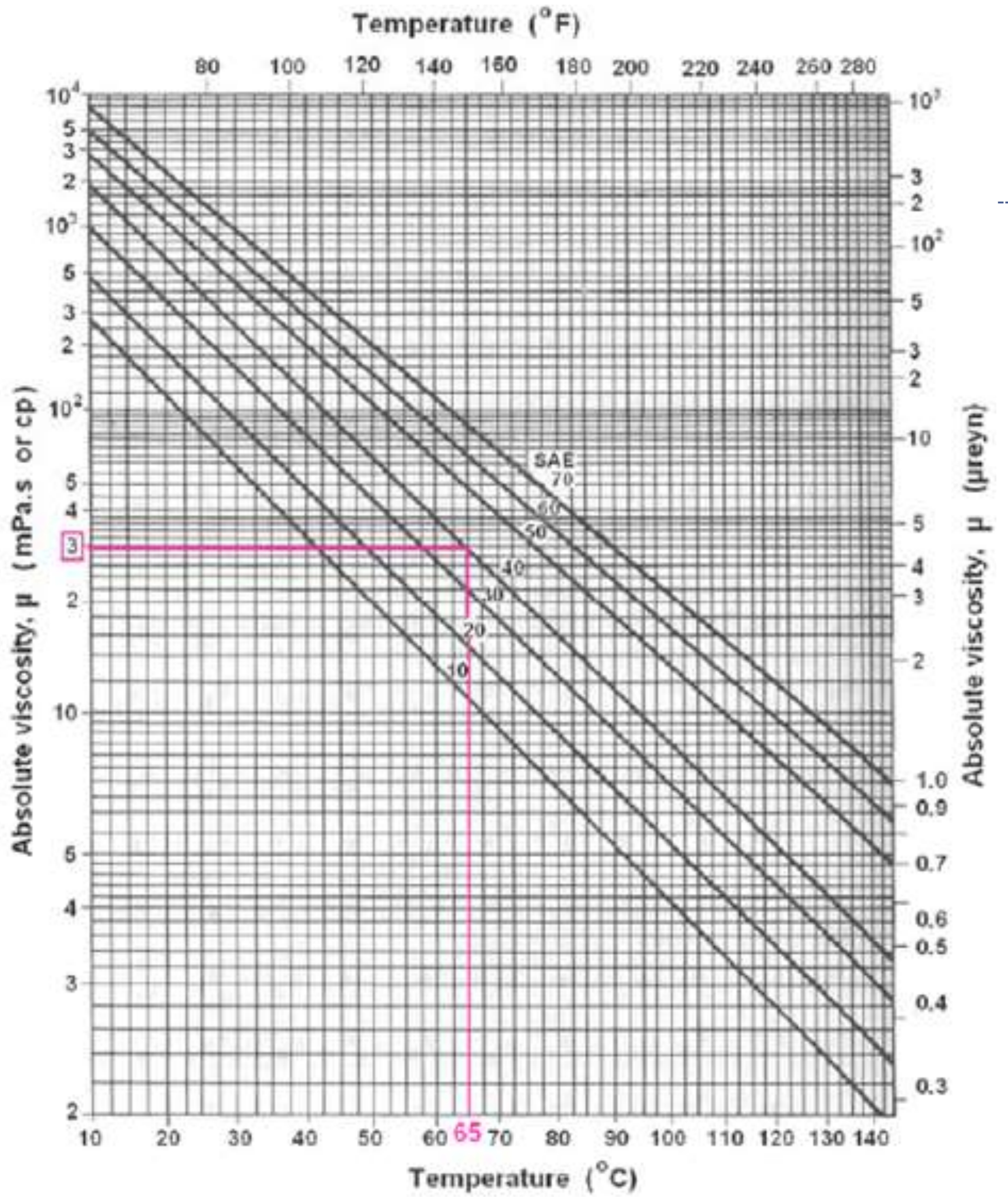

Chart for minimum-film-thickness variable

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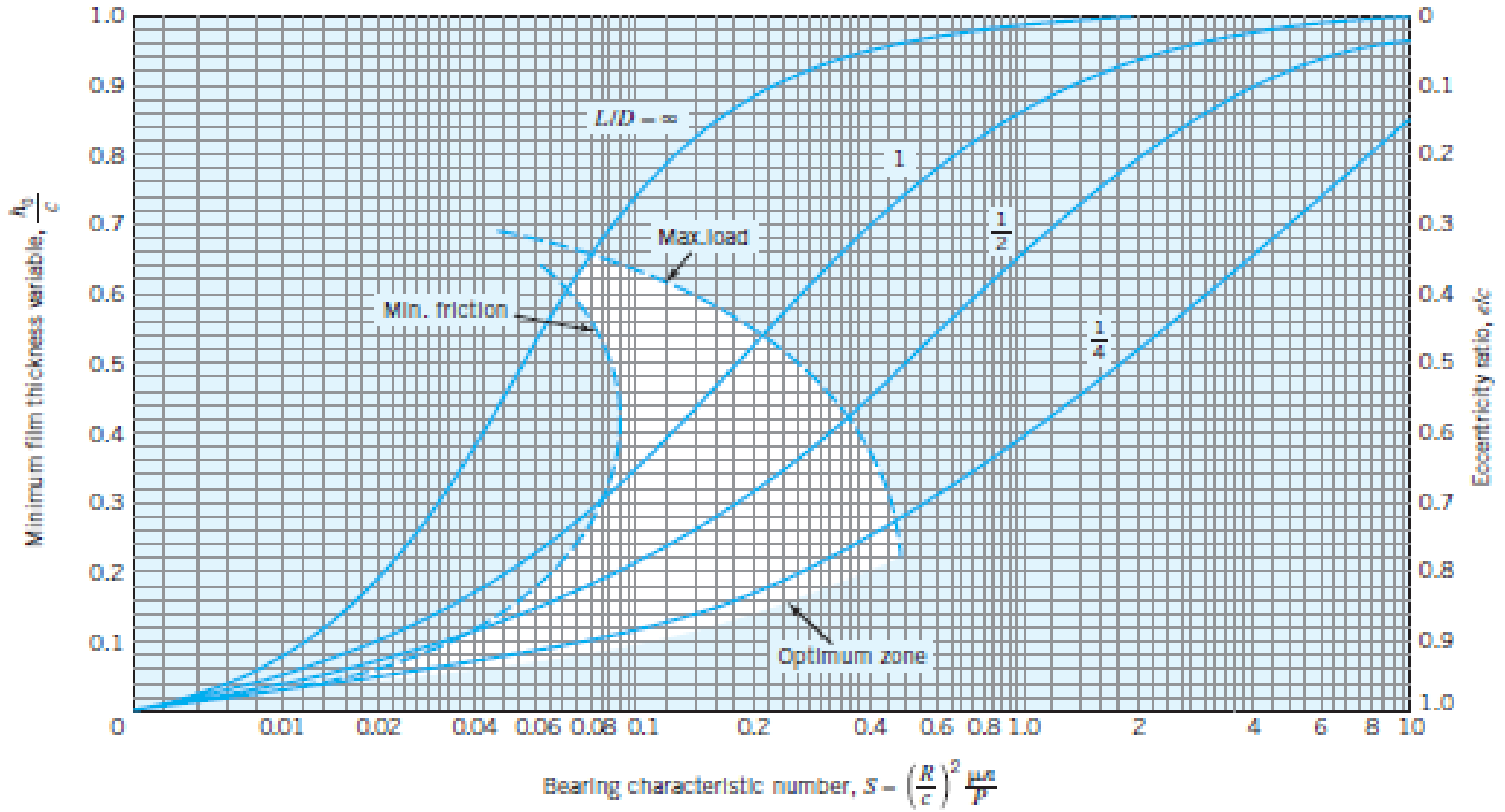


Coefficient of Friction

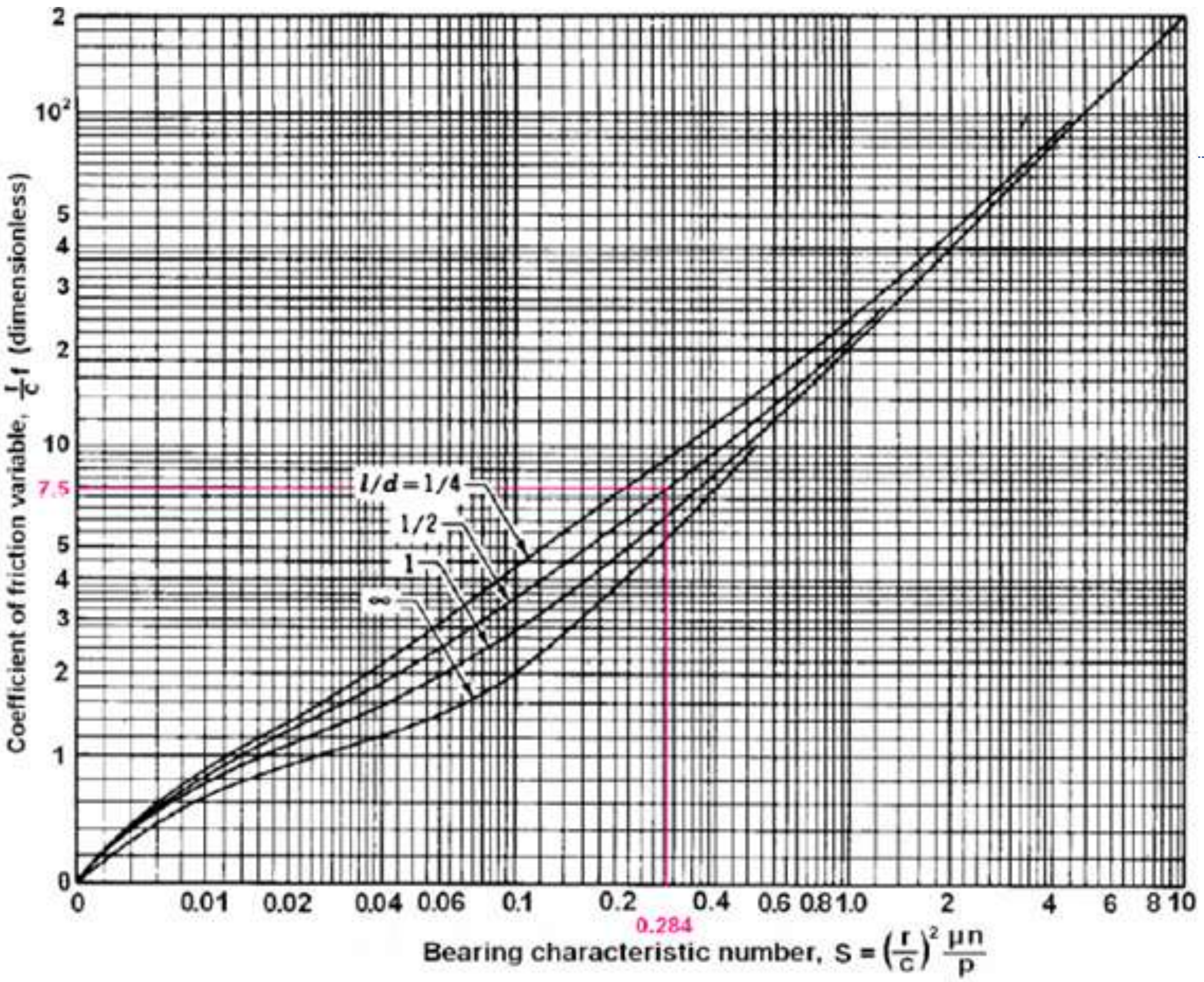


Chart for the position of minimum film thickness *ho*

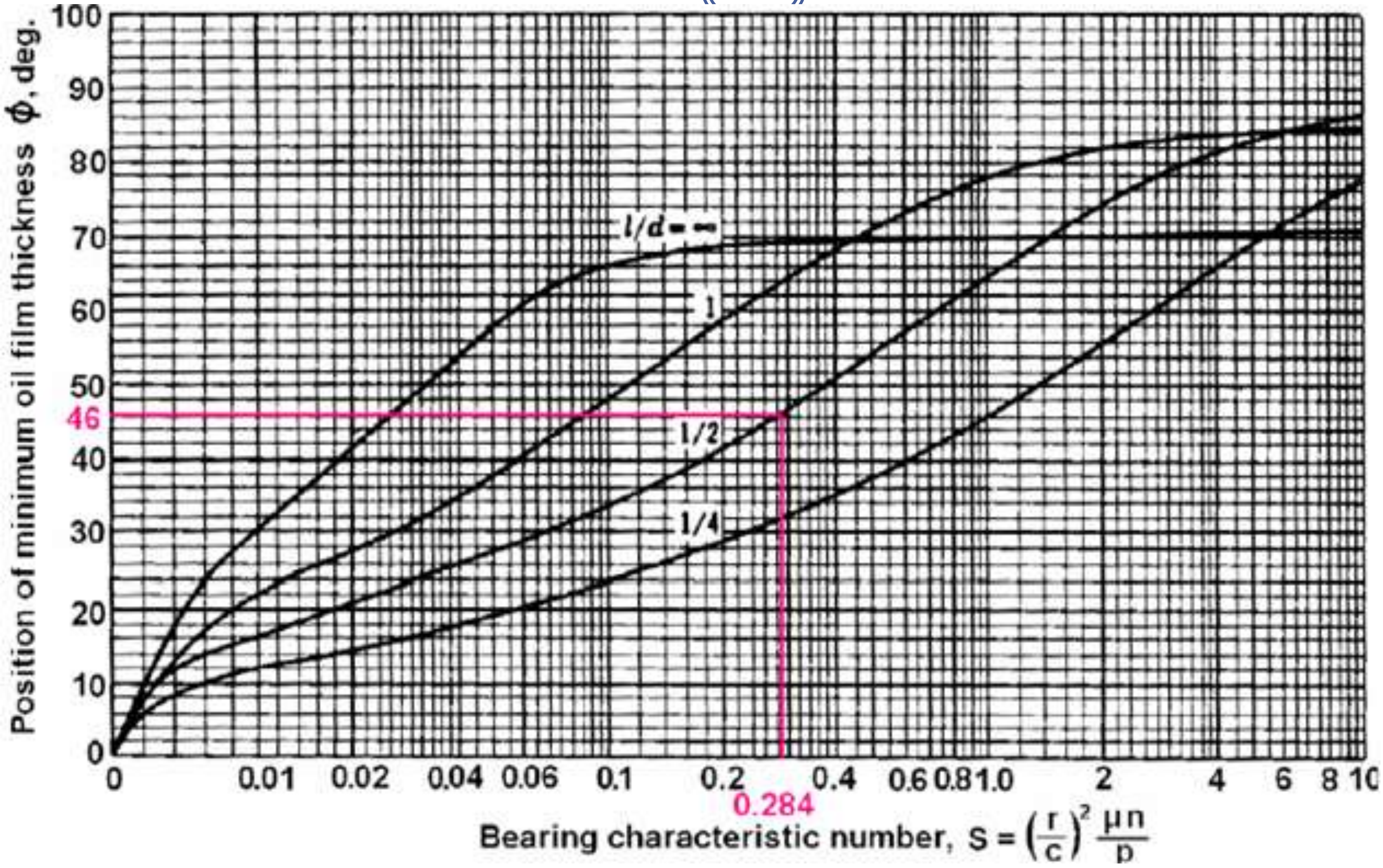


Chart for coefficient-of friction variable

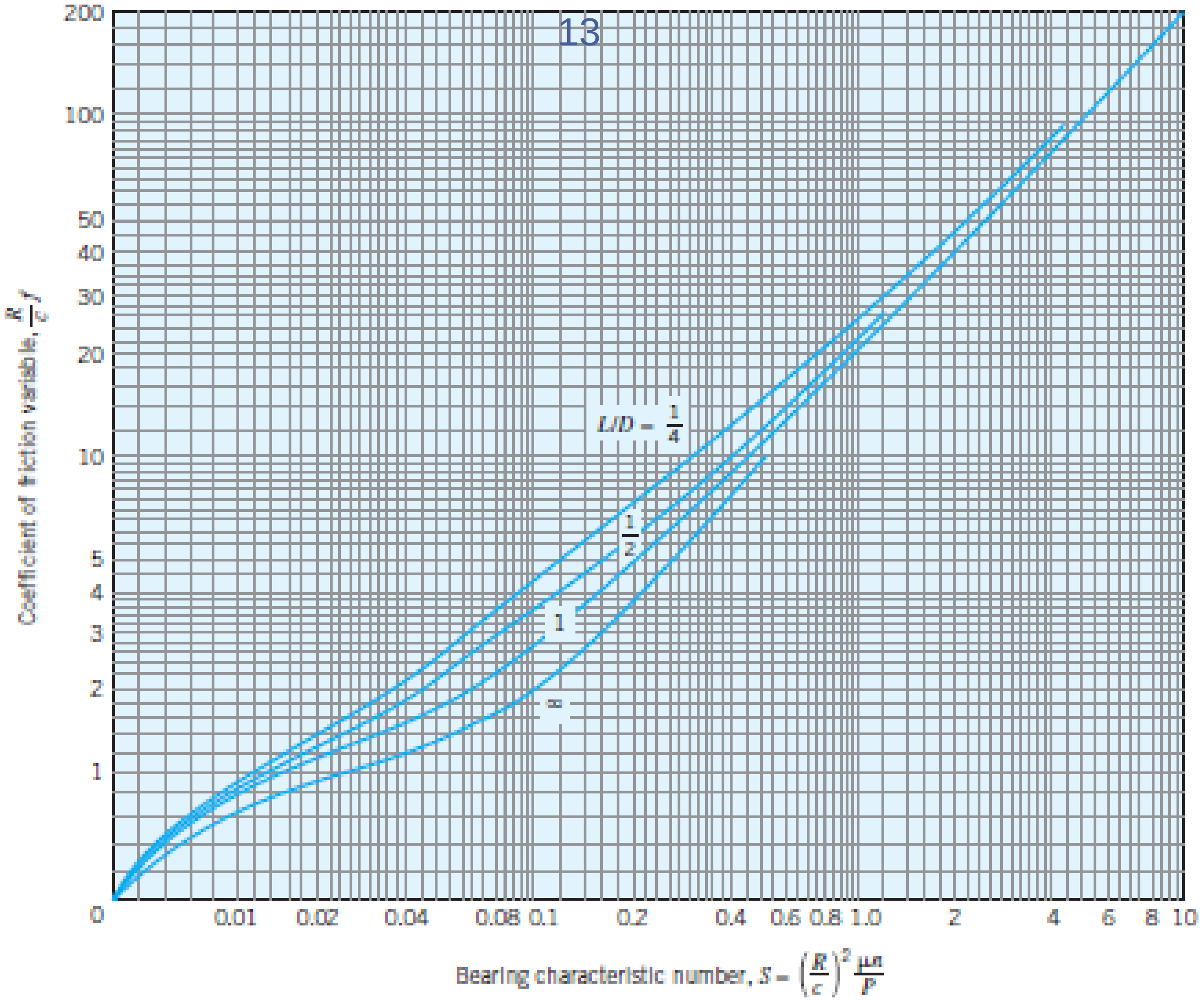


Chart for determining maximum film pressure

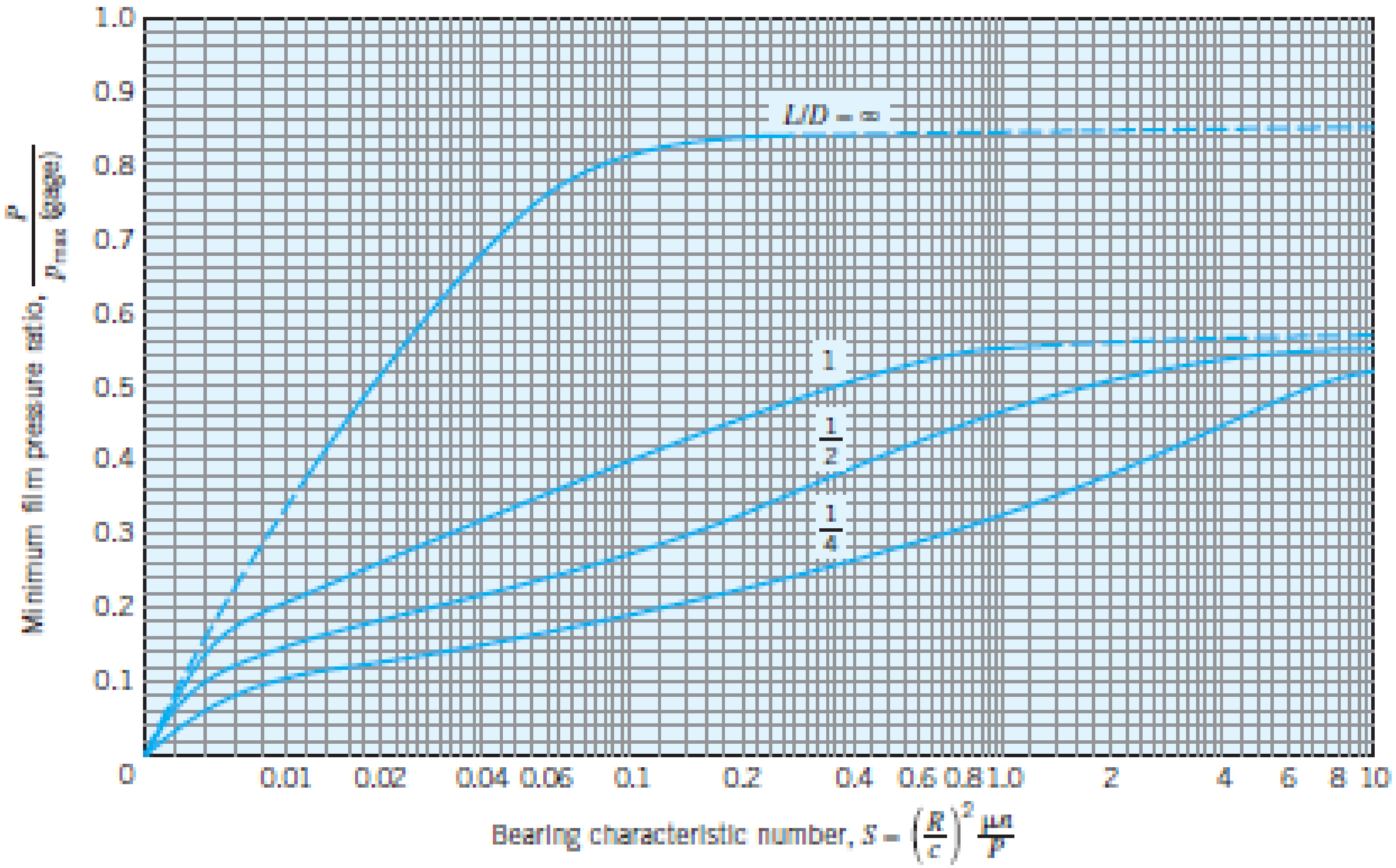


Chart for determining the position of the minimum film thickness *h*0

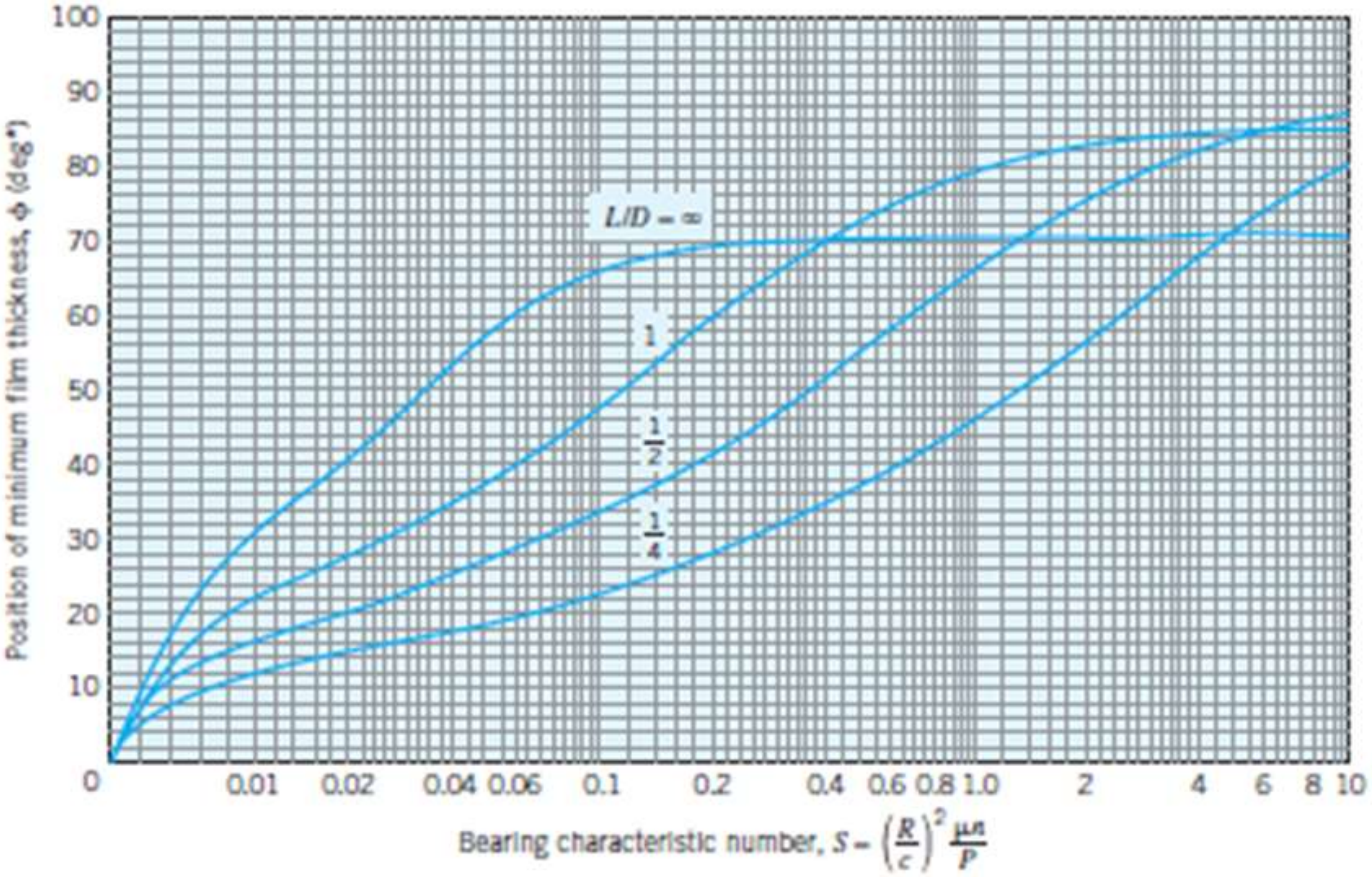


Chart for positions of maximum film pressure and film termination

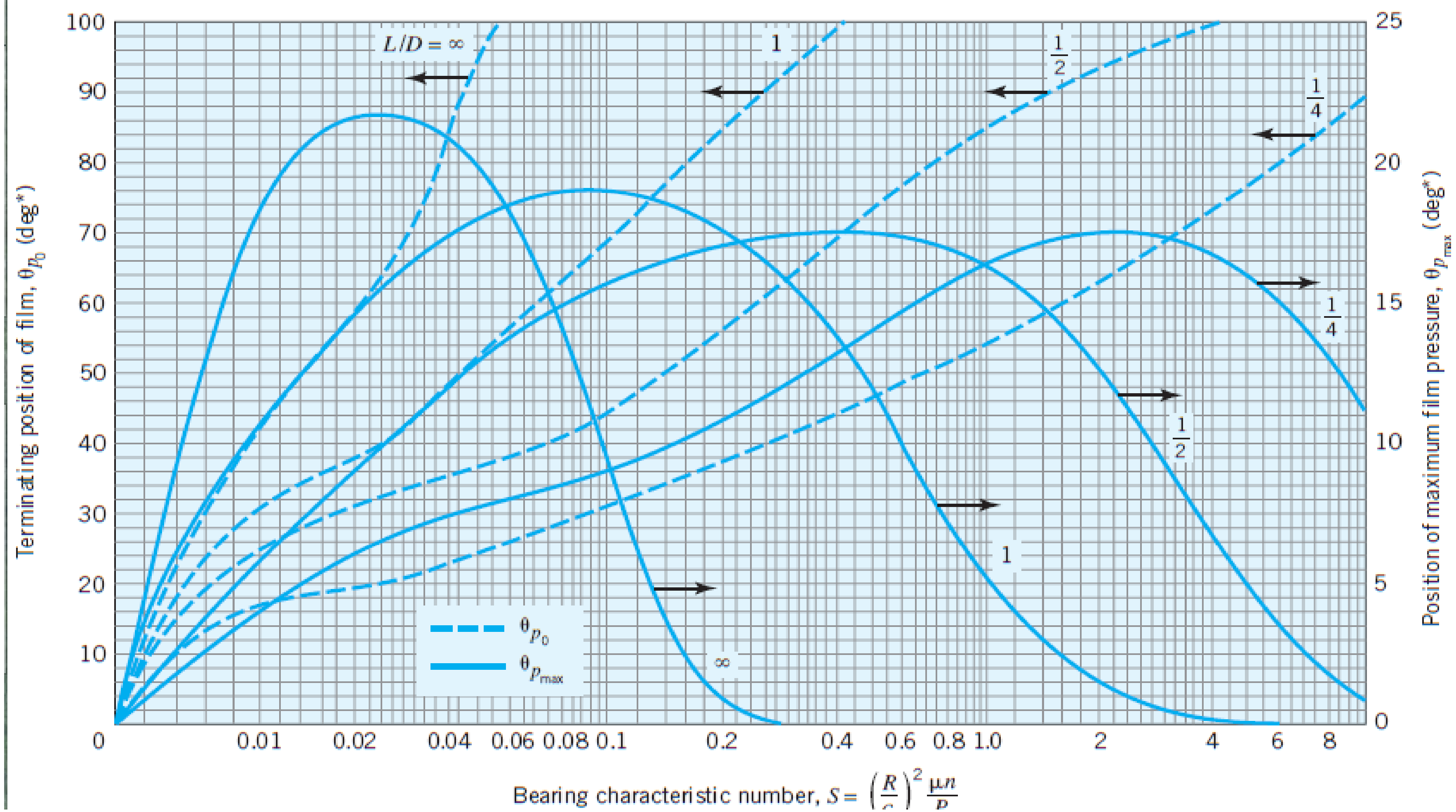


Chart for flow variable

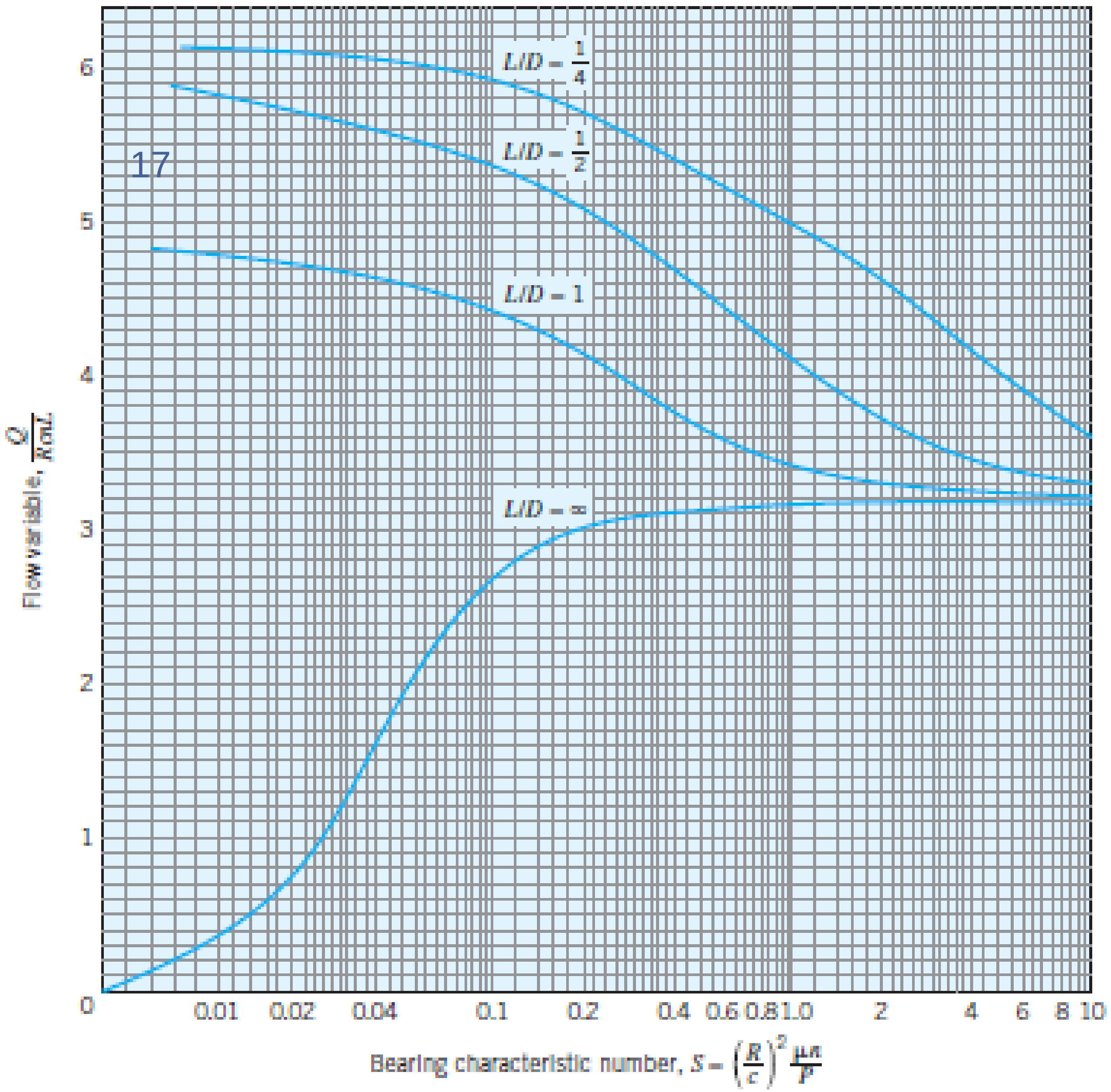


Chart for the ratio of side flow to total flow

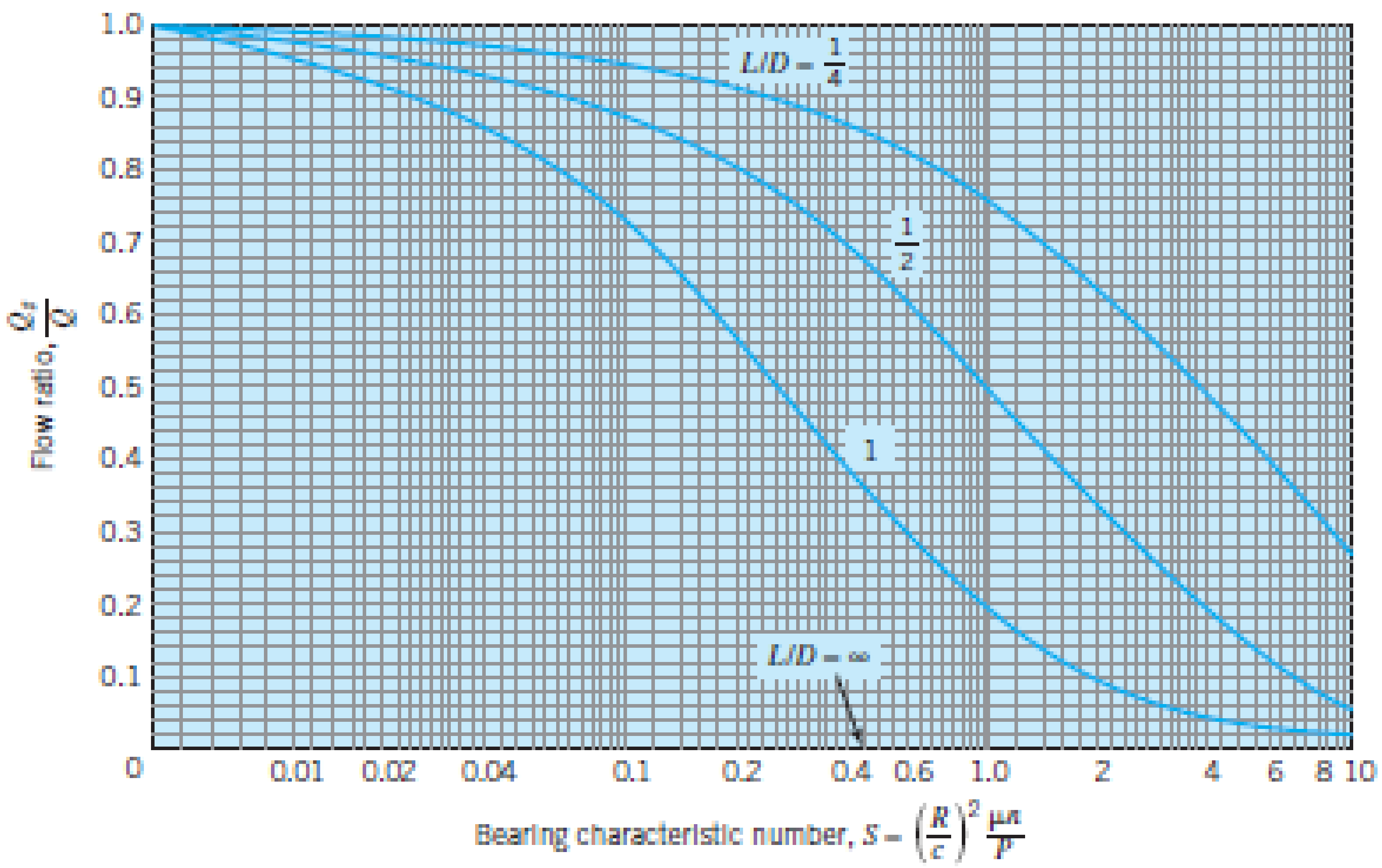
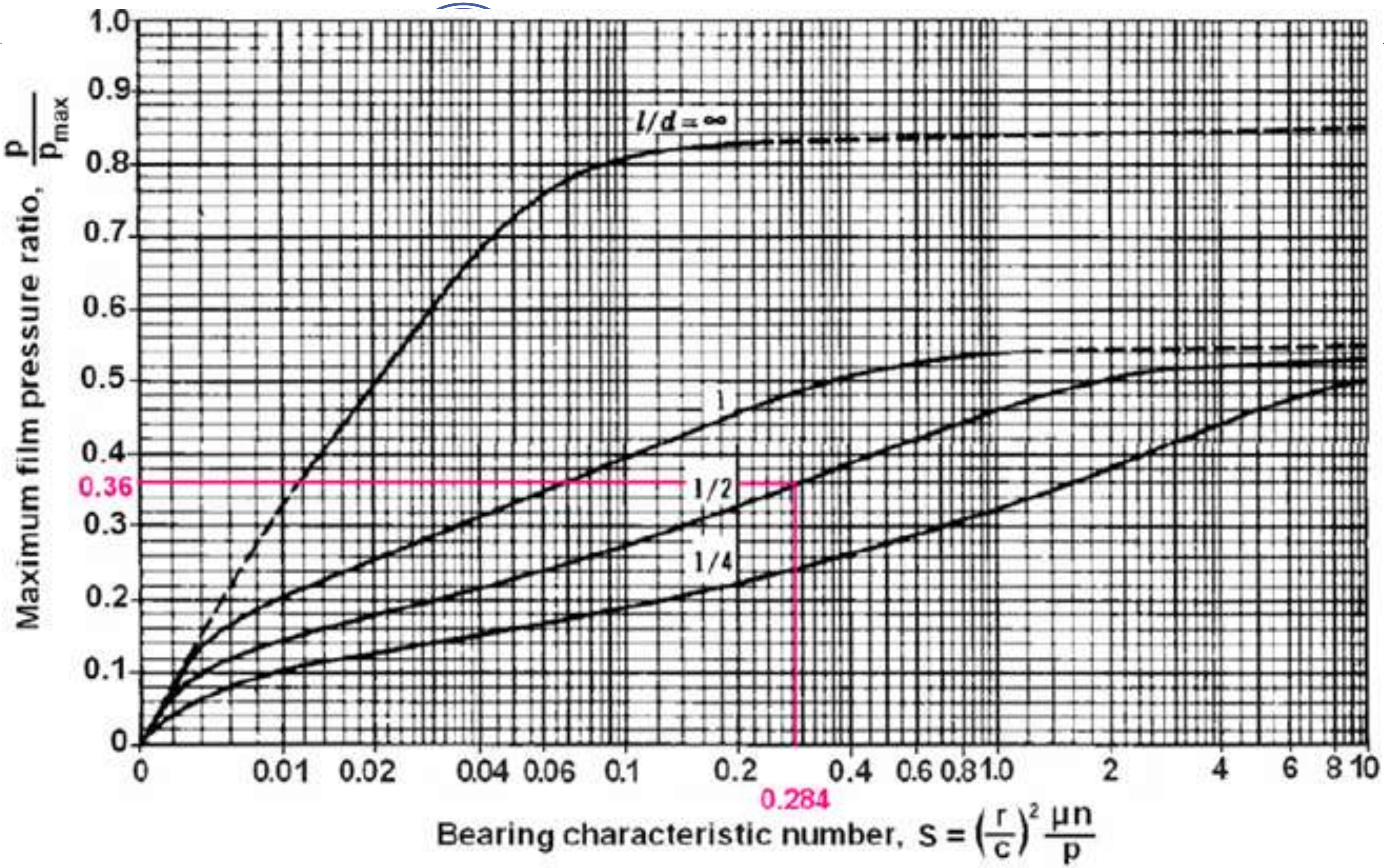
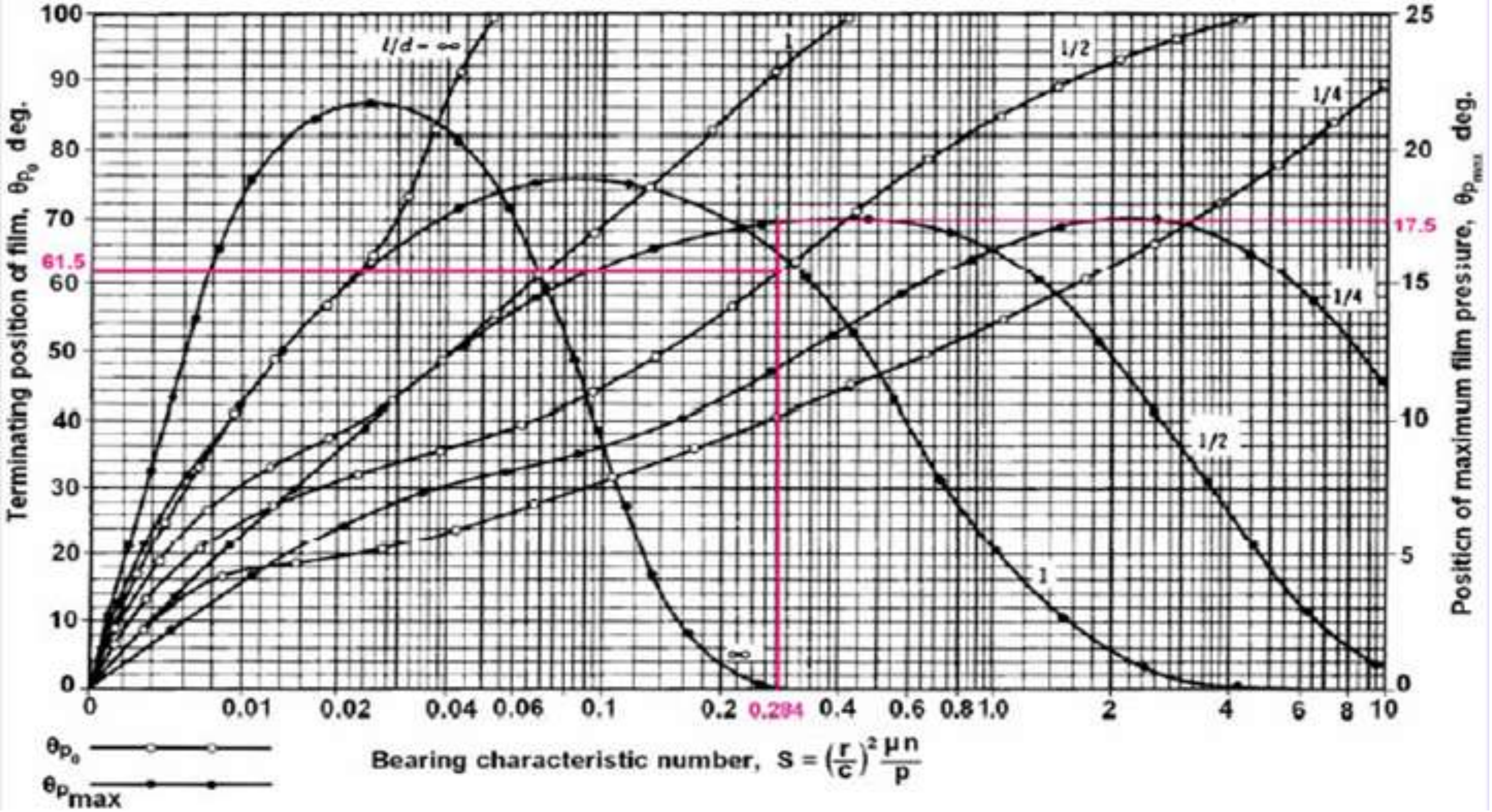


Chart for maximum film pressure

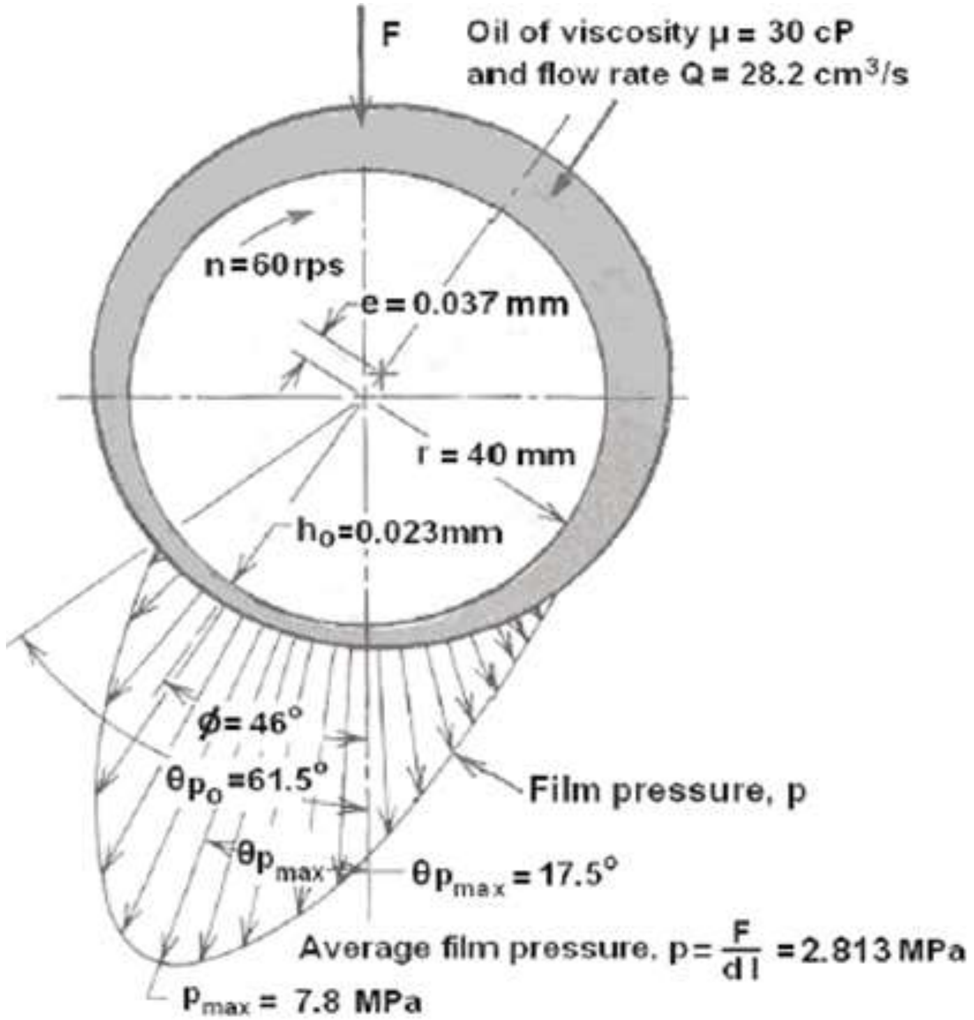


Terminating position of oil film and position of maximum film pressure



- **Fig – 15(a)**

Stable hydrodynamic Lubrication Diagram



- **Fig – 10(a)**

End of Lecture

Any Questions?

INTERACTION IS HIGHLY ENCOURAGED