The University of Tennessee at Martin
MARTIN School of Engineering

Plane Surface Bearings

Lecture 24

Engineering 473
Machine Design

MARTIN

Examples of Plain Surface Bearings

In **plain surface bearings** the shaft moves relative to the stationary bearing surface – there is sliding contact versus rolling contact.

Bronze Bearings

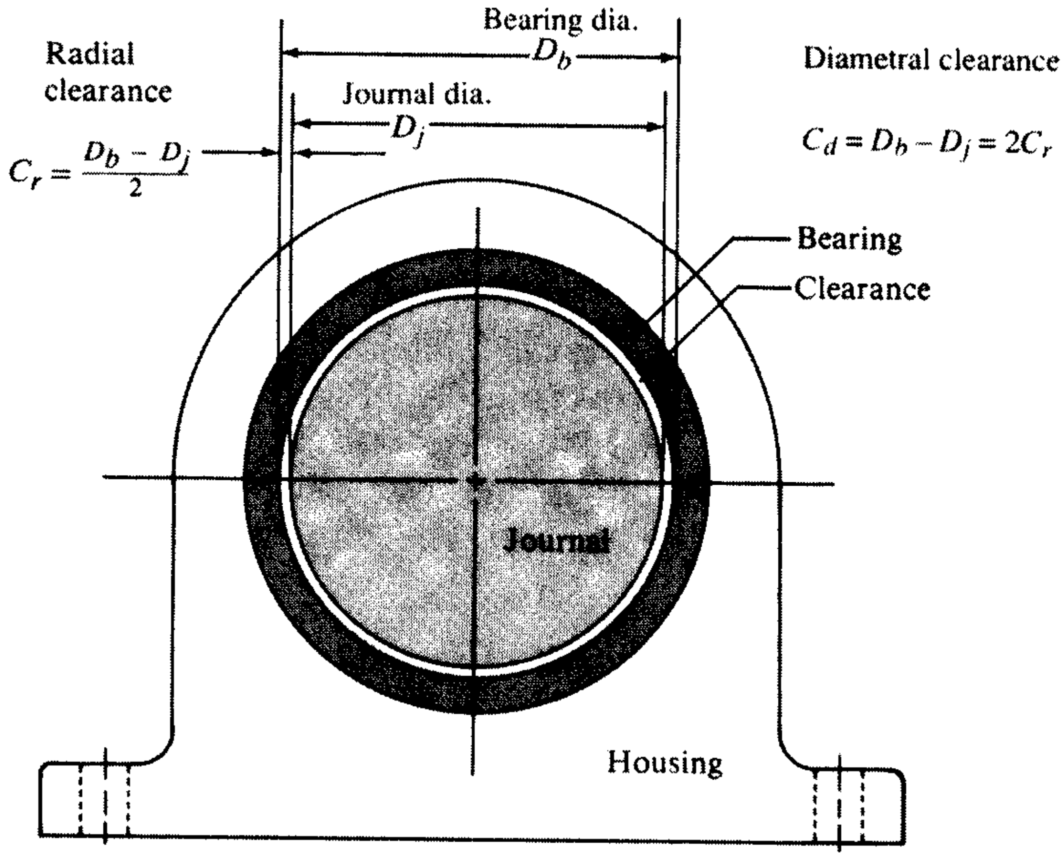
Polymer Bearings

Bronze and Polymer Bearings are two examples of plain surface bearings.

www.igus.com/iglide/iglide.htm

Journal Bearings

Plain Surface Bearings are often called **journal** bearings.



Journal bearings usually employ a lubricating fluid between the bearing and the journal.

Polymer bearings are often self-lubricating and do not employ a lubricant.

Mott, Fig. 16-1

Lubrication Zones

Boundary Lubrication

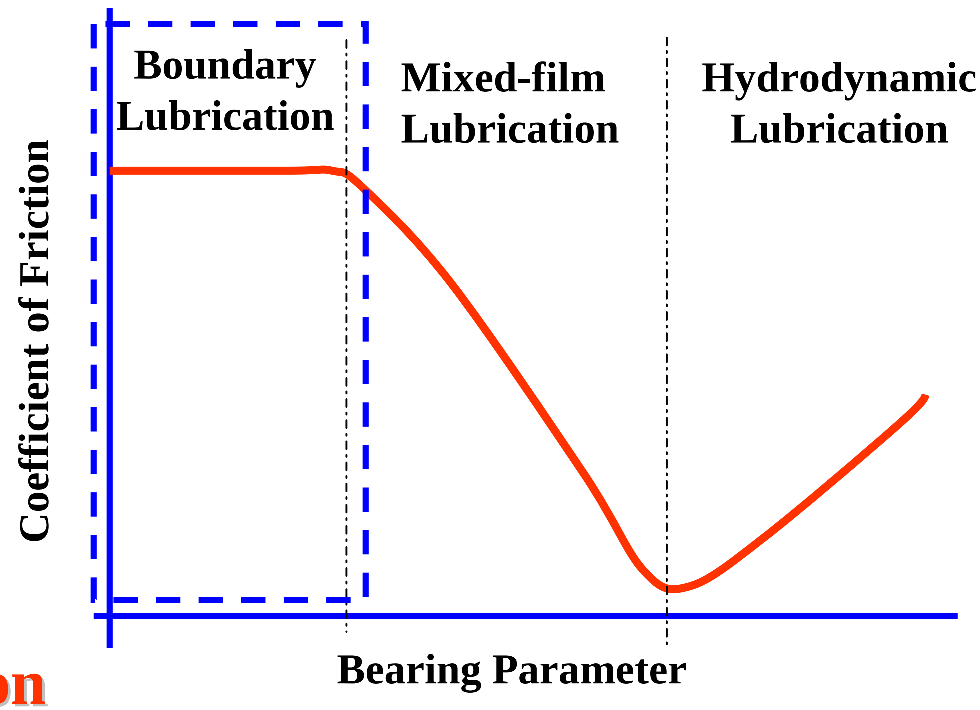
Contact between journal and bearing

Mixed-film Lubrication

Intermittent contact

Hydrodynamic Lubrication

Journal rides on a fluid film. Film is created by the motion of the journal.



$$\text{Bearing Parameter} \equiv \frac{\mu n}{p}$$

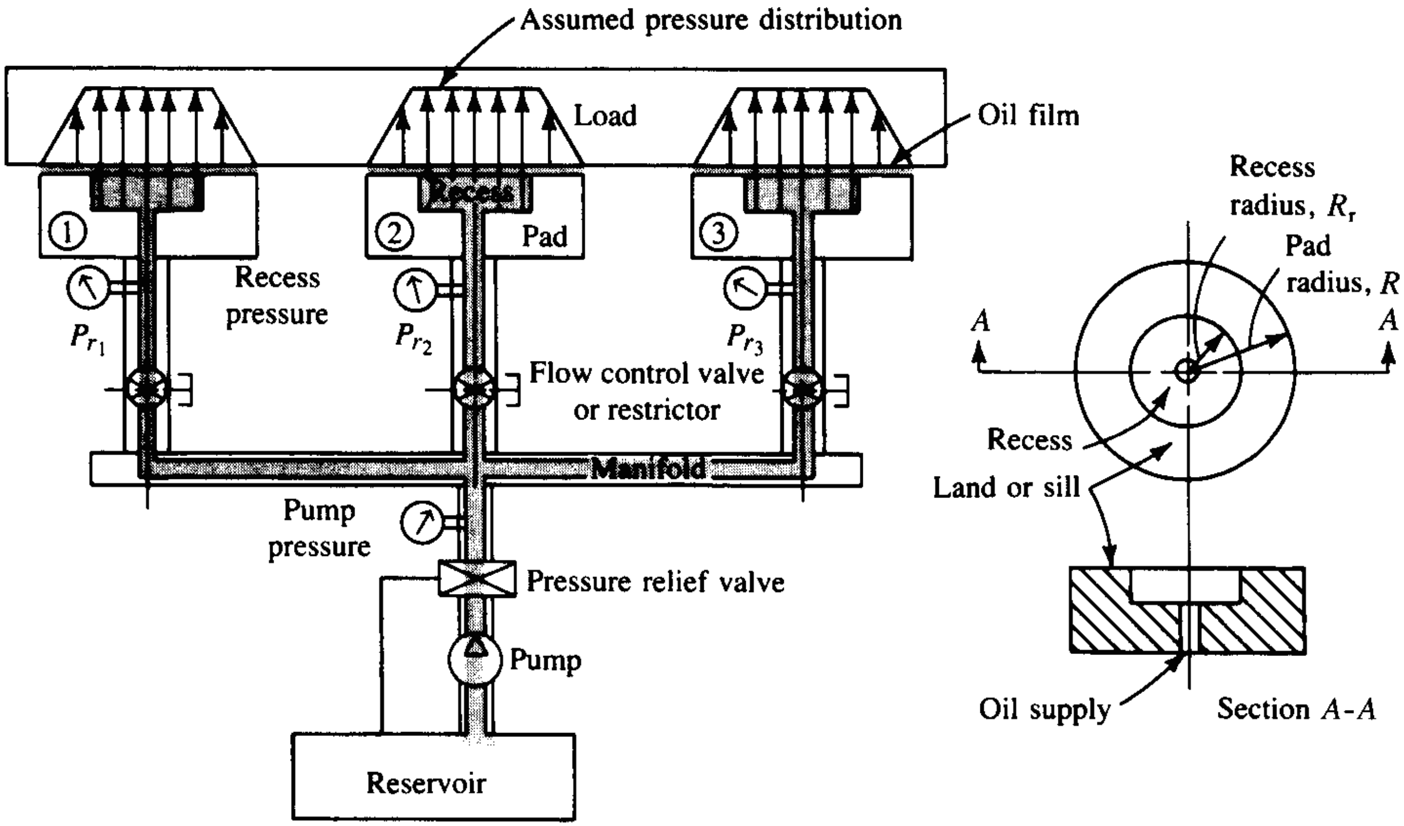
$\mu \equiv$ dynamic viscosity, lb - sec/in^2

$n \equiv$ rotational speed, rev/sec

$p \equiv$ pressure (force/projected area), psi

Hydrostatic Bearings

Pressure is used to lift the journal off of the bearing surface.



(a) Hydrostatic bearing system

(b) Pad geometry

Mott, Fig. 16-9

Boundary Lubrication - Bearing Materials

Bronze – copper with tin, lead, zinc, or
aluminum alloying elements

Babbit – lead or tin with copper and
antimony alloying elements

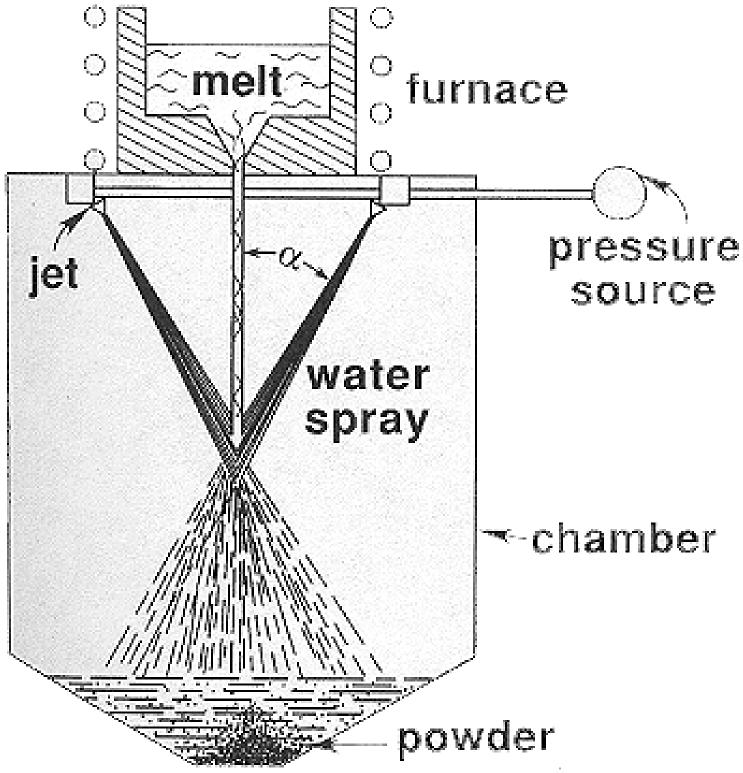
Aluminum

Powdered Metals (Sintered metals)

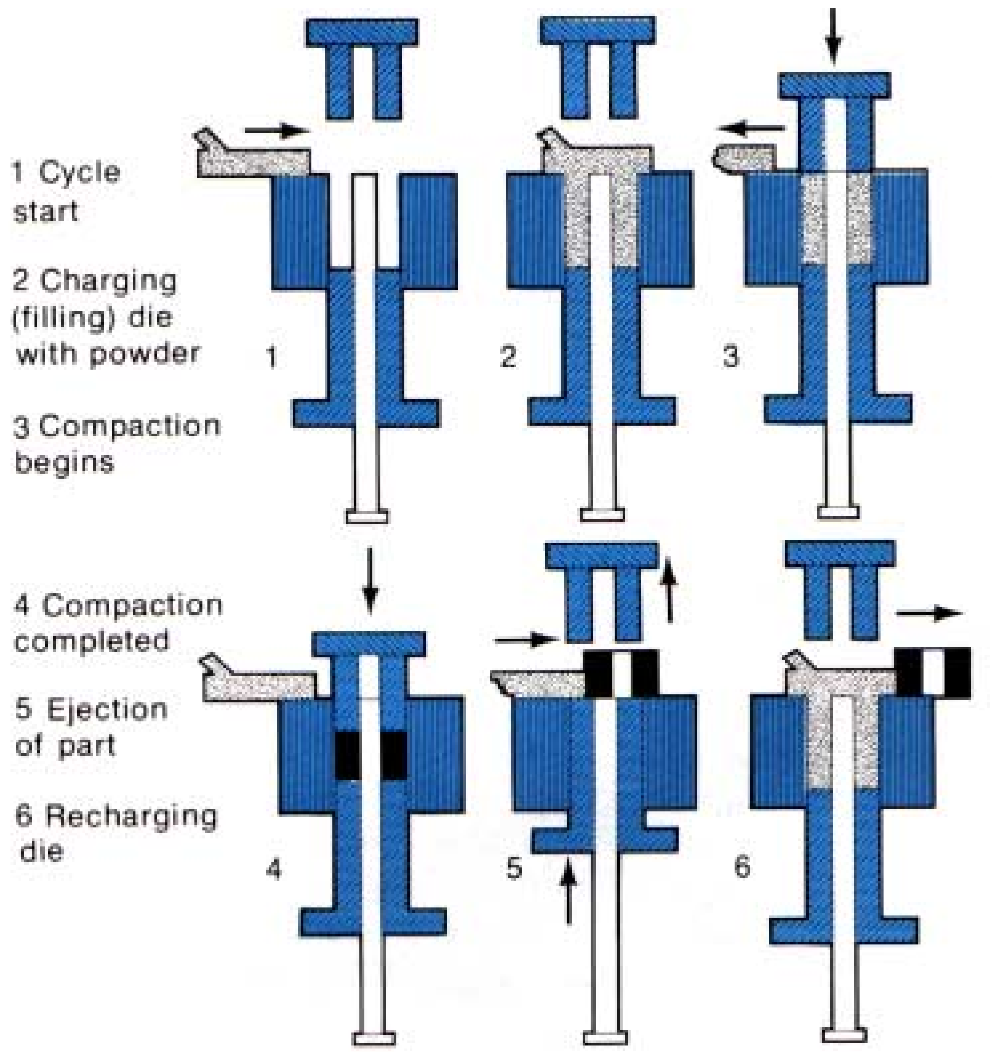
Polymers (plastics)

Manufacture of Powdered Metals

Metal granules are formed by cooling liquid metals in jets of water.

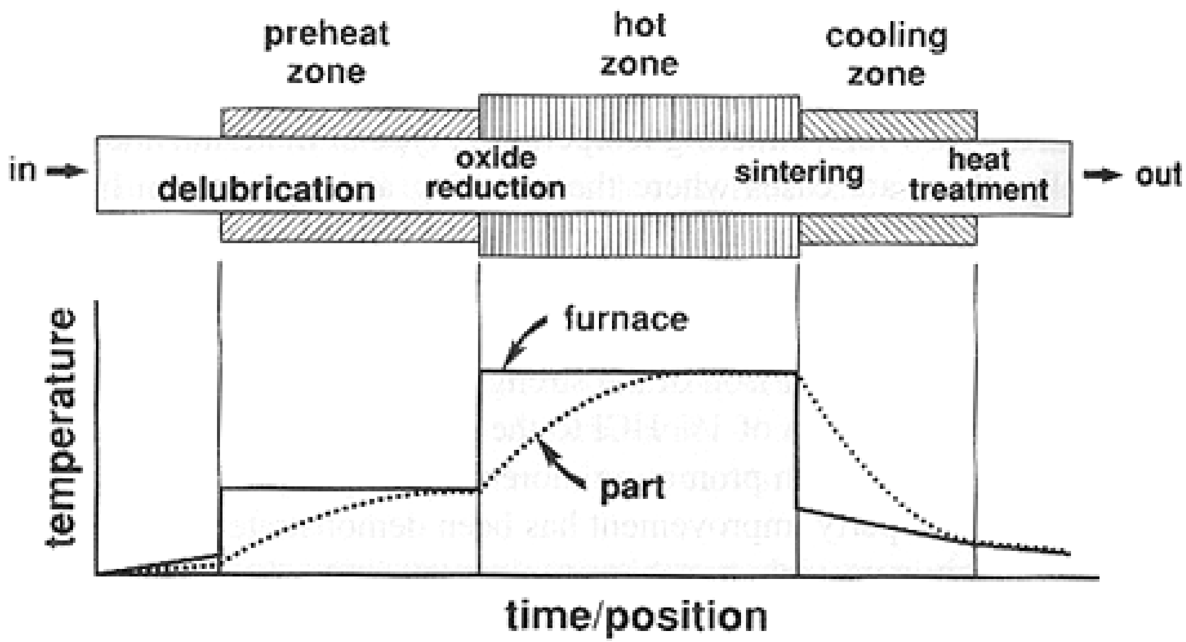


P/M Compaction Cycle



P/M Design Guide, Metal Powder Industries Foundation

P/M Sintering



During the sintering process, metallurgical bounds are made between the particles at a temperature less than the material's melting point.

Volatile liquids are evaporated out during the delubrication stage.

Sintering is normally done in an inert environment to prevent oxidation of the material at the high temperatures.

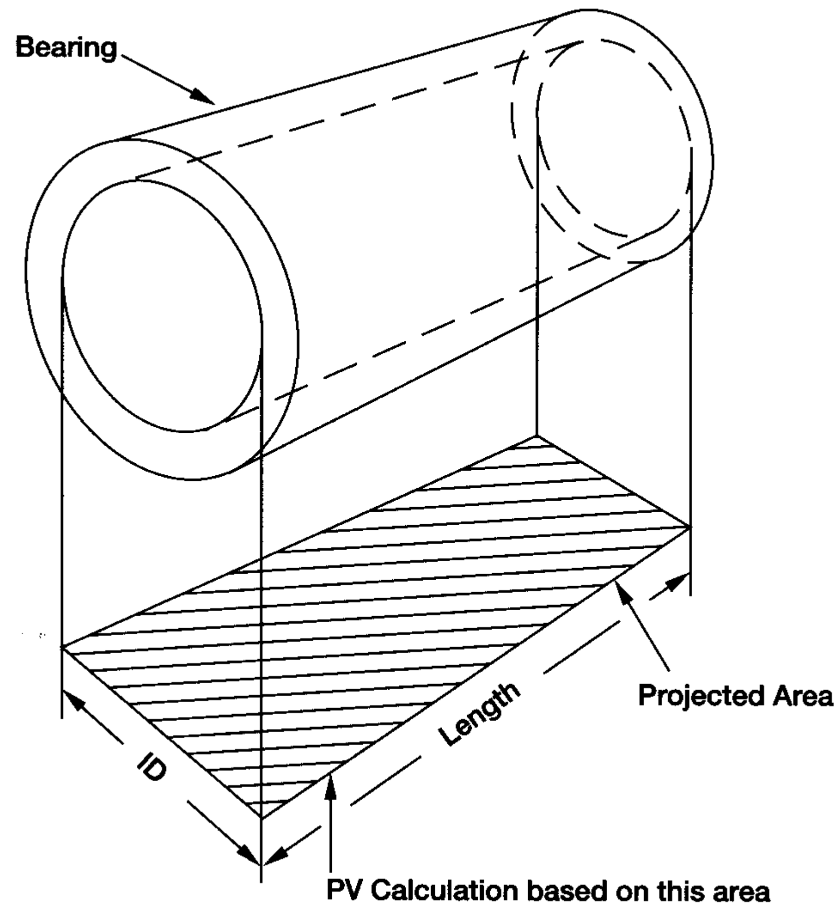
PV Factor
(Used for Boundary Lubrication Design)

$$PV \le (PV)_{all.}$$

$P \equiv$ Force/Projected Area [psi]

$V \equiv$ Journal Surface Speed [ft/min]

PV defines the maximum combination of pressure and speed that a bearing material is capable of withstanding.



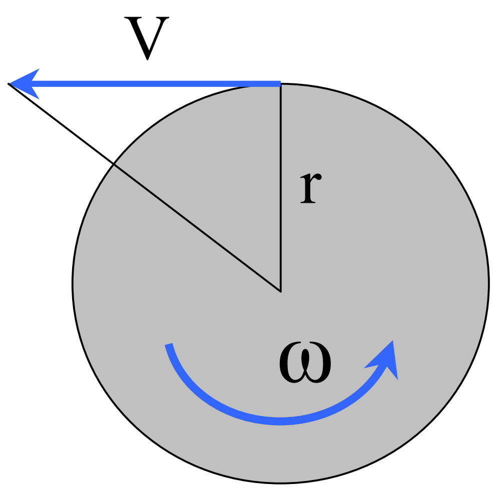
Velocity Calculation

$$V = r\omega = \frac{d\omega}{2}$$

$$\left(\omega\,\frac{\text{rads}}{\text{min}}\right) = \left(n\,\frac{\text{rev}}{\text{min}}\right)\left(\frac{2\cdot\pi\ \text{rads}}{\text{rev}}\right)$$

$$V = \frac{1}{2}(d\ \text{in})\left(\frac{\text{ft}}{12\ \text{in}}\right)\left(n\,\frac{\text{rev}}{\text{min}}\right)\left(\frac{2\cdot\pi\ \text{rads}}{\text{rev}}\right)$$

$$V = \pi\cdot d\cdot n \big/ 12$$



Temperature Adjustments

- PV factors are determined at a specific ambient temperature.

- If an application is at a temperature significantly different than that at which the PV factor was determined, a temperature adjustment factor will be required.

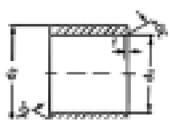
- Consult with the bearing manufacturer to obtain appropriate values for a specific material.

Sample Manufacturer's Data

Iglide Line	Load psi	PV	Friction	Temp. Continuous	Temp. Short Term	Color
M250	2,610	9,800	.18 - .30	-40 to + 240 F	390 F	Charcoal Glossy
Description:	Cost effective, interchange with bronze bearings					
Ideal for:	Low to Medium Loads					
J	5,075	28,600	.05 - .15	-40 to +176 F	248 F	Yellow
Description:	Low wear, low friction material					
Ideal for:	Stainless, Aluminum Shafts					
G300	11,600	28,600	.09 - .18	-40 to +275 F	430 F	Dark Gray
Description:	Medium grade, all-around bearing					
Ideal for:	general bearing applications					
L280	9,425	28,000	.08 - .15	-40 + 275 F	410 F	Yellow
Description:	Low wear, low friction					
Ideal for:	Stainless, Aluminum Shafting					
Q	20,300	42,000	.03 - .12	-40 to + 275 F	518 F	Glossy Black
Description:	High load material					
Ideal for:	Pivot Points					
T500	21,750	100,000	.09 - .18	-149 to + 485 F	600 F	Black
Description:	High load, high temperature, chemical resistant material					
Ideal for:	very demanding applications and demanding environments					

Sample Dimensional Data

Download Instructions



	Nominal Sizes			ID after Pressfit		Housing Bore		Shaft Size		
Part	d1	d2	b1	Max.	Min.	Max.	Min.	Max.	Min.	DXF
GSI-0203-03	1/8	3/16	3/16	.1269	.1251	.1878	.1873	.1243	.1236	DXF
GSI-0203-04	1/8	3/16	1/4	.1269	.1251	.1878	.1873	.1243	.1236	DXF
GSI-0203-06	1/8	3/16	3/8	.1269	.1251	.1878	.1873	.1243	.1236	DXF
GSI-0304-04	3/16	1/4	1/4	.1892	.1873	.2503	.2497	.1865	.1858	DXF
GSI-0304-06	3/16	1/4	3/8	.1892	.1873	.2503	.2497	.1865	.1858	DXF
GSI-0304-08	3/16	1/4	1/2	.1892	.1873	.2503	.2497	.1865	.1858	DXF
GSI-0405-04	1/4	5/16	1/4	.2521	.2498	.3128	.3122	.2490	.2481	DXF
GSI-0405-06	1/4	5/16	3/8	.2521	.2498	.3128	.3122	.2490	.2481	DXF
GSI-0405-08	1/4	5/16	1/2	.2521	.2498	.3128	.3122	.2490	.2481	DXF
GSI-0405-12	1/4	5/16	3/4	.2521	.2498	.3128	.3122	.2490	.2481	DXF
GSI-0506-04	5/16	3/8	1/4	.3148	.3125	.3753	.3747	.3115	.3106	DXF
GSI-0506-06	5/16	3/8	3/8	.3148	.3125	.3753	.3747	.3115	.3106	DXF
GSI-0506-08	5/16	3/8	1/2	.3148	.3125	.3753	.3747	.3115	.3106	DXF
GSI-0506-12	5/16	3/8	3/4	.3148	.3125	.3753	.3747	.3115	.3106	DXF
GSI-0607-04	3/8	15/32	1/4	.3773	.3750	.4691	.4684	.3740	.3731	DXF
GSI-0607-06	3/8	15/32	3/8	.3773	.3750	.4691	.4684	.3740	.3731	DXF

Assignment

Design a plain surface bearing for a radial load of 300 lb on a 1.5 inch diameter shaft rotating at 625 rpm. Use an L/D ratio of approximately 1.0-1.5. Consider both bronze and a polymer material for your design decision. Explain the advantages of the design using one material over the other. You will need to find allowable PV data from manufacturer's data (recommend looking at www.igus.com).

Review information provided by Metal Powder Industries Foundation at www.mpif.org.