Iron: Combine low cost with good bearing qualities, widely used in automotive applications, toys, farm equipment, and machine tools. Powdered-iron is frequently blended with up to 10% copper for improved strength. These materials have a relatively low limiting value of PV (on the V side), but have high oil-volume capacity because of the high porosity. They have good resistance to wear, but should be used with hardened and ground steel shafts.

Leaded Iron: Provide improved speed capability, but are still low-cost bearing materials.

Aluminum: In some applications they provide cooler operation, greater tolerance for misalignment, lower weight and longer oil life than porous bronze or iron. The limiting PV value is 50000, the same as for porous bronze and porous iron.

2.2 Sizing Sintered Bearings

The load-carrying capacity of porous-metal bearings can be measured by a friction/wear criterion, which is a measure of the heat generated by the bearing. It is called the PV factor. The PV factor, as its name implies, is the product of the bearing load, P, expressed in pounds per square inch of projected bearing area, and the surface velocity of the shaft expressed in feet per minute.

If d = inside bearing diameter (in)
l = length of bearing (in)
F = bearing load (lbs)
and N = shaft speed (rpm), then:

$$P = \frac{F}{l d} \quad (\text{lbs/in}^2) \tag{14}$$

$$V = \frac{\pi d N}{12} \quad (\text{ft/min}) \tag{15}$$

and hence,

$$PV = \left(\frac{F}{l\,d}\right)\left(\frac{\pi d N}{12}\right) = \frac{\pi F N}{12\,l} = \frac{0.262\ FN}{l} \tag{16}$$

Most engineering data relating to the PV factor lists an upper limit to the factor; i.e., a value which should not be exceeded for satisfactory bearing operation. The working value of the PV factor, however, is often less than this upper limit, such as in the case where the sliding velocity is not sufficiently high to maintain an adequate lubricating film. In addition, the PV limit is affected by the static load-carrying capacity of the material, which should not be exceeded. The latter is a function of environmental factors, bearing clearances, geometry and the nature of the load (continuous, intermittent or shock loading). Detailed information on these considerations is usually furnished by the metal manufacturer. General guidelines are summarized in **Table 2-1**.

2.3 Clearances

As in all bearings, satisfactory operation of porous-metal bearings require suitable clearances between shaft and housing. While guidelines depend on the materials used and the nature of the application, a representative chart showing recommended bearing clearances for porous-bronze and porous-iron bearings is given in **Figure 2-1**.

We carry a full line of both thick and thin wall bushings. Please consult the tables in this section of the handbook for information on recommended shaft size and bore diameter to be used with various bushing sizes.

Table 2-1 General Guidelines for the PV Factor in Porous-Metal Bearings

Limiting conditions for operation of porous bearings can be expressed as a PV factor. Since P = load, psi; V = surface velocity, fpm; the PV value gives an index of frictional heat generated on a unit area of the bearing surface. A maximum value of 50000 is common for porous bearings. For long-time running with no additional lubrication, 20000 should be a limit in selecting loads for various speeds. For thrust bearings, a maximum PV of 10000 should be used.

Provision to replenish the oil supply is desirable when the PV factor approaches the maximum under continuous operation for extended periods of time, or for high temperatures. For such cases, oil can be applied to the OD or ends of the bearing. From there it is drawn, by capillary action, into the bearing and metered to the shaft. A reservoir of grease next to the bearing also can be helpful.

Material	PV	Static P (psi)	Dynamic P (psi)	V (fpm)
Bronze	50000	8000	2000	1200
Lead-Bronze	60000	3500	800	1500
Copper-Iron	35000	20000	4000	225
Hardenable Copper-Iron	75000	50000	8000	35
Iron	30000	10000	3000	400
Bronze-Iron	35000	10500	2500	800
Lead-Iron	50000	4000	1000	800
Aluminum	50000	4000	2000	1200

Under certain conditions these recommended values can be exceeded but with a sacrifice in service life.

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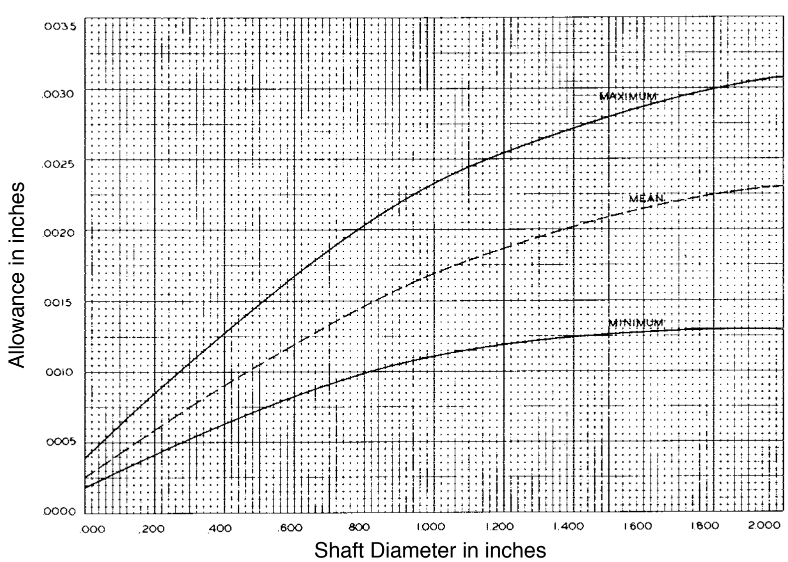

The upper curve (maximum) and all allowances above the mean are suggested for iron-based bearings only. The chart is representative of average conditions, and each application needs to be evaluated individually.

Fig. 2-1 Recommended Bearing Clearances*

*Reprinted with the permission of Keystone Carbon Company, St. Mary's, PA, from Keystone Porous-Bronze and Porous-Iron Bearings, **Fig. B-34**, p. 9.

SINTERED BEARINGS INSTALLATION DATA

Table 2-2 Thin Wall Bearings

Nominal Hole Size		Hole to Accommodate Bearing		Bearing Outside Diameter		Interference	
Fractional	Decimal	Min.	Max.	Min.	Max.	Min.	Max.
3/16	.1875	.1875	.1885	.1895	.1905		
1/4	.2500	.2500	.2510	.2520	.2530		
5/16	.3125	.3125	.3135	.3145	.3155		
3/8	.3750	.3750	.3760	.3770	.3780		
7/16	.4375	.4375	.4385	.4395	.4405	.0010	.0030
1/2	.5000	.5000	.5010	.5020	.5030		
9/16	.5625	.5625	.5635	.5645	.5655		
5/8	.6250	.6250	.6260	.6270	.6280		
11/16	.6875	.6875	.6685	.6890	.6905		
3/4	.7500	.7500	.7510	.7525	.7535		
13/16	.8125	.8125	.8135	.8150	.8160	.0015	.0035
7/8	.8750	.8750	.8760	.8775	.8785		

Nominal Hole Size		Bearing Hole Size After Close - In		Shaft Size		Clearance	
Fractional	Decimal	Min.	Max.	Min.	Max.	Min.	Max.
1/8	.1250	.1250	.1260	.1235	.1245		
3/16	.1875	.1875	.1885	.1860	.1870	.0005	.0025
1/4	.2500	.2500	.2510	.2485	.2495		
5/16	.3125	.3125	.3135	.3105	.3115		
3/8	.3750	.3750	.3760	.3730	.3740		
7/16	.4375	.4375	.4385	.4355	.4365		
1/2	.5000	.5000	.5010	.4980	.4990	.0010	.0030
9/16	.5625	.5625	.5635	.5605	.5615		
5/8	.6250	.6250	.6260	.6230	.6240		

Table 2-3 Thick Wall Bearings

Nominal Hole Size		Hole to Accommodate Bearing		Bearing Outside Diameter		Interference	
Fractional	Decimal	Min.	Max.	Min.	Max.	Min.	Max.
1/4	.2500	.249	.250	.251	.252		
5/16	.3125	.311	.312	.313	.314	.001	.003
3/8	.3750	.374	.375	.376	.377		

Nominal Hole Size		Bearing Hole Size After Close - In		Shaft Size		Clearance	
Fractional	Decimal	Min.	Max.	Min.	Max.	Min.	Max.
1/8	.1250	.1245	.1255	.1230	.1240		
3/16	.1375	.1875	.1885	.1860	.1870	.0005	.0025
1/4	.2500	.2500	.2510	.2485	.2495		