For New Technology Network

NTN®

NTNcorporation

BEARPHITE
Oil-impregnated Sintered Bearings
BEARPHITE 含油轴承

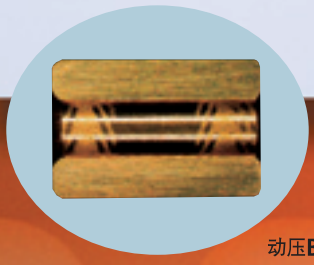
CAT. No. 5202-Ⅵ／CE

NTN has employed its unique technology to develop the NTN BEARPHITE series of innovative products. BEARPHITE bearings were designed to accommodate increasingly stringent market needs.

Developed by NTN Powder Metal Corporation with NTN's propriety technology and experience in rolling bearing manufacturing, NTN's BEARPHITE bearings are renowned for their outstanding quality and many advantages.
NTN's line of BEARPHITE bearings has been employed in a wide variety of applications including household appliances, audiovisual equipment, office equipment and automotive electrical equipment. The outstanding quality of BEARPHITE bearings will continue to expand the scope of their application.
NTN's Hydrodynamic BEARPHITE bearings are fluid hydrodynamic bearings made from sintered material. Their sliding bore surface incorporates herringbone-shaped hydrodynamic grooves. These grooves demonstrate a hydrodynamic effect that contributes to higher running accuracy at high speeds.

为满足时代的需要，通过独特的技术开发的「NTN BEARPHITE」

NTN BEARPHITE是NTN特殊合金株式会社运用滚动轴承制造技术和经验所开发具有众多优秀品质和特长的轴承。
NTN BEARPHITE含油轴承活跃在家电产品、音响影像设备、公室机器、汽车电气装备品等广泛领域，我们坚信其优秀的质量可充分满足各种特殊的要求。
NTN动压BEARPHITE通过烧结材料创出了流体动压轴承。鲱骨型动压槽处于轴承摺动面上，通过动压效果实现了高速时的高旋转精度。



动压BEARPHITE轴承

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1 Features of NTN BEARPHITE and Hydrodynamic BEARPHITE Bearings

NTN **BEARPHITE**以及动压**BEARPHITE**的特长

1-1 Features of NTN BEARPHTE

(1) **NTN** BEARPHITE Bearings incorporate a unique material comprising a metal combined with a fine powder of quality natural graphite. This composition contributes to excellent bearing performance across a wide variety of applications.
(2) **NTN** BEARPHITE oil-impregnated bearings are manufactured from sintered metal which has a porous metal structure. As a result, these bearings retain lubricant efficiently, helping to keep the bearing continuously lubricated.
(3) Thanks to their stable lubrication function, **NTN** BEARPHITE Bearings provide a longer life and excellent performance across a wide temperature range.

1-1 NTN **BEARPHITE**的特长

(1) NTN **BEARPHITE**采用混合了天然优质石墨微粉末的金属，这独特的材质具有优异的轴承性能，适用于不同的场所。

(2) NTN **BEARPHITE**属于烧结金属，因此具有多孔质金属组织，在作为含油轴承所必需的润滑油保持力和循环功能等方面表现十分出色。

(3) NTN **BEARPHITE**润滑特性稳定，轴承寿命长，从低温到高温均能发挥卓越的轴承性能。

Copper series spherical bearing before solution
铜类球型轴承

NTN BEARPHITE graphite skeleton
上图轴承溶解后的石墨骨架

1-2 Features of hydrodynamic BEARPHTE bearings

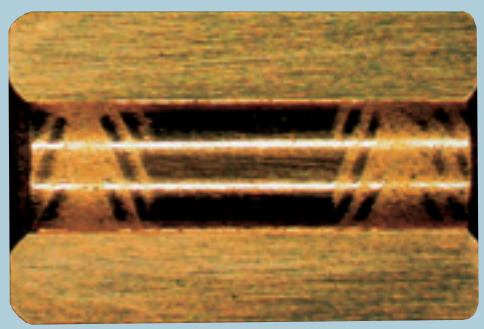
(1) The herringbone-shaped hydrodynamic grooves located on the bearing bore greatly improve bearing rigidity and promote the formation of an oil film.
(2) The hydrodynamic bearing design incorporating sintered metal helps reduce the cost of hydrodynamic BEARPHITE bearings.
(3) The performance of **NTN** hydrodynamic BEARPHITE Bearings is equivalent to or better than that of fluid Hydrodynamic bearings.

1-2 动压**BEARPHITE**的特长

(1) 采用了鲱骨型动压槽，大幅度提高了油膜形成能力和刚性。

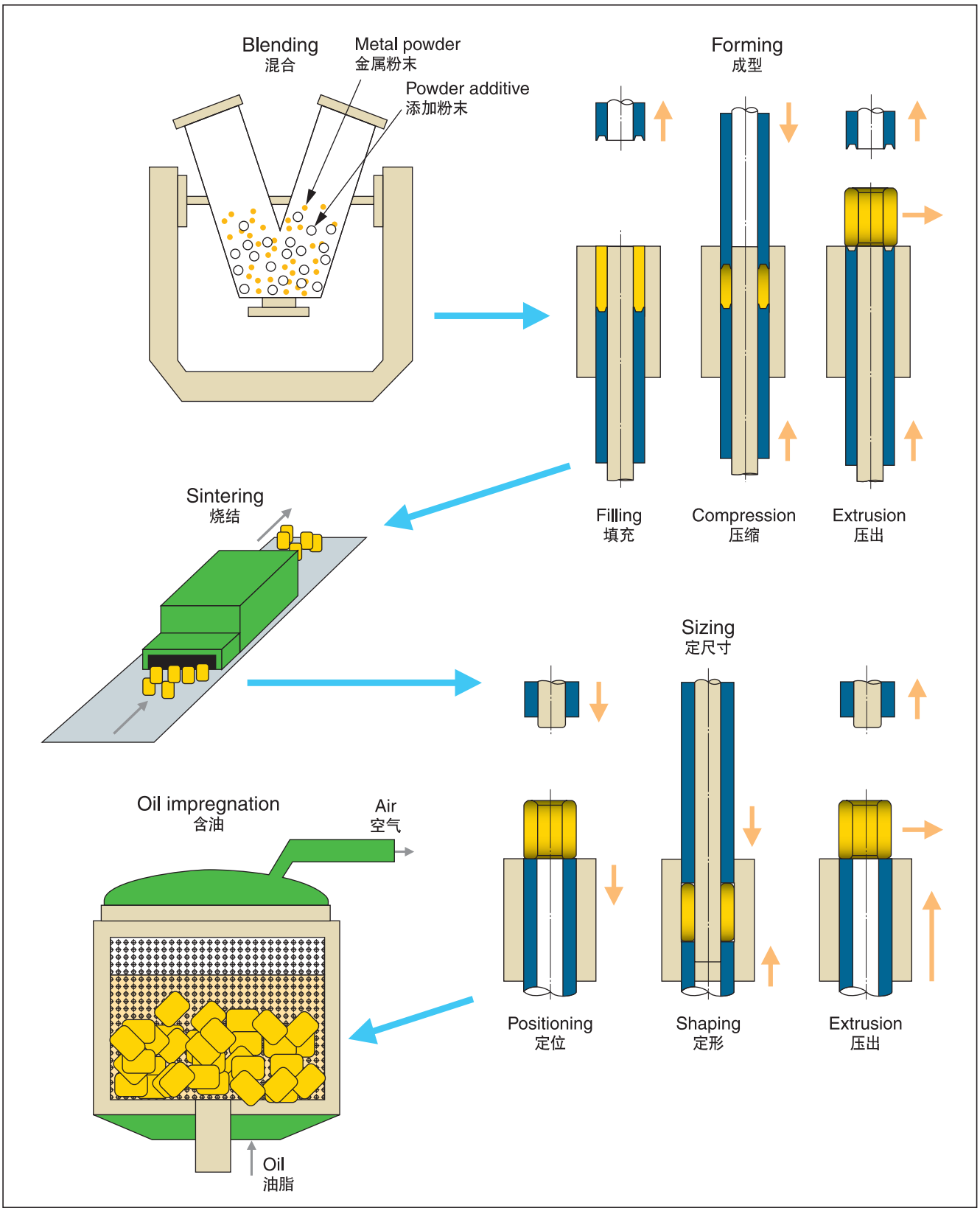
(2) 采用了烧结合金的动压轴承,降低了动压轴承**BEARPHITEE**的成本。

(3) 可发挥与流体动压轴承同等或以上的性能。



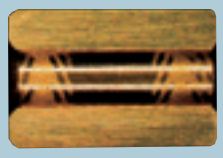
Hydrodynamic grooves are located on the bore of **NTN**'s hydrodynamic BEARPHITE bearing
动压**BEARPHITE**内径的状态

1-3 Manufacturing process for NTN BEARPHITE
1-3 NTN BEARPHITE的制造工序图



2 Product Types and Applications
种类与用途

Table 1 Types and typical applications of **NTN** BEARPHITE
NTN BEARPHITE的种类与主要用途

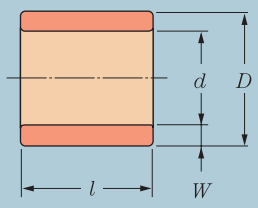
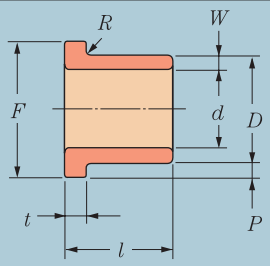
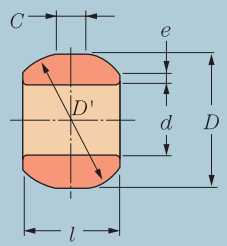
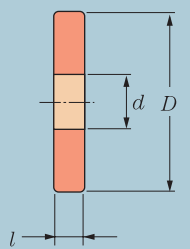
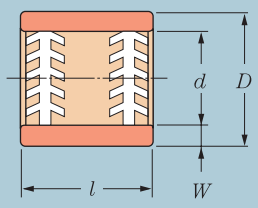
Type 类型	Shape 形状	Function 功能	Typical Applications 主要用途
Sleeve Type 套筒型		(1) Supports radial loads. (1) 可承受径向荷重	Household appliances 家电产品 Audiovisual equipment 音响、影像设备 Automotive electrical equipment 汽车电气装备品 Office equipment 公室机器 Agricultural machinery 农业机械
Flange Type 法兰型		(1) Supports both radial and axial loads. (2) Flange area simplifies locating. (1) 可承受径向荷重和轴向荷重 (2) 可在法兰部进行位置决定	Automotive electrical equipment 汽车电气装备品 Office equipment 公室机器
Spherical Type 球 型		(1) Supports radial loads. (2) Designed to be self-aligning (1) 可承受径向荷重 (2) 具有调心能力	Household appliances 家电产品 Audiovisual equipment 音响、影像设备 Automotive electrical equipment 汽车电气装备品
Thrust Washer Type 推力垫圈型		(1) Supports axial loads. (1) 可承受轴向荷重	General machinery 一般机械
Hydrodynamic BEARPHITE 动压BEARPHITE		(1) Suitable for high-speed operation (2) Runs quietly. (1) 可用于高速旋转的场合 (2) 噪音极小	Polygon scanner motors 多角型扫描马达 Fan motors 风扇马达

3 Bearing Dimensions
轴承的尺寸

Table 2 summarizes the standard dimensional ranges attainable with powder metallurgy. **NTN** can provide BEARPHITE Bearings outside the dimensions and shapes indicated in this table. If you require such a nonstandard bearing, contact **NTN** Engineering.

表2中显示了可实现粉末成型的制造尺寸之范围。在**NTN**还制造着表中未显示的其他特殊形状以及尺寸的轴承。如有需要，请洽询**NTN**。

Table 2 Available dimensional ranges
制造尺寸范围

Type 类型	Code	Shape 记号	Available Ranges 制造尺寸范围			Remarks 备考
			d	D	l	
Sleeve Type 套筒型	S		0.8 60	1.6 70	1 40	W=0.5 min. l=W 10 W=0.5 l=W 10
Flange Type 法兰型	F		0.8 50	2 60	1 35	W=0.5 min. t=0.5 min. P t R=0.2 min. W=0.5 最小 t=0.5 最小 P t R=0.2 最小
Spherical Type 球 型	A		1.5 22	5 34	3 20	C=2 min. e=0.8 min. C=2 最小 e=0.8 最小
Thrust Washer Type 推力垫圈型	W		5 62	18 75	2 3	L=1.2 min. L=1.2 最小
Hydrodynamic BEARPHITE 动压BEARPHITE	HDB		1.5	3	3.5 5	
			2	4	6	
			3	5.5	8.75	

4 Material Characteristics and Applications for NTN BEARPHITE

NTN **BEARPHITE**的材质特性和用途

4-1 Material characteristics and applications for sintered oil-impregnated bearings

4-1 烧结含油轴承的材质特性和用途

Table 3-1 NTN BEARPHITE material characteristics and applications
NTN **BEARPHITE**的材质特性和主要用途

Series 类别	Material Code 材质记号	Chemical Components 化学成分 %						Density 密度 g/cm³ (±0.2)	Oil Retention 含油率 vol. % (±0.2)	Radial Crushing Strength 径向受压强度 MPa(min.) (以上)
		Cu	Sn	C	Fe	Ni	Other 其它			
Copper Series 铜类	H	Residual amount 残余量	8～11	1～2	—	—	—	6.6	18	150
	HD	Residual amount 残余量	8～11	1～2	—	2～4	—	6.8	18	150
	HQ	Residual amount 残余量	8～11	—	—	—	—	6.6	18	150
	HR	Residual amount 残余量	8～11	3～4	—	—	—	6.6	12	120
	HZ12	Residual amount 残余量	8～11	0.4～1	—	—	—	6.8	18	150
	HZ16	Residual amount 残余量	8～11	0.5～2.5	—	—	P:1 max. P:1以下	7.2	15	150
	HZ18	Residual amount 残余量	8～11	—	—	—	MoS_2:4～7	6.6	12	150
Copper-Iron Series 铜铁类	EE	33～38	3～6	1～2	Residual amount 残余量	—	3以下	6.2	18	150
	EB	18～22	0.5～2.5	0.5～2.5	Residual amount 残余量	—	1以下	6.2	18	150
	EC	38～42	1～3	0.5～2.5	Residual amount 残余量	—	1以下	6.4	18	150
	EZ06	Residual amount 残余量	1～3	0.5～2.5	38～42	—	1以下	6.5 6.9	18 12	150
Iron Series 铁类	P	8～11	—	—	Residual amount 残余量	—	3以下	6.1	18	200
	F	—	—	—	Residual amount 残余量	—	3以下	5.9	20	180
	L	1～3	—	2～4	Residual amount 残余量	—	1以下	6.0	15	180

	JIS Z2550 (2000)	Previous JIS B1581 老式JIS B1581	Features 特 性	Applications 特 性	Material Code 材质记号
	P4022Z	SBK1218	Standard copper series material 铜类标准材质	Used in a wide range of applications. 使用范围广泛。	**H**
	—	—	Excellent wear resistance 耐磨耗性能卓越。	Capstan motors for VTRs Capstan motors for car stereos VTR用绞盘马达 汽车音响用绞盘马达	**HD**
	P4012Z	—	Suitable for sliding motion 适于滑动摺动。	Micromotor, Carriages 微型马达、托架	**HQ**
	—	—	Excellent seizure resistance 耐烧损性能卓越。	Automotive fuel pumps 汽车燃油泵	**HR**
	—	—	Excellent wear resistance and ease of caulking 耐磨耗性能、耐紧固性能卓越。	Capstans for car stereos 汽车音响用绞盘	**HZ12**
	—	—	Excellent wear resistance at higher speed range 高速旋转时的耐磨耗性能卓越。	Motors for automotive electrical equipment 汽车电气装备用马达	**HZ16**
	—	—	Excellent wear resistance at higher temperature range 高温下的耐磨耗性能卓越。	Motors for automotive electrical equipment 汽车电气装备用马达	**HZ18**
	P2083Z	—	Used as a substitute for copper H series. 作为铜类H的代用材料使用。	Photocopiers 复印机	**EE**
	—	SBF2218	Used as a substitute for copper-iron EC series. 作为铜铁类EC的代用材料使用。	Ventilating fans, electric fans, stepper motors 换气扇、电扇、步进马达	**EB**
	—	—	Offers acoustic characteristics superior to those of the EB series. 音响性能比EB卓越。	Ventilating fans, electric fans, axial flow fan motors 换气扇、电扇、轴流风扇马达	**EC**
	—	—	Provides excellent wear resistance. 耐磨耗性能卓越。	Dynamic Pressure Bearphite 动压**BEARPHITE**	**EZ06**
	—	SBF2118	Used as a high-strength material for general-purpose applications. 作为高强度材料用于一般场合。	Automotive electrical equipment, power tools 汽车电气装备品、电气工具	**P**
	P1012Z	SBF1118	Standard iron-series material 铁类标准材质	Used in a wide range of applications. 使用范围广泛。	**F**
	—	SBF4118	Offers excellent high-speed operation and wear resistance. 高速旋转和耐磨耗性能卓越。	Electric fan motors, mixers, juicer motors 电动风扇马达、搅拌机、榨汁器马达	**L**

4-2 Applications and characteristics of materials used for sintered mechanical components
4-2 烧结机械部件的材质特性和用途

Table 3-2 Characteristics of materials used for sintered mechanical components and typical applications
烧结机械部件的材质特性和主要用途

Material Code 材质记号	Chemical Components 化学成分 %						Density 密度 g/cm³ (±0.2)	Tensile Strength 拉伸强度 MPa (min.) (以上)
	Fe	C	Cu	Ni	Mo	Other 其它		
FB60	Residual amount 残余量	–	–	—	—	–	6.0	70
FB64	Residual amount 残余量	—	—	—	—	—	6.4	98
FB68	Residual amount 残余量	—	—	—	—	—	6.8	147
FE60	Residual amount 残余量	0.2～0.8	0.5～0.2	—	—	—	6.0	147
FE64	Residual amount 残余量	0.2～0.8	0.5～0.2	—	—	—	6.4	169
FE68	Residual amount 残余量	0.2～0.8	0.5～0.2	—	—	—	6.8	245
FG60	Residual amount 残余量	0.2～0.8	2～5	—	—	—	6.0	245
FG64	Residual amount 残余量	0.2～0.8	2～5	—	—	—	6.4	343
FG68	Residual amount 残余量	0.2～0.8	2～5	—	—	—	6.8	441
Z15	Residual amount 残余量	0.2～1.0	2～5	—	—	—	6.4	—
Z17	Residual amount 残余量	0.5～1.5	1～2	3～5	0.3～0.8	1 max. 1以下	7.0	690
Z19	Residual amount 残余量	0.5～1.5	1～2	3～5	0.5～1.5	1 max. 1以下	7.0	600
S02	Residual amount 残余量	0.1 max. 0.1以下	15～20 (Cr)	10～15	2～4	2 max. 2以下	6.6	—
S03	Residual amount 残余量	0.1 max. 0.1以下	15～20 (Cr)	10～15	2～4	0.5～1.0 (Si)	6.6	—

Note: Materials with the same chemical composition have different density values.
※化学成分相同的材质在密度上有差别。

	Apparent Hardness 表象硬度 HRF	Radial Crushing Strength 压环强度 MPa（min.）	JIS Z2550 (2000)	Previous JIS Z2550 老式JIS Z2550	Features 特　长	Material Code 材质记号
	40	147	P1022-	—	High-precision compact components Used as a ferromagnetic core. 高精度的小型部品。 作为磁性铁心使用。	FB60
	50	245	P1023-	SMF1010		FB64
	70	294	P1025-	SMF1015		FB68
	70	294	—	—	Low-load structural components 轻负荷结构品	FE60
	75	490	—	—		FE64
	85	637	—	—		FE68
	80	392	P2063-	SMF4020	Strength is enhanced by hardening and tempering. Excellent durability. 通过淬火和回火提高强度。 耐久性卓越。	FG60
	90	588	P2064-	SMF4030		FG64
	95	735	—	SMF4040		FG68
	—	—	—	SMF4030	Smaller dimensional variation (suitable for high-precision products) 尺寸变化小。（高精度品）	Z15
	90	1400	P3105-	—	Suitable for high-strength, high-precision products 高强度品、高精度品	Z17
	105	900	—	—	High hardness without the need for heat treatment 无需热处理而有高硬度	Z19
	—	—	P3525-	SMS1025	Excellent corrosion resistance and wear resistance (equivalent to SUS 316L) 耐腐蚀性能和耐磨损性能卓越（与SUS316L相当）	S02
	—	—	P3516-	—	Excellent corrosion resistance (equivalent to SUS 304L) 耐腐蚀性能卓越（SUS304L）	S03

5 Bearing Selection
轴承的选定

5-1 Allowable load and speed

The performance of **NTN** BEARPHITE bearings is limited by the allowable PV value, which is the product of bearing load P MPa and sliding velocity V m/min.

Table 4 summarizes the generally recommended allowable PV values.

5-1 允许荷重与速度

NTN BEARPHITE的使用限度基准为轴承荷重P MPa(kgf/cm^2)与滑动速度 Vm/min的乘积。

表4中显示了一般推荐的允许 PV 值。

Table 4 Allowable PV values
允许PV 值

Application 项目	Allowable PV value 允许PV 值 MPa·m/min
General-purpose machinery 普通机械	100
Household appliances 家用电器设备	50
Office equipment 公室机器	50
Low noise and low wear applications 对噪音和磨损有限制的场合	25
Low noise applications 对噪音限制特别严格的场合	20
Axial loaded applications 有轴向荷重的场合	20

Fig. 2. graphically plots the interrelation between bearing load and sliding velocity at various PV values.
有关这些 PV 值的轴承荷重与滑动速度的关系显示于图2中。

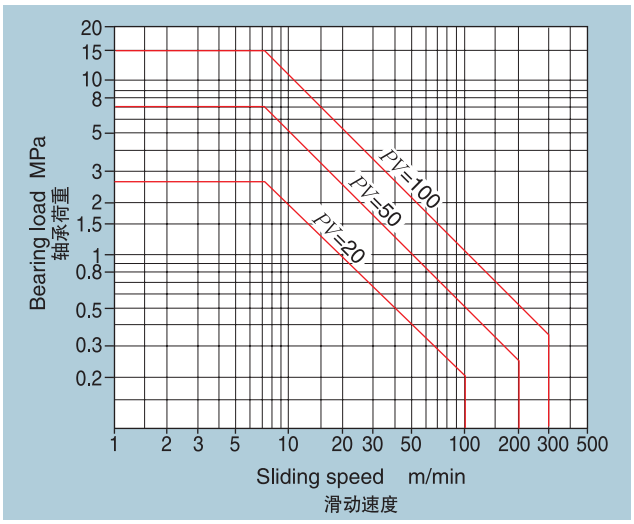


Fig. 2 Interrelation between bearing load and sliding velocity
轴承荷重与滑动速度的关系

5-2 Bearing life

The life of oil-impregnated bearings can vary depending on the rate of consumption of the lubricating oil in the bearings. Once 40% of the impregnated oil has been consumed, bearing wear begins to accelerate and bearing performance deteriorates accordingly. For this reason, once the residual lubricating oil drops to 60%, the bearing in question is regarded as having reached the end of its service life.

Lubrication is adversely affected by high temperatures. The maximum allowable temperature for lubricating oil is usually 80˚C.

Fig. 3 summarizes the effect of typical bearing temperatures on bearing life.

5-2 轴承寿命

含油轴承的寿命由含浸润滑油的消耗率所决定。含油量被消耗了40％之后，轴承的磨损会急剧增大，并引起性能降低。一般认为残余润滑油为60％时所需的时间为轴承的寿命。

另外润滑油还受温度的影响，通常以80℃为上限。

以轴承的温度为基准的轴承寿命的例子显示于图3中。

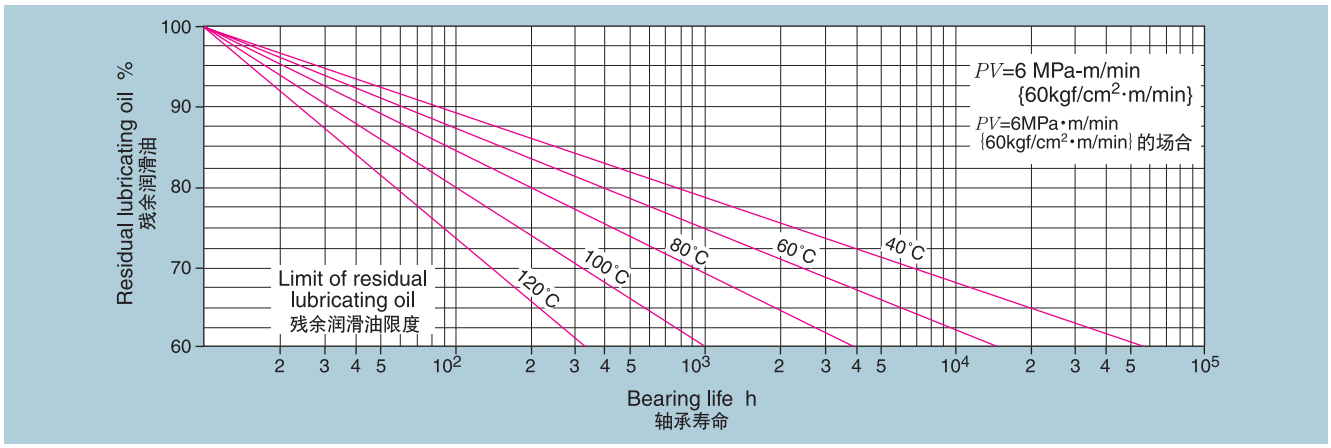


Fig. 3 Typical bearing life at varying temperature levels
典型轴承寿命

5-3 Lubricating oil

The type of lubricating oil to be used for impregnating a BEARPHITE bearing is based on bearing load, sliding speed, and bearing temperature. **Table 5** summarizes the guidelines for determining the lubricating oil viscosity for a given application.

For the standard bearing operating temperature range (0–80°C), a mineral-based lubricating oil can be used. If the operating temperature is expected to be outside this range on the high or low end, a synthetic-based lubricating oil is recommended.

Table 5 Operating conditions and lubricating oil viscosities
使用条件与润滑油的粘度

Operating Conditions 使用条件		Lubricating Oil Viscosity 润滑油的粘度	Oil Type (reference) 油的种类(参考)
Load MPa 荷重	Velocity m/min 速度		
～0.3	15～80	ISO VG 22～68	Spindle oil, turbine oil 主轴油、涡轮油
	60～250	ISO VG 10～32	Spindle oil 主轴油
0.2～0.8	～20	ISO VG 46～100	Gasoline engine oil 汽油引擎油
	15～80	ISO VG 32～68	Turbine oil 涡轮油
0.7～2.5	～20	ISO VG 100～220	Gear oil 齿轮油

5-3 润滑油

轴承中含浸的润滑油是根据轴承荷重、滑动速度以及轴承温度等方面进行选定。表5中显示了润滑油粘度选定的基准。通常轴承温度为0～80℃范围时采用矿物油类的润滑油。然而当轴承的温度范围在高温或者低温或者横跨高温至低温的场合，采用适合此时温度的合成油。

5-4 Bearing accuracy

Table 6 summarizes bearing accuracy values for three generic oil-impregnated bearings:sleeve type, flange type and spherical type.

The accuracy of standard **NTN** BEARPHITE bearings conforms to these tables. **NTN** can provide BEARPHITE bearings with better accuracy upon request. **Fig. 4** shows the dimensional tolerances of certain high-accuracy BEARPHITE bearings.

5-4 精度

表6中显示了关于套筒型、法兰型、球型等三种形式的一般含油轴承的精度。

NTN BEARPHITE的精度符合该基准，且在生产比该精度更高的轴承。图4中显示了部分尺寸允许误差。

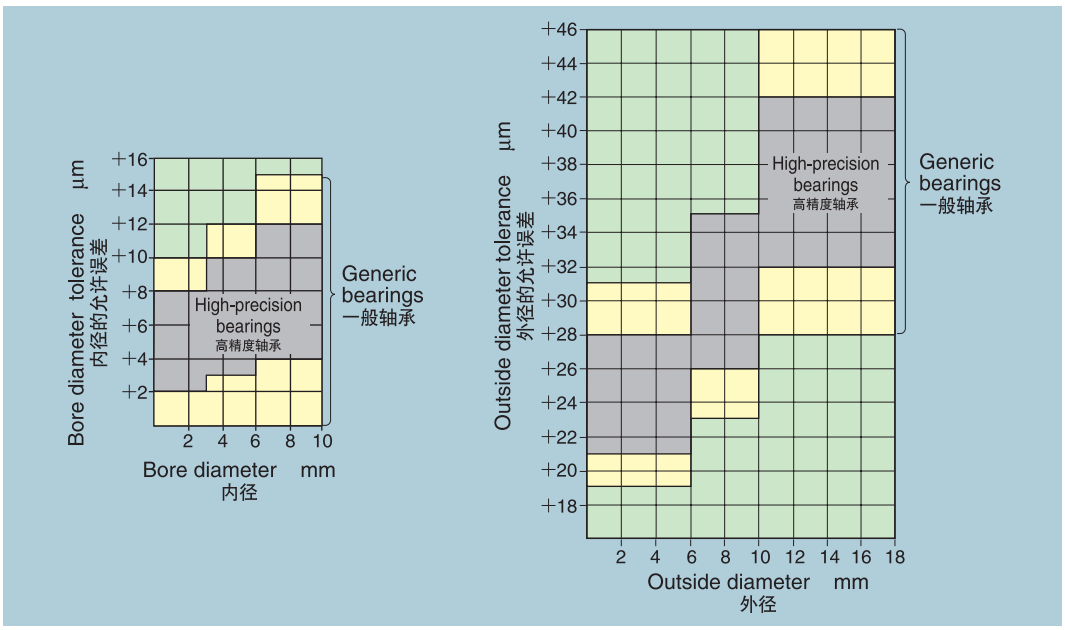


Fig. 4 Dimensional tolerances of **NTN** BEARPHITE bearings
NTN BEARPHITE的尺寸允许误差

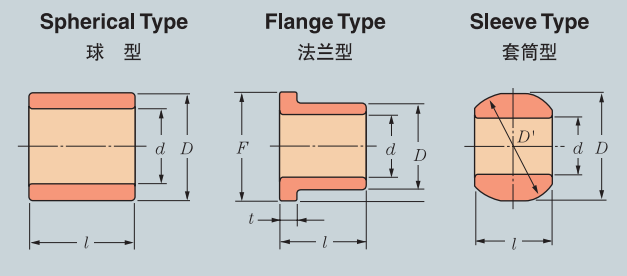


Table 6 Tolerances of generic oil-impregnated bearings
一般含油轴承的精度

Table 6-1 Bore diameter tolerance
内径d的允许误差

Unit mm

Bore dia./内径 over/超过	Bore dia./内径 incl./以下	Tolerances of Bore dia. 内径的允许误差
—	3	H7 $^{+0.010}_{0}$
3	6	H7 $^{+0.012}_{0}$
6	10	H7 $^{+0.015}_{0}$
10	18	H7 $^{+0.018}_{0}$
18	24	H7 $^{+0.021}_{0}$
24	30	H8 $^{+0.033}_{0}$
30	50	H8 $^{+0.039}_{0}$

Table 6-2 Outside diameter tolerance
外径D的允许误差

Unit mm

Outside dia./外径 over/超过	Outside dia./外径 incl./以下	Tolerances of Outside dia. 外径的允许误差
—	6	s7 $^{+0.031}_{+0.019}$
6	10	s7 $^{+0.038}_{+0.023}$
10	18	s7 $^{+0.046}_{+0.028}$
18	24	s7 $^{+0.056}_{+0.035}$
24	30	t7 $^{+0.062}_{+0.041}$
30	40	t7 $^{+0.073}_{+0.048}$
40	50	t7 $^{+0.079}_{+0.054}$
50	65	t7 $^{+0.096}_{+0.066}$

Table 6-3 Length tolerance
长度l的允许误差

Unit mm

Length/长度 over/超过	Length/长度 incl./以下	Tolerances of Length 长度的允许误差
—	8	±0.10
6	24	±0.15
24	65	±0.20

Table 6-4 Flange outside diameter tolerance
法兰外径F的允许误差

Unit mm

Flange Outside dia./法兰外径 Max./以下	Tolerances of Flange Outside dia. 法兰外径的允许误差
100	±0.10

Table 6-5 Flange thickness tolerance
法兰厚度t的允许误差

Unit mm

Flange Thickness/法兰厚度 Max./以下	Tolerances of Flange Thickness 法兰厚度的允许误差
10	±0.20

Table 6-6 Ball diameter tolerance
球径D'的允许误差

Unit mm

Ball dia./球径 over/超过	Ball dia./球径 incl./以下	Tolerances of Ball Diameter 球径的允许误差
—	10	±0.06
10	18	±0.08
18	30	±0.10

Table 6-7 Outside surface runout tolerance
外径面的振动的允许误差

Unit mm

Bore dia./内径 over/超过	Bore dia./内径 incl./以下	Tolerances of Outside Surface Runout (max.) 外径面的振动的允许误差(最大)
—	6	0.040
6	10	0.050
10	24	0.070
24	50	0.100

Table 6-8 Spherical surface runout tolerance
球面的振动的允许误差

Unit mm

Bore dia./内径 over/超过	Bore dia./内径 incl./以下	Tolerances of Spherical Surface Runout (max.) 球面的振动的允许误差(最大)
—	10	0.050
10	18	0.070

5-5 Recommended shaft specifications

5-5-1 Shaft composition

The shaft is typically made from carbon steel, an alloy steel or stainless steel for special applications.

5-5-2 Shaft hardness

The minimum allowable shaft hardness is HV300. Improved performance can be obtained with higher shaft hardness.

5-5-3 Shaft surface roughness

The recommended shaft surface roughness is 0.4Ra. For stricter sound requirements, a finish of 0.2Ra is suggested.

5-5 轴的规格

5-5-1 材质

相关轴的材质一般使用机械结构用碳素钢或者合金钢。在特殊场合使用不锈钢。

5-5-2 硬度

轴的硬度一般超过HV300便可，但如果硬度更高则可获得更理想的结果。

5-5-3 表面粗糙度

轴的表面粗糙度一般希望0.4Ra的精加工，但在噪音要求特别严格的场合则需要0.2Ra的精加工。

6 Recommended Housing Fits and Mounted Clearance

推荐轴承箱配合及安装游隙

Sleeve-type and flange-type bearings are usually mounted in a housing with an interference fit. In order to ensure optimal mounted clearance, the reduction in the bearing bore diameter due to the interference fit must be considered.

套筒型、法兰型轴承通常与轴承箱是紧配合。 为确保最佳安装游隙, 必须考虑因紧配合所造成的轴承内径收缩。

6-1 Recommended housing fits

When pressing the bearing into the housing, the smallest amount of interference is preferred to avoid damage to the bearing. However, sufficient interference must be kept between the housing and the bearing so they remain fixed to each other.

Fig. 5 graphically illustrates the appropriate interference.

- **Situations requiring increased interference**
  (1) Higher bearing load
  (2) Smaller bearing length
  (3) Higher expansion coefficient of the housing material
- **Situations requiring reduced interference**
  (1) Larger bearing length
  (2) Higher bearing wall thickness

Generally, the reduction in the bearing bore diameter increases with a larger bearing outside diameter, a thinner bearing wall thickness, a greater interference between the housing and the bearing, or a higher housing rigidity.

Fig.6 shows several plots of bore diameter shrinkage percentage versus bearing outside diameter. The graph displays copper-series bearings with varying wall thickness.

6-1 推荐轴承箱配合

压入轴承箱时，在不伤害到轴承的情况下，选择最小的游隙量。

适当的过盈量显示于图5中。

- 需要增加游隙量的场合
  (1) 轴承荷重较大时
  (2) 轴承长度较小时
  (3) 箱体的膨胀系数较大时
- 需要减少游隙量的场合
  (1) 轴承长度较大时
  (2) 轴承的壁厚较小时

一般按入轴承时轴承内径的收缩量在下述情况下会变大:轴承的外径较大且壁厚较小时、过盈量较大时、箱体的刚性较高时等等。相对于铜类轴承过盈量的内径收缩率如图6所示。

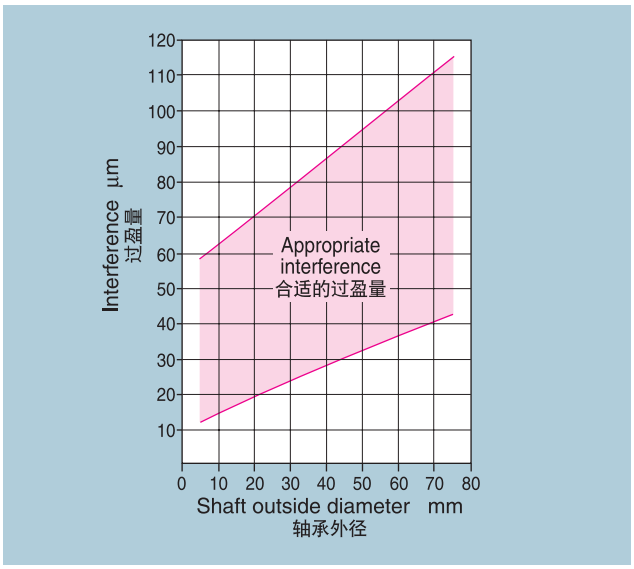


Fig. 5 Recommended Interference
合适的过盈量

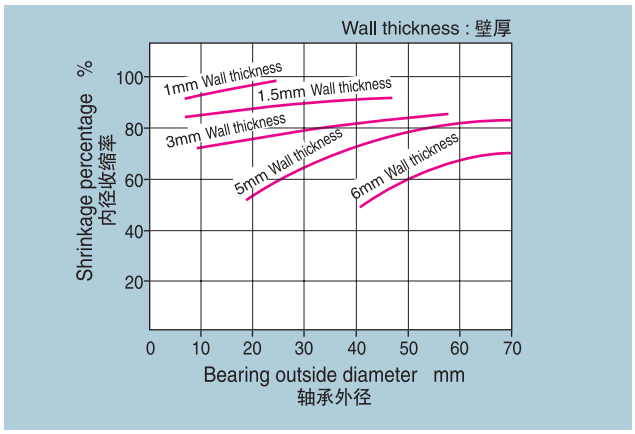


Fig. 6 Bore diameter shrinkage percentage vs. bearing outside diameter at different wall thickness
相对于铜类轴承过盈量的内径收缩率

6-2 Mounted clearance

The mounted clearance of a bearing is governed by PV value, viscosity of the lubricating oil, distance between bearings, bearing width, and other factors.

- **Situations that require larger clearance**
  (1) Higher PV value
  (2) Higher loads and higher viscosity of the lubricating oil
  (3) Large distance between bearings, which leads to shaft deflection
  (4) Two or more bearings mounted on a shaft
  (5) Very large bearing width
- **Situations that require smaller clearance**
  (1) Higher running accuracy is required
  (2) Low bearing noise and vibration is required

Fig. 7 shows the standard operating clearances recommended for **NTN** BEARPHITE bearings.

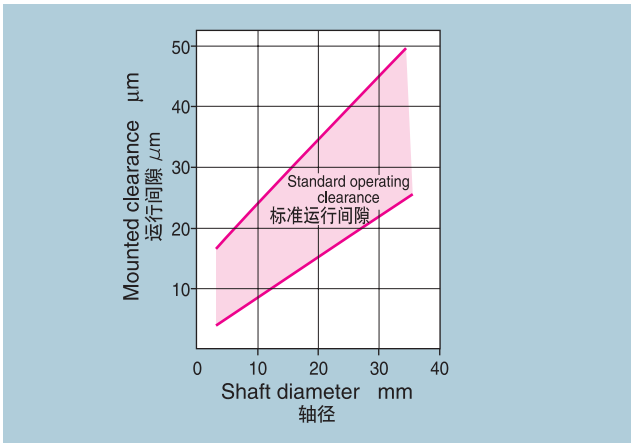


Fig. 7 Standard mounted clearance
标准安装游隙

6-2 安装游隙

轴承的运行间隙由PV值、润滑油的粘度、轴承间距离以及轴承长度等来决定。

- **需要较大游隙量的场合**
  (1) PV值较大时
  (2) 荷重较大、润滑油的粘度较高时
  (3) 轴承间距离较大、轴出现下垂时
  (4) 一根轴上有数个轴承使用时
  (5) 轴承长度较长时
- **需要较小游隙量的场合**
  (1) 有必要提高旋转精度时
  (2) 噪音、振动成为问题时

NTN BEARPHITE的推荐标准运行间隙被显示于图7中。

7 Care & Handling of Bearings

轴承的使用及保养

7-1 Bearing handling precautions

When mounting a bearing, be aware of the following:

(1) Handle the bearing only in a clean, dust-free location.
(2) Avoid using any tools that generates debris.
(3) Make sure that the fitting surfaces of the shaft and housing are free of dents, burrs and dust.
(4) Never use a hammer to install a bearing.

7-2 Bearing maintenance

When performing bearing maintenance, be sure to remember the following:

(1) Relubrication is recommended to ensure smooth continuous operation. Relubrication intervals vary depending on operating conditions. As a guideline, relubrication should be performed every 500 to 1,000 operating hours.
(2) To impregnate a bearing with oil, immerse the bearing in an oil bath heated to approximately 60°C and heat the bearing uniformly for 1 to 2 hours. When bubbles are no longer released, allow the bath to cool down with the bearing in it, or immerse the bearing in cool oil.

7-3 Storage

When storing a bearing, observe the following:

(1) Avoid storage locations with high humidity.
(2) Store the bearing in a cool location. The lubricating oil contained in a bearing deteriorates at temperatures exceeding 70°C.
(3) Do not allow the bearing to come into direct contact with an oil-absorbing material such as paper or wood.

7-1 轴承使用时的注意事项

使用轴承时请注意以下事项。

(1) 请在清洁的场所进行作业。
(2)对于操作的工具，请避免使用易于产生碎片的工具。
(3) 对于轴以及外壳与轴承的配合面，请确认是否有裂痕，毛刺,或者是否有异物。
(4) 必须避免用锤子等将轴承敲打进去。

7-2 轴承的保养

关于轴承的维护，请注意以下各项。

(1) 连续运行的场合，希望能按时加油。
加油的期间因使用条件而异，一般大约以500～1000小时为标准。
(2) 当进行含油操作时，请将轴承放入加热至大约60℃的油槽中，经过1～2小时的均匀保温，当气泡不再出现时，在该状态下进行冷却或者再浸入冷油中。

7-3 保管

关于轴承的保管，请注意以下各项。

(1) 避开湿气较重的场所。
(2) 含油的润滑油温度超过70℃时会发生变质，请在阴冷的场所加以保管。
(3) 勿让轴承接触纸张或者木材等吸收润滑油的物体。

8 Hydrodynamic BEARPHITE Bearings

动压BEARPHITE

8-1 Lubrication principle of hydrodynamic BEARPHITE bearings

With standard oil-impregnated bearings, the oil film only forms in the loaded area as shown in **Fig. 8.** At the same time, air is present in the area of the bearing where there is clearance.

When a standard bearing is subjected to an unbalanced load, the oil film cannot follow the eccentric motion of the unbalanced load at a higher speed range. Because of the eccentricity, the NRRO will deteriorate and the bearing cannot be used for an application that requires high accuracy at high speed.

NTN's hydrodynamic BEARPHITE bearings have a better oil-film forming ability when used in such an application.

8-1 动压BEARPHITE的润滑原理

一般含油轴承的油膜仅在荷重负重区域形成，在轴承空隙处还会有空气混入，如图8所示。

轴承上有不平衡荷重作用时，在高速旋转的场合油膜不能追随这一振动旋转，使得空洞产生、出现NRRO恶化，因而不能用于要求高速旋转高精度的场合。

在这种场合，如果采用了动压**BEARPHITE**，则可提高油膜的形成性。

Hydrodynamic BEARPHITE Bearing : A relative sliding motion between the shaft and the bearing helps generate a hydrodynamic pressure within the lubricating oil film. This pressure helps the BEARPHITE bearing support a load better than a standard bearing

动压BEARPHITE ：通过轴与轴承的相对滑动运动，使得轴承空隙处存在的流体润滑膜上产生压力(动压)，从而支承荷重。

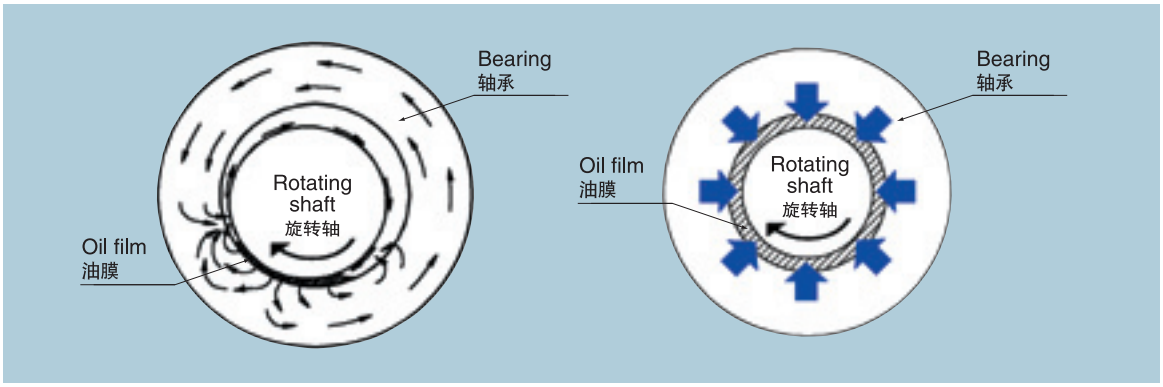


Fig. 8 Mechanism of flow in the oil film of a standard oil-impregnated bearing
含油轴承的油膜和油的动作

Fig. 9 Mechanism of flow in the oil film of a hydrodynamic BEARPHITE bearing
动压**BEARPHITE**的油膜和油的动作

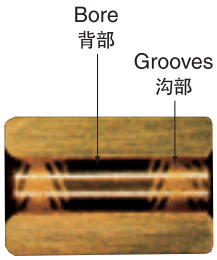
8-2 Comparison with other bearings

8-2 与其他轴承的比较

Table 7 Comparison with other bearings
与其他轴承的比较

	Hydrodynamic BEARPHITE Bearing 动压BEARPHITE	Fluid Hydrodynamic Bearing 流体动压轴承	Rolling Bearing 滚动轴承	Oil-impregnated Sintered Bearing 烧结含油轴承
Running accuracy 旋转精度	◎	◎	○	×
High speed range 高速区域	◎	◎	○	×
Low speed range 低速区域	○	×	◎	○
Seizure resistance 耐烧损性	○	×	○	○
Noise 静音性	◎	◎	×	○
Torque 力矩	△	△	◎	○
Cost 成本	○	△	△	◎

◎Excellent 优异　○Good 良好　△Fair 可使用　×Poor 不可使用



8-3 Dimensional accuracy of hydrodynamic BEARPHITE bearings
8-3 动压BEARPHITE的尺寸精度

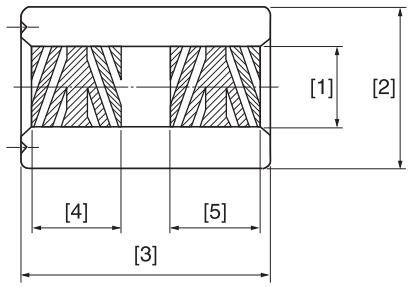


Table 8 Product dimensions
产品尺寸

No.	[1] Bore dia. 内径	[2] Outside dia. 外径	[3] Bearing Width 长度	[4] Groove Width 轴承幅宽	[5] Groove Width 轴承幅宽
1	1.5 -0.002 -0.005	3 +0.028 +0.020	5 ±0.05	1.8	1.8
2	2 0 -0.003	4 +0.028 +0.020	6 ±0.05	1.8	1.8
3	3 +0.003 0	5.5 +0.010 0	8.75 ±0.05	1.8	1.2

8-4 Materials used in hydrodynamic BEARPHITE bearings
8-4 动压BEARPHITE的材质

Table 9 Material properties of hydrodynamic BEARPHITE bearings
动压BEARPHITE的材料特性

Material Code 材质记号	Chemical Composition % 化学成分%					Density 密度 g/cm³	Oil Retention Percentage 含油率 vol. % (min.)	Radial Crushing Strength Constant 径向受压强度 MPa (min.)
	Cu	Sn	C	Fe	Others/其它			
EZ06	Residual amount 残余	1～3	0.5～2.5	38～42	1 max. 1以下	6.9±0.2	12 12以上	150 150以上

8-5 Lubricating oil used for hydrodynamic BEARPHITE bearings
8-5 动压BEARPHITE的润滑油

Table 10 Lubricating oil used for hydrodynamic BEARPHITE bearings
动压BEARPHITE的润滑油

Table 10-1 Lubricating oil for fan motors
风扇马达用润滑油

Description 名称		NS3	
Item 项目		Test method 试验方法	Representative characteristics 代表性状
Base oil 基体油		–	Ester-based synthetic oil 酯类合成油
Appearance 外观		Visual 目测	Clear orange 橙色透明
Density (g/cm³) 密度		JIS K 2249	0.95
Kinematic viscosity (mm²/S) 动粘度	40˚C	JIS K 2283	24.5
	100˚C	JIS K 2283	5.3
Viscosity index 粘度指数		JIS K 2283	154
Flash point (˚C) 着火点		JIS K 2265	260
Total acid number (mgKOH/g) 全酸值		JIS K 2501	0.10

The values shown above are typical values and are not a guarantee of performance.
上述数值仅为代表值，而非保证数值。

Table 10-2 Lubricating oil for polygon scanner motors
多角型扫描马达用润滑油

Description 名称			NL202	
Item 项目			Test method 试验方法	Representative characteristics 代表性状
Base oil 基体油			–	Diester + lithium 二酯+锂
Appearance 外观			Visual 目测	Milky white 乳白色
Density (g/cm³) 密度			JIS K 2249	0.919
Base oil 基体油	Kinematic viscosity (mm²/S) 动粘度	40˚C	JIS K 2283	12.46
		100˚C	JIS K 2283	3.35
	Viscosity index 粘度指数		JIS K 2283	148
	Flash point (˚C) 着火点		JIS K 2265	235
	Total acid number (mgKOH/g) 全酸值		JIS K 2501	0.10

The values shown above are typical values and are not a guarantee of performance.
上述数值仅为代表值，而非保证数值。

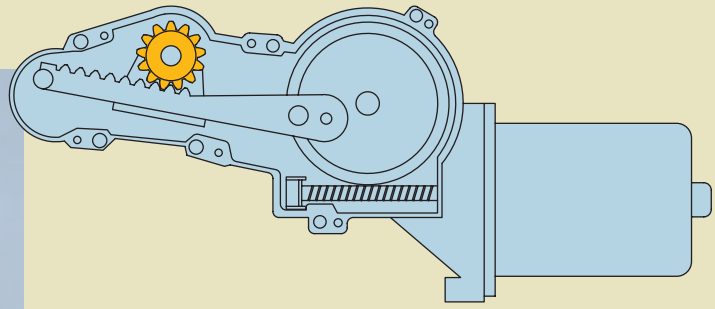
8-6 Precautions when using hydrodynamic BEARPHITE bearings
8-6 动压BEARPHITE使用时的注意事项

- Avoid operating temperatures above 80˚C.
  The lubricating oil will start to deteriorate at temperatures above 80˚C.
- Do not store bearings in a hot and/or humid atmosphere.
- Do not allow the bearing to come in contact with a material such as paper or wood, which could absorb the lubricating oil.
- When installing a bearing into an application, work in a clean environment to avoid contamination.
- NTN's hydrodynamic BEARPHITE bearings are designed to be mounted in a particular direction. Make sure that the bearing is installed in the proper orientation.
- Handle BEARPHITE bearings very carefully so they are not damaged (e.g.dents).
- When mounting the bearing for the first time, fill the bearing space 70-80% with the same lubricating oil to be used for oil impregnation. This will avoid any disruptions in the oil film from air between the bearing and the shaft.
- After replenishing oil inside the bearing, be careful when inserting the rotor so oil is not spilled.
- Do not remove the rotor after it has been installed.
- The typical orientation of BEARPHITE bearings has the rotor located above the bearing. If considering a different orientation, carefully consider the possibility of oil leakage in the application.

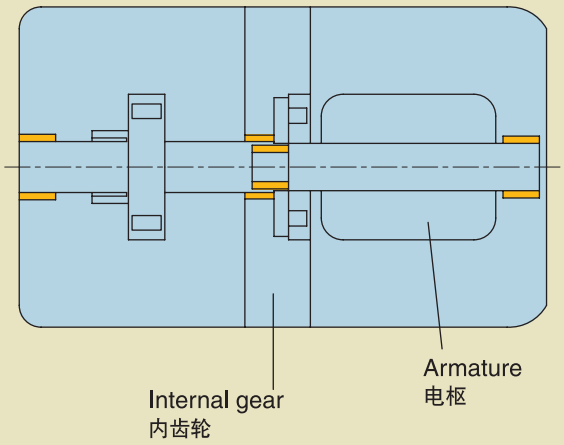
- 请避免在80℃以上的条件下使用，否则会加速润滑油的劣化。
- 请避免在高温高湿环境下进行保管。
- 请勿让轴承接触纸张或者木材等吸收润滑油的物体。
- 将轴承或者单元品组装至马达时，请在清洁的场所进行操作。
- 动压BEARPHITE具有方向性，请勿组装成反方向。
- 在使用产品时需十分小心,避免弄伤。(如打痕)
- 初次使用时，请注入与含浸油相同的润滑油达空间容积的7至8成。
  (目的在于防止由于空气混入而造成油膜断裂)
- 初次注入油后，请将转子轻轻地插入，注入勿让油泄漏出。
- 转子插入后请勿在中途将其抽出。
- 运行姿态为转子处于上侧，如果使用时未呈现该姿态，则请充分注意确认有无油的泄漏以及马达的特性等等。

9 Applications
应用

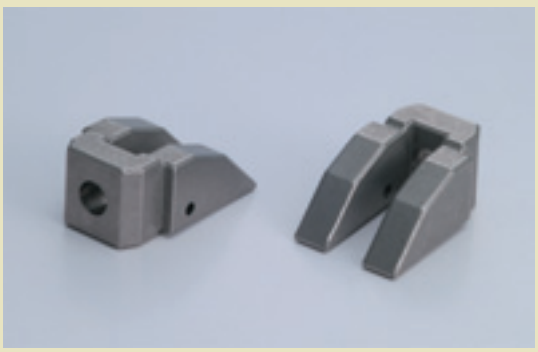
Wiper Motor / 刮水器马达

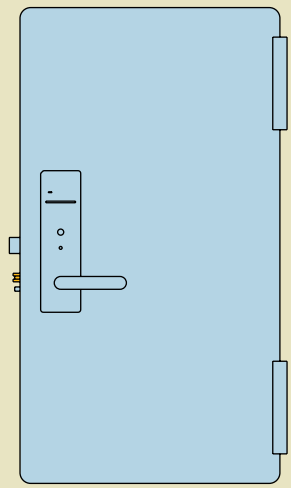


Starter Motor / 起动机马达

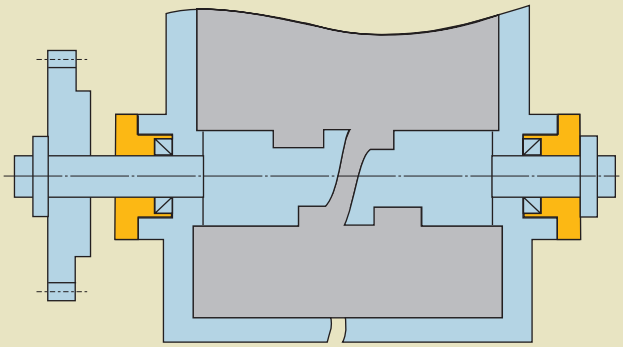


Key Card System / 卡片锁定系统

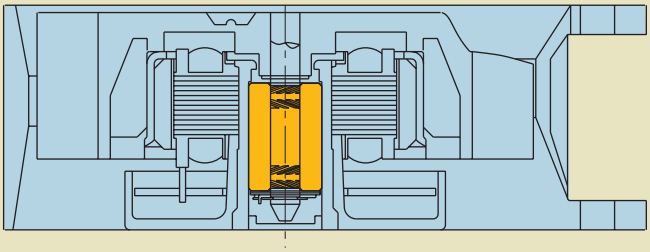




Copier (Toner Stirring Shaft) 复印机(油墨搅拌轴)



Fan Motors 轴流风扇马达



Polygon Scanner Motor for Laser Beam Printers LBP用多角型扫描马达