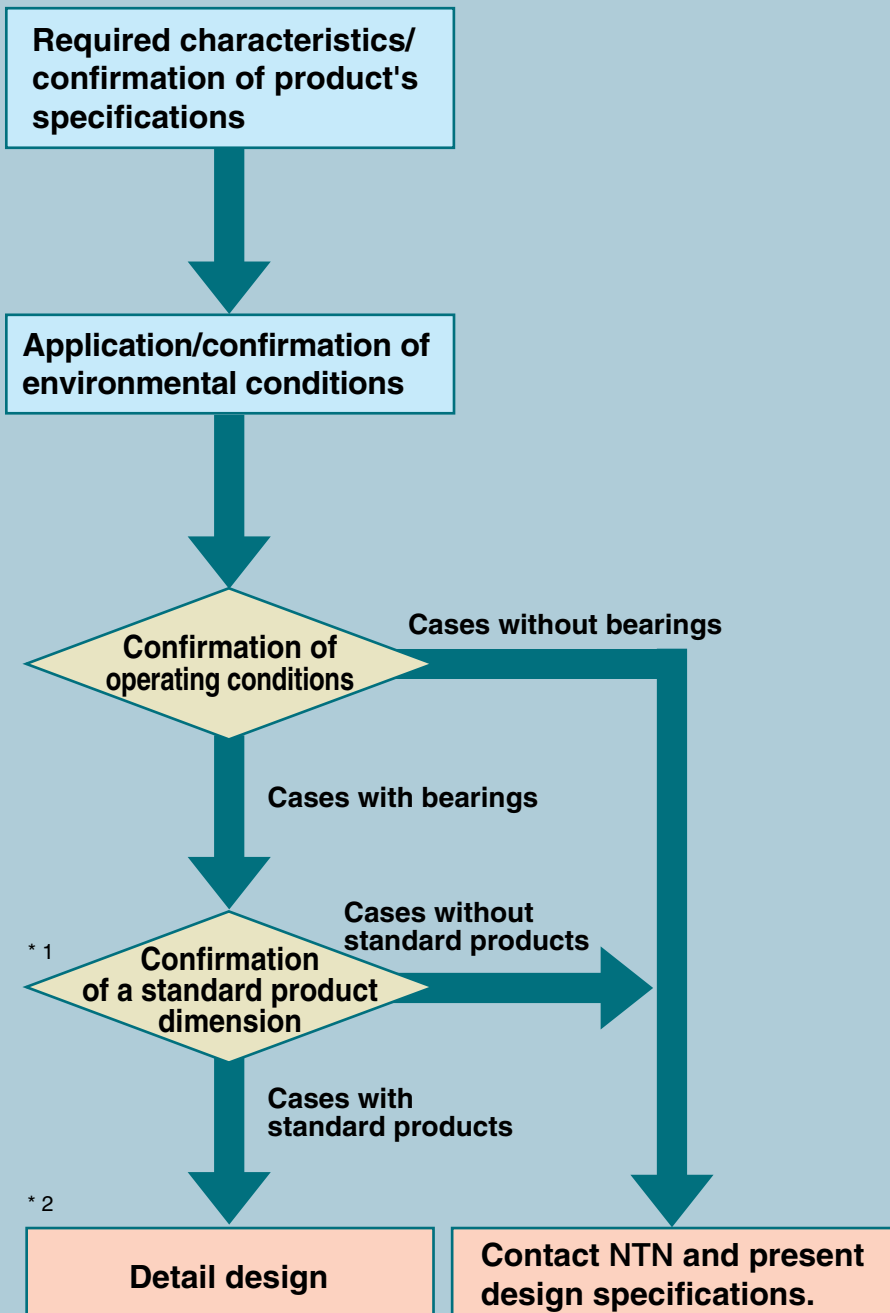


## 7-1 Design guideline of sliding performance parts



## Introduction of Materials and Products for Applications

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## Load / Speed / Temperature

See page 39~44, 51~54

## A demand wearing life

See page 46, 10~17 and 53

\* 1) Even for selecting a standard product, determine if the materials are suitable for use. Further, if the proper dimensions can not be found, design after selecting materials.

\* 2) In the case of using the standard product, check the fittings and clearance according to the calculation on pages 47 to 49.

Remarks: If the application is for bearings and seal rings, use the "check list of conditions for use".

## 7-2 Temperature and allowable face pressure

The allowable face pressure of plastic sliding bearings depends on the base resin materials, it decrease when the temperature rises.

Table 22 shows the guideline.

Table 22 Temperature and the allowable face pressure of bearings

Allowable face pressure $P$ MPa	Ambient temperature $^{\circ}\text{C}$		BEAREE FL3000 (PTFE)	BEAREE AS5000 (PPS)	BEAREE PI 5001 (PI)	BEAREE UH3000 (PE)	BEAREE PK5300 (PEEK)	BEAREE NY5000 (PA)	BEAREE DM5030 (POM)	BEAREE FL7075 (Coating)
	Over	Below								
	—	20	7	20	50	5	35	15	10	50
	20	60	6	20	50	2	35	10	7	50
	60	100	5	15	50	0.5	30	5	3	40
	100	140	4	10	40	—	25	1	—	30
	140	180	3	10	30	—	20	—	—	20
	180	220	1	7	20	—	15	—	—	10
	220	260	0.5	—	10	—	10	—	—	—
Allowable sliding velocity : $\bar{V}$ m/min			200	200	200	30	150	30	50	50
Allowable pressure $P\bar{V}$ MPa · m/min			60	60	200	10	80	10	20	40

Allowable face pressure: Means the guideline for bearings.

Allowable sliding velocity, allowable  $P\bar{V}$  value: Means the allowable value at room temperature.

### 7-3 Friction coefficient

The friction coefficient of plastic sliding bearings can vary widely in application conditions. **Table 23** shows the friction coefficients and test conditions for typical material grades of NTN Engineering Plastics.

**Table 23 Friction coefficient of NTN Engineering Plastics materials**

Materials	Test condition						Friction coefficient
	Test type	Mating material	Face pressure MPa	Sliding velocity m/min.	Lubrication	Ambient temperature °C	
BEAREE FL3000	Thrust	SUJ2	1.0	10.0	None	Room temperature	0.13
BEAREE FL3030	Thrust	SUS304	1.96	36.0	None	Room temperature	0.18
BEAREE PI 5001	Thrust	SUJ2	1.0	10.0	None	Room temperature	0.3
	Thrust	SUJ2	0.5	128.0	None	Room temperature	0.1
BEAREE UH5041	Thrust	SUJ2	1.0	10.0	None	Room temperature	0.12
BEAREE AS5053	Thrust	A5056	0.25	3.4	None	165	0.13
	Thrust	A5056	0.35	2.8	None	200	0.09
BEAREE PK5900	Thrust	SUS304	1.0	10.0	None	Room temperature	0.28
BEAREE NY5000	Thrust	SUJ2	0.3	32.0	None	Room temperature	0.21
BEAREE DM5030	Thrust	SUJ2	1.0	10.0	None	Room temperature	0.21
	Thrust	A5056	1.0	10.0	None	Room temperature	0.13
BEAREE ER3000	Thrust	SUJ2	0.3	1.0	None	Room temperature	0.28
	Thrust	SUS304	0.3	1.0	None	Room temperature	0.22
BEAREE FL7075	Thrust	A5056	0.22	2.4	None	Room temperature	0.13

## 7-4 Specific wear rate

The specific wear rate (wear factor) of plastic bearings can vary widely in application conditions. **Table 24** shows the specific wear rate and test conditions for typical material grades of NTN Engineering Plastics.

**Table 24** Specific wear rate of NTN Engineering Plastics materials

Materials	Test condition						Specific wear rate × 10 <sup>-7</sup> mm <sup>3</sup> /N·m
	Test type	Mating material	Face pressure MPa	Sliding velocity m/min.	Lubrication	Ambient temperature °C	
BEAREE FL3000	Thrust	SUJ2	0.25	128.0	None	Room temperature	1.0
BEAREE FL3030	Thrust	SUS304	1.96	36.0	None	Room temperature	1.6
BEAREE PI 5001	Thrust	SUJ2	1.95	128.0	None	Room temperature	6.23
	Thrust	SUJ2	0.2	128.0	None	Room temperature	1.0
BEAREE UH5041	Thrust	SUJ2	0.3	32.0	None	Room temperature	0.3
BEAREE AS5053	Radial	A5056	0.25	3.4	None	165	13.0
	Radial	A5056	0.35	2.8	None	200	17.0
BEAREE PK5900	Thrust	SUS304	0.5	100.0	None	Room temperature	6.2
BEAREE NY5000	Radial	S45C	0.19	70.0	None	Room temperature	8.3
BEAREE DM5030	Thrust	SUJ2	0.3	32.0	None	Room temperature	1.5
	Thrust	A5056	0.3	32.0	None	Room temperature	5.0
BEAREE ER3000	Thrust	SUJ2	0.23	128.0	None	Room temperature	3.3
	Thrust	A2017	0.23	128.0	None	Room temperature	2.9
BEAREE FL7075	Thrust	SUS304	0.5	30.0	None	Room temperature	10.0

### 7-5 Thermal expansion coefficient

**Table 25** shows the linear expansion coefficient of BEAREE FL. PTFE has a conversion point at 23°C, and its volume changes drastically at this point. Therefore, the dimensions measurement should be performed at 25°C. Also, since the expansion rate is different along the longitudinal (M.D.) and lateral (C.D.) direction regarding the molding direction, more caution is requested to determine the clearance.

**Table 25** Linear expansion coefficient of BEAREE(FL) ( $\times 10^{-5}/^{\circ}\text{C}$ )

Range of temperature change °C	BEAREE FL3000		BEAREE FL3030		BEAREE FL3700		PTFE
	C.D.	M.D.	C.D.	M.D.	C.D.	M.D.	
-50~+ 20	6.7	9.6	9.2	9.2			13.5
-18~+ 20	8.2	12.6	9.2	9.2	9.0	7.9	16.2
+20~+ 25	22.2	36.8	19.1	29.8	24.6	33.5	50.2
+25~+100	8.0	10.1	9.0	9.8	7.2	8.5	12.4
+25~+150	8.3	10.7	9.0	9.8	7.7	9.9	13.5
+25~+200	9.3	11.7	10.4	11.2	8.5	10.6	15.1
+25~+260	11.0	13.6	11.1	11.8	9.7	13.5	18.0

Remarks M.D.: Longitudinal direction (Compression molding, the axial direction of continuously molded rod or pipe.)  
 C.D.: Lateral direction (Right angled direction to the axial direction mentioned above.)

### 7-6 Test data

Applications of plastic bearings are rapidly increasing. The latest test data are shown as follows.

#### BEAREE FL3000

Test condition (Friction test)

- Test unit : Thrust type friction and wear test unit.
- Mating material : Bearing steel(SUJ2). Rotation sample piece
- Face pressure : 0.5-10 MPa
- Sliding velocity : 10 m/min.
- Lubrication : None

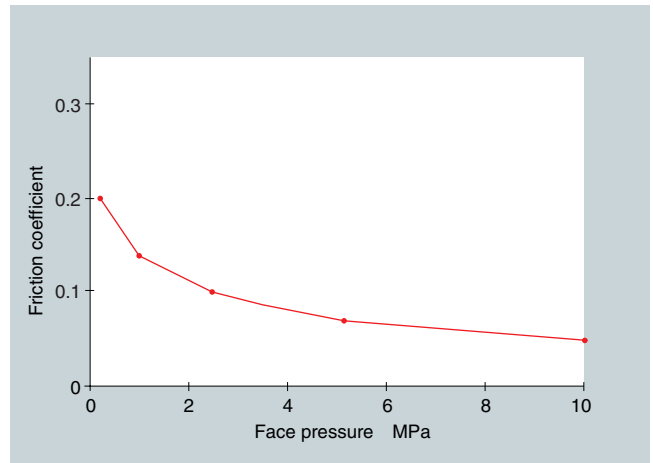


Fig.20 Friction coefficient versus face pressure

#### BEAREE FL3000

Test condition (Friction test)

- Test unit : Thrust type friction and wear test unit.
- Mating material : Bearing steel(SUJ2). Rotation sample piece
- Face pressure : 1 MPa
- Sliding velocity : ~100 m/min.
- Lubrication : None

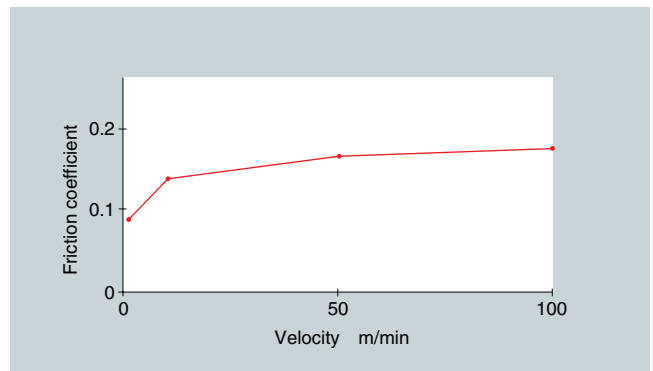


Fig.21 Friction coefficient versus sliding velocity

#### BEAREE FL3000

Test condition (Wear test)

- Test unit : Thrust type friction and wear test unit.
- Mating material : Bearing steel(SUJ2). Rotation sample piece
- Face pressure : 0.08-0.8 MPa
- Sliding velocity : 128 m/min.
- Lubrication : None
- Test time : 100 hours

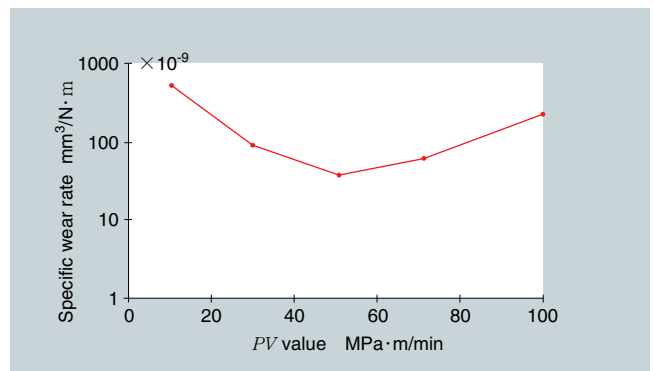
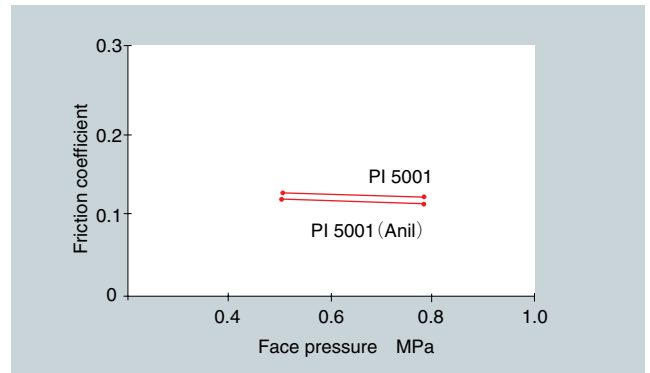


Fig.22 Specific wear rate versus PV value

### BEAREE PI5001

**Test condition (Friction test)**

Test unit : Thrust type friction and wear test unit.  
 Mating material : Bearing steel(SUJ2). Rotation sample piece  
 Face pressure : 0.5, 0.8 MPa  
 Sliding velocity : 128 m/min.  
 Lubrication : None  
 Ambient temperature: 100°C

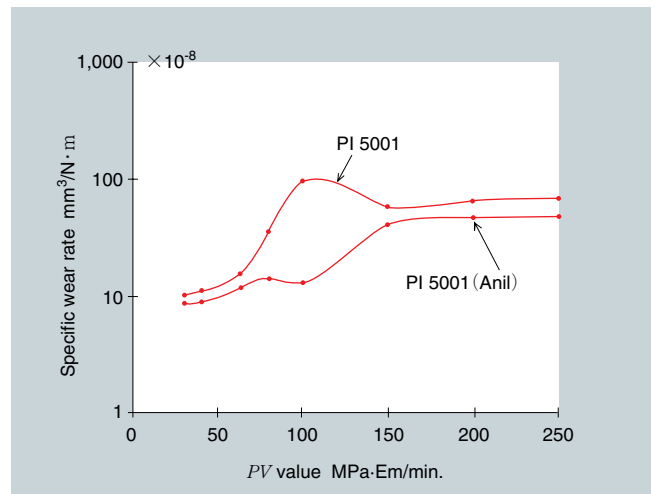


**Fig.23 Friction coefficient versus face pressure**

### BEAREE PI5001

**Test condition (Wear test)**

Test unit : Thrust type friction and wear test unit.  
 Mating material : Bearing steel(SUJ2). Rotation sample piece  
 Face pressure : 0.2-2.0 MPa  
 Sliding velocity : 128 m/min.  
 Lubrication : None  
 Ambient temperature: Room temperature

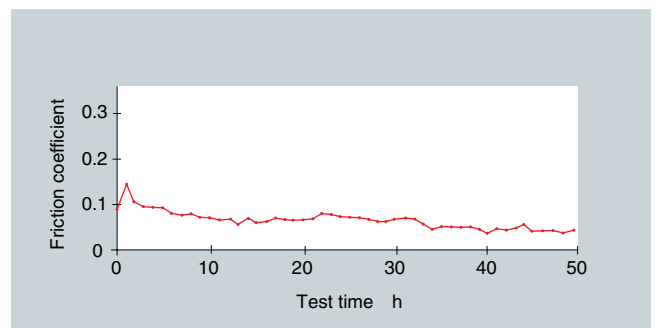


**Fig.24 Specific wear rate versus PV value**

### BEAREE AS5053

**Test condition (Wear test)**

Test unit : Radial type friction and wear test unit.  
 Mating material : A5056(3.2S, HV45)  
 Face pressure : 0.35 MPa  
 Sliding velocity : 2.8 m/min.  
 Lubrication : None  
 Ambient temperature: 200°C  
 Test time : 50 hours  
 Specific wear rate : 1.7×10<sup>-6</sup> mm³/N·m



**Fig.25 Friction coefficient during the wear test**

### BEAREE DM5030

Test condition (Friction test)

- Test unit : Thrust type friction and wear test unit.
- Mating material : Bearing steel(SUJ2). A5056
- Face pressure : 1 MPa
- Sliding velocity : 10 m/min.
- Lubrication : None
- Ambient temperature : Room temperature
- Test time : 60 minutes

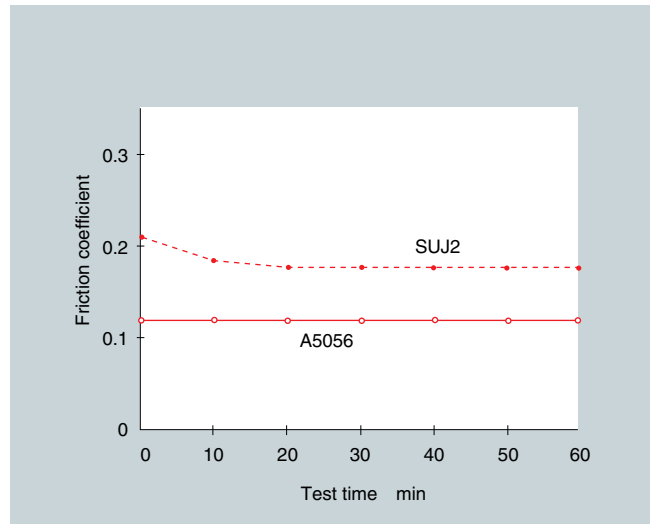


Fig.26 Friction coefficient versus running time

### BEAREE ER3000

Test condition (Friction test)

- Test unit : Thrust type friction and wear test unit.
- Mating material : Bearing steel(SUJ2)
- Face pressure : 0.3 MPa
- Sliding velocity : 1.0 m/min.
- Lubrication : None
- Ambient temperature : Room temperature

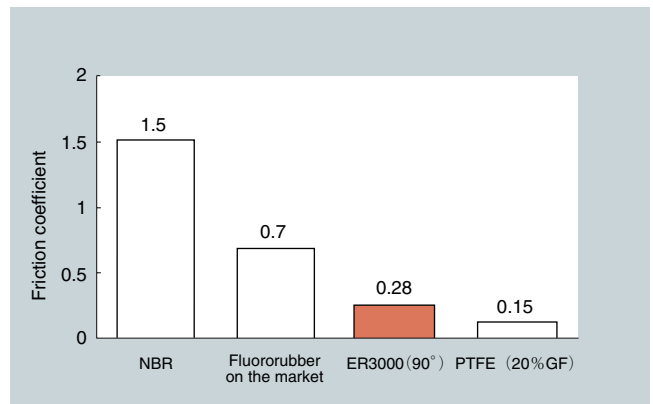


Fig.27 Friction coefficient comparison mating SUJ2

### BEAREE FL7075 (Coating)

Test condition (Friction test)

- Test unit : Thrust type friction and wear test unit.
- Mating material : SUS304
- Face pressure : 0.01, 0.2 MPa
- Sliding velocity : 0.01-10 m/min.
- Lubrication : None
- Ambient temperature : Room temperature

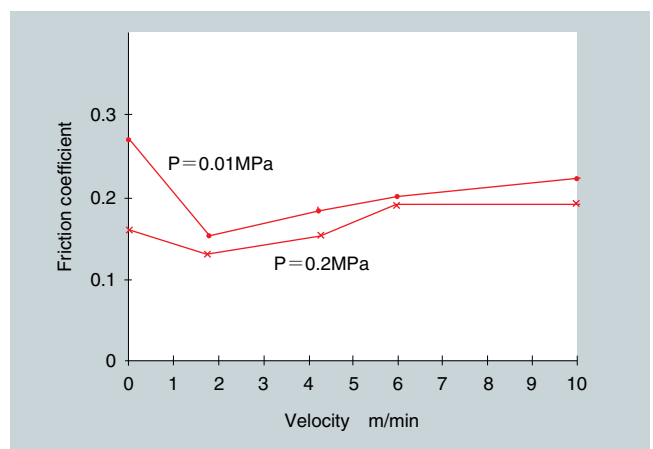


Fig.28 Friction coefficient versus sliding velocity