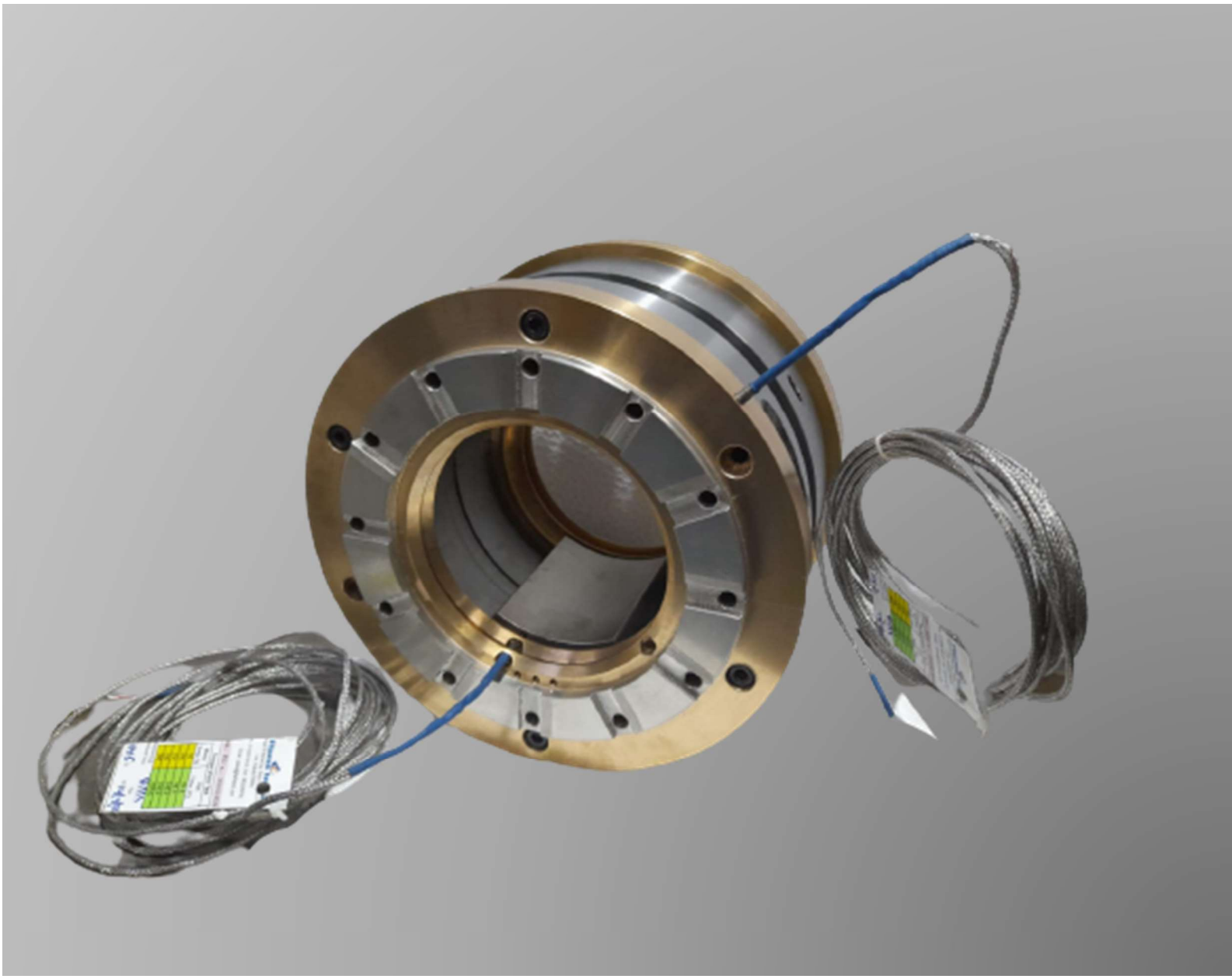


TILTING PAD BEARING ASSEMBLY.
JOURNAL & COMBINED.
40 – 355 MM

SUNTECH ENGINEERING CORPORATION

www.suntechbearings.com

1. BASIC PRINCIPLES

1.1 INTRODUCTION OF HYDRODYNAMIC LUBRICATION

As the speeds of turbomachinery are increased in order to improve aerodynamic performance, bearing designs are stretched to their limit and, in some cases, beyond. It is becoming increasingly important for the bearing designer to use every design tool possible to ensure that bearings will operate satisfactory for these high performance applications.

SUNTECH® slide bearings are usually designed based on the principle of hydrodynamic lubrication which increases its reliability. When the calculation design and manufacturing conditions permit this type of lubrication, the slide bearings will fulfil all the requirements expected of them.

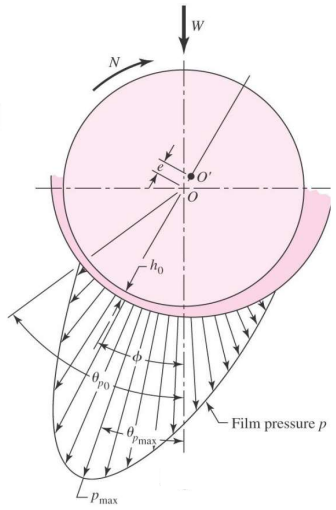


Fig: 1

It has been proven that plain cylindrical bearings (fig. 01) built-up its carrying oil wedge by making possible clearance between bearing shell and shaft due to its eccentric position (converging film).
Now a days various special geometry design has been implanted which are also based on hydrodynamic calculation as per DIN 31657.

1.2 JOURNAL BEARING LIMITS OF OPERATION

A two axial groove sleeve bearing is illustrated in Figure I supporting a vertically downward load with a displacement that is not directly downward, but at some attitude angle, with rotation from bottom dead centre. This property of sleeve bearings is responsible for producing destabilizing cross coupling forces that cause oil whirl (exactly 50 percent of synchronous speed vibration) and/or shaft whip (re excitation of the rotor's first critical speed at a frequency that is less than 50 percent of synchronous speed).
This phenomena is most prevalent at high speeds and/or light loads. For this reason, in addition to a high load design limit, a low load limit is also placed on sleeve bearings.

Define the bearing unit load as L= (W / L x D).

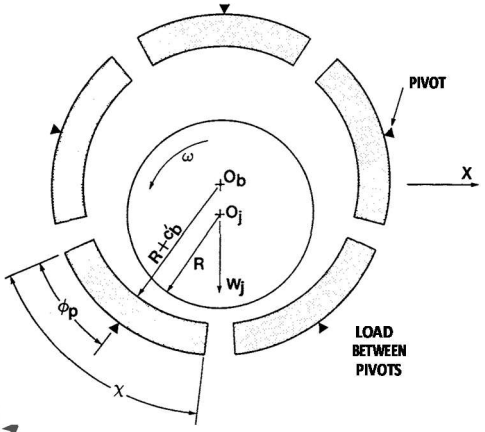
For sleeve bearings, suggested load design limits are $L \leq 2.06$ N/mm2 to $L \geq 0.60$ N/mm2 .

Ideally, a sleeve bearing should be designed between these limits. However, bearings with higher unit loads can operate without problems as long as care is taken to properly cool the bearing. That is, unit loads above the design limit may require higher oil flows and/or a reduced temperature design similar to Tilting Pad Technology implementation on Journal Bearing.

1.3 TILTING PAD JOURNAL BEARING LIMITS OF OPERATION AND TEMPERATURE SENSOR LOCATION

All of the above limits apply to tilting pad bearings with the exceptions noted in this section. A tilting pad bearing with between pivot loading is illustrated in Figure 2. Note that the journal sinks straight down in the bearing, thereby producing zero destabilizing cross coupling forces.

Fig:2



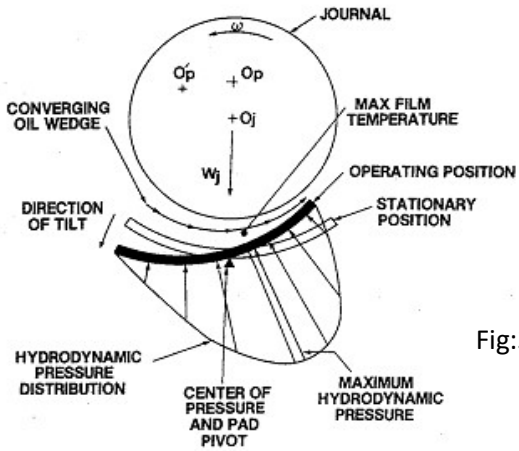


Fig:3

The angle of pad tilt and the maximum film pressure and temperature are shown in Figure 3. The pads leading edge tilts open to provide a converging wedge to produce hydrodynamic load. The resultant load vector passes through the pad pivot

As before, the maximum pressure is located not at the pad pivot location, but at some angle with rotation from the pivot. Thus, temperature sensors should be placed downstream from the pivot. A good rule-of-thumb is to locate the sensor at the 75 percent position as in thrust bearings. That is, at 75 percent of the total pad arc length from the leading edge (Figure 4).

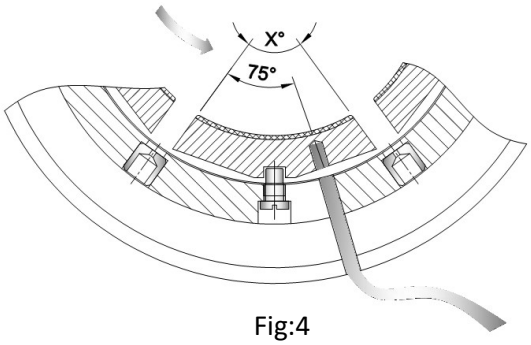


Fig:4

2 GEOMETRIC ADVANTAGE OF TILTING PAD BEARINGS

2.1TILTING PAD ORIENTATION

Main advantage of tilting pad bearings is that Tilting Pad enable to set the many design parameters that are available to handle maximised Load and speed . The load between pivot configuration is shown in Figure 3 while the load on pivot case may be seen in Figure 4.

Load between pads provides more symmetric stiffness and damping coefficients. In that case the xx and yy values for K and C approach extreme asymmetry as the Somerfield number decreases for the load on pad case. For load between pads (between pivots), the xx and yy values are very close for the entire Somerfield number range. Symmetric support properties provide circular orbits, whereas asymmetric supports cause the elliptical orbit .

For centrally pivoted pads, n = 0.5 (50 percent offset). Typical offset pivot values range from o = 0.55 to n = 0.6 (55 to 60 percent offset).
Offset pivots are very popular with thrust bearings, as offset- ting the pivot increases the operating film thickness, thereby decreasing the operating temperature (i.e., increases the load capacity). For tilt pad journal bearings, offset pivots also increase load capacity.

2.1 BEARING PRELOAD

Possibly" PRELOAD" is most used Tilting Pad Bearing parameter to the Bearing designer to application wise bearing Design.

2.1.a ZERO PRELOADED PAD

The zero preload is the pattern where the pad radius of curvature equals the pivot radius ,and the pad clearance equals the bearing clearance . When the bearing and journal centres coincide, the journal-to-pad radial clearance at any circumferential location along the pad is constant and equal to the bearing radial clearance.

2.1.b PRELOAD PAD

A preload in enable to the pad when the pad clearance is greater than the bearing clearance. In general preload values range vary from 0.2 to 0.6. When a pad is preloaded, a converging film section exists and the pad will produce hydrodynamic forces even if the bearing load approaches zero.

Advantages of Tilting Pad Journal Bearings

- Maximum possible stability of rotating parts
- Low sensitivity to load direction
- Oil flow can be minimised - it reduces losses caused by friction
- Multiple Pad orientation enable to handle a huge range of roto-dynamic circumstance.

Advantage of SUNTECH® Tilting Pad Journal Bearing.

- Simple and sustainable design.
- Combination of Journal and Thrust arrangement enables universal applicability.
- Optimised lubrication of bearings enables minimum power loss and temperature.
- Customized backing material enable to handle wide customer needs.
- Varity range of sealing system-Floating and Rigid seal.

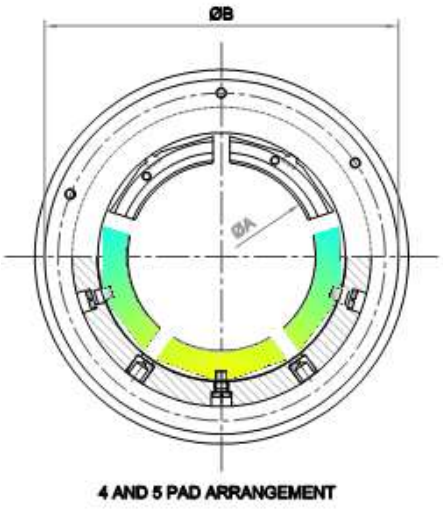
3. BEARING SELECTION EXAMPLE

	1	2	3	4	5	6	7
Model Nomenclature "STPB"	STPB	4	C	70	R	UD	125
Number Of Pads							
4 Bearing with 4 Tilting Pad							
5 Bearing with 5 Tilting Pad							
Load Direction							
J Journal Bearing							
C Combined Bearing							
L/D Ratio							
40 40% Brg Diameter							
70 70% Brg Diameter							
100 100% Brg Diameter							
Sealing Option							
R Rigid Seal							
F Floating seal							
o Open Cover							
Direction of Rotation							
CP Centre Pivoted							
OP Offset Pivoted							
UD Unidirectional							
Journal diameter							

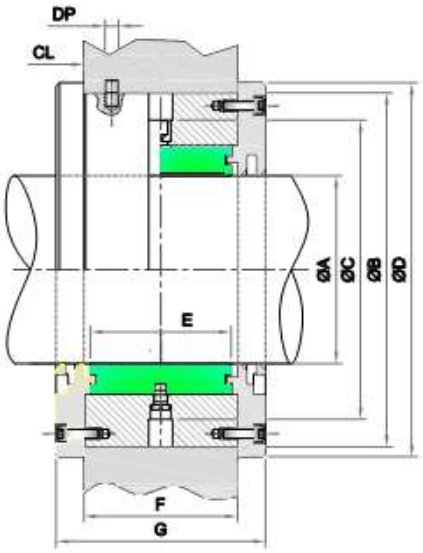
***Example: Force Lubricated , 5 Padded , Combined Bearing having L/D Ratio 70% with Rigid Seal,Bearing ID 125 mm and Un-idirectional in rotation.

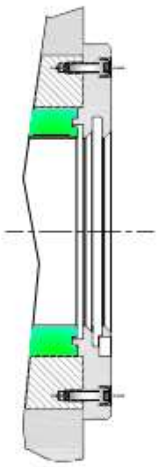
STPB-4C70R-UD-125

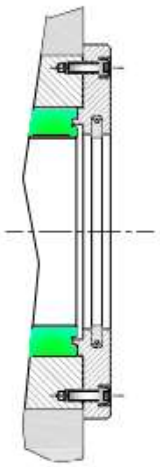
4. TILTING PAD JOURNAL BEARING 40 – 355 MM



4 AND 5 PAD ARRANGEMENT

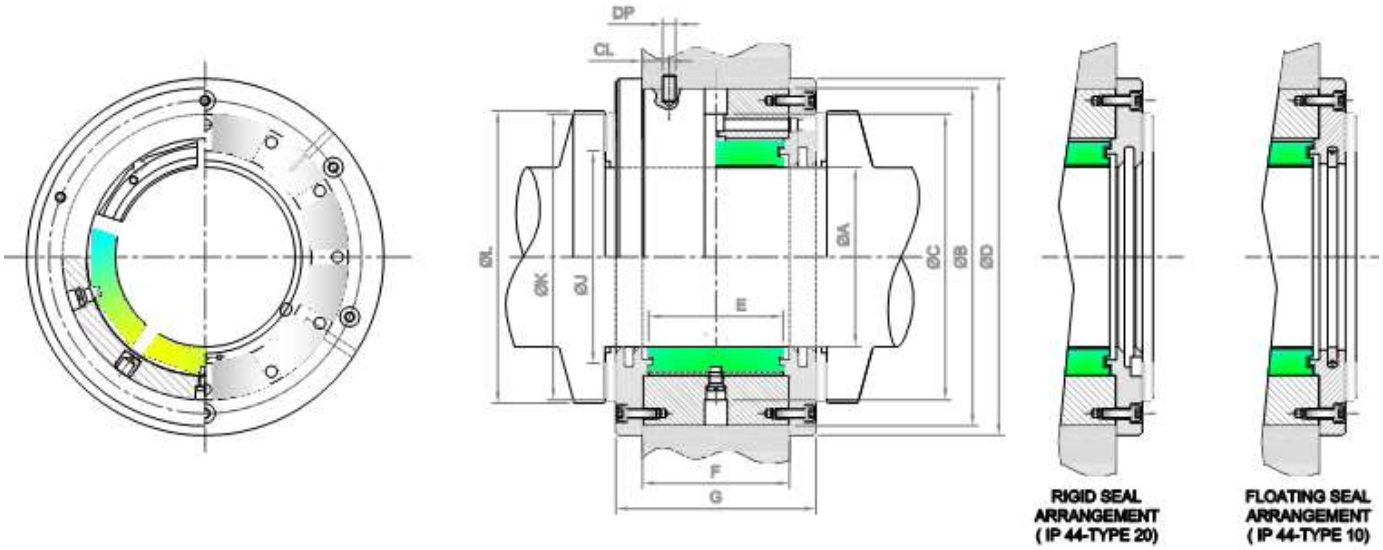



RIGID SEAL ARRANGEMENT (IP 44-TYPE 20)


FLOATING SEAL ARRANGEMENT (IP 44-TYPE 10)

A	B	C	D	E			F			G			DP	CL
				40	70	100	40	70	100	40	70	100		
40	82	75	90	16	28	40	21	33	45	50	62	74	4	4
45	89	81	98	18	32	45	23	36	50	52	65	79	4	4
50	95	88	104	20	35	50	25	40	55	54	69	84	5	5
55	110	103	120	22	38	55	27	43	60	56	72	89	5	5
60	120	112	130	24	42	60	29	47	65	58	76	94	5	5
65	120	112	130	26	45	65	31	49	70	60	78	99	5	5
70	130	121	141	28	49	70	33	54	75	63	84	105	6	6
80	138	128	150	32	56	80	37	61	85	77	101	125	6	6
90	160	150	177	36	63	90	42	69	96	82	109	136	8	8
100	175	163	190	40	70	100	46	76	106	86	116	146	8	8
110	190	178	204	44	77	110	50	83	116	90	123	156	8	8
120	215	200	230	48	84	120	54	90	126	95	131	167	10	10
125	220	205	230	50	88	125	58	97	136	99	138	177	10	10
140	228	212	244	56	98	140	63	105	147	104	146	188	10	10
160	265	245	284	64	112	160	71	119	167	112	160	208	12	12
180	295	272	317	72	125	180	80	134	188	121	175	229	12	12
200	330	305	357	80	140	200	88	148	208	130	190	250	16	16
220	370	345	397	88	154	220	96	162	228	153	219	285	16	16
225	370	345	397	90	158	225	104	176	248	161	233	305	16	16
250	400	370	431	100	175	250	109	184	259	166	241	316	20	20
280	450	420	477	112	196	280	122	206	290	179	263	347	20	20
300	450	420	511	120	210	300	130	220	310	188	278	368	20	20
315	510	474		126	220	315							20	20
355	575	535		142	248	355							20	20

5. TILTING PAD COMBINED BEARING 40 – 355 MM



A	B	C	D	E			F			G			J	K	L	DP	CL
				40	70	100	40	70	100	40	70	100					
40	82	75	90	16	28	40	21	33	45	50	62	74	80	50	82	4	4
45	89	81	98	18	32	45	23	36	50	52	65	79	85	55	87	4	4
50	95	88	104	20	35	50	25	40	55	54	69	84	95	60	98	5	5
55	110	103	120	22	38	55	27	43	60	56	72	89	100	70	103	5	5
60	120	112	130	24	42	60	29	47	65	58	76	94	105	75	108	5	5
65	120	112	130	26	45	65	31	49	70	60	78	99				5	5
70	130	121	141	28	49	70	33	54	75	63	84	105	120	85	123	6	6
80	138	128	150	32	56	80	37	61	85	77	101	125	130	95	133	6	6
90	160	150	177	36	63	90	42	69	96	82	109	136	155	105	158	8	8
100	175	163	190	40	70	100	46	76	106	86	116	146	165	120	168	8	8
110	190	178	204	44	77	110	50	83	116	90	123	156	175	130	178	8	8
120	215	200	230	48	84	120	54	90	126	95	131	167	190	140	193	10	10
125	220	205	230	50	88	125	58	97	136	99	138	177				10	10
140	228	212	244	56	98	140	63	105	147	104	146	188	215	160	218	10	10
160	265	245	284	64	112	160	71	119	167	112	160	208	245	185	248	12	12
180	295	272	317	72	125	180	80	134	188	121	175	229	280	210	283	12	12
200	330	305	357	80	140	200	88	148	208	130	190	250	305	230	309	16	16
220	370	345	397	88	154	220	96	162	228	153	219	285	325	250	329	16	16
225	370	345	397	90	158	225	104	176	248	161	233	305				16	16
250	400	370	431	100	175	250	109	184	259	166	241	316	370	285	374	20	20
280	450	420	477	112	196	280	122	206	290	179	263	347	410	320	415	20	20
300	450	420	511	120	210	300	130	220	310	188	278	368	430	340	435	20	20
315	510	474		126	220	315										20	20
355	575	535		142	248	355										20	20

SUNTECH® uses a spray nozzle lubrication system for Tilting Pad Journal Bearings. Spray nozzles are located between Tilting Pads which improves oil flow and oil film thickness. The Tilting Pad profile is designed to reduce power loss. SUNTECH® standard pads are made from steel with tin white metal lining.

A common alternative to steel backed pads is a Copper Chrome (Cu/Cr) backing to reduce surface temperatures and increase load capacity at higher speeds. Lining materials such as lead bronzes are also available to meet special requirements.

The Tilting Pad Journal Bearings can be supplied with temperature sensors. For bearing size selection it is necessary to make bearing calculation. Number of pads in bearing depends on calculation results. SUNTECH® can supply Tilting Pad Combined Bearings with hydrostatic jacking for special applications.

POWER LOSS AND OIL FLOW

The power loss in a bearing results from the combination of viscous shear in the oil film and (in flooded bearings) of turbulence in the oil caused by the rotation of the shaft in an oil filed housing. This power loss appears as heat, and this must be removed from the bearing by the flow of lubricant. Computer programs exist to give accurate estimates of power loss and the oil flow required.

LUBRICATION

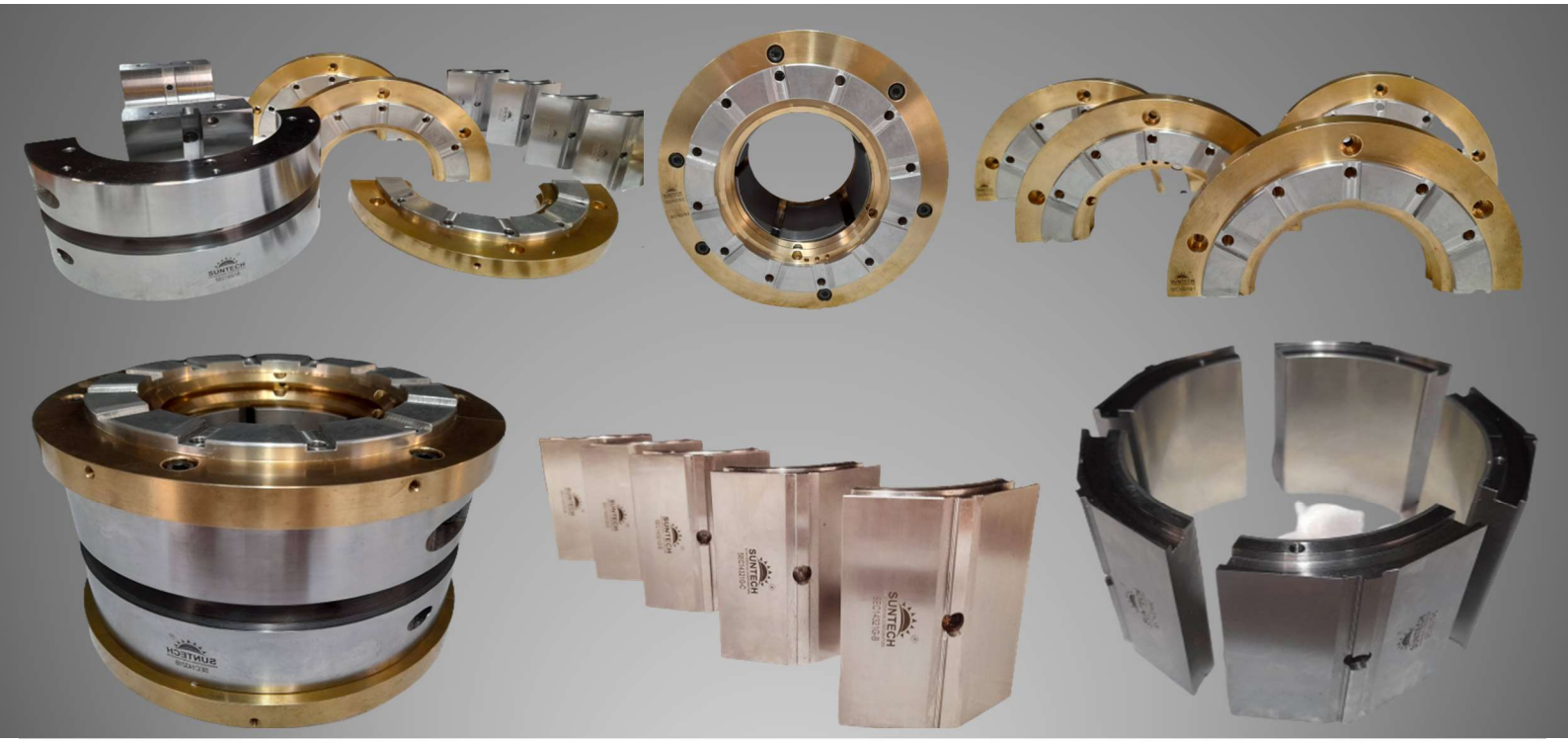
SUNTECH® make Tilting Pad Thrust Bearings will normally be supplied with the' Directed Lubrication' system of lubrication since, even at relatively low sliding speeds, benefits such as the avoidance of shaft oil seals make this an obvious preference. However, there may be occasions when flooded lubrication is more appropriate, and this option is available. For a proper explanation of the differences between flooded and 'Directed Lubrication' it is requested to contact with “SUNTECH® Engineering Corporation”

INTERCHANGEABILITY

SUNTECH® make modular range of Tilting pad Journal bearing is designed for optimum compactness and flexibility. As such, it can match or improve upon the space envelope required for any similar bearing product. It can therefore retrofit or be made completely interchangeable with other equalized bearing types. It can also be customised in terms of external dimensions

ANTI-ROTATION

The Thrust Bearings will normally supplied with the standard anti-rotation pin position which is optimal from the bearing design point of view. In case the machine casing cannot accommodate the corresponding slot in this position, an alternative anti-rotation pin position will be provide.



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