



MATERIAL AND APPLICATIONS

The table below lists the different materials used in the bearings currently manufactured by AMES and their most important characteristics from the point of view of the bearing's performance.

MATERIAL	AMES Reference	CHEMICAL COMPOSITION %					δ (g/cc)	K (MPa)	Oil %min	COMPARABLE STANDARDS			APPLICATIONS
		Fe	Cu	Sn	C	Others				MPIF Std/35	ISO 5755/1	Others	
Bronze (low graphite)	SC-Sn10-62	-	87,2÷90,5	9,5÷10,5	<0,3	2,0	6,0÷6,4	131	24	CT-1000-K19	P4011 Z	ASTM B438	Good corrosion resistance. Withstands abrupt loads at low densities. At high densities, contains less oil and is used for high speed. Adapts to the shaft's shape better than iron.
	SC-Sn10-66	-	87,2÷90,5	9,5÷10,5	<0,3	2,0	6,4÷6,8	179	19	CT-1000-K26	P4012 Z	SINT-A50	
	SC-Sn10-70	-	87,2÷90,5	9,5÷10,5	<0,3	2,0	6,8÷7,2	255	12	CT-1000-K37	P4013 Z	SINT-B50	
Bronze (medium graphite)	SC10-Sn10-62	-	87,5÷90,0	9,5÷10,5	0,5÷1,8	2,0	6,0÷6,4	117	22	CTG-1001-K17	P4022 Z	ASTMB438	Can withstand high loads and high speeds, in addition to moderately abrasive conditions.
	SC10-Sn10-66	-	87,5÷90,0	9,5÷10,5	0,5÷1,8	2,0	6,4÷6,8	159	17	CTG-1001-K23	P4023 Z	SINT-A51	
	SC10-Sn10-70	-	87,5÷90,0	9,5÷10,5	0,5÷1,8	2,0	6,8÷7,2	228	9	CTG-1001-K33		SINT-B51	
Bronze (high graphite)	SC40-Sn10-60	-	82,5÷87,5	9,5÷10,5	3,0÷5,0	2,0	5,8÷6,2	69	11	CTG-1001-K10			Silent. Require less oil. Used for oscillating or alternating movements. Can be used without oil, withstanding high temperatures.
	SC40-Sn10-64	-	82,5÷87,5	9,5÷10,5	3,0÷5,0	2,0	6,2÷6,6	103	4	CTG-1004-K15			
	SC40-Sn10-68	-	82,5÷87,5	9,5÷10,5	3,0÷5,0	2,0	6,6÷7,0	155	-				
Bronze with Zinc and Lead	SC-Sn8-Zn5-Pb3-62	<0,5	84,0÷86,0	6,5÷8,5	<0,5	Zn 3,5÷5,5 Pb<4,0	6,0÷6,4	131	22			UNE 37.103	Generally speaking, ideal for reducing friction and wear. More silent than the 90/10 Bronze. SC-Sn8-Zn5-Pb2-76 is special for high PV's with additional outer lubrication. From the tribological viewpoint, they are the best type of bronze of those listed here. Their only drawback may be the fact that they contain small quantities of Lead.
	SC-Sn8-Zn5-Pb3-66	<0,5	84,0÷86,0	6,5÷8,5	<0,5	Zn 3,5÷5,5 Pb<4,0	6,4÷6,8	179	17			UNE 37.103	
	SC-Sn8-Zn5-Pb3-70	<0,5	84,0÷86,0	6,5÷8,5	<0,5	Zn 3,5÷5,5 Pb<4,0	6,8÷7,2	255	9			UNE 37.103	
	SC-Sn8-Zn5-Pb3-76-AP	<0,5	84,0÷86,0	6,5÷8,5	<0,5	Zn 3,5÷5,5 Pb<4,0	7,4÷7,8	342	-				
	SC-Sn5-Zn5-Pb5-62	<0,5	84,0÷86,0	4,0÷6,0	<0,5	Zn 4,0÷6,0 Pb 4,0÷6,0	6,0÷6,4	131	22				
	SC-Sn5-Zn5-Pb5-66	<0,5	84,0÷86,0	4,0÷6,0	<0,5	Zn 4,0÷6,0 Pb 4,0÷6,0	6,4÷6,8	179	17				
	SC-Sn5-Zn5-Pb5-70	<0,5	84,0÷86,0	4,0÷6,0	<0,5	Zn 4,0÷6,0 Pb 4,0÷6,0	6,8÷7,2	255	9				
	SC-Sn8-Zn4-62	<0,5	86,0÷89,0	7,5÷9,0	<0,5	Zn 3,0÷5,0 Pb<0,3 Ni<1,0	6,0÷6,4	131	22				
Bronze with Zinc, Lead and graphite or S₂Mo	SC40-Sn5-Zn4-Pb2-64	<0,5	82,0÷85,0	4,0÷6,0	3,0÷5,0	Zn 4,0÷6,0 Pb<4,0	6,2÷6,6	103	-				Special materials for operating without oil at moderate speeds (maximum 1 m/s) and pressures below 4 kg/cm ² (maximum PV=2; see page 11).
	SC40-Sn5-Zn4-Pb2-68	<0,5	82,0÷85,0	4,0÷6,0	3,0÷5,0	Zn 4,0÷6,0 Pb<4,0	6,6÷7,0	155	-				
	SM40-Sn5-Zn4-Pb2-64	<0,5	82,0÷85,0	4,0÷6,0	<0,5	Zn 4,0÷6,0 Pb<4,0 S ₂ Mo <4,5	6,2÷6,6	103	-				
	SM40-Sn5-Zn4-Pb2-68	<0,5	82,0÷85,0	4,0÷6,0	<0,5	Zn 4,0÷6,0 Pb<4,0 S ₂ Mo <4,5	6,6÷7,0	155	-				
Iron	SF-58	97,7÷100	-	-	<0,3	2,0	5,6÷6,0	103	21	F-0000-K15	P1012 Z	SINT-A00	Suitable for medium loads. Harder and tougher than the 90/10 Bronze. In poor lubrication conditions, performs less well than the bronzes. Cheaper. Risk of rusting.
	SF-62	97,7÷100	-	-	<0,3	2,0	6,0÷6,4	158	17	F-0000-K23	P1013 Z	SINT-B00	
Iron Carbon	SF05-58	97,4÷99,7	-	-	0,3÷0,6	2,0	5,6÷6,0	138	21	F-0005-K20			Better features than iron alone, greater toughness with greater radial crushing strength, greater resistance to wear and compressive strength. In poor lubrication conditions, performs less well than the bronzes.
	SF05-62	97,4÷99,7	-	-	0,3÷0,6	2,0	6,0÷6,4	193	17	F-0005-K28			
	SF08-58	97,1÷99,4	-	-	0,6÷0,9	2,0	5,6÷6,0	138	21	F-0008-K20			
	SF08-62	97,1÷99,4	-	-	0,6÷0,9	2,0	6,0÷6,4	221	17	F-0008-K32			
Iron Copper	SF-C3-58	93,8÷98,5	1,5÷3,9	-	<0,3	2,0	5,6÷6,0	138	22	F-0200-K20	P2012 Z	SINT-A10	The addition of copper to the iron improves hardness and strength compared with bronze. The value of these two features decreases at higher copper contents. With the addition of 20% copper, the material is harder and tougher than the 90/10 Bronze and has a greater impact load resistance. In poor lubrication conditions, performs less well than the 90/10 bronzes. This type of material is normally used when improved mechanical properties are required.
	SF-C3-62	93,8÷98,5	1,5÷3,9	-	<0,3	2,0	6,0÷6,4	234	17	F-0200-K34	P2013 Z	SINT-B10	
	SF-C10-58	87,2÷90,5	9,5÷10,5	-	<0,3	2,0	5,6÷6,0	139	22	F-1000-K20			
	SF-C10-62	87,2÷90,5	9,5÷10,5	-	<0,3	2,0	6,0÷6,4	276	17	F-1000-K40			
	SF-C20-58	75,7÷82,0	18,0÷22,0	-	<0,3	2,0	5,6÷6,0	172	22	F-2000-K25		SINT-A20	
	SF-C20-62	75,7÷82,0	18,0÷22,0	-	<0,3	2,0	6,0÷6,4	276	17	F-2000-K40		SINT-B20	
Iron Copper-Carbon	SF05-C3-58	93,5÷98,2	1,5÷3,9	-	0,3÷0,6	2,0	5,6÷6,0	138	22	FC-0205-K20			They are less tough than copper iron with small copper percentages. They have a higher wear and compressive strength. The hardness and strength values decrease at higher copper contents. In poor lubrication conditions, performs less well than the 90/10 bronzes.
	SF05-C3-62	93,5÷98,2	1,5÷3,9	-	0,3÷0,6	2,0	6,0÷6,4	241	17	FC-0205-K35			
	SF08-C3-58	93,2÷97,9	1,5÷3,9	-	0,6÷0,9	2,0	5,6÷6,0	172	22	FC-0208-K25			
	SF08-C3-62	93,2÷97,9	1,5÷3,9	-	0,6÷0,9	2,0	6,0÷6,4	276	17	FC-0208-K40		SINT-B11	
	SF08-C5-58	91,1÷95,4	4,0÷6,0	-	0,6÷0,9	2,0	5,6÷6,0	241	22	FC-0508-K35			
	SF08-C5-62	91,1÷95,4	4,0÷6,0	-	0,6÷0,9	2,0	6,0÷6,4	317	17	FC-0508-K46			
	SF08-C20-58	75,1÷81,4	18,0÷22,0	-	0,6÷0,9	2,0	5,6÷6,0	303	22	FC-0208-K44		SINT-A22	
	SF08-C20-62	75,1÷81,4	18,0÷22,0	-	0,6÷0,9	2,0	6,0÷6,4	317	17	FC-0208-K46		SINT-B22	
Iron Bronze	SF08-Cu36-Sn4-58	54,2÷62,0	34,0÷38,0	3,5÷4,5	0,5÷1,3	2,0	5,6÷6,0	110	22	FCTG-3604-K16			Used for low and medium loads and medium to high speeds.
	SF08-Cu36-Sn4-62	54,2÷62,0	34,0÷38,0	3,5÷4,5	0,5÷1,3	2,0	6,0÷6,4	152	17	FCTG-3604-K22			
	SF08-Cu38-Sn6-58	50,2÷58,0	36,0÷40,0	5,5÷6,5	0,5÷1,3	2,0	5,6÷6,0	97	22	CFTG-3806-K14			
	SF08-Cu38-Sn6-62	50,2÷58,0	36,0÷40,0	5,5÷6,5	0,5÷1,3	2,0	6,0÷6,4	152	17	CFTG-3806-K22			

NOTE: The density values are given with the bearing impregnated with oil having a density of 0.88 g/cc.



LOAD-SPEED CURVES

Definition of PV

The **PV** factor will be an indicator of the severity under which the bearing is operating. It is obtained by multiplying the mean pressure applied on the bearing by the linear speed of the shaft surface.

To obtain the value of the mean pressure **P** applied on the bearing, we must first know the value of the load **Q** on the bearing and the area **S** over which this load is distributed. **Figure 5** shows how the distribution area is calculated. It is equal to the projected area of the bearing's inner diameter. The projected area **S** is obtained by multiplying the inner diameter by the bearing's length.

The mean pressure **P** obtained by dividing **Q** by **S** is a theoretical value that has very little similarity with the specific pressures received by the bearing due to the roughness of the shaft surface and of the bearing itself.

The speed **v** (in m/s) is

the linear speed at the shaft end in contact with the bearing.

Thus, **PV** is defined as the product of the mean pressure **P** multiplied by the linear speed **V**.

Load-speed curves

It is possible to plot each bearing's operating limits, depending on the material it is made of. The limits will be imposed directly by the load or by the speed.

Graph 3 shows the usual limits at which AMES standard bearings operate. The units used for **PV** are [MPa][m/s].

The limit for **PV** shown in this graph is **1,8 MPa-m/s**.

PV 50 bearings.

For special cases, AMES has developed bearings able to operate at **PV=5MPa-m/s**.

They are suitable for replacing ball and needle bearings in many cases, of-

fering economic and technical advantages such as reduced noise or increased corrosion resistance.

Interested customers should ask our technical department about this type of bearing.

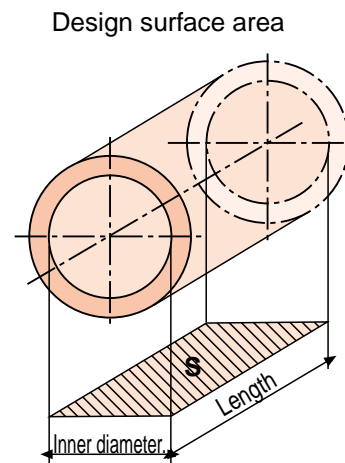
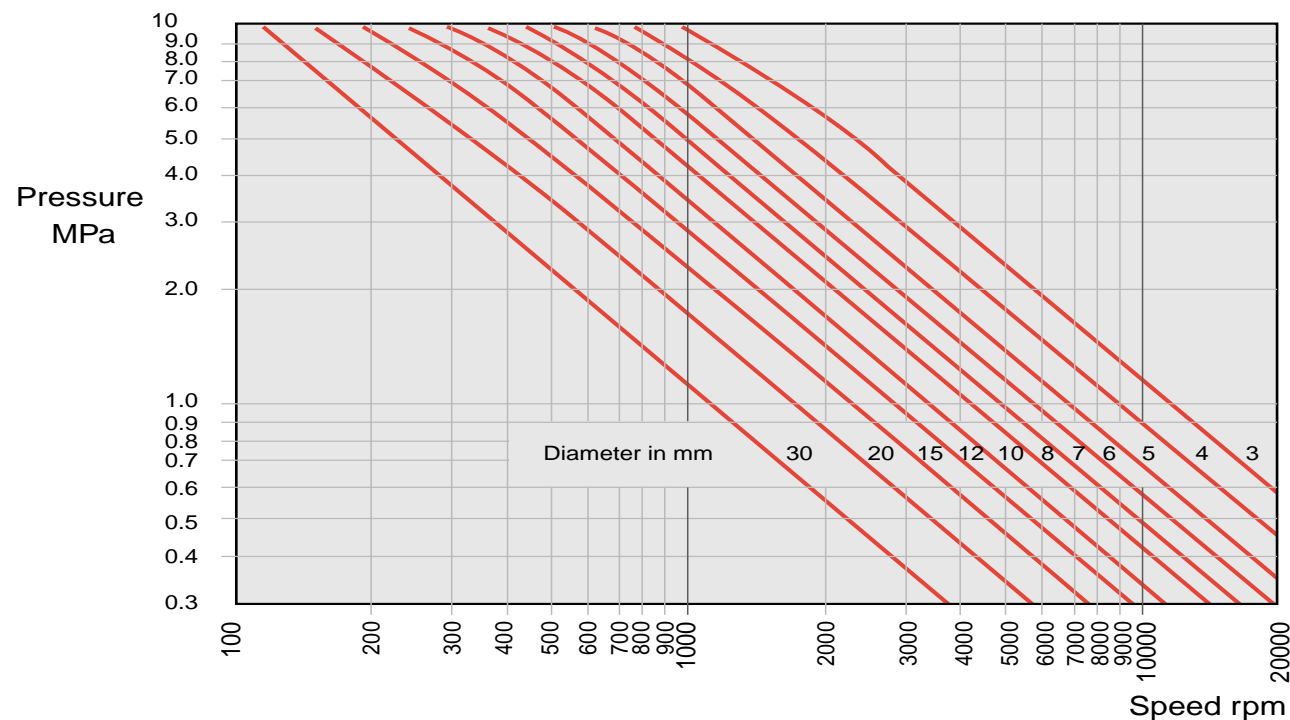


Figure 5. PROJECTED AREA



Graph 3 . MAXIMUM PRESSURE AS A FUNCTION OF THE SPEED



LUBRICANTS. SELECTION CRITERIA.

The lubricant is stored inside the pores. Its primary function is to form a lubricating film between the shaft and the bearing to prevent direct friction between the two and thus avoid wear. This is achieved by the oil's slipperiness and the shaft's effect on the oil stored inside the bearing's structure, entraining it until the desired film is formed (oil wedge).

When the shaft stops, this oil is reabsorbed by the bearing's pores due to capillary action.

The lubricant chosen should fulfil this function in each application's operating conditions.

First, we must choose between a mineral oil and a synthetic lubricant.

Mineral oils. These are hydrocarbons obtained from the distillation of crude oil. They can be classified as paraffinic, naphthenic and aromatic, depending on the functional groups they are composed of. The paraffinic oils, with a viscosity index of about 100, are the most suited for self-lu-

bricating bearings at temperatures between -10°C and 90°C . At temperatures below -10°C , they lose lubricating properties. The naphthenic oils are not such good lubricants as the paraffinic oils, but they are reasonably good for low temperatures to -20°C . Their viscosity index is about 50. Finally, the aromatic oils are virtually never used for self-lubricating bearings.

Generally speaking, the mineral oils are better lubricants than synthetic lubricants for temperatures between -10°C and 90°C . At higher temperatures, mineral oils oxidise and rapidly lose their properties. For very low temperatures, synthetic lubricants must be used because of their low freezing point.

The mineral oils' properties are improved with additives added in small concentrations to the mineral base. These concentrations may range from ppm to several percent.

The additives improve the base oil's properties, giving it the characteristics required for each type of ap-

plication.

Antioxidant additives reduce the rate at which the oil oxidises.

Defoamant additives prevent foaming while the oil circulates through the pores.

Antiwear additives form a molecule-sized separating layer between the two working surfaces.

Extreme pressure additives etch the bearing's surface, forming an anti-seize layer suitable for operating in oily conditions.

Anti "stick-slip" additives alter the static coefficient of friction, enabling smooth movement of the shaft without short stops and starts.

Additives improving the viscosity index offer increased viscosity stability over a range of temperatures.

Synthetic lubricants. Synthetic lubricants are synthetic fluids whose chemical composition and structure have been specifically formulated to give good lubrication properties.

Their main advantages over mineral oils include in-

creased oxidation resistance, higher viscosity index, increased stability of all properties over the lubricant's life (i.e., a longer service life) and increased compatibility with the materials surrounding them. Some of these characteristics are not general to all synthetic lubricants but are found individually in particular lubricants.

Synthetic lubricants are used at high or low operating temperatures ($<-20^{\circ}\text{C}$ or $>90^{\circ}\text{C}$) or in other special conditions. They can be used in extreme conditions between -50°C and 250°C .

	Mineral		Synthetic			
	Low additive content	High additive content	Polyalphaolefins	Esters	Silicones	Perfluorinated ether
Operating temperatures ($^{\circ}\text{C}$)	-10 80	-20* 90	-40 160	-60* 190	-50 190	-50 230
Density (g/cc)	0,87	0,88	0,84	0,92*	1,00	1,92
Viscosity Index (VI)	97	120	140	160*	180	140*
Performance as lubricant	Good	Very good	Good	Good	Medium	Medium
Relative price-per-litre ratio	1	1,5	20	from 8 to 50	40	300
Remarks	Good lubricant in moderate operating conditions. If the temperature and other requirements permit, it is to be preferred to any other type.	Improves the lubricants' behaviour, particularly as regards VI, antioxidant properties and Extreme Pressure.	Good lubricant for a broad range of temperatures. Particularly good for sintered bearings. Low reactivity.	Very high VI: temperature stability. Very high slipperiness. Attacks paints and sealants.	VI may reach 400. Stable to oxidation. Non-flammable. Broad temperature range. Does not tolerate temperature changes well.	Suitable for very high temperatures. Long service life. Compatible with plastics and metals. Insoluble in petrol, chemically inert. Non-inflammable.

*May vary depending on the specific type and manufacturer.

Table 1. LUBRICANTS