

# Sintered Self-Lubricating Bearings

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## Properties

- silent running
- great reliability
- low maintenance costs
- no oil leakage

## Applications

Dish-washers	Computer equipment	Agricultural machines
Washing machines	Machine tools	Snow-scooters
Extractor fans	Packing equipment	Medical equipment
Hair dryers	Conveyors	Toys
Lawn mowers	Cranes	Office equipment
Electric motors	Cars and trucks	
Pumps	Fork-lift trucks	

## How do sintered self-lubricating bearings work?

The bearing is impregnated with oil. The volume of the oil is between 20 and 30 per cent of the volume of the bearing. The oil is sufficient for thousands of running hours.

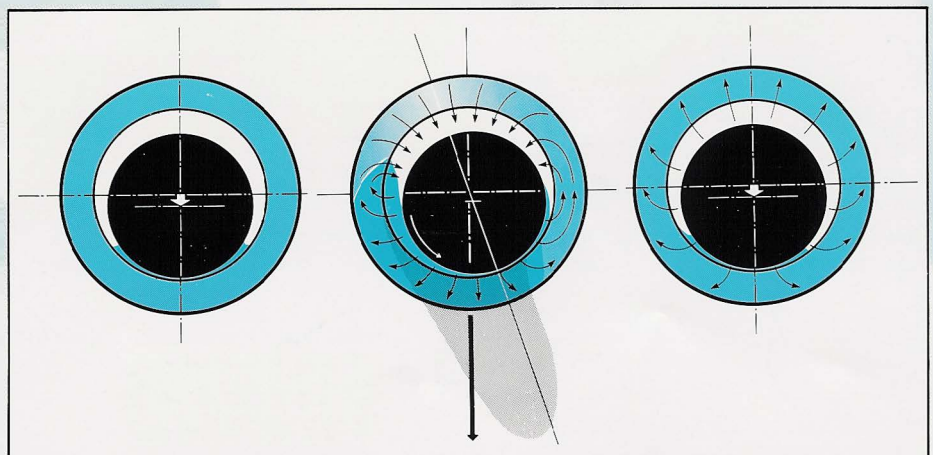
The film of oil between the sintered bearing and the shaft is formed by capillary action, elastic deformation and thermal expansion.

When starting it is mainly the capillary action which forms the oil film. When the shaft is stationary, there is an oil film on both sides of the line where the shaft and the bearing are in contact with each other. The position of the

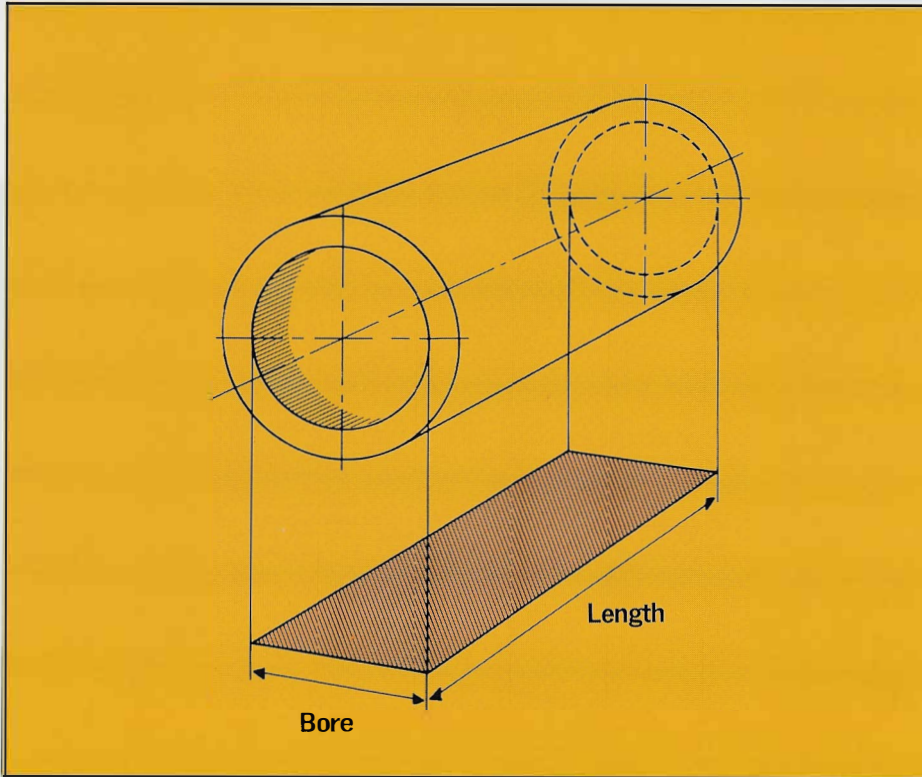
shaft in relation to the bearing changes once it starts to rotate. The porous bearing material is compressed and oil squeezes out into the bearing wedge.

When the shaft rotates the temperature of the bearing increases. More oil is then pushed out into the wedge due to the fact that oil has a larger thermal expansion than the bearing metal.

Once the speed of rotation increases the lubrication becomes hydro-dynamic.



# Loading



The possible loading surface is equal to the projected bearing area.

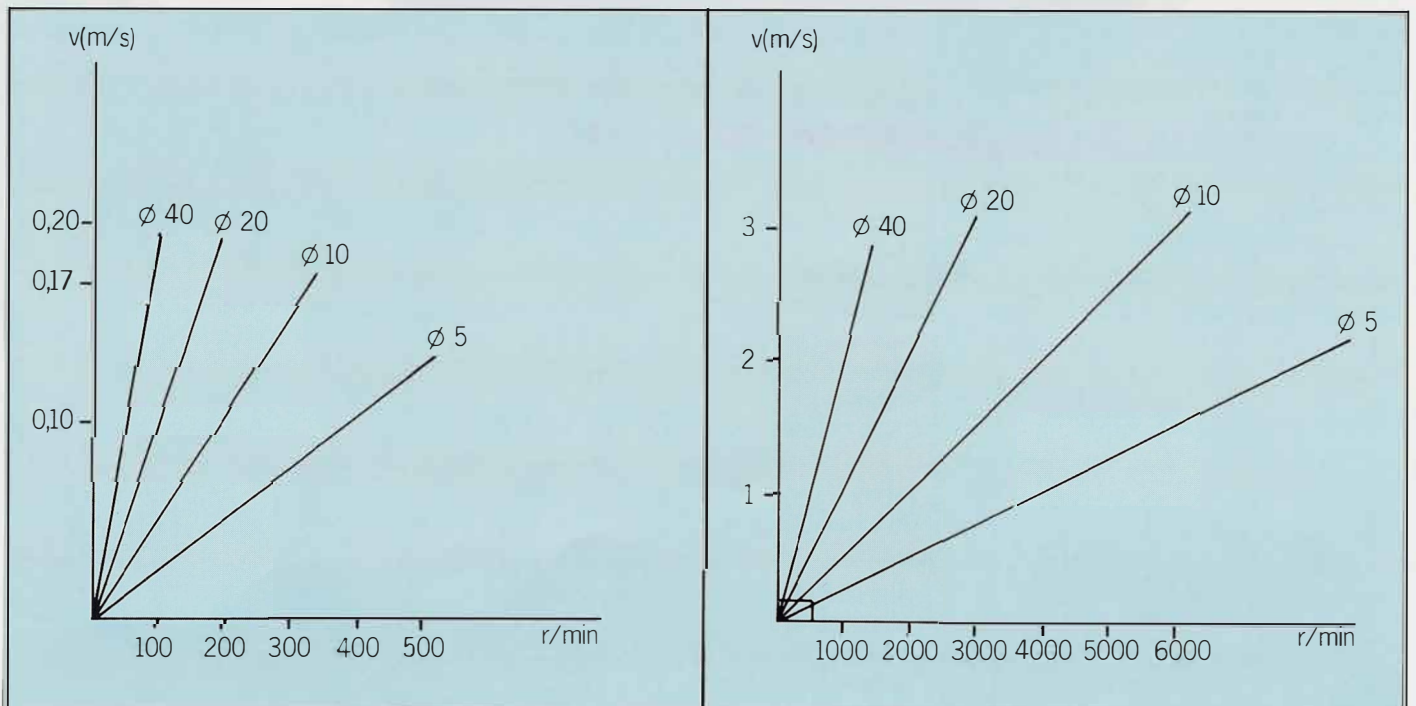
When deciding which self-lubricating bearing to use several factors such as loading, surface velocity, temperature and shaft material, must be taken into account. The bearing function is also affected by the method of fitting, vibrations and heat dissipation. It is therefore not possible to give exact data for permissible loading, speed and life.

It can generally be said that the permissible loading is higher at lower speeds than at higher speeds.

Permissible loads are given in the table on page 4 as a  $p \times v$ -value. This is the product of the specific load,  $p$ , and the surface velocity of the shaft,  $v$ .

$$p \times v \text{ (N/mm}^2 \times \text{m/s)}$$

Relation between speed (r.p.m.) and surface velocity for different shaft diameters.



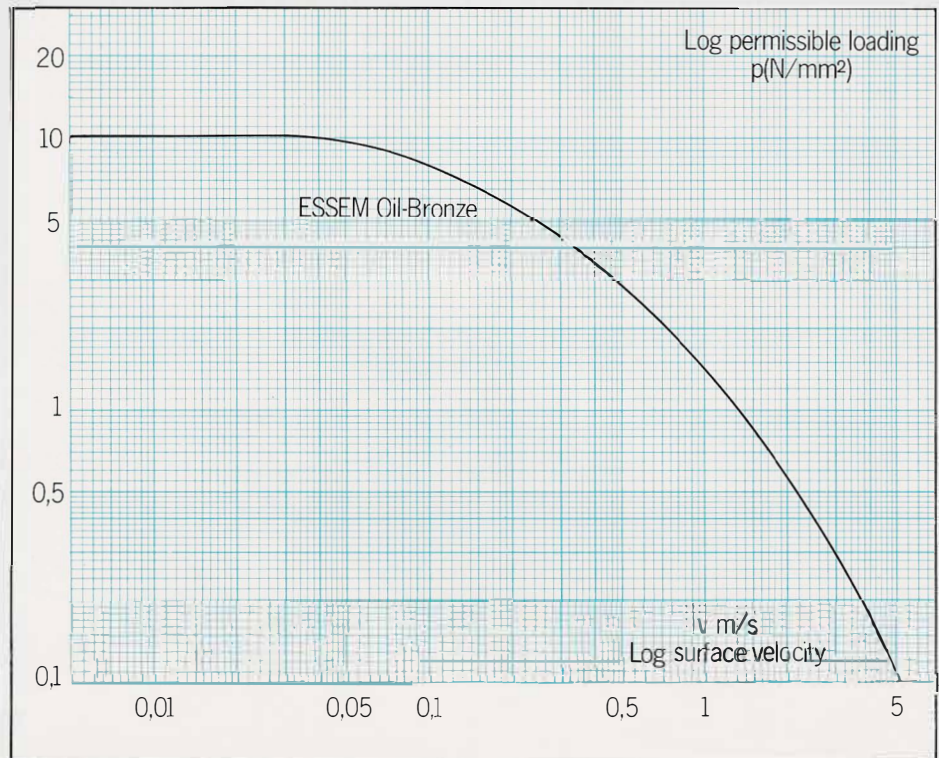


# Permissible loads and speeds

## Life

When used under ideal conditions a self-lubricating bearing can run for thousands of hours without additional lubrication. Abnormal running conditions, such as loading above the maximum permissible pv-value, shorten the life. Vibrations, misalignment and high ambient temperatures also shorten the life of oil lubricated bearings.

If possible, bearings should have lower loading and speed during a short running-in period than during normal usage.



The graph shows certain values for self-lubricating bearings without additional lubrication. Note that with additional lubrication the permissible loading can be increased even for high surface velocities.

## Coefficient of friction

The coefficient of friction is affected by many factors, such as the surface finish of the shaft material, the speed of rotation and the temperature of the bearing.

If the recommendations on page 5 are followed a coefficient of friction of 0,05–0,1 for oil lubricated bearings and 0,15–0,25 for dry lubricated bearing can be considered as normal.

With low loads and at high speeds lower values can be obtained for oil lubricated bearings.

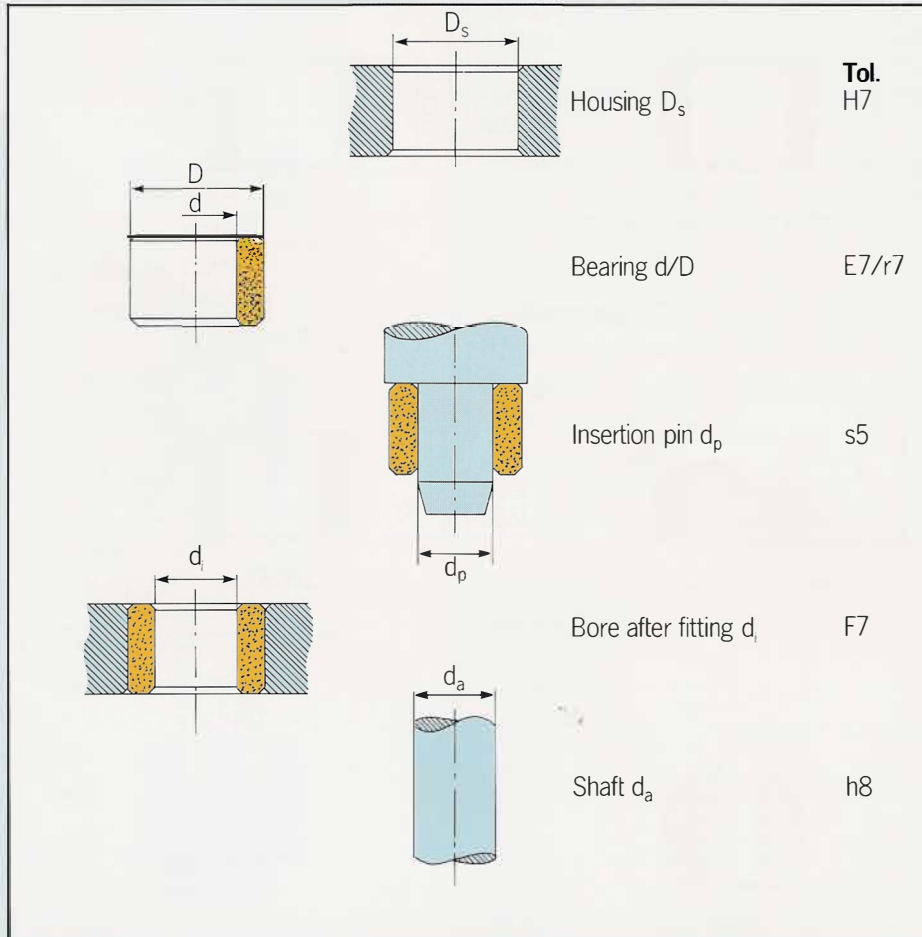
	ESSEM Oil-Bronze	GLISSA Oil-Steel	ESSEM Graphite-Bronze	ESSEM Lead-Bronze*	ESSEM Ferro-Bronze
<b>pv/Nmm<sup>2</sup> x m/s</b> Continuous service Life 10.000 h	1,6	1,6	0,4	1,3	1,7
<b>p max (N/mm<sup>2</sup>)</b> Continuous service Surface velocity approx. 0.17 m/s	10*	9,5*	2,5	10**	10*
<b>p max (N/mm<sup>2</sup>)</b> Static load 0,1 % deformation	50	50	40	50	50
<b>v max (m/s)</b> Continuous service	5	5	0,25	5	5

\* The oil film, which is formed quickly after starting, has its best loading capacity at a surface velocity of approx. 0,17 m/s.

\*\* External lubrication

# Recommended bearing tolerances, shafts and running clearances

## Plain and flanged bearings



## Shaft

It is important that the fitting of the bearing is carried out correctly and that the shaft has a good surface finish. The best results are obtained by grinding or polishing the shaft. A shaft with a poor surface finish can act as a reamer and thereby close the pores of the bearing surface. A surface finish of  $Ra \leq 1 \mu m$  is recommended.

Suitable shaft materials:

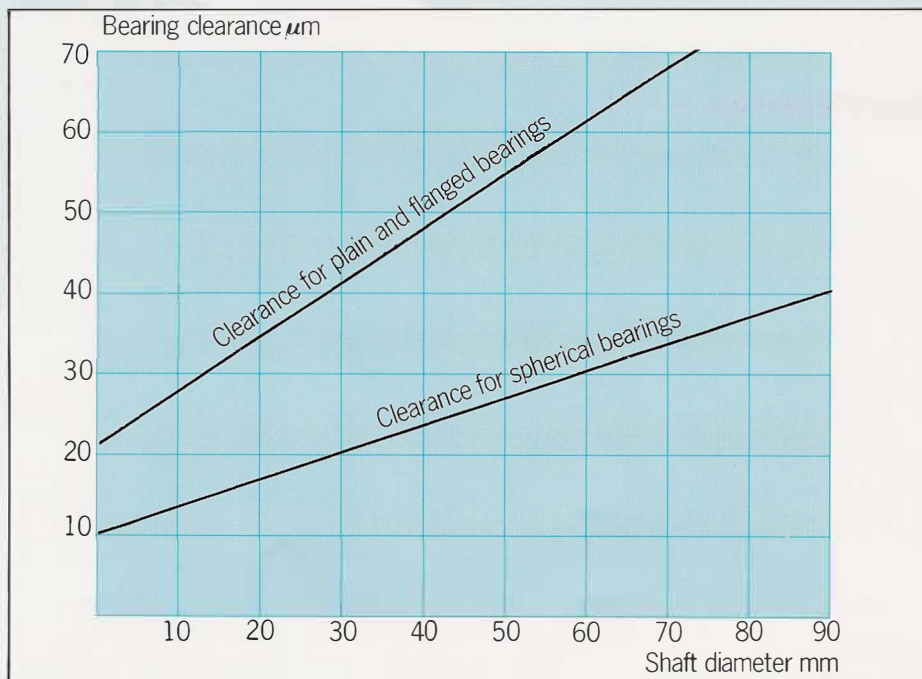
ISO/R 1052, Fe 60-2,  
ISO/R 683/XII-1972, Steel 3  
BS 972:1972 part 1, 080 M46

ISO 4957, Steel 19  
BS 4659, B 01

The shaft should be ground to tolerance h8 and can in most cases be used unhardened. Hard chromium plating is recommended where the shaft comes into contact with corrosive substances. Shafts of stainless steel can also be used but should be chromium plated or treated with molybdenum disulphide to improve the sliding properties.

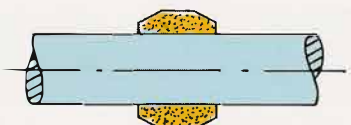
Bearings used in dirty or polluted environments should be protected by axial seals.

## Recommended clearance



## Spherical bearings

Bore $d$	Shaft $d_a$	Fitting
H7	g6	Close running fit
H6	g5	fit
F7	h6	Running fit
F6	h5	





# Standard bearings

## Stock sizes

Most sizes corresponding to ISO 2795 are available from stock.

## Special sizes

Many special sizes and tolerances can be manufactured from existing tooling by special order.

## Tolerances

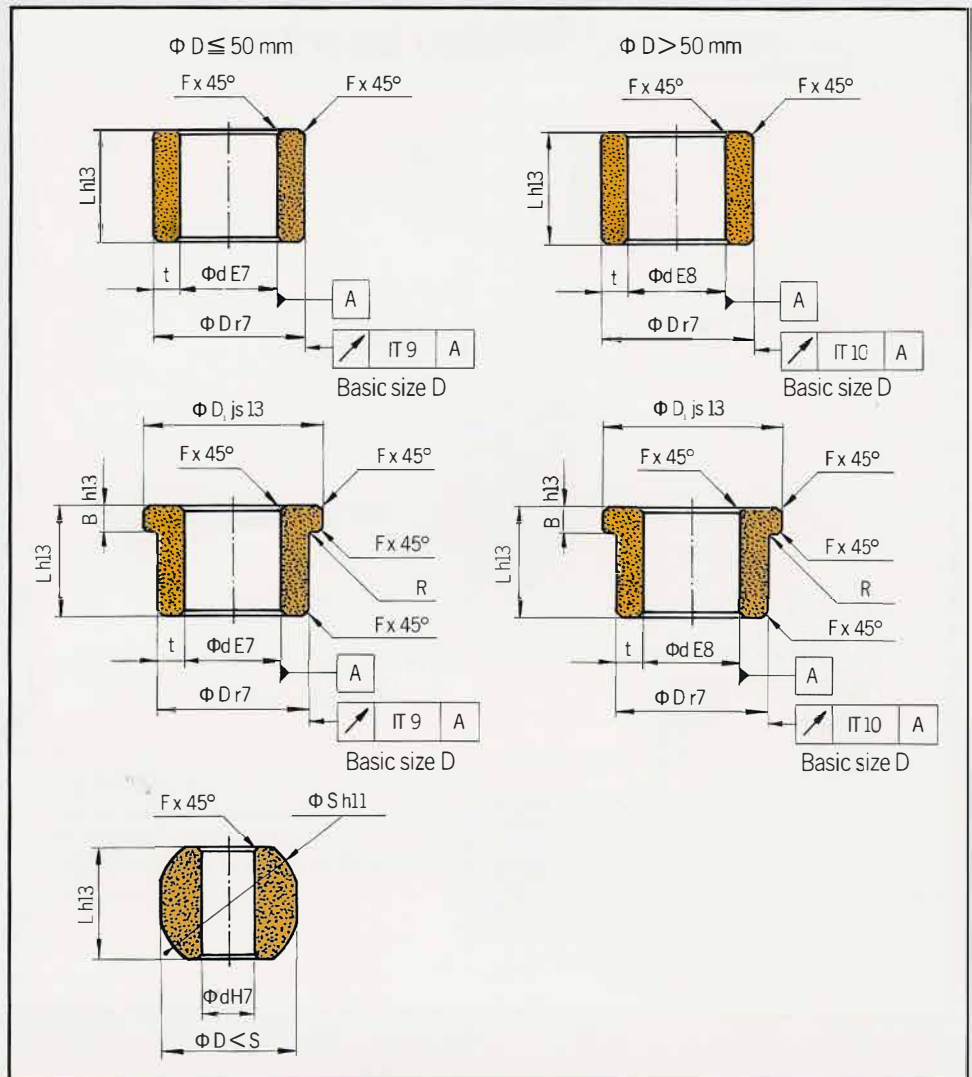
The sketches on the right show the normal tolerances for self-lubricating standard bearings.

### Exceptions:

Length tolerance h14 for bearings with wall thickness  $\leq 2$  mm.

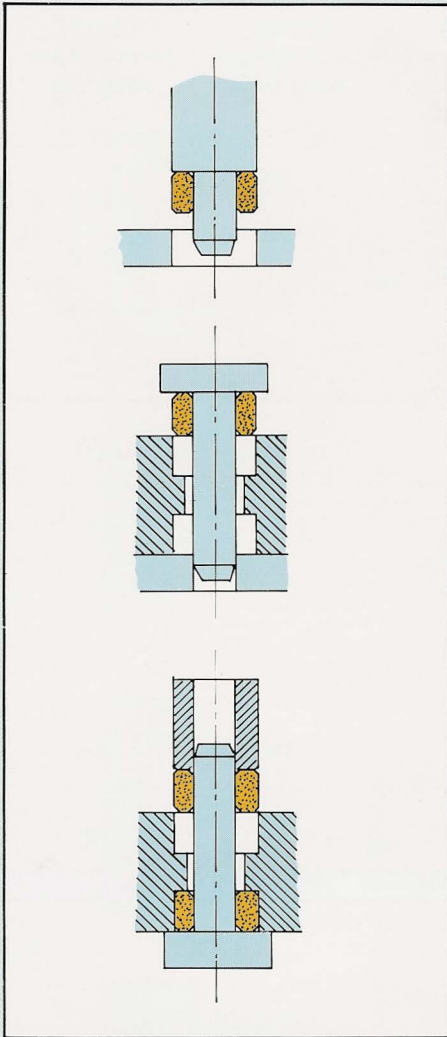
ESSEM Graphite-Bronze diameter tolerances dE8/Dr8, length tolerance h14, radial run-out IT 10 TIR.

Any deviation from these standards must be specified in enquiries and orders.



ISO tolerances Basic sizes (over)-to	Internal dimensions				External dimensions									
	E7	E8	F7	H7	g6	h8	h11	h13	h14	js13	r7	r8	IT9	IT10
-3	+24	+28	+16	+10	-2	0	0	0	0	+70	+20	+24	25	40
(3)-6	+14	+14	+6	0	-8	-14	-60	-140	-250	-70	+10	+10	30	48
(6)-10	+32	+38	+22	+12	-4	0	0	0	0	+90	+27	+33	36	58
(10)-18	+20	+20	+10	0	-12	-18	-75	-180	-300	-90	+15	+15	43	70
(18)-30	+40	+47	+28	+15	-5	0	0	0	0	+110	+34	+41	52	84
(30)-50	+25	+25	+13	0	-14	-22	-90	-220	-360	-110	+19	+19	62	100
(50)-65	+50	+59	+34	+18	-6	0	0	0	0	+135	+41	+50	74	120
(65)-80	+32	+32	+16	0	-17	-27	-110	-270	-430	-135	+23	+23	87	140
(80)-100	+61	+73	+41	+21	-7	0	0	0	0	+165	+49	+61	100	
(100)-120	+40	+40	+20	0	-20	-33	-130	-330	-520	-165	+28	+28	120	
	+75	+89	+50	+25	-9	0	0	0	0	+195	+59	+73	140	
	+50	+50	+25	0	-25	-39	-160	-390	-620	-195	+34	+34	160	
											+71	+87	180	
	+90	+106	+60	+30	-10	0	0	0	0	+230	+41	+41	200	
	+60	+60	+30	0	-29	-46	-190	-460	-740	-230	+73	+89	220	
											+43	+43	240	
											+86	+105	260	
	+107	+126	+71	+35	-12	0	0	0	0	+270	+51	+51	280	
	+72	+72	+36	0	-34	-54	-220	-540	-870	-270	+89	+108	300	
											+54	+54	320	

# Assembly—fitting



## Pressing

The bearings are porous and can be damaged if fitting is not carried out correctly. Assembly by hammer blows deforms the bearing. The correct method is by using a shouldered insertion pin.

When the recommended interference between housing and bearing (H7/r7) is used the shrinkage of the inner diameter will be 0,5–0,6 times the interference.

Fitting without the use of an insertion pin can only be done where a tolerance of more than IT8 is acceptable on the fitted bearing.

Insertion force required per mm<sup>2</sup> of outside surface area:

ESSEM Oil-Bronze	approx. 3 N
ESSEM Graphite-Bronze	approx. 2 N
ESSEM Ferro-Bronze	approx. 5 N

## Casting

Self-lubricating bearings can advantageously be cast into light metals, zinc alloys or plastics. This should be done before oil impregnation of the bearing. Grooving or knurling of the surface is not necessary as the bearing will normally have a good grip due to its porosity.

If it is not possible to impregnate the bearing, grease can be added during the assembly of the shaft. The bearing can be adjusted after fitting by sizing or machining.

Impregnation of the bearing is carried out by immersing in warm oil, max. temperature 80°C. The component should be immersed until the oil cools or for one hour in warm oil and then in cold oil.

## Bonding

It is also possible to fit self-lubricating bearings with Loctite or similar adhesives. The outer surface of the bearing should be degreased before bonding. Note that only the outer surface should be degreased and therefore degreasing apparatus cannot be used.

The clearance between the bearing and the housing should be up to 0.1 mm. When setting the tolerance on the shaft it should be remembered that the tolerance on the inner diameter of the bearing does not change when fitted by bonding as is the case when fitted by pressing.

# Material properties for standard materials

	ESSEM Oil-Bronze Alloy 630	GLISSA Oil-Steel Alloy 100	ESSEM Graphite- Bronze Alloy 640	ESSEM Lead-Bronze Alloy 670	ESSEM Ferro-Bronze Alloy 611
Approx. composition %					
Cu	89,5		78,0	80,0	45,0
Sn	9,3		8,0	10,0	4,5
C	1,2		6,0		1,0
Pb			8,0	10,0	
Fe		100,0			49,5
Density g/cm <sup>3</sup>	6,0	5,5	6,6	7,0	6,2
Oil content volume %	25	25			20
Ultimate tensile strength R <sub>m</sub> N/mm <sup>2</sup> <sup>1)</sup>	60	60	25	100	100
Elongation A % <sup>1)</sup>	1	2	0,5	3	1
Hardness HV 5	15	20	15	35	40
Linear expansion x 10 <sup>-6</sup> /K <sup>2)</sup>	18	12	14	18	15
Thermal conductivity W/m x K	40	30		40	35

Corresponding standards	MPIF CTG-1001-K17 ASTM B 438 grad 1 typ 1 SAE 840 Sint-A 51 ISO 5755/1 P 4021 Z	MPIF F-0000-K15 ASTM B 439 grad 1 SAE 850 Sint-A 00 ISO 5755/1 P 1011 Z			
	300 standard stock sizes				

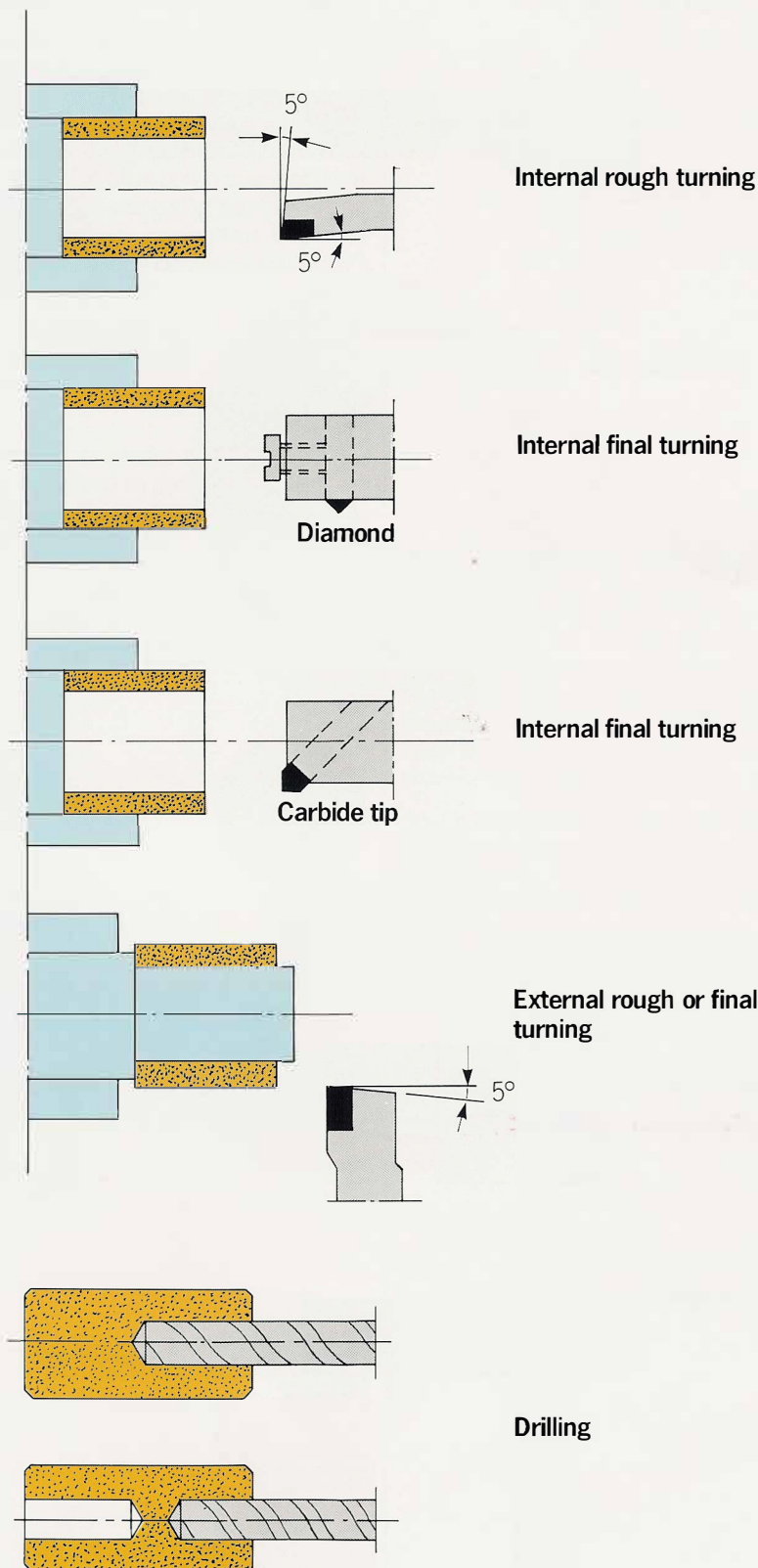
<sup>1)</sup> Tensile strength and elongation measured on test pieces in accordance with ISO 2740-1973.

<sup>2)</sup> Within the working temperature limits for the bearing

The above table shows the standard materials used. Many others are manufactured with differing compositions and densities corresponding to various international standards.



# Machining



Machining of self-lubricating bearings should be avoided whenever possible in order to maintain the best bearing properties. When machining is absolutely unavoidable it is important that the recommendations below are followed. Machining should be carried out with the bearing impregnated with oil.

ESSEM Oil-Bronze, ESSEM Ferro-Bronze and ESSEM Graphite-Bronze can be turned but not the bearing face on oil steel. Diamond or carbide tips, quality ISO K 20, with a tip radius of max. 0,1–0,2 mm should be used for final turning. Suitable cutting speeds are: for ESSEM Oil-Bronze and ESSEM Graphite-Bronze 100–200 m/min. and for ESSEM Ferro-Bronze 50–100 m/min.

The bearing surface of self-lubricating bearings must not be ground as the oil transportation pores are then closed. The outer surface of the bearing can, however, be machined in any way required. If external additional lubrication is used then even the pores on the outside diameter must be kept open.

The bearing can be heated on an electrical hot plate after machining to check that the pores are still open. Oil will then ooze out of the bearing.

Bearings usually lose oil during the turning operation and the oil should be replaced before the bearing is used. A simple method of doing this is by immersing the bearing in oil SAE 20 heated to 80°C. The bearing should be immersed until the oil has cooled. The pores are filled with oil by this process and the bearing is then ready for use.

The edge strength of graphite bronze is rather low and special care should therefore be taken when turning end surfaces. When drilling, the bearing should be placed as shown in the adjoining sketches.

Threads can be rolled in ESSEM bearing alloys.



# Quality Control

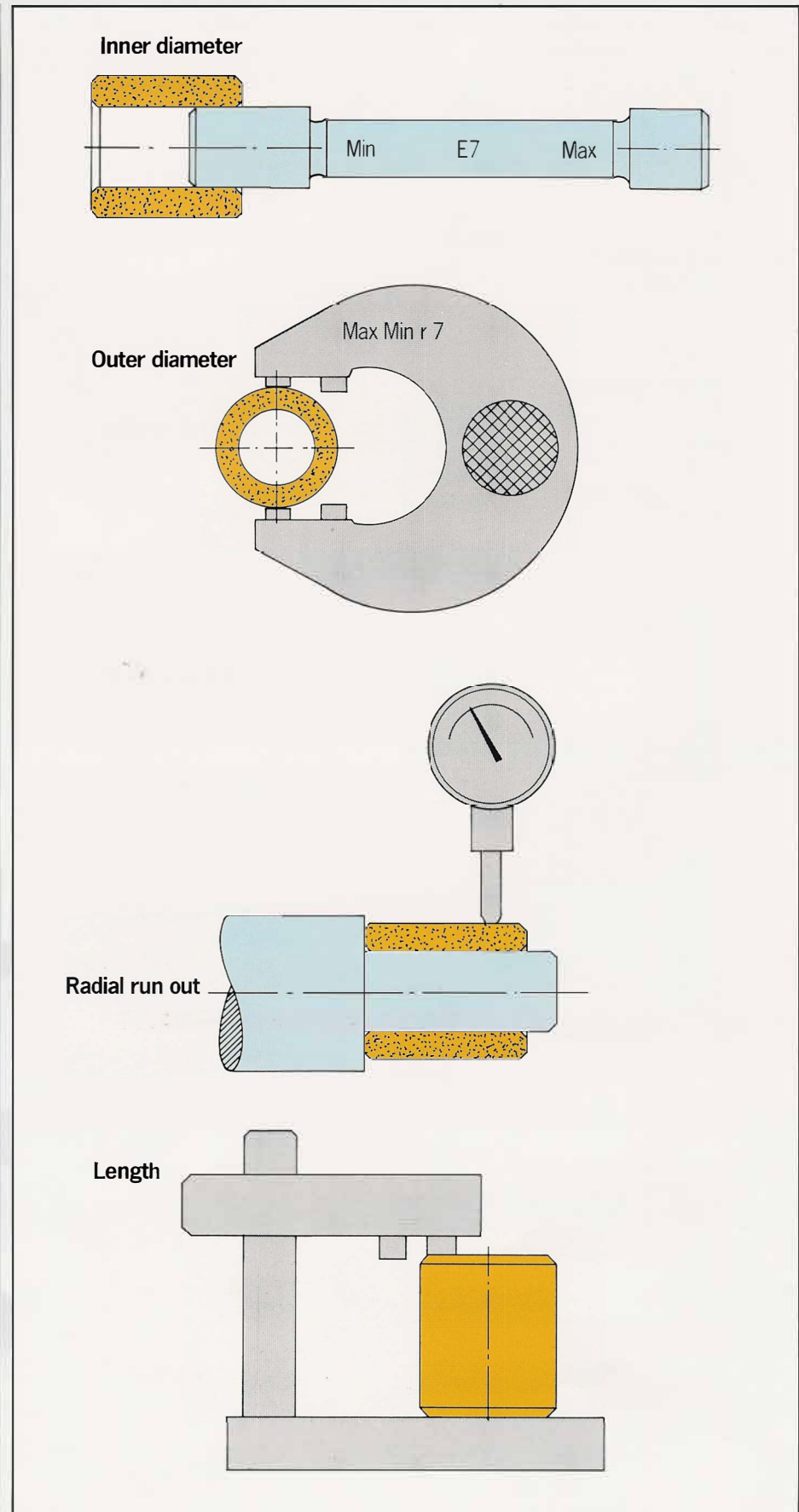
## Dimensional inspection

Each delivery batch is checked by statistical random sampling. Max. and min. plug gauges are used for checking internal diameters and gap gauges according to standards are used on external dimensions. If the customer uses other methods of inspection it is important that these are discussed prior to orders being placed.

**The use of measuring instruments with sharp measuring points is not to be recommended as the porosity of the material gives smaller values on external and larger values on internal dimensions.**

## Surface finish

Self-lubricating bearings are made in tools which have a surface finish of less than  $Ra 1\mu m$ . The finished bearing has a similar surface finish but the porous structure of the bearing surface makes it difficult to evaluate results received from mechanical measuring instruments.



# Lubricants

## Oil for impregnation

The oil used in self-lubricating bearings must meet very high demands with regard to lubrication and stability. The oil must be able to circulate within the bearing even at higher temperatures without any change in its properties. The choice of oil is therefore only made after extensive testing. Self-lubricating bearings manufactured by Keab are, as standard, impregnated with a well refined paraffin-based oil with the following properties:

Min. working temperature	-12°C
Max. working temperature	+90°C
Viscosity	3-5°E/50°C 20-35 cSt

A different oil or grease can be used if the bearing is required to operate in conjunction with high speeds, temperatures or loads. As the bearing can be supplied with the lubricant suitable for the actual working conditions it is important that this is discussed before the order is placed.

## Prevention of oil loss

Self-lubricating bearings should always be stored so that the oil does not seep out. Oil impregnated bearings must not come into contact with absorbent material such as paper, unpainted wood, dust etc. The packaging material, in which the bearings are delivered, provides protection during storage.

Any oil, which oozes out onto the surface, must not be wiped off as this reduces the oil content of the bearing. If, despite all precautions, the bearing does lose oil it can be re-impregnated. (See under Machining, page 9.)

## Additional lubrication

No extra lubrication is usually required but can be provided where speeds, loads or temperatures are high. The oil can be introduced anywhere on the surface of the bearing without pressure. The new oil is then sucked into the bearing by capillary action and thus replaces the oil previously lost.

Additional lubrication can also be carried out with grease. A hole must be drilled through the wall of the bearing to allow the grease free passage to the bearing surface. Grease can also be used as a lubrication back-up.