TUFCOT

TECHNICAL BROCHURE

+44 (0)114 244 2363 / info@tufcot.com / www.tufcot.com

Introduction	3
Application Details	4
Our Products	5-6
Grades	7
Machining Services	8
Special Products	9
Density	10
Physical And Mechanical Properties	11
Chemical And Corrosion Resistance	12-13
Radiation Resistance	14-15
Electrical And Magnetic Properties	16
Thermal Properties	17
Friction Values	18-20
Machining Advice	21-22
Running Clearance	23
Recommended Interference Fit	24
Design And Installation Of Bushes & Bearings A. Bearing Design B. Installation	25-31
Material Safety Data	32-34

Contact Us

Tufcot Engineering Ltd, 330 Coleford Road,
Darnall, Sheffield, South Yorkshire, S9 5PH, UK.

+44 (0)114 244 2363

info@tufcot.com

INTRODUCTION

Tufcot® composite materials are manufactured from synthetic fabric or fibre reinforcement & thermosetting resins. They offer designers & engineers an attractive, economical alternative to traditional materials used in industry for bushes, bearings, wear pads & more applications.

Tufcot® is 1/6th the weight of steel, easily machined, contains no harmful or toxic materials and has exceptional dimensional stability, even when immersed in water.

Tufcot® is highly recommended for use where other forms of lubricant are either not desirable or erratic, intermittent or none existent. In numerous cases, where the maintenance of a lubricant film is difficult, our composite bearings have been found to give improved performance.

All grades of Tufcot® are available with solid lubricant incorporated. The various grades contain, solely or a combination of, Graphite, P.T.F.E. or Molybdenum Disulphide dispersed evenly throughout the material, so that the wear of the bearing continually releases further lubricant.

The physical and mechanical properties of Tufcot® make it an excellent bearing material. By varying the fabric reinforcement and the resin used, the physical and chemical properties of the material can be engineered to suit a wide range of applications.

The chemical resistance of Tufcot® allows many process liquors, solvents and sludges to be used as lubricants, in addition light or heavy mineral oils, vegetable oils, soluble oils & greases are satisfactory. The surface asperities of the fibres in Tufcot® tend to hold lubricant & thus assist in the maintenance of a continuous film on the working surface.

The grade T100 and its derivatives (T100G, T100M and T100MP) have an extremely low rate of moisture absorption (< 0.1% volumetric) & therefore negligible dimensional change, making it ideally suitable for use in submerged water applications.

APPLICATION DETAILS

Low Co-efficient of Friction - With most lubricants, this allows Tufcot® to reduce both bearing power loss and the rate of wear.

Water Lubrication - Almost any fluid can be used as a lubricant with Tufcot® materials, although under suitable conditions water and aqueous solutions give the best results. Dynamic friction co-efficients in the region of 0.03 have been recorded with water lubrication. Satisfactory bearing operation with liquid lubricants depends upon the interaction between the lubricant and the bearing surface.

Wear Mechanisms - The wear mechanisms found with Tufcot® differ from those commonly associated with metals and are usually much less severe. The material is however susceptible to cutting wear when in contact with rough surfaces and consequently a fine machined finish should be given to mating parts. If this precaution is observed and the lubrication is adequate, the metal and the Tufcot® will acquire highly polished surfaces whilst in use thus prolonging life and reducing friction.

Metal Polishing - Although Tufcot® is a relatively soft material, because of its thermosetting nature, it acts as a metal polisher and it's none scratch properties make it suitable for many applications where process materials are subject to damage by metal roll surfaces. In particular Tufcot® covered rolls have found a wide use in the handling of bright metal strips on run out tables for rolling mills, also in electroplating and pickling processes. In the latter cases, the corrosion resistance of Tufcot® makes it particularly suitable. Tufcot® rolls have been used in handling metal rods and tubes where damage to metal surfaces and excessive wear of roll covering, particularly grooving effects must be avoided.

In the plastics industry Tufcot® rolls are used in the handling of thermoplastics in sheet and rod form. In some cases low thermal conductivity of the materials is useful where rapid cooling of the process material is undesirable.

Cost Savings - Over many years and thousands of applications Tufcot® has given considerable cost savings. In particular it has proven that it does not wear mating components such as shafts and pins.

Non-Magnetic - Tufcot® is non-magnetic and is useful where rotating metal rolls interfere with magnetic or electrical fields. An interesting use of this property occurs in the mining industry where Tufcot® rolls are used in the tramp iron detection points on conveyor belts.

OUR PRODUCTS

RAW SHEETS, RODS, TUBES

BUSHES - FLANGE/STANDARD/NON-STANDARD

WASHERS

WEAR PADS

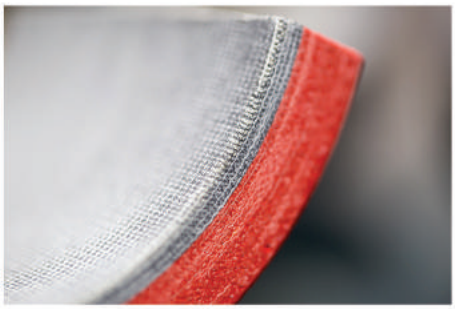
WEARSTRIP

WEAR RINGS - SPLIT/UNSPLIT

SPHERICALS

CUSTOM PARTS

PTFE LAYERED MATERIALS (XPL)



GRADES

Grade	Colour	Properties and Typical Applications
S100G	Dark Grey	Special reinforcing fabric with low friction additive, Ideally suited to general wear pad applications.
S100MP	Light Grey	Special reinforcing fabric with low friction additives, Ideally suited to marine wear pad applications.
T100	White	Dimensionally stable bearing material for use primarily in harmless fluids, e.g. in water, oils etc.
T100G	Dark Grey	Self-lubricating version of T100. It is an inexpensive general-purpose hard wearing material to replace most existing metallic or non-metallic bearing materials.
T100M	Light Grey	Self-lubricating high performance bearing material.
T100MP	Light Grey	Low friction marine approved bearing material.
T100PC	Red	PTFE with the addition of wear resistant additive. For use in extremely hard wearing applications.
T100XPL	Dark Grey	Special PTFE layer incorporated in wearing surface which creates a very low co-efficient of friction.
T200G	Dark Grey	Enhanced Temperature version of T100G. Has limited chemical resistance, Capable of withstanding: 100°C constant and 120°C intermittent.
T200P	White	High performance hard wearing material. High slip properties most suitable for Wear Pad or Press Slide arm type applications.
T400G	Dark Grey	Fire retardant, self-lubricating grade. Essential for underground mining applications.
T600PA	To Order	Superior chemical resistant grade.
T600G	Dark Grey	Superior chemical resistance at lower temperatures than T200G. Excellent for applications in sewage, acid pickling baths and acid vapour environments.

G = Graphite

M = Molybdenum Disulphide

P.T.F.E = Polytetrafluoroethylene

PC = PTFE Plus Abrasion Resistant Additive

XPL = Special PTFE Layer

Tufcot can produce a variety of grades, so for a special application or for grade specific details please contact our Technical department, Technical@tufcot.com.

MACHINING SERVICES

We have a full range of machining services available including Milling, Turning, Boring, Drilling and Finishing.

This ensures that any size, shape and application can be designed and manufactured to the clients exacting standards.

Semi - Finished Product	Dimension	mm	Inches
Tube	Minimum I/D	8	3/8"
	Maximum O/D	1500	59"
	Maximum Length	1000	39"
Solid Rod	Minimum O/D	25	1"
	Maximum O/D	300	12"
	Maximum Length	500	19 5/8"
Sheet	Minimum Thickness	2	1/8"
	Maximum Thickness	200	8"
	Maximum Length	5000	196 7/8"
	Maximum Width	1000	39"

Finished Product	Dimension	mm	Inches
Bushes	Minimum I/D	10	3/8"
	Maximum O/D	1500	59"
	Maximum Length	620/254	24"/10"
Milled Pads	Minimum Thickness	3	1/8"
	Maximum Thickness	305	12"
	Minimum Width/Length	8 x 8	3/8" x 3/8"
	Maximum Width/Height	850 x 2000	33 ½" x 78 ¾"

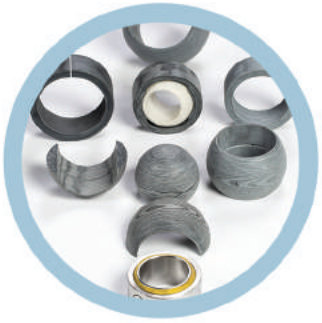
Most sizes can be handled by our works, for exceptional sizes, contact our sales department. You may want to machine our product on site, for more details about machining Tufcot® please see Machining Advice on pages 21 and 22.

SPECIAL PRODUCTS

Special components can be manufactured to customers drawings from all grades of Tufcot®.

Please see below for some examples of these:

- We produce special wear pads, bearings and bushings with specific dimensions and design details such as lubrication grooves, holes and other special features.
- In addition plain spherical bearings can be manufactured in Tufcot® to solve misalignment problems. Spherical bearings with both metallic and Tufcot materials combined can also be produced.
- For those applications where a fire risk exists, Tufcot® can be produced with exceptional fire retardant properties.
- In applications where "stick slip" must be avoided and a low co-efficient of friction is required, we have developed a special composite PTFE material. This involves placing an XPL layer on the wearing surface ensuring the lowest possible co-efficient of friction in dry running applications. This material is suitable for wear pads or bushes.



DENSITY

MATERIAL	DENSITY GMS/CC	COMPRESSIVE STRENGTH P.S.I (N/MM^2)	STRENGTH WEIGHT RATIO
STAINLESS STEEL	7.85	150000.00 (1034)	19100.00
ALUMINUM ALLOY	2.30	40000.00 (276)	17400.00
MAGNESIUM ALLOY	1.18	35000.00 (241)	19300.00
TYPICAL HARDWOOD	0.07	9250.00 (64)	13200.00
TYPICAL SOFTWOOD	0.45	6500.00 (45)	14500.00
TUFCOT	1.25 - 1.48	30000.00 – 50000.00 (206 – 345)	24000.00 – 40000.00

TYPICAL PHYSICAL & MECHANICAL PROPERTIES

Tensile Strength	PSI	9427
	N/mm^2	65.00
Compressive Strength - Normal to Laminate	PSI	50000.00
	N/mm^2	345.00
Compressive Strength - Parrallel to Laminate	PSI	14000.00
	N/mm^2	97.00
Flexural Strength	PSI	20000.00
	N/mm^2	138.00
Tensile Modulus	$lbs/in^2 \times 10^6$	0.47
	$N/mm2 \times 10^4$	0.32
Impact Strength - Normal to Laminate (Notched Izod) B.S 2782	Ft lb/in	> 10.0
Shear Strength	PSI	19500.00
	N/mm^2	134.00
Hardness Rockwell M		90 - 100
Density	Gms/cc	1.25-1.48
Swell in Water Volumetric		< 0.1%

CHEMICAL AND CORROSION RESISTANCE

The below table refers in particular to Tufcot® T200 grades. "Satisfactory" means that the material retains 50% or over of its original dry strength after immersion for at least six months.

S = Satisfactory

L = Satisfactory for limited service

U = Unsatisfactory

		20°C	50°C
ACETIC ACID	15%	S	L
ACETIC ACID	100%	U	U
ACETONE	15%	S	L
ACETONE	100%	U	U
ALCOHOL ETHYL	15%	S	S
ALCOHOL ETHYL	100%	S	S
ALUMINIUM SULPHATE		S	S
AMMONIA LIQUID		U	U
AMMONIA AQUEOUS		U	U
AMMONIUM CARBONATE		S	L
AMMONIUM NITRATE		S	S
BENZENE		S	L
BLEACH LIQUORS		S	L
CALCIUM CHLORIDE		S	S
CALCIUM HYDROXIDE		U	U
CARBON TETRACHLORIDE		S	S
CHLORINE WATER		S	L
CREOSOTE		S	S
CITRIC ACID		S	S
ETHYLENE GLYCOL		S	S
FATTY ACIDS		S	S
HYDROCHLORIC ACID		S	S
HYDROFLUORIC ACID		U	U
MALEIC ACID		S	S
NAPHTHA		S	S
NITRIC ACID	15%	S	L
NITRIC ACID	100%	U	U
OXALIC ACID		S	S
PHOSPHORIC ACID		S	S
PHTHALIC ANHYDRIDE		S	S
POTASSIUM HYDROXIDE		U	U
SODIUM CARBONATE	25%	S	S
SODIUM CARBONATE	100%	L	U

CHEMICAL AND CORROSION RESISTANCE

S = Satisfactory

L = Satisfactory for limited service

U = Unsatisfactory

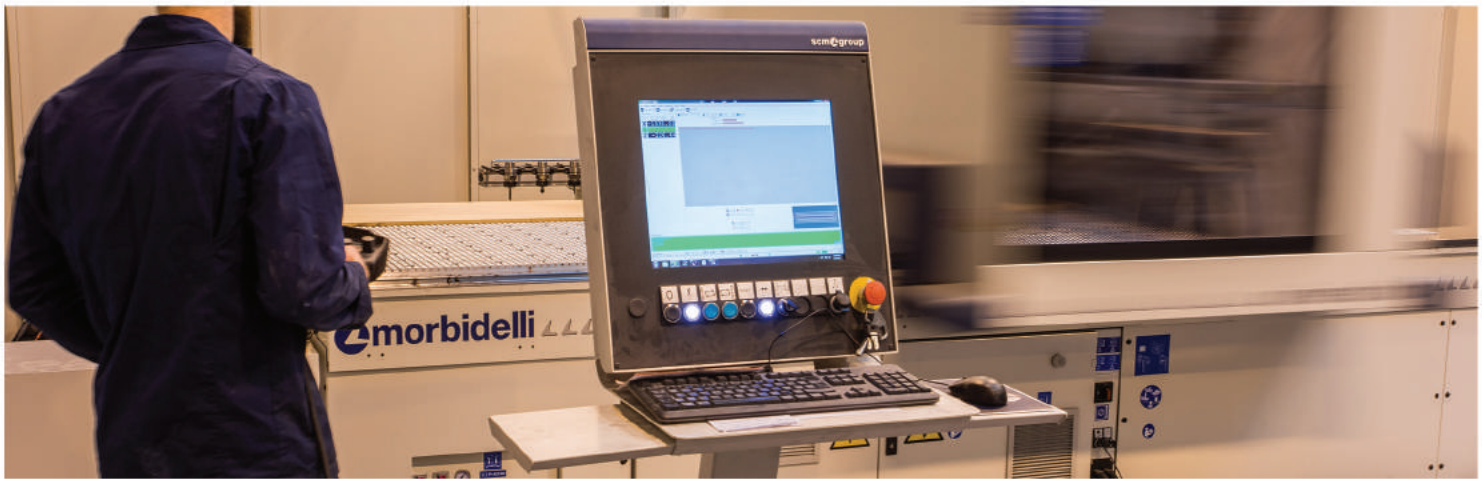
		20ºC	50ºC
SODIUM CHLORIDE		S	S
SODIUM HYDROXIDE		U	U
SODIUM NITRATE		S	S
SODIUM NITRITE		S	S
SULPHURIC ACID	50%	S	S
SULPHURIC ACID	100%	U	U
TRICHLOROETHYLENE		U	U

Despite the previous table referring to T200, in many cases the alternative grades of Tufcot® may be used.

Tufcot® does not corrode and is unaffected by many solvents, inorganic solutions, fats and weak acids.

It should be noted that water and chemical liquids often act as lubricants on the material giving low coefficients of friction and thereby eliminating the problems commonly encountered by metal bearings.

Tufcot® is attacked by Acetone, ketones, chlorinated solvents, strong alkalis and hot strong oxidising agents. For acidic and alkaline applications, refer to our technical department for recommendations.



RADIATION RESISTANCE

		EXPOSURE		
	CONTROL	1 X 10^6 GREY	3 X 10^6 GREY	10 X 10^6 GREY
		(100 MRAD)	(300 MRAD)	(500 MRAD)
TENSILE STRENGTH (LBS/IN^2)	11,150	8,700	6,000	3,250
TENSILE STRENGTH (N/MM^2)	77	60	41	22
COMPRESSIVE STRENGTH (PARALLEL TO LAMINATE) (LBS/IN^2)	14,900	21,700	18,000	13,800
COMPRESSIVE STRENGTH (PARALLEL TO LAMINATE) (N/MM^2)	103	150	124	95
NORMAL TO LAMINATE (LBS/IN^2)	49,100	43,400	35,200	26,800
NORMAL TO LAMINATE (N/MM^2)	339	299	243	185
IMPACT STRENGTH - IZOD UN-NOTCHED (FT LB/IN)	20	20	11.5	4.5
FLEXURAL STRENGTH (LBS/IN^2)	10,700	11,900	11,100	8,350
FLEXURAL STRENGTH (N/MM^2)	74	82	76	58
FLEXURAL MODULUS (LBS/IN^2 X 10^6)	0.485	0.590	0.535	0.487
FLEXURAL MODULUS (N/MM^{2}X10^3)	3.343	4.067	3.688	3.357

RADIATION RESISTANCE

In nuclear engineering applications, bearing materials are required which can operate without oil or grease, retain physical strength under heavy radiation and remain unaffected by immersion in 'pond' water.

When polymers are exposed to gamma radiation, the first result is the activation & crosslinking of linear chains. This mechanism is most marked in the case of Thermo-composite polymers which increase in hardness and softening point at the same time losing flexibility.

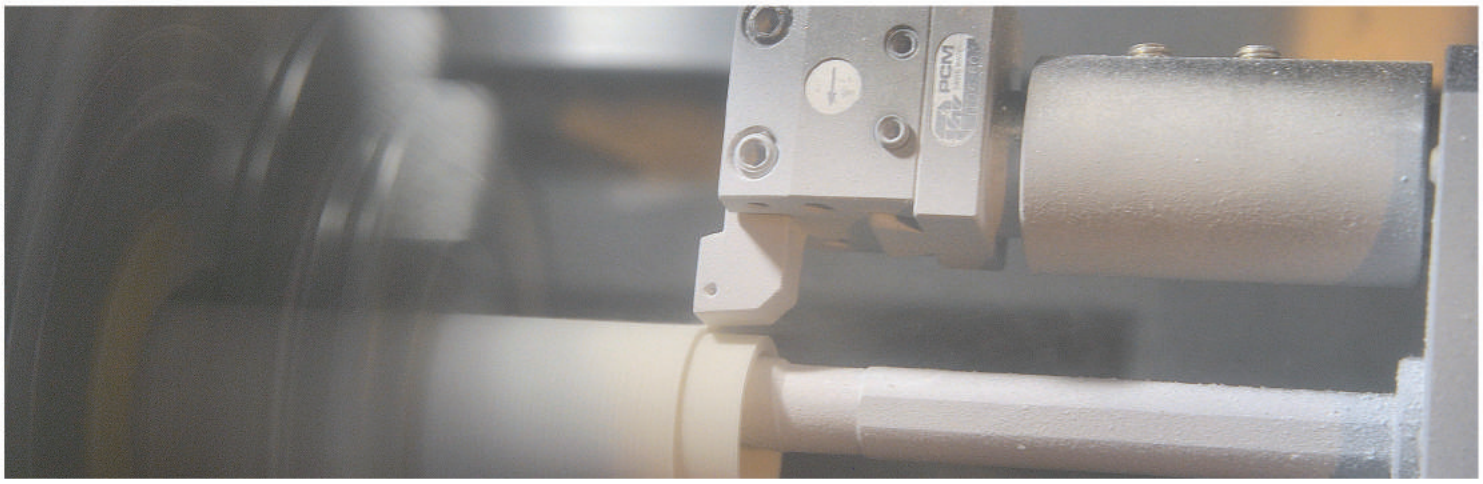
If irradiation is continued scission of linkages becomes significant and degradation of physical properties by depolymerisation results.

Thermosetting polymers are affected in the same way although less opportunity for increased crosslinking occurs in the early stages, depolymerisation generally requires higher radiation levels than with thermoplastics.

However when used as bearings, thermosetting polymers are always reinforced by fibre or fabrics, consequently the radiation resistance of the laminates are usually dependent on the properties of the reinforcement.

Tufcot® Grade T100 shows excellent resistance to the effects of radiation.

From the table on the previous page, it can be seen that although there is a marked reduction in tensile strength at high radiation levels, the compressive strength normal to laminate shows only a gradual reduction and parallel to the laminate, a considerable increase in strength up to high radiation levels, indicating an improvement in inter-laminate adhesion.



ELECTRICAL & MAGNETIC PROPERTIES

	Grade - T100
Insulation Resistance (Megohms) - BSS. 2782 (Pt.2)	2000.00
Electrical Strength at 90°C - BSS. 2782 (Pt.2) Flatwise (Volts / mil)	210.00
Edgewise (kV / inch)	47.00
Power Factor (1 M/c per sec)	0.021
Permittivity (1 M/c per sec)	3.1

All grades of Tufcot® are excellent insulating materials and may be used in many electrical applications.

Used as bushes or washers, Tufcot® is suitable for use in dynamos, electric motors, generators etc.

As flat laminate, it can be used in heavy switchgear, transformers insulating chassis and as general constructional material.

Slip rings and other current transfer devices can be also be manufactured from Tufcot®.

Tufcot® is non-magnetic and does not build-up static charges.

These properties may often be exploited to an advantage where interference with magnetic or electrical fields, or where accumulation of static electricity must be avoided.

THERMAL PROPERTIES

	Grade - T100
Linear Expansion Coefficients	
20 - 100°C (per mm per °C x 10-(5)	
1. Parallel to Laminate	**6 - 7**
2. Normal to Laminate	**12 - 13**
Maximum Operating Temperature	**100°C requirement specified**
Minimum Operating Temperature	**-70°C**
Thermal Conductivity	**0.293**
Specific Heat (J/kg °K)	**1.005**

In common with all resin bonded fabrics Tufcot® has a low thermal conductivity and although in normal circumstances frictional heat is removed via the mating metal part, in cases where shafts or housings are conducting heat to the bearing assembly, the lubricant supply must be sufficient to remove both frictional and conducted heat.

The frictional heat generated in a bearing is given by the relation:

$$\text{Heat (in kW)} = \frac{\mu PDN\pi}{6 \times 107}$$

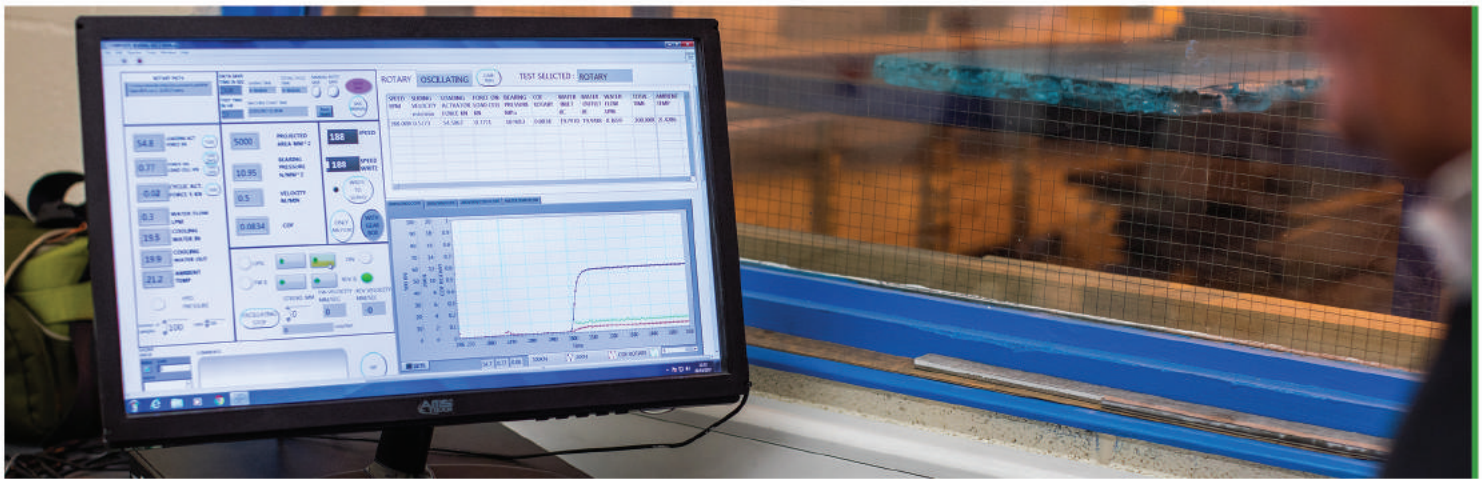
Where D = Shaft diameter (in mm)
N = Shaft r.p.m.
P = Total load (in N)
μ = Coefficient of friction

The removal of frictional heat may be improved, particularly in dry running applications by using the housing as the main heat conductor.

The wall thickness of bearings should be kept to a minimum in order to improve heat dissipation.

Thermal expansion of Tufcot® is greater than that of many metal alloy bearings, this characteristic must be taken into account in designs for higher temperature applications.

As Tufcot® is a laminated material, coefficients of expansion vary with the direction of measurement.



FRICTION VALUES

PV (Pressure / Velocity)

The frictional heat build-up at a journal bearing interface is the principle limiting factor controlling its successful operation.

The rate at which the temperature rise takes place is dependent on the speed and pressure at the bearing, the coefficient of friction and the thermal dissipation rate of the design. Factors such as the surface roughness of the shaft, the type of lubrication system, environmental temperature etc. will also influence the performance of the bearing.

Bearing calculations attempting to take account of all these variables would be unreasonably complex and experience has shown that the use of a simple pressure / velocity (PV) factor when correctly applied is just as effective. The PV value is the product of the applied pressure and the rubbing velocity.

PV values should be calculated for the continuously applied operational conditions ensuring that the P and V limits for the material grade are not exceeded. Where bearings are subjected to intermittent shock or overload conditions for short periods, the pressure should also be calculated at the peak loading, it must not exceed the maximum working compressive stress.

If the calculated PV figure is too high, then the bearing length or shaft diameter should be increased to reduce pressure.
Note: it is better to keep the bearing length to diameter ratio below 2:1 if possible.

Typical PV curves for the basic grades of Tufcot are shown on the next page.

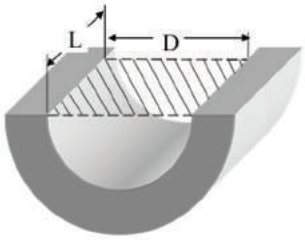
Calculation:

$$\text{Bearing pressure (P)} = \frac{\text{kgf}}{D \times L} \quad \text{kgf/cm}^2$$

Diameter and length expressed in cm for above (P)

$$\text{Rubbing Velocity (V)} = \frac{\pi \times d \times RPM}{1000} = \text{Metres/min}$$

Shaft diameter expressed in mm for above (V)



FRICTION VALUES

PV (Pressure / Velocity)

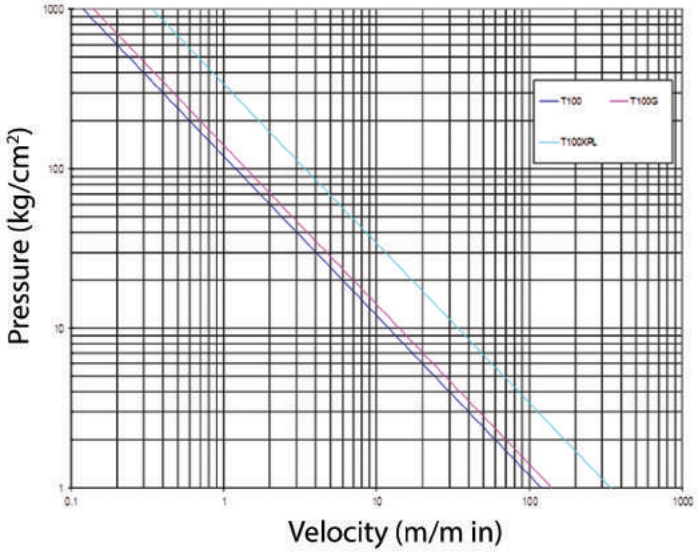
The lowest PV rating in each case is for a completely dry running application.

The addition of lubricant and / or cooling medium will permit this to be considerably increased.

The rubbing velocity limit set in these graphs can be increased by a considerable margin when hydrodynamic conditions exist. When a bearing is required to run hydrodynamic, PV values become meaningless and new criteria apply.

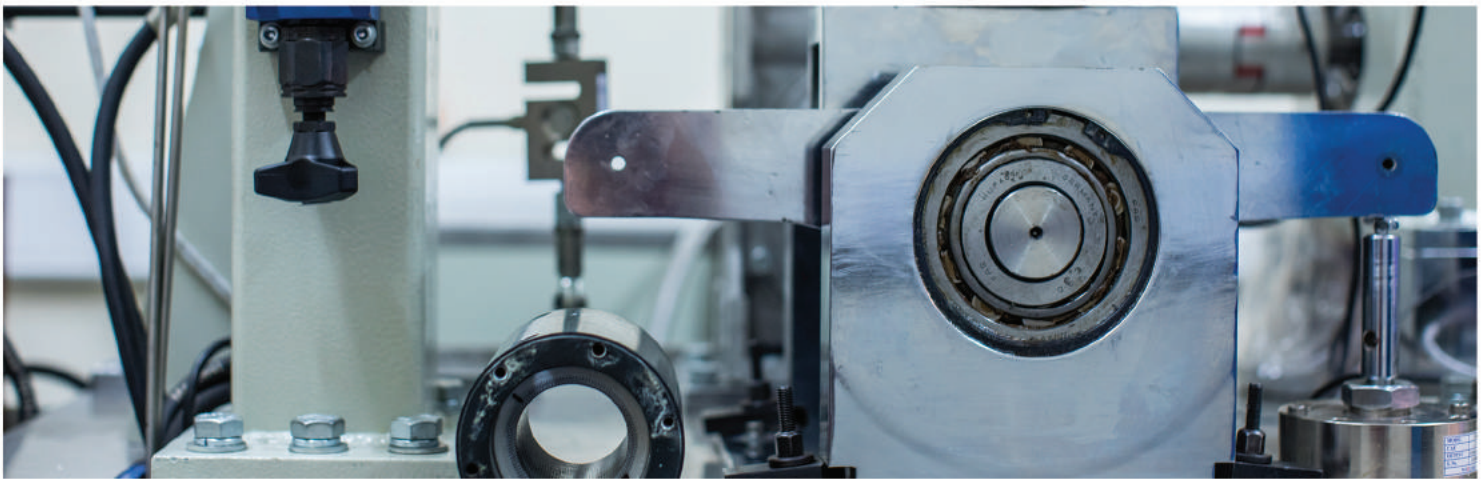
Speeds in excess of 300 metres/minute are frequently used on pump bearings with negligible wear.

TUFCOT® GRADES LIMITING PV VALUES



Material Typle	Dry Running	Regular Grease
T100	120	340
T100G	140	340
T100XPL	350	

PV VALUES IN kg/cm2. M/MIN
TEST PIECES MILD STEEL SHAFTS - EN3B (Hardened) SURFACE FIN. 0.8 µm Ra.



FRICTION VALUES

(A) Effects of Lubrication on Co-Efficient of Friction

	LUBRICATION				
	NONE	WATER	SOLUBLE OIL	GREASE	OIL
T100G	0.18 - 0.21	0.010	0.019	0.013	0.020

Material: Standard Tufcot® grade running against 316 Stainless Steel
Bearing pressure – 15.4 N/mm2 (2240 lb/in2)
Surface Speed – 2.25m/sec (450 feet/min)

(B) Co-Efficient of Friction Dry

Material: Tufcot® grade T100G running against 316 stainless steel

SURFACE SPEED (MM/SEC)	BEARING PRESSURE (N/MM^2)											
	5		10		15		20		25		30	
	STATIC	DYNAMIC	STATIC	DYNAMIC	STATIC	DYNAMIC	STATIC	DYNAMIC	STATIC	DYNAMIC	STATIC	DYANMIC
1	0.138	0.124	0.132	0.128	0.129	0.125	0.131	0.125	0.130	0.125	0.125	0.124
5	0.145	0.140	0.140	0.136	0.135	0.132	0.132	0.129	0.132	0.130	0.132	0.131
10	0.154	0.146	0.147	0.143	0.141	0.137	0.136	0.133	0.137	0.136	0.138	0.137

MACHINING ADVICE

Tufcot® is readily machined by conventional engineering techniques, as a general guide it may be treated as brass or lignum vitae, but should be machined dry without coolant.

Turning

Diamond tooling or Tungsten carbide tipped tools should be used to obtain a fine finish. High-speed steel tools can be used for machining where accuracy below 0.005" (0.127mm) is not required, or on small quantity production.

Tool cutting angles

Top rake	3 to 5 degrees
Side rake	5 to 7 degrees
Front rake	5 degrees

Cutting speeds

For good surface finish	1,200 f.p.m. (6.1m/sec)
For longer tool life	1,000 - 1,100 f.p.m. (5.1 - 5.6m/sec)
For form tools	900 - 1,000 f.p.m. (4.6 - 6.1m/sec)

Cutting feeds

Rough turning	0.020" - 0.030" (0.51 - 0.76mm) per rev.
Finishing cut	0.010" - 0.015" (0.25 - 0.38mm) per rev.

Milling

This follows metal machining techniques and cutting speeds as for turning. Feeds should be limited to 0.010" - 0.015" (0.25 - 0.38mm) per tooth, to prolong cutter life and reduce excessive heat build-up.

Drilling

This should be carried out with high-speed or solid carbide twist drills at 100 - 120 f.p.m. (0.5 - 0.6m/sec) peripheral speed. The feed should be limited to 2" - 3" (51 - 76mm) per minute.

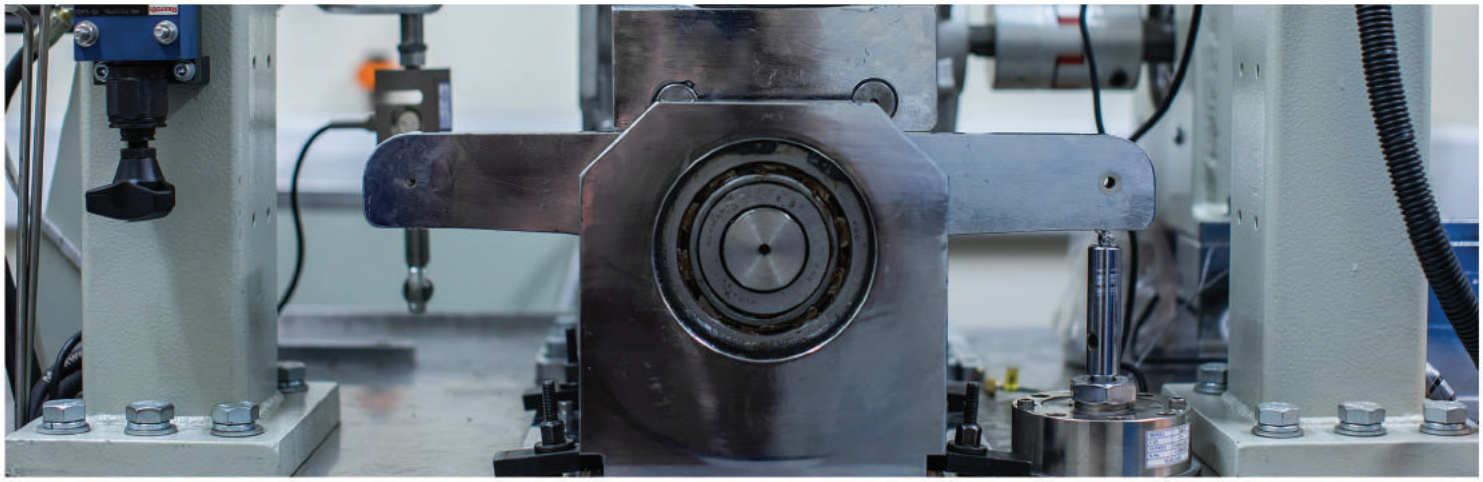
MACHINING ADVICE

Grinding & Sanding
While good surface finishes can be obtained with turning and it is seldom necessary to finish by grinding, Tufcot® can be successfully ground and sanded.

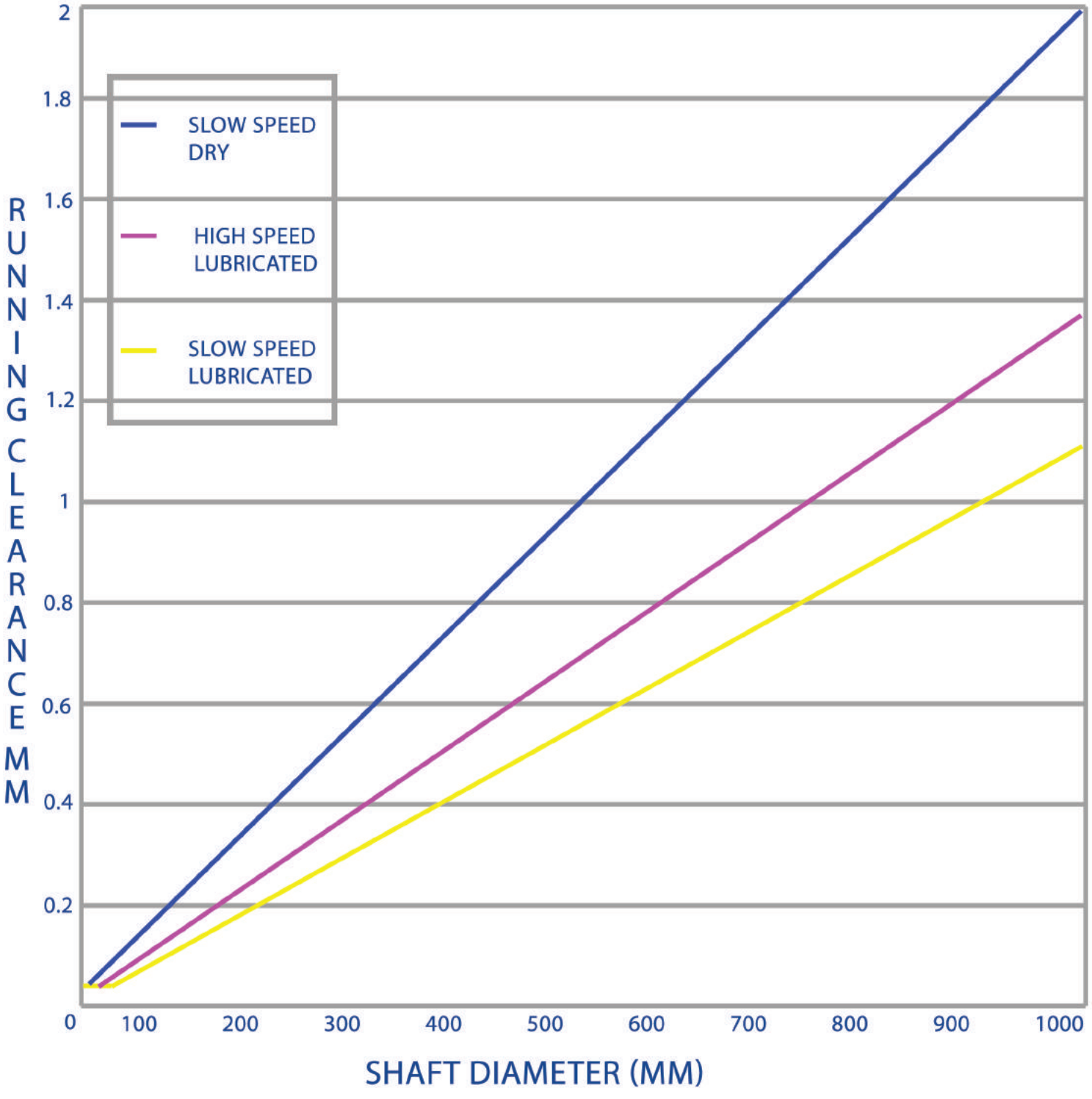
High surface speeds should be used and cuts limited to 0.001" (0.025mm) for final surfacing.

Toxicity
No phenolic resins or Asbestos are used in the manufacture of Tufcot® products, the material is completely non-toxic.

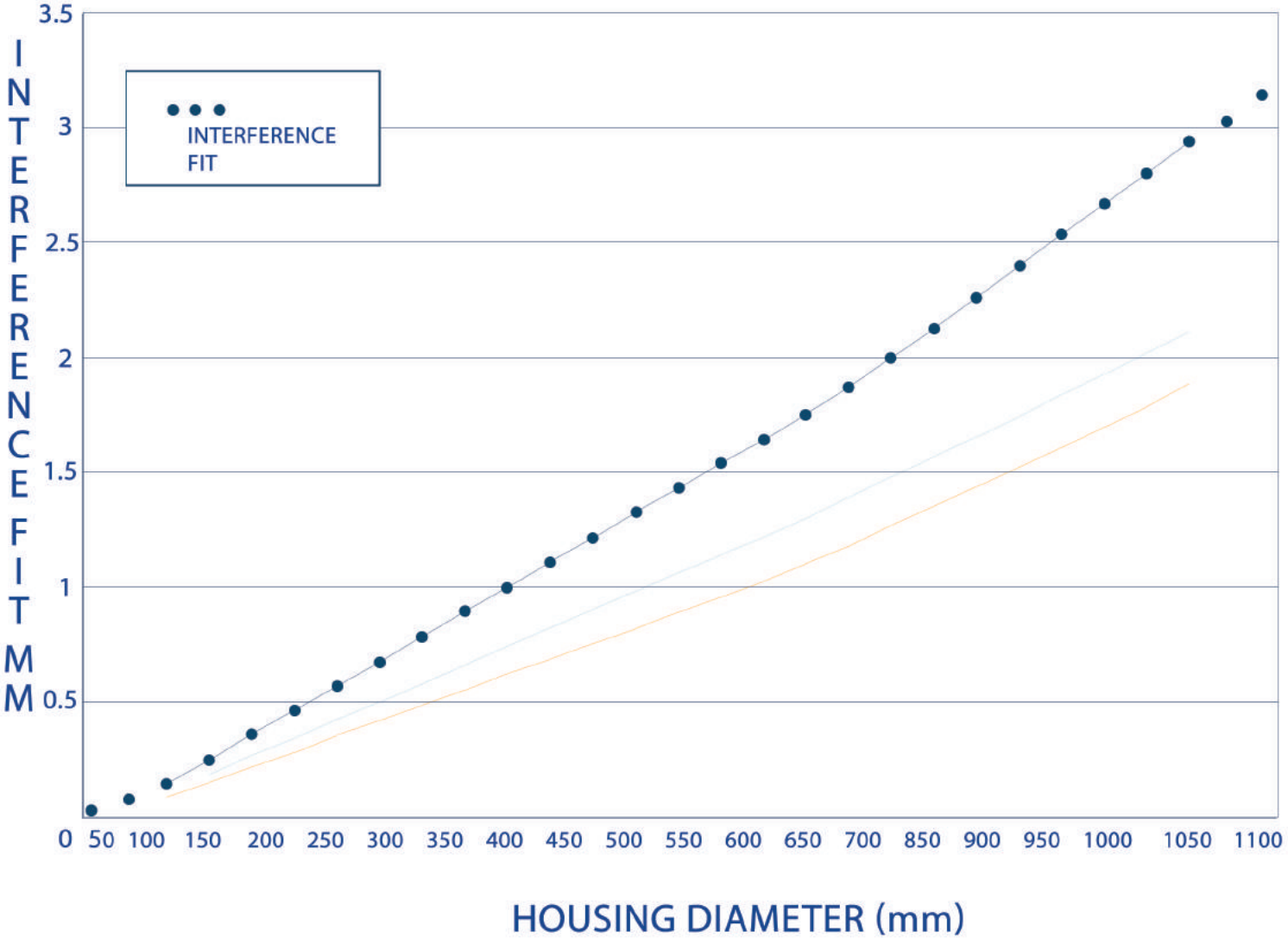
Dust
It is advisable to use adequate dust extraction when machining Tufcot®.



RUNNING CLEARANCE



RECOMMENDED INTERFERENCE FIT



DESIGN & INSTALLATION OF BUSHES & BEARINGS

A. Bearing Design

Flanges: The best results are obtained when the bearing surface is parallel to, or concentric with the layers of the material and at right angles (normal) to the load direction.

Radial bushes: Are manufactured from Tufcot® material with the layers concentric with the axis of the rotating or sliding journal or pin.

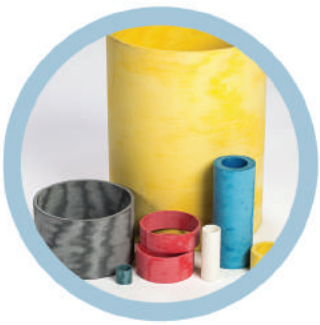
End or Thrust bearings: Are made from flat laminate with the laminations at right angles (normal) to the journal axis and the end load.

It is recommended that where bushes have integral flanges, axial loads (i.e. on the face of the flange) are kept to a minimum. Similarly consideration must be given to the design of any component (e.g. pulleys) where there are likely to be bending or shear loads applied along the direction of lamination.

Surface finish: The surface finish of the mating component has a major effect on the performance of the bearing. Surface roughness should ideally be between 0.8 µm (32 µ-in) and 1.2 µm (48 µ-in) Ra. In certain applications up to 1.6 µm can be tolerated.

Suitable materials for shafts, thrust faces etc. are hardened steels, some stainless steels and gunmetal. Hard chrome plated surfaces can cause higher wear rates under certain conditions, therefore surface finishing or other specialist surface finish treatments should be considered as an alternative.

The main criteria is that the mating surface should be free of cutting edges. Similarly journals or thrust faces should be free of lubrication grooves or holes, except where matched to non-loaded grooves in the bearing.



DESIGN & INSTALLATION OF BUSHES & BEARINGS

Fig. 3.0,

Typical manufacturing tolerances for Tufcot® T100 bushes.

Shaft Outside Diameter	Manufacturing Tolerance
Millimetres (mm)	Millimetres (mm)
10 - 100	0.05
101 - 200	0.07
201 - 300	0.10
Over 400	Consult Tech Department

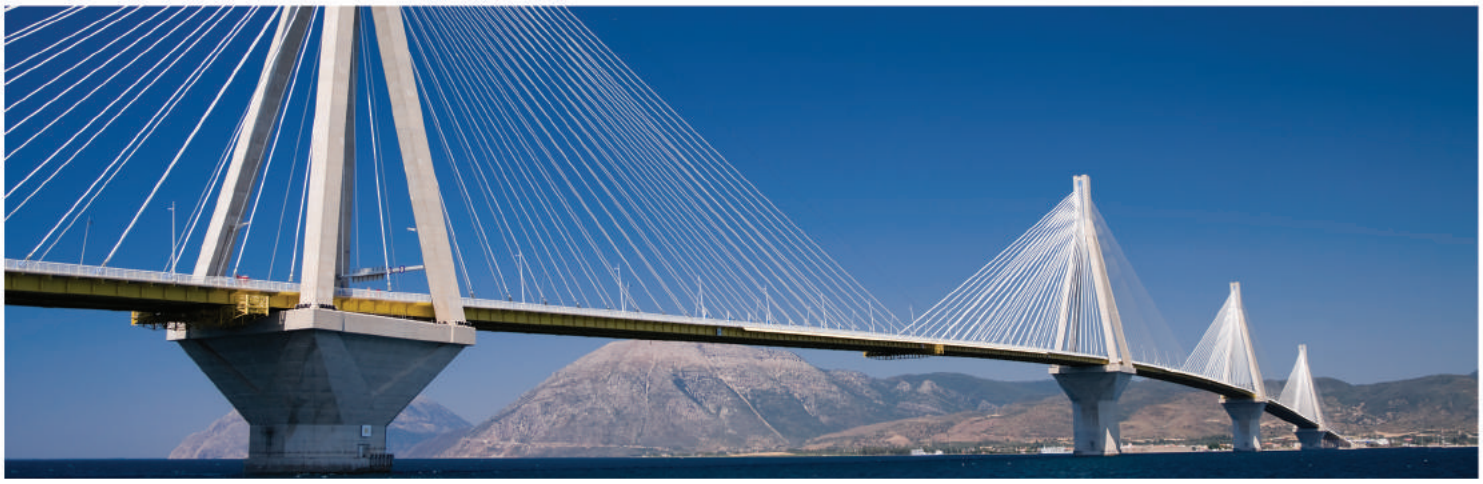
Fig. 4.0,

Recommended minimum wall thickness for Tufcot® T100 bushes.

Shaft Outside Diameter	Recommended Wall Thickness
Millimetres (mm)	Millimetres (mm)
6 - 25	2.00
26 - 50	2.50
51 -75	3.50
76 - 100	5.00
101 - 150	6.50
151 - 200	8.00
201 - 280	10.00
281 - 400	12.00

Note: If special running clearances are required (e.g. for highly loaded static applications) please contact Tufcot technical department.

All test results are based on a standard temperature of 20°C.



DESIGN & INSTALLATION OF BUSHES & BEARINGS

B. Installation

The Tufcot® material should be fully supported over its loaded area, with uniform interference fit in the case of bushes.

A suitable lead-in chamfer should be provided in the housing and drawing or pressing-in methods should be used. ***Hammer blows should be avoided.***

It is recommended that bearings be retained by shoulders whenever possible. Flat components such as wear pads can be retained by countersunk screws and located by keeper plates.

Where high lateral or shearing loads are anticipated Tufcot® can also be bonded using two-part epoxy resin adhesives, but manufacturers recommendations must be strictly followed, particularly with reference to pre-treatment of the surfaces. Toughened acrylic adhesives have been found to give exceptional bonding performance with lesser requirements for steel surface treatment.

Where possible, unless being used as lubricants, contaminating or corroding liquids should be excluded from the bearing interface, as should abrasive particles. Sealing will also help to retain lubricants.

Calculating bush sizes

To calculate the bush O.D.:

Bush O.D. (min) = Housing (max) + Interference (min) see Fig. 1,0.

Bush O.D. (max) = Bush O.D. (min) + Manufacturing tolerance see Fig. 3,0.

To calculate the bush I.D.:

Bush I.D. (min) = Shaft dia (max) + Bore closure + running clearance (min) see Fig. 2,0.
NOTE: see bore closure details.

To calculate the wall thickness:

$$\text{Wall thickness (max)} = \frac{\text{Bush O.D. (max)} - \text{Bush I.D. (min)}}{2}$$

Wall thickness (min) = wall thickness (max) - manufacturing tolerance

DESIGN & INSTALLATION OF BUSHES & BEARINGS

Bore closure

For wall thickness shown in Fig. 4,0. 100% of the bush / housing interference will be transmitted to the bush internal diameter, causing a corresponding reduction in the bore size when fitted.

For temperatures above 20°C and thick wall bushes above the recommended wall thickness, thermal expansion should be taken into account.

Typical examples:

1. For shaft size of 55.0 mm diameter, the recommended wall thickness from Fig. 4,0. would be 3.5 mm, therefore the bush O.D. would be 55 + (2 X 3.5) = 62.0 mm nominal.

The recommended wall thickness, bore closure would be 100% of the bush housing interference from Fig. 1,0. = 100% X 0.080 = 0.080 mm

2. For shaft size of 55.0 mm diameter, wall thickness 25.0 mm, the bush O.D. would be 55 + (2 X 25) = 105 mm nominal. Bore closure due to bush housing interference from Fig. 1,0. = 0.105 mm.

For a temperature of 90°C, increase from standard = 90 - 20 = 70°C temperature change.

Wall thickness X temperature change X linear expansion co-efficient:

= 25 X 70 X 12 X 10-5
= 21000 X 10-5
= 0.21 mm

Bore closure due to expansion = 2 X 0.21 = 0.42 mm

Bore closure due to bush / housing interference = 0.105 mm.

Total bore closure = 0.105 + 0.42 = 0.525 mm

DESIGN & INSTALLATION OF BUSHES & BEARINGS

Press-Fit interference allowance

An allowance must be made in calculating the free bush bore diameter and as such, an allowance must be made for the transfer of interference which will be reflected in the bearing bore.

Reference should be made to the chart for transfer of fit.

Keying and mechanical location of Tufcot is not normally required. Due to its low modulus of elasticity, moderate interference fits can be applied and these are normally sufficient to locate and hold the bush. The recommended interference fits for all grades are given in table Fig. 5,0.

Fig. 5.0,

Shaft Diameter	Bearing pressures up to (14N/mm²) 2000 p.s.i. interference fit on outside diameter
Millimetres (mm)	Millimetres (mm)
13	+ 0.05
25	+ 0.06
38	+ 0.08
51	+ 0.09
64	+ 0.11
76	+ 0.13
89	+ 0.15
102	+ 0.20
114	+ 0.20
127	+ 0.23
140	+ 0.26
152	+ 0.27
203	+ 0.32
254	+ 0.52
305	+ 0.62
356	+ 0.76

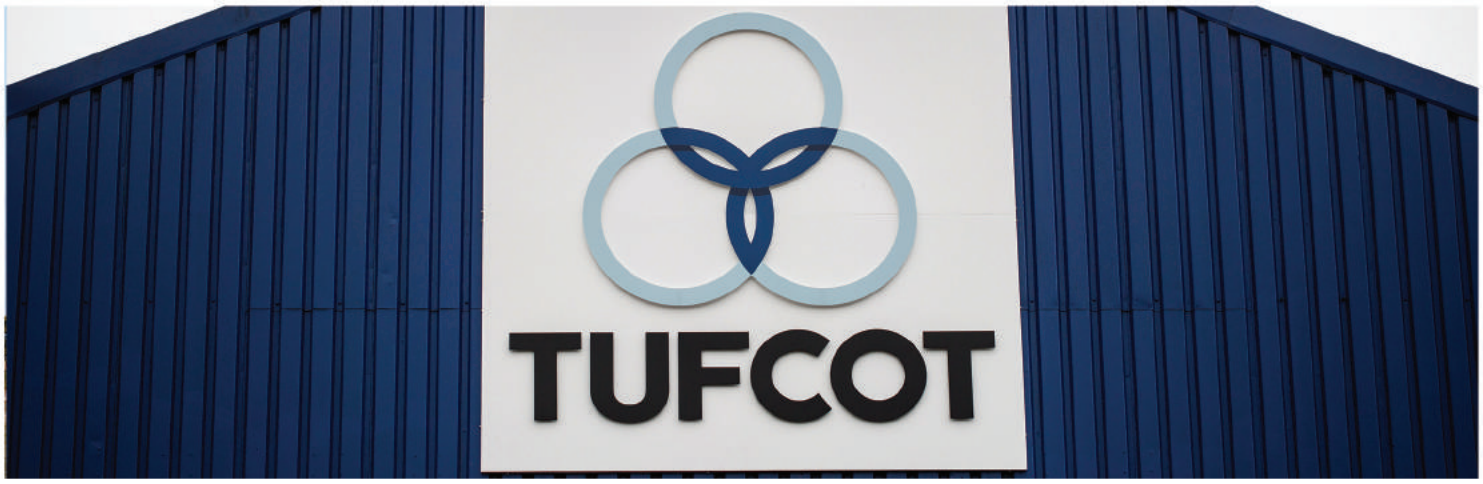
DESIGN & INSTALLATION OF BUSHES & BEARINGS

Journal clearance – Typical Running fits

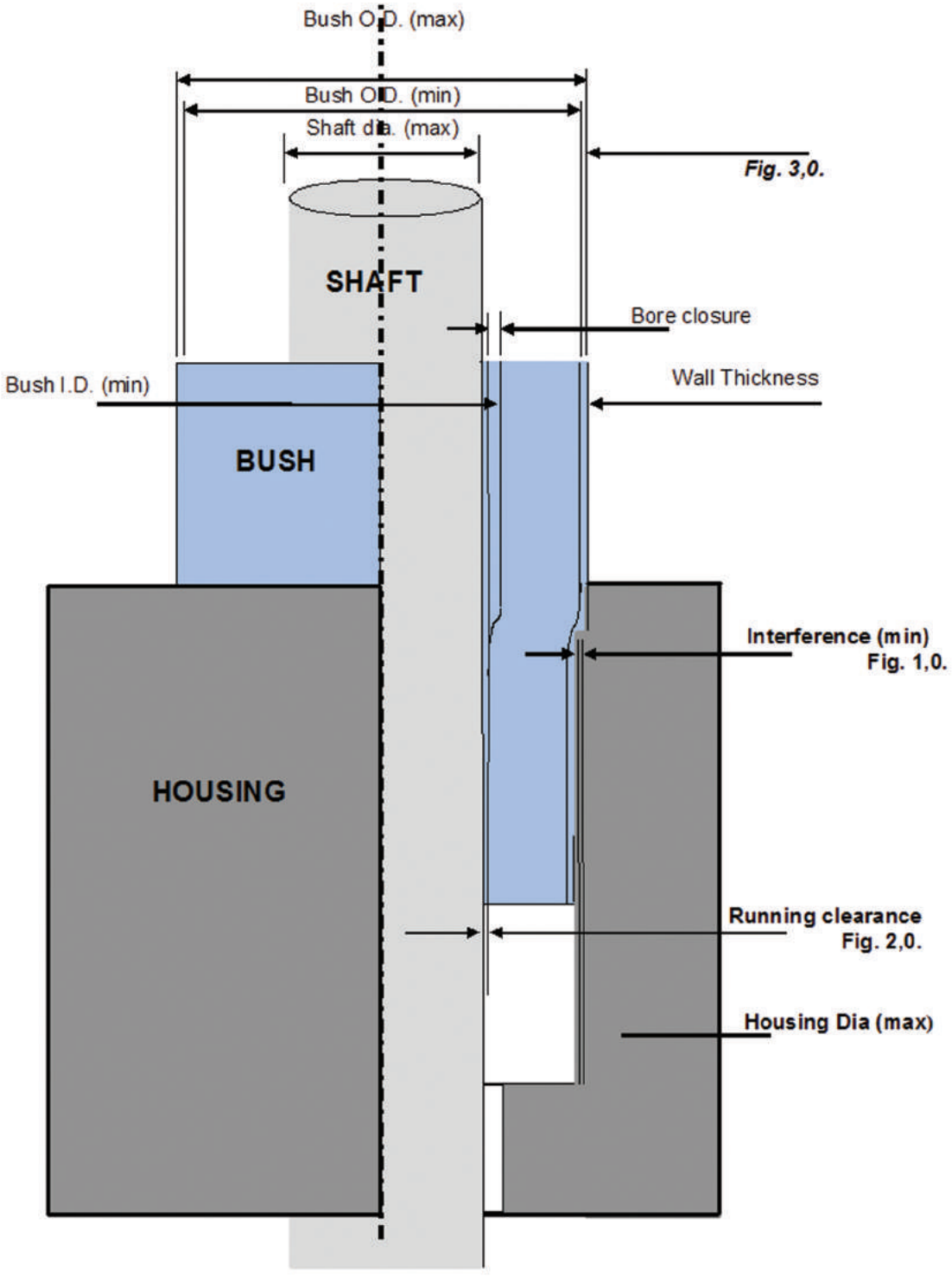
Fig. 6,0. below lists the recommended bore allowances for a range of bush sizes under load conditions. These are for final running clearance, the value for transfer of interference fit should be added to this when machining.

Shaft Diameter	Bore allowances on I/D up to 1000 p.s.i. 7 N/mm^2
Millimetres (mm)	Millimetres (mm)
13	+ 0.15
25	+ 0.15
38	+ 0..20
51	+ 0.23
64	+ 0.28
76	+ 0.30
89	+ 0.33
102	+ 0.33
127	+ 0.38
152	+ 0.40
203	+ 0.46

Shaft Diameter	Bore allowances on I/D up to 1000 - 2000 p.s.i. (7 – 14 N/mm^2)
Millimetres (mm)	Millimetres (mm)
13	+ 0.20
25	+ 0.20
38	+ 0.25
51	+ 0.28
64	+ 0.33
76	+ 0.36
89	+ 0.38
102	+ 0.38
127	+ 0.41
152	+ 0.46
203	+ 0.51



DESIGN & INSTALLATION OF BUSHES & BEARINGS



MATERIAL SAFETY DATA

See below an example of our safety data sheets. The below is for one of our base grades, T100.

SAFETY DATA SHEET – T100

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION & THE COMPANY/UNDERTAKING

Manufacturers Name: Tufcot Engineering Ltd

Address: 330 Coleford Road, Darnall, Sheffield, S9 5PH.

Emergency Telephone No: +44 0114 2442363

Product Name: TUFCOT - T100

Chemical Name: Polyester Composite

2. HAZARDS IDENTIFICATION

Main Hazards: Dust Inhalation, Particles in the Eyes, Manual Handling.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Identification of the Preparation: Manufacture of Composite Materials

Chemical Name	Weight (%)	Other
Polyester Resin		
Catalyst		
Accelerator		
Polyester Cloth		

4. FIRST AID MEASURES

Ingestion:	Non-hazardous.
Inhalation:	Irritant above recommended exposure limits.
Skin:	Non-hazardous.
Eyes:	Remove affected person to fresh air, wash with copious water/eye wash and seek medical attention.

MATERIAL SAFETY DATA

5. FIRE-FIGHTING MEASURES

Flash Point:	N/A
Method Used:	N/A
Extinguishing Media:	Foam, ABC powder, Carbon dioxide.
Extinguishing Media NOT to Use:	N/A
Special Fire Fighting Procedure:	None.
Unusual Fire and Explosion Hazards:	Non-combustible but flammable when exposed to direct flame. Avoid breathing fumes.

6. ACCIDENTAL RELEASE MEASURES

Steps if Material is Released or Spilled:	Sweep up spillage and avoid creating dust.

7. HANDLING AND STORAGE

Safe Handling:	Follow Manual Handling guides.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: (Specify type)	Dust mask recommended.
Ventilation:	Local exhaust.
Protective Gloves:	N/A
Eye Protection:	Safety goggles worn.
Other Protective Suggestions:	Hair tied back, sleeves rolled up.

MATERIAL SAFETY DATA

9. PHYSICAL AND CHEMICAL PROPERTIES

Specific Gravity (H2O = 1):	1.25	Vapour Density (Air = 1):	N/A
Melting Point (°C):	N/A	Vapour Pressure (mm Hg):	N/A
Boiling Point (°C):	N/A	Percent Volatile:	N/A
Solubility in Water:	INSOLUBLE	Evaporation Rate:	N/A

10. STABILITY AND REACTIVITY

Material Stability:	Good.
Conditions / Materials to Avoid:	Highly concentrated acids, Ketones.
Hazardous Decomposition Products:	None.

11. TOXICOLOGY INFORMATION

No Information

12. ECOLOGICAL INFORMATION

No Information

13. DISPOSAL CONSIDERATIONS

Waste Disposal Method: Commercial landfill.

14. TRANSPORT INFORMATION

No Information

15. REGULATORY INFORMATION

No Information

16. OTHER INFORMATION

No Information

TUFCOT

address
Tufcot Engineering Ltd
330 Coleford Road
Darnall, Sheffield
England
S9 5PH

phone
+44 (0)114 244 2363

fax
+44 (0)114 256 1688

email
info@tufcot.com

website
www.tufcot.com

All data within this document was tested in laboratory conditions and therefore are the 'ultimate' figures.

Whilst the utmost care is taken to ensure the validity of the data given herein, any advice or opinions given by the company are offered in good faith without obligation or liability.

The decision to determine the suitability of the product and any alleged injury, damage or loss resulting is the responsibility of the user.