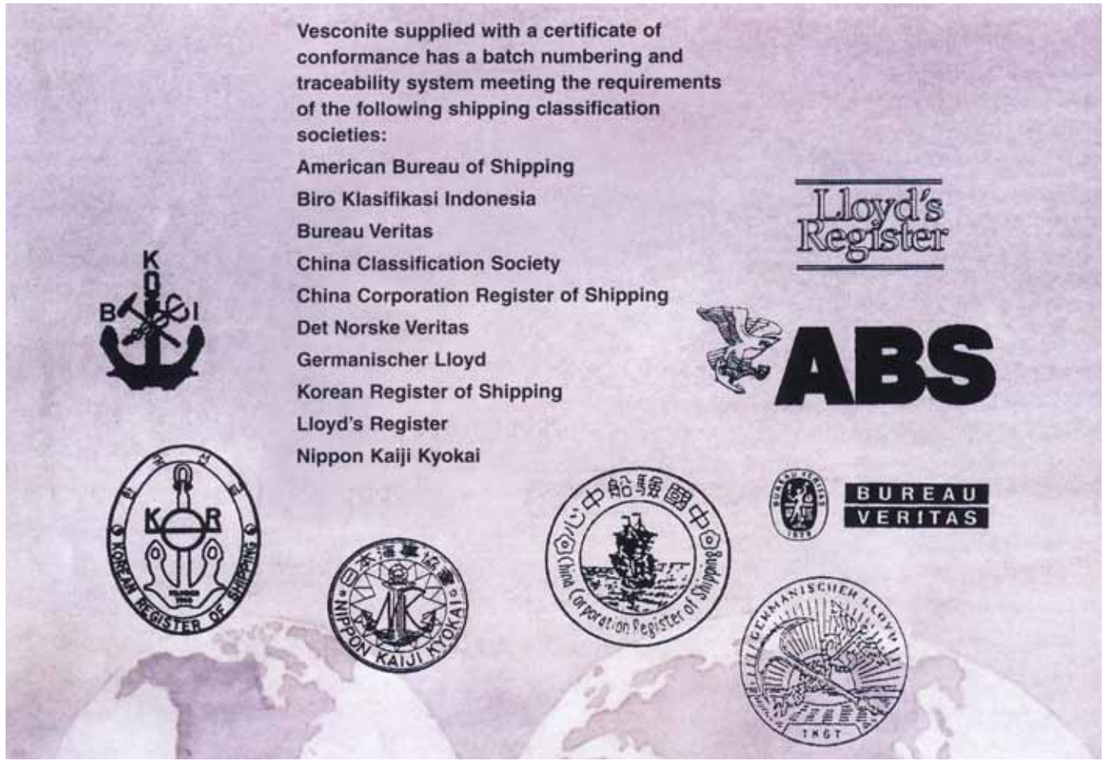
Not limited to pumps, Vesconite has been approved and used for many years in marine applications.



LIMITED WARRANTY AND LIMITATION OF LIABILITY

1. This design manual is based upon many years of experience of VescoPlastics Australia and Armstrong Energy in manufacturing and installing Vesconite.

   Experience shows that no two applications are the same in every detail so the Company encourages that every application be treated as individual and unique.

   This information is offered in good faith as part of our client service, but favourable results cannot be guaranteed. This manual is intended for use by persons with technical skill, at their discretion and risk. The purchaser must determine the suitability of the goods for their intended purpose.

2. The company reserves the right to change or amend any recommendation or specification without notice.

3. Goods are supplied on the express condition that the Company's liability is limited to the replacement of defective goods or materials.

4. The company does not hold itself responsible for any damage, incidental or consequential loss suffered as a result of the use of goods supplied.

5. Acceptance of goods will be held to imply agreement to the above conditions.

Specialising in parts for power generation, oil and gas installations, and the mining industry.

ARMSTRONG ENERGY PTY LTD

181A Star Street Carlisle WA 6101 P.O Box 685 Cloverdale WA 6985
TEL: +61 8 9361 2772 FAX: +61 8 9361 2761
EMAIL: info@armstrongenergy.com.au WEB: www.armstrongenergy.com.au

ARMSTRONG ENERGY

Vesconite Pump Bearing Design Manual

Specialising in parts for power generation, oil and gas installations, and the mining industry.

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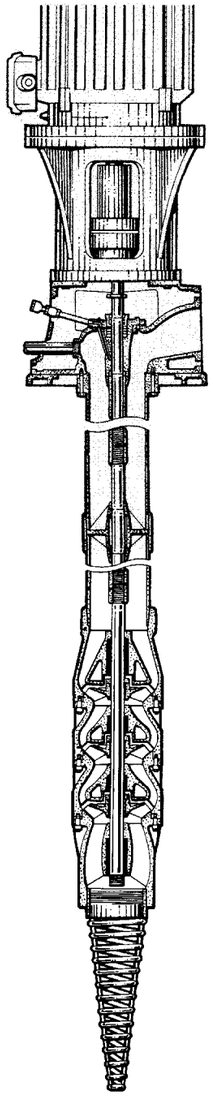
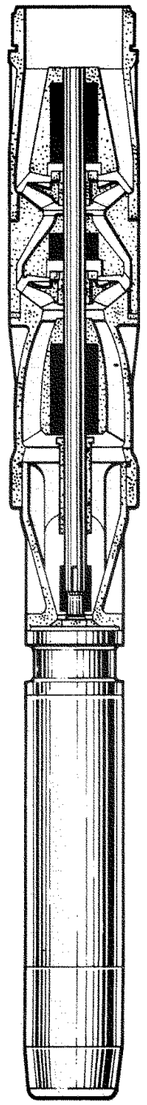
VESCONITE

Water lubricated bearing materials for line shaft bearings, pump bowl bearings, stuffing box bushes, impeller wear rings and submersible motor bearings.





APPLICATIONS INCLUDE

- *High pressure dewatering pumps for underground mines.*
- *Fire fighting service water pumps for offshore oil drilling platforms.*
- *High pressure bilge pumps for submarines.*
- *Cooling water pumps for power stations.*
- *Irrigation and potable water supply.*

Chemical Resistance Chart

Chemical Name	%
Fluorine (gas)	
Formaldehyde	
Formic acid	10
Formic acid	90
Freon	
Furfural	
Gasoline	
Glycerine	
Glycerol	
Glycol	
Grease	
Heptane	
Hexane	
High octane petrol	
Hydrobromic acid	50
Hydrochloric acid	36
Hydrochloric acid	100
Hydrofluoric acid	5
Hydrofluoric acid	40
Hydrofluoric acid	50
Hydrogen peroxide	35
Hydrogen sulfide (gas)	
Ink	
Iodoacetic acid	
Isopropanol	
Kerosene	
Linseed oil	
Lubricating oil	
Magnesium chloride	
Methanol	
Methyl alcohol	
Methyl ethyl ketone	
Methyl glycol	
Methylene chloride	
Mineral oils	
n-Hexane	
Nickel chloride	

Chemical Name	%
Nitric acid	10
Nitric acid	40
Nitrobenzene	
Octane	
Oil of cloves	
Oleic acid	100
Olive oil	
Oxalic acid	
Ozone (gas)	
Paraffin	
Perchloroethylene	
Petrol	
Phenol	
Phosphoric acid	30
Potassium bichromate	10
Potassium bromide	
Potassium carbonate	
Potassium hydroxide	1
Potassium hydroxide	10
Potassium hydroxide	60
Potassium permanganate	25
Potassium sulphate	
Propane	
Propanol	
Propyl alcohol	
Pyridine	
Rapeseed oil	
Silicone fluids	
Silver nitrate	
Soap solutions	1
Sodium bicarbonate	10
Sodium borate	
Sodium carbonate	20
Sodium chloride	25
Sodium hydroxide	1
Sodium hydroxide	10
Sodium hydroxide	60

Chemical Name	%
Sodium hypochlorite	20
Sodium nitrate	10
Stannic chloride	
Stearic acid	
Sucrose	
Sulphur dioxide (gas)	
Sulphuric acid	10
Sulphuric acid	70
Sulphuric acid	96
Tea	
Tetrahydrofurane	
Tetralin	
Toluene	
Transformer oil	
Trichloroacetic acid	
Trichloroethane	
Trichloroethylene	
Tricresyl phosphate	
Triethanol amine	
Triethylene glycol	
Turbo oil	
Turpentine	
Urea	
Vaseline	
Vegetable oils	
Vinyl chloride	
Water	
Water (sea)	
Wine	
Xylene	
Zinc chloride	
Zinc sulphate	

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Chemical resistance chart

Vesconite has a wide range chemical resistance, including resistance to many acids, mild alkalis, organic chemicals, solvents, hydrocarbons, oils and fuels.
Resistance at 25˚C (77˚F) for Vesconite and Vesconite Hilube.

- Resistant
- Partly resistant
- Not resistant

This chemical resistance chart is given as a guide only. The resistance data are estimates. The aggressiveness of chemical solutions generally increases with higher concentrations and rising temperatures. While general guidelines may be provided, every application needs to be considered individually.

It is recommended that the resistance be checked in practical field tests in the solutions in question.

Chemical Name	%	
Acetaldehyde		🙂
Acetic acid	10	🙂
Acetic acid	100	😐
Acetic anhydride		🙂
Acetone		🙂
Acetonitrile		😐
Acetophenone		😐
Acetyl chloride		😐
Aluminium chloride	10	🙂
Aluminium sulphate	50	🙂
Ammonia	conc	🙂
Ammonium hydroxide	10	😐
Ammonium sulphate	50	🙂
Amyl acetate		😐
Amyl alcohol		🙂
Aniline		🙂
Anti freeze		🙂
Aqua regia		☹
ASTM oils		🙂
Barium chloride		🙂
Barium salts		🙂
Benzaldehyde		🙂
Benzene		🙂
Benzyl alcohol		🙂
Benzyl chloride		🙂
Bleaching lye		🙂

Chemical Name	%	
Bleaching solution		🙂
Boric acid		🙂
Brake fluid		🙂
Bromine		😐
Butane		🙂
Butanol		🙂
Butyl acetate		🙂
Butyl amine		😐
Butyl chloride		😐
Butyric acid		🙂
Calcium chloride		🙂
Calcium hypochlorite		🙂
Calypsol greases		🙂
Carbon disulphide		🙂
Carbon tetrachloride		🙂
Castor oil		🙂
Cellosolve		🙂
Chloride of lime		🙂
Chlorine (gas-dry)		🙂
Chlorine dioxide		🙂
Chlorine in water		😐
Chloroacetic acid		😐
Chlorobenzene		🙂
Chloroform		😐
Chlorosulfonic acid		☹
Chromic acid	40	🙂

Chemical Name	%	
Citric acid	10	🙂
Copper sulphate		🙂
Cottonseed oil		🙂
Cresol		☹
Cyclohexane		🙂
Cyclohexanol		🙂
Cyclohexanone		🙂
Decalin		😐
Detergents	25	🙂
Dibutyl phthalate		🙂
Diesel		🙂
Diethyl ether		☹
Diethylene amine		🙂
Diethylene glycol		🙂
Dimethyl formamide		🙂
Dioctyl phthalate		😐
Dioxane		🙂
Ethanol		🙂
Ether		🙂
Ethyl acetate		🙂
Ethyl alcohol		🙂
Ethyl chloride		🙂
Ethylene dichloride		😐
Ethylene glycol		🙂
Ferric chloride		🙂
Fixer solution		🙂

Vesconite water lubricated bearings are a “fluid film” or “hydrodynamic” type, where fluid is drawn from the axial grooves and flows across the bearing surface forming a thin lubricant film. Fluid is then expelled through the next groove and is constantly replaced, keeping the temperature stable and the fluid film intact.

Vesconite contains internal lubricants which give low friction and the ability to cope with incidental surface contact at pump speeds without damage to the bush or shaft.

Dry starts of a few seconds duration should not cause concern, however prolonged dry running, grease or oil lubrication should be avoided as there is insufficient cooling available without a positive water flow through the bearing. Plastics have low thermal conductivity and higher thermal expansion than metals. It is imperative that any heat generated is removed directly from the bearing surface by the lubricating fluids.

FIGURE 1

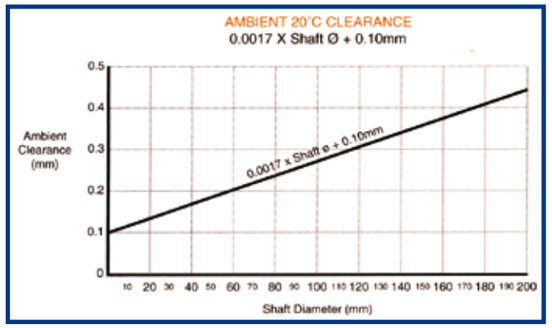
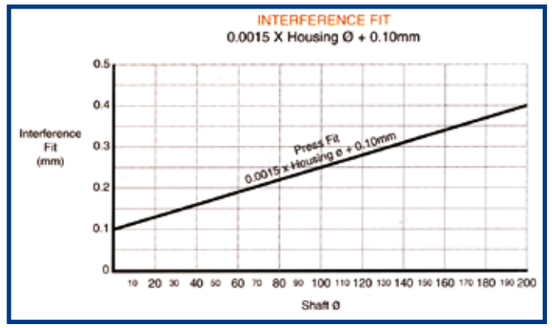


FIGURE 2



The clearance in mm required for ambient conditions (20°C) can be calculated from
Fig 1 0.0017 x shaft diameter mm + 0.10mm

EXAMPLE (Fig 1)
0.0017 x 50mm + 0.10mm = 0.18mm fitted clearance

The interference (Press Fit) required is calculated from
Fig 2 0.0015 x Housing Diameter mm + 0.10mm

EXAMPLE (Fig 2)
0.0015 x 70mm + 0.10mm = 0.20mm interference
i.e. for 70mm Housing, machine bush O.D. to 70.20mm

Bore closure during fitting will be equal to the actual interference fit between bush and housing. For bushes which are fully machined before fitting.
Machined I.D. (unfitted) = Shaft diameter + ambient clearance + bore closure

EXAMPLE
Shaft diameter 50mm + clearance 0.18mm + bore closure 0.20mm =
unfitted I.D. 50.38mm (50.18, after fitting)

For bushes which are not press fitted, or have the I.D. machined after fitting do not add bore closure allowance.

Water lubricated bearings need a reliable flow of fluid to avoid excessive temperature rise. Bearings in pump bowls, pressure fed line shaft and stuffing box bushes have a pressure differential from entry to exit ensuring good fluid flow. Housing steps, circlips, retaining rings, or keeper plates if used should be located towards the low pressure end of the bush. Flanged bushes (used in large split case pumps) should have the flange located at high pressure end.

Suction cover and “wet” lineshaft bushes have little pressure differential and rely on the speed of flow to funnel water to the bearings. Make sure that suction cover bores are open at both ends, or that there is a pressure feed to the bearing. In all cases, make sure that steps in the housing bore do not block the grooves. Step I.D. should be greater than the base diameter of the grooves.

For excessively sandy or abrasive conditions, an external feed with a positive pressure supplying clean water directly to the bearings is recommended.

Shafts

- Metal mating surfaces must suit the media and wear conditions encountered.
- Mild carbon steels and stainless steel shafts are acceptable for moderate applications.
- Non corrosive shafts are better as shaft corrosion will result in rapid wear.
- When operating in sandy or abrasive conditions, hard shaft surfaces ensure longer shaft as well as bush life.In dirty conditons, Vesconite Hilube running against hard shafts gives the best performance.

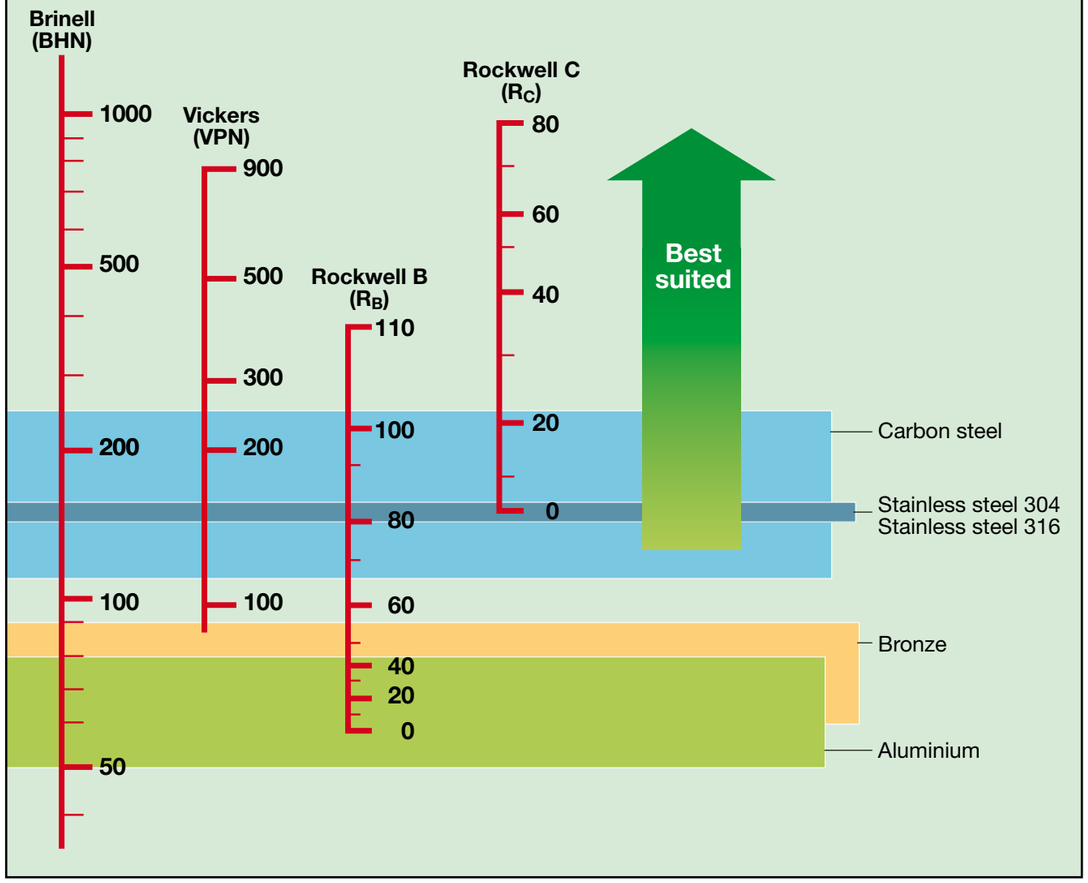
Ideal shaft material

- Hardchrome plated surfaces
- Hardnesses > 50 rockwell (C) are ideal (Brinell 480, Vickers 510).

Housings and casings

Housing metals are not critical provided they do not corrode severely under the operating conditions.

Common hardness scales and typical hardness for various metals.
Hardness may vary significantly due to surface and heat treatments.
Material suppliers should be consulted for specific data values.



Surface finishes

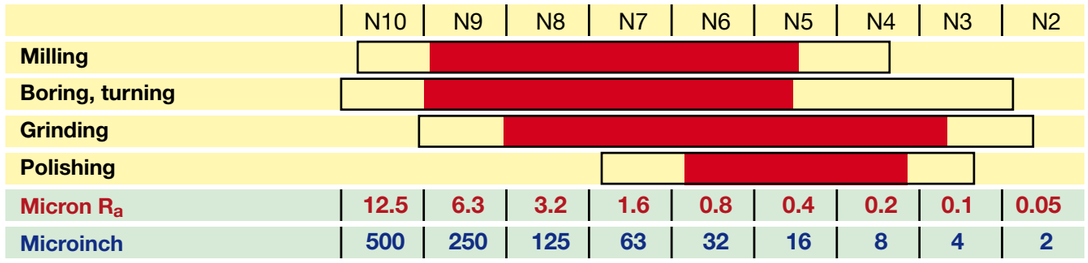
Shafts
The surface finish of the shaft is important to ensure long bush life. Rough surface finishes and corroded and scored shafts will cause accelerated wear of Vesconite bushes and should be avoided.

A recommended ground finish of 0.5 μm R_a (20 microinch R_a) is ideal. Shaft roughness should not exceed 2.5 μm R_a (100 microinch R_a).

For solid drawn shafts which have axial tool marks, roughness should be less than 0.5 μm R_a (20 microinch R_a). Centreless ground shafts are usually acceptable.

Shafts should be round and not oval.

Typcal surface finishes for common machining methods



Housing and casings

The surface finish on the housing is not critical as there is no movement after installation.

To facilitate installing the bush, the housing surface should be smooth.

Lead in chamfers are advised to avoid scoring or shaving of the bush during installation.

Ovality of the housing must be avoided. If housing ovality presents a problem, it is best to install the bush and then bore the inside diameter to size after installation.

Machining tolerances

Standard ISO machining tolerances of H7 for metal housings and h7 for metal shafts are recommended for use with Vesconite bushes.

Housing / shaft diameter in mm (ISO tolerances)									
Diameter in mm			10 - 18	18 - 30	30 - 50	50 - 80	80 - 120	120 - 180	180 - 250	250 - 315
Housing	**H7**	**Upper**	+ 0.018	+ 0.021	+ 0.025	+ 0.030	+ 0.035	+ 0.040	+ 0.046	+ 0.052
		Lower	0	0	0	0	0	0	0	0
Shaft	**h7**	**Upper**	0	0	0	0	0	0	0	0
		Lower	- 0.018	- 0.021	- 0.025	- 0.030	- 0.035	- 0.040	- 0.046	- 0.052

Housing / shaft diameter in inches									
Diameter in inches			0.4 - 0.7	0.7 - 1.2	1.2 - 2.0	2.0 - 3.2	3.2 - 4.7	4.7 - 7.1	7.1 - 10.0	10.0 - 12.5
Housing	**H7**	**Upper**	+ 0.000 71	+ 0.000 83	+ 0.001 0	+ 0.001 2	+ 0.001 4	+ 0.001 6	+ 0.001 8	+ 0.002 1
		Lower	0	0	0	0	0	0	0	0
Shaft	**h7**	**Upper**	0	0	0	0	0	0	0	0
		Lower	- 0.000 71	-0.000 83	- 0.001 0	- 0.001 2	- 0.001 4	- 0.001 6	- 0.001 8	- 0.002 1

Synthetic materials such as Vesconite and Vesconite Hilube have a wider tolerance specification than metal mating surfaces. Tight clearances and thin walled sections may require tighter tolerances on metal components.

FIGURE 3

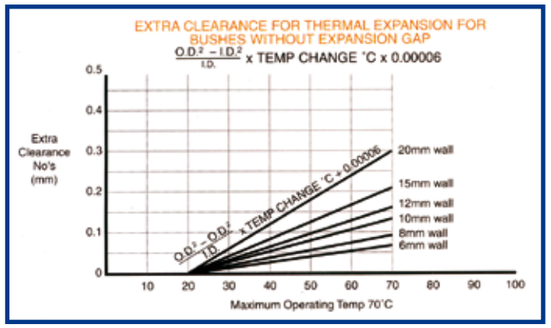
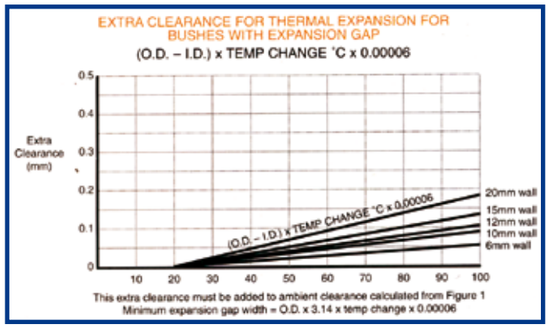


FIGURE 4



Extra clearance must be added to ambient clearance for temperatures over 20°C. For operation up to 70°C an interference fit is recommended. Use Fig 3. to calculate extra clearance required.

$$\frac{O.D.^2 - I.D.^2}{I.D.} \text{ x Temperature Change °C x } 0.00006$$

EXAMPLE (Fig 3)

At 70°C (50°C Temperature Rise)

$$\frac{70^2 - 50^2}{50} \text{ x } 50°C \text{ x } 0.00006 = 0.14mm$$ (extra clearance add to ambient clearance)

Fitted Clearance (at 20°C) = 0.18mm
Fitted Clearance (at 70°C) = 0.32mm

For operation between 70°C and 100°C Vesconite bushes must have an expansion gap. Do not use interference fits above 70°C as the resulting strain and loss of elasticity can result in bushes becoming loose at ambient temperature. For bushes with an expansion gap calculate clearance from Fig 4.

(O.D. - I.D.) x Temp Change °C x 0.00006

EXAMPLE (Fig 4)

At 80°C (60°C Temperature Rise)
(70mm - 50mm) x 60°C x 0.00006 = 0.07mm extra clearance
Add this to the ambient clearance calculated (0.18mm)
Fitted clearance bush to shaft (at 20°C) = 0.18mm
Fitted clearance bush to shaft (at 80°C) = 0.25mm

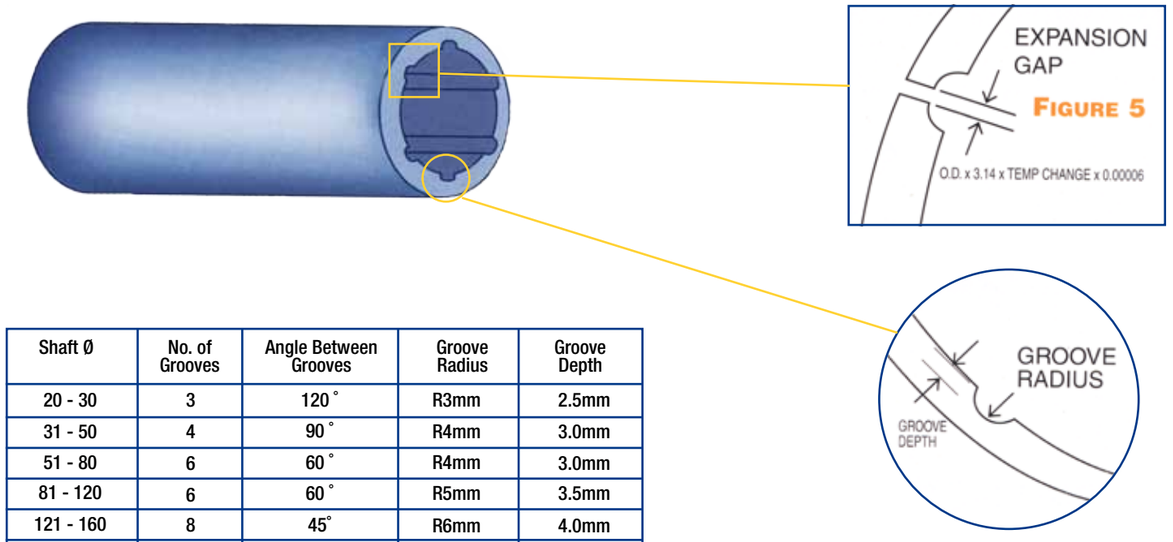
Expansion gap width = housing diameter (mm) x 3.14 x temperature change °C x 0.00006

EXAMPLE (Fig 5)

70mm x 3.14 x 60°C x 0.00006 = 0.08mm minimum

Note: Bushes with expansion gaps require machanical retention against axial and rotary movement. These can include roll pins, grub screws, retaining rings or canister type bush and case sets. Thinner wall sections require less clearance for elevated temperatures.

Groove Dimensions



Shaft Ø	No. of Grooves	Angle Between Grooves	Groove Radius	Groove Depth
20 - 30	3	120˚	R3mm	2.5mm
31 - 50	4	90˚	R4mm	3.0mm
51 - 80	6	60˚	R4mm	3.0mm
81 - 120	6	60˚	R5mm	3.5mm
121 - 160	8	45˚	R6mm	4.0mm
161 - 200	10	36˚	R6mm	4.0mm

Groove depth should not exceed half the wall thickness. Use more grooves or wider grooves if depth must be reduced due to restricted wall thickness. Avoid grooves less than 2.5mm deep as they are easily blocked by sand or coarse debris.

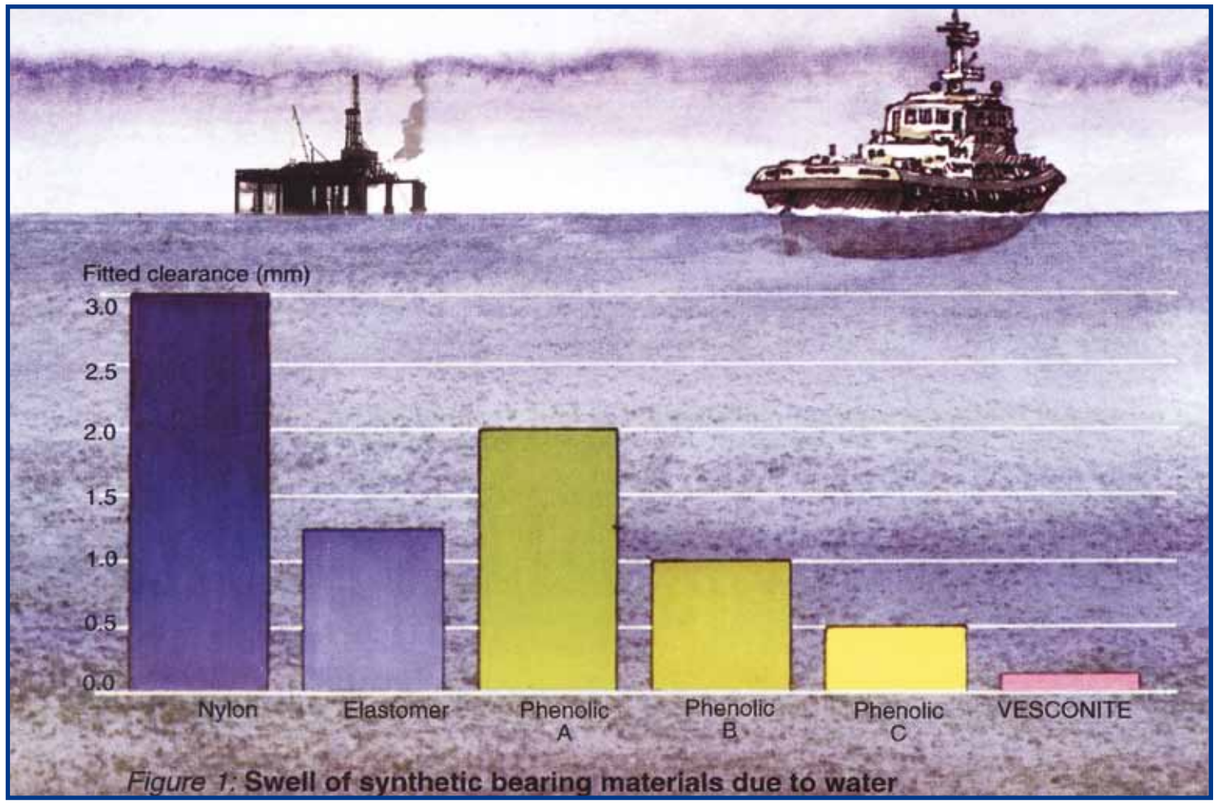


Figure 1: **Swell of synthetic bearing materials due to water**

Typical Properties

	VESCONITE	VESCONITE HILUBE
Density	1.38	1.38
Melting point	260˚C	260˚C
Hardness (Shore D)	84	82
Tensile strength at yield	65 MPa	66 MPa
Tensile strength at break	62 MPa	65 MPa
Elongation at break	26%	58%
Tangent modulus of elasticity (D790)	3400 MPa	3726 MPa
Flexural yield strength	120 MPa	113 MPa
Deflection temperature at 1.85 MPa	93˚C	117˚C
Modulus of elasticity under compression	2290 MPa	2206 MPa
Compression strength at yield	98 MPa	99 MPa
Shear strength	49 MPa	49.4 MPa
Notched Impact strength Charpy (D256)	33 J/M	26 J/M
Notched Impact strength IZOD (D256)	16 J/M	30 J/M
Heat conductivity	0.3W/ (k.m.)	0.3W/ (k.m.)
Coefficient of linear thermal expansion	6mm/mm/˚C x 10^{-5}	6mm/mm/˚C x 10^{-5}
Maximum moisture absorption in water at 20˚C	0.5%	0.5%
Equilibrium moisture absorption in air 50% RH, - 23˚C	0.2%	0.2%
Dynamic unlubricated friction coefficient on steel	0.12	0.10
Static friction coefficient on polished steel (no lube)	0.20	0.09
Dielectric strength	14 kV/mm	14 kV/mm
Gamma ray resistance 50% loss of properties	100 M Rads	100 M Rads

The above data should be taken for indicative purposes only, as physical properties are altered to some extent by processing conditions, and the thermal history of the material.

For more information on Vesconite Hilube please refer to Vesconite Hilube Brochure.

Material Safety Data

Vesconite being a thermoplastic polyester based product is a particularly safe product to handle.

1. It does not contain any asbestos or other dangerous fillers which could cause a problem to persons machining the product.
2. The product can be considered safe for ingestion, and it does not pose a carcinogenic risk.
3. Vesconite does not present a hazard in handling as the constituents are not considered skin irritants or sensitisers.

4a. FIRE

A high temperature is required to ignite Vesconite, which has a melting point of 260°C. Vesconite therefore has a limited fire risk, but normal good housekeeping precautions should be used in respect of machined shavings, etc, as like most organic materials it will burn once ignited above 500°C.

4b. It is composed of carbon, hydrogen and oxygen which produce carbon dioxide and water vapour on burning, the respiratory gases of mammals.

4c. Should a fire involving Vesconite occur, any commonly available fire extinguishers can be used. Care should thus be taken to avoid direct contact of molten material on the skin, as it will then be hot enough to adhere to the skin and cause severe burns.

In a fire situation, care should be taken to avoid breathing the products combustion.

4d. Vesconite Hilube contains P.T.F.E. (Teflon®) which is liable to evolve small amounts of fluorine at high temperatures (above 400°C).

5. Vesconite shavings and other waste products can be safely left in landfills as it will remain virtually unchanged for very long periods, without giving rise to problems of leaching into ground waters.

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