Vesconite and Vesconite Hilube

Marine Bearings

- Carry high loads
- Minimal lubrication
- No water swell
- Longest life
- Lowest maintenance

Why Vesconite for general marine applications?

- No swell in water – maintain close clearances.
- High load capacity - not affected by water absorption.
- Self lubricating – reduce greasing and maintenace without fear of seizure.
- No stick-slip problem – operate smoothly and quietly.
- Dimensionally stable – no water swell and low thermal expansion.
- Long wear life – low wear to bearings and expensive shafts and pins.
- No electrolytic corrosion.
- No delamination.

Where can Vesconite be used?

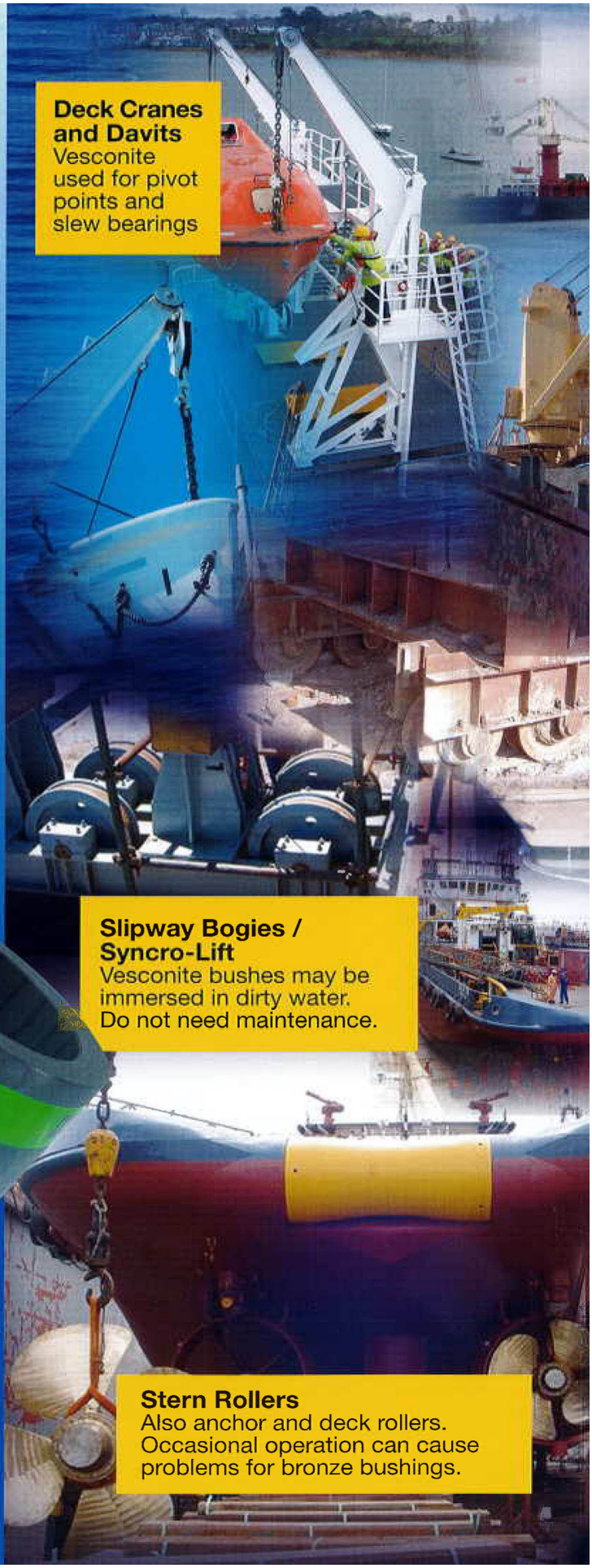
Vesconite is ideal for bushing applications with high loads and slow speeds where lubrication and maintenance is a problem and where long life is required.

Consider applications like

- Pivot joints
- Bushings that are partially and fully immersed in water
- Bushings for dirty applications
- Maintenance and greasing is not practical
- Low friction is required

ISO 9001 QUALITY ASSURANCE

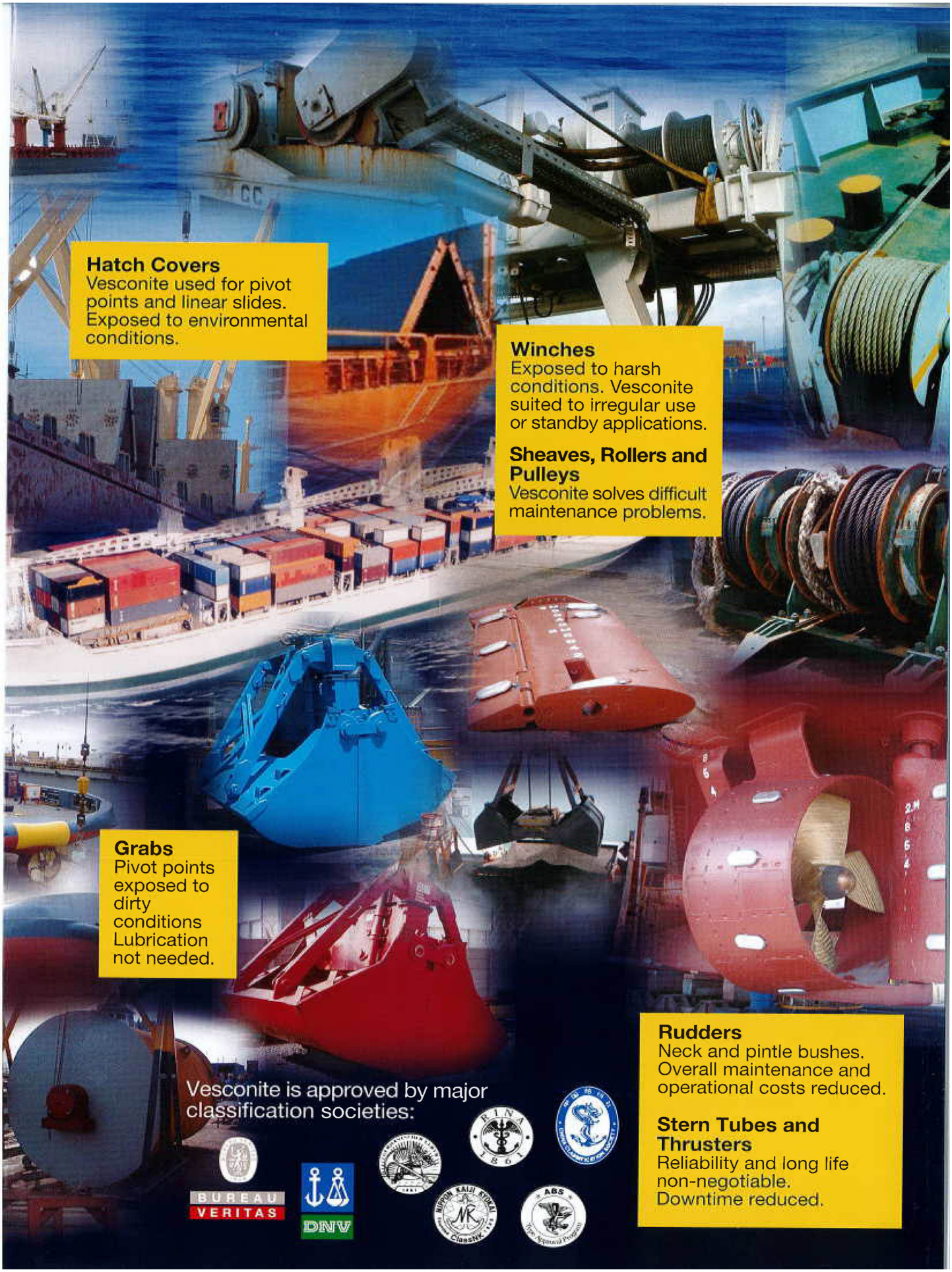
SABS



Deck Cranes and Davits
Vesconite used for pivot points and slew bearings

Slipway Bogies / Syncro-Lift
Vesconite bushes may be immersed in dirty water. Do not need maintenance.

Stern Rollers
Also anchor and deck rollers. Occasional operation can cause problems for bronze bushings.


Hatch Covers
Vesconite used for pivot points and linear slides. Exposed to environmental conditions.
Winches
Exposed to harsh conditions. Vesconite suited to irregular use or standby applications.
Sheaves, Rollers and Pulleys
Vesconite solves difficult maintenance problems.
Grabs
Pivot points exposed to dirty conditions Lubrication not needed.
Rudders
Neck and pintle bushes. Overall maintenance and operational costs reduced.
Stern Tubes and Thrusters
Reliability and long life non-negotiable. Downtime reduced.
Vesconite is approved by major classification societies:
BUREAU VERITAS
DNV

VESCONITE Rudder and Stern tube bearings

Photo: Safmarine

Contents

What is Vesconite?

VESCONITE is a specialised thermoplastic made from internally lubricated polymers. It has been proven since the late 1960s to be an exceptional plain bearing material, giving long life in applications where only the lowest rates of wear can be accepted. Even when conditions are dirty and unlubricated, Vesconite gives long life together with low maintenance and low friction.

Vesconite - with very low coefficients of friction whether dry or underwater, unlubricated or lubricated - is ideal for many marine applications. It is suited to both dry and immersed applications. In fact water is an excellent lubricant for Vesconite.

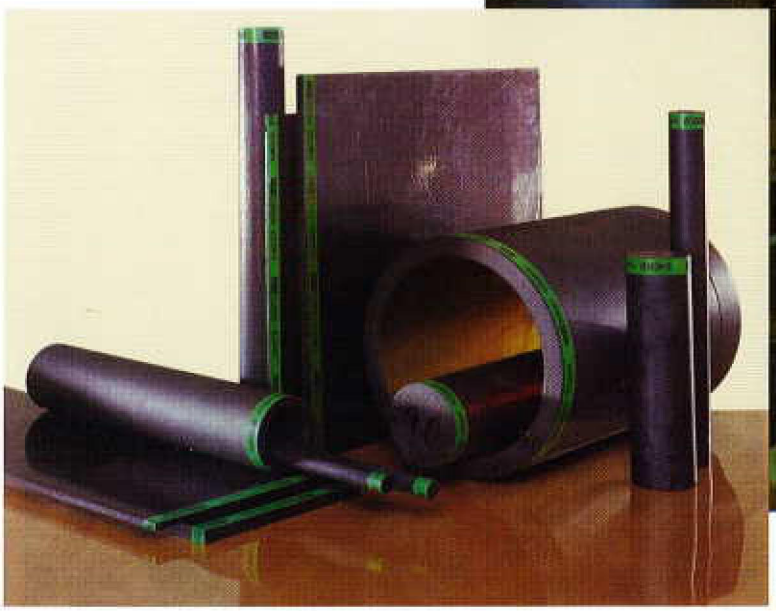
For rudder and stern tube bearings, Vesconite has many advantages compared to nylon, elastomers, phenolic laminates, *lignum vitae* and phosphor bronze.

Vesconite is dimensionally stable, unlike nylon, some elastomeric materials and phenolic laminates.

Underwater or in humid conditions, Vesconite will not swell and seize which is a major problem with nylon bushes. Nor does Vesconite soften and wear in water like nylon.

Vesconite's internal lubricants make it eminently suited to upper rudder bearing applications where there are long periods between greasing or no greasing at all, or where water lubrication cannot be ensured when operating with light ballasts.

Since 1977 Vesconite has been proved and approved as a bearing material for marine applications. (See page 4)



Why Use Vesconite?

Vesconite combines the advantages of metallic and non-metallic bearings and bushes.

Vesconite is extremely versatile. It outperforms in most plain bearing applications, whether unlubricated, grease and oil lubricated, or water lubricated.

Long wear life

Vesconite gives up to 10 times the service life of phosphor bronze in poorly lubricated conditions.

Vesconite keeps size - no water swell

Vesconite does not swell. Vesconite is one of the most dimensionally stable synthetic materials available as shown in Figure 1. Vesconite bearings may be machined to the correct clearances without fear of swelling. Clearances do not disappear. Vesconite gives you security!

For most synthetic bearing materials, water swell is a major problem. With water swell, there is always a risk of seizure. To compensate, suppliers of materials which swell advise excessive clearances.

Excessive clearances must be avoided for three reasons.

Firstly, they allow increased vibration.

Secondly, when machining an excessive clearance, one is machining away part of the wear life of the bearing - before installation!

Thirdly, and most negatively, the rate of wear of a sleeve bearing increases in proportion to the clearance. The greater the clearance, the faster the bearing wears, which greatly shortens bearing life.

Vesconite remains hard

In a wet environment, Vesconite does not absorb moisture nor does it soften. Vesconite remains hard, and keeps its compression strength and excellent resistance to creep.

Many synthetic bearing materials, like those based on elastomers and nylons, soften and lose their compression strength in water. This is shown in Figure 2.

In the long term, humidity in the general environment leads to water absorption. Softening caused by humidity and immersed conditions has two major disadvantages for these materials.

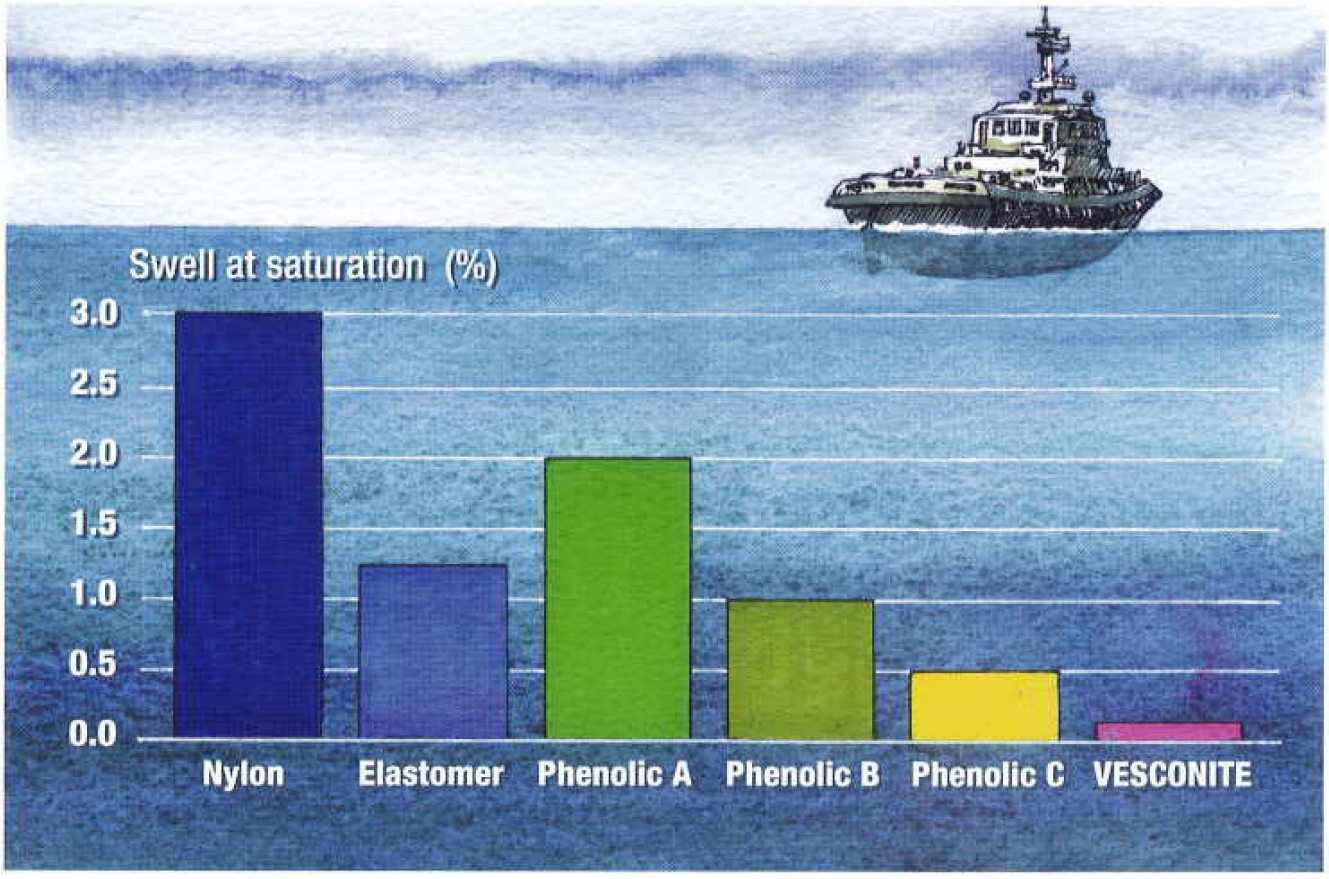


Figure 1: Swell of synthetic bearing materials due to water

Firstly, the drop in compression strength leads to creep. If the bearing is reasonably loaded, it will squeeze out, and no longer hold the shaft in its proper location.

Secondly, because the bearing surface is softer, its rate of wear increases dramatically, leading to a shorter bearing life.

This is why Vesconite is the marine bearing material of choice - it remains hard in moist and immersed conditions, keeps its compression strength and maintains its excellent long life wear characteristics.

Vesconite does not delaminate

Vesconite is a homogenous bearing material without any lamination reinforcement. The result is that delamination cannot take place with Vesconite, whereas it is a major problem for many laminated and composite products, for example laminated phenolics, laminated polyesters and thermosets.

What is delamination?

Delamination is the peeling off of layers of the bearing. It is not a slow, steady process like wear - instead whole layers of the bearing break off, causing uneven and excessive clearance.

How does delamination occur?

Laminated bearings are manufactured in layers, with a fibre or cloth reinforcement. As wear at the bearing surface occurs, water penetrates the exposed micro-channels that are formed by the cloth.

Swelling occurs along these surfaces, causing weakness between the layers of the laminate. The result is that the surface layers of the bearing material start peeling off.

Avoid delamination problems by switching to Vesconite.

Vesconite has low friction, even in actual working conditions

Compared to most elastomers, rubbers, nylons and laminates, Vesconite has a low friction. And this remains the case even in the practical, tough conditions of the real working environment.

Many products are claimed to have a low friction, but often only in the laboratory when tested under lightly loaded conditions, and before the effects of softening caused by water. Vesconite keeps its low static and dynamic friction whether dry or wet, or lightly or heavily loaded.

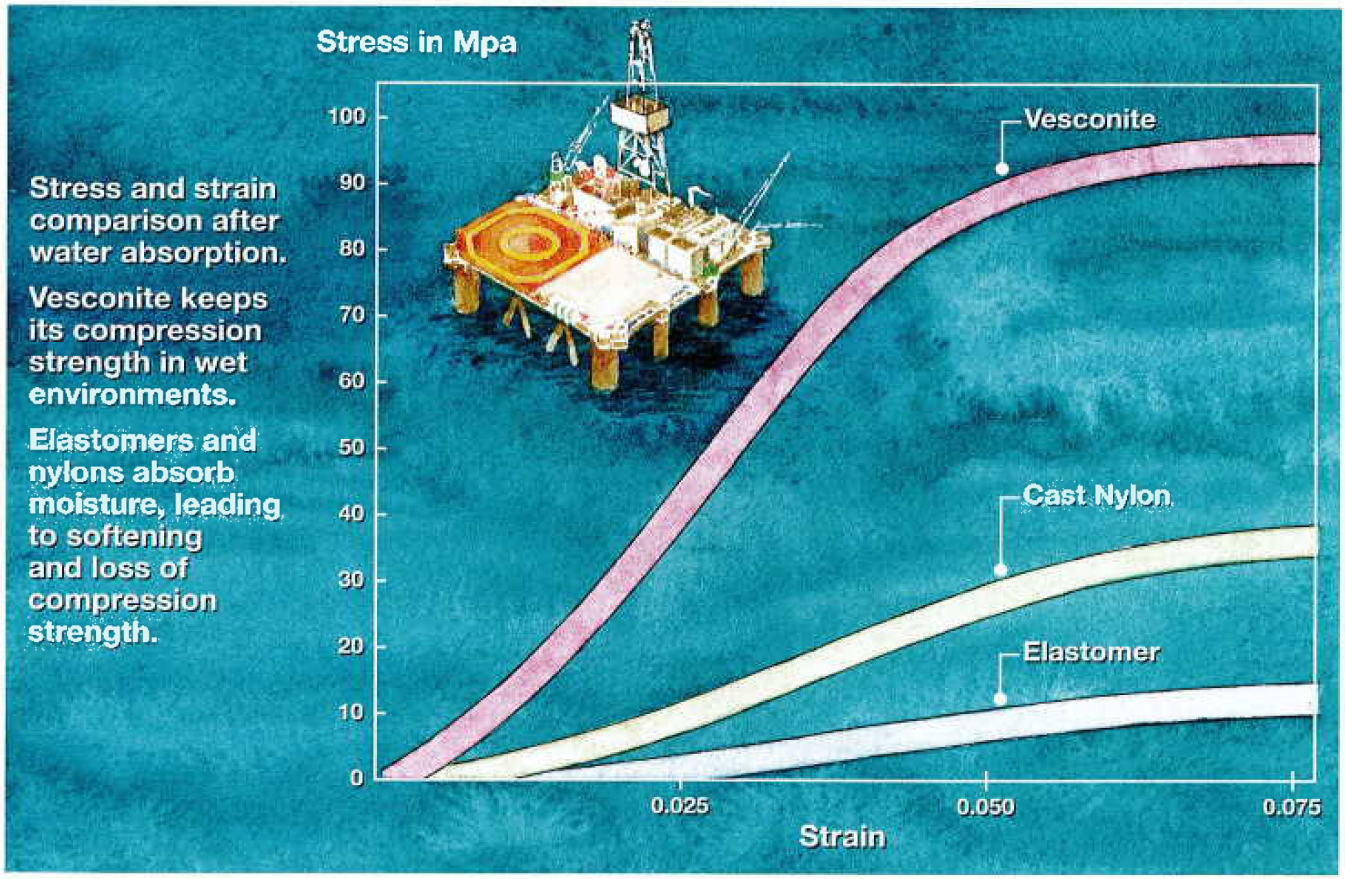
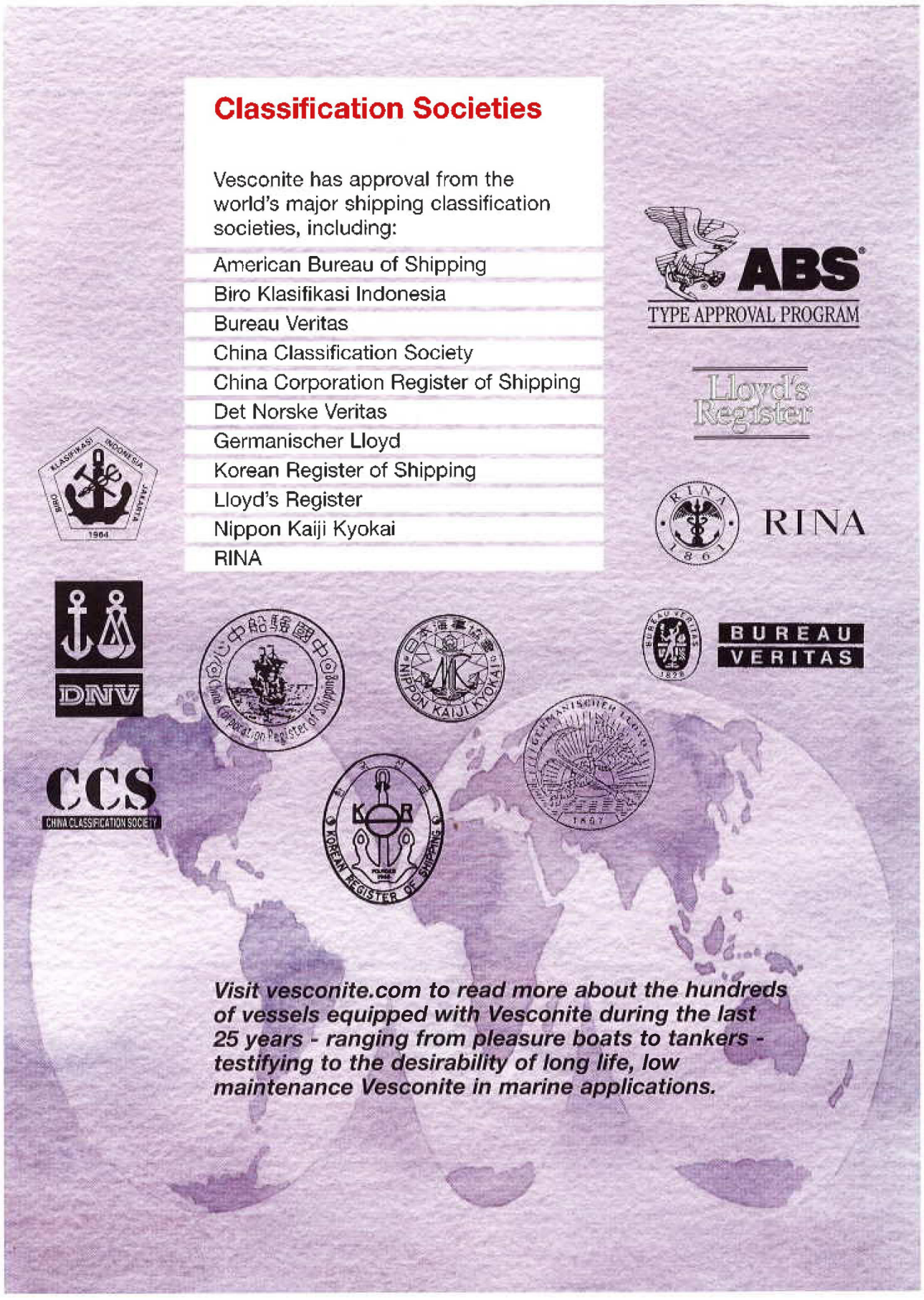


Figure 2: Vesconite maintains its compression strength whether wet or dry.

Classification Societies

Vesconite has approval from the world's major shipping classification societies, including:

- American Bureau of Shipping
- Biro Klasifikasi Indonesia
- Bureau Veritas
- China Classification Society
- China Corporation Register of Shipping
- Det Norske Veritas
- Germanischer Lloyd
- Korean Register of Shipping
- Lloyd's Register
- Nippon Kaiji Kyokai
- RINA



Visit vesconite.com to read more about the hundreds of vessels equipped with Vesconite during the last 25 years - ranging from pleasure boats to tankers - testifying to the desirability of long life, low maintenance Vesconite in marine applications.

Why is this important? Low friction for a rudder bearing means less bearing wear, as well as smoother operation and less wear to the whole steering gear.

The low static friction of Vesconite is especially beneficial to the low amplitude oscillating movements of rudders. With Vesconite every change of direction occurs smoothly, with a minimal power requirement and without any jerking.

Test this for yourself with Vesconite - its the best way to prove it. You will be delighted with the performance improvement compared to conventional materials.

SOS: Save Our Shafts

Vesconite saves your shafts. Because of its low friction, most users report greatly reduced wear rates on shafts and liners. In many applications, users have switched to Vesconite because of the reduced wear, increased life and savings obtained on their shafts, often a very expensive component.

The case study of the propeller shaft bearings of the Jackson pilot boat on page 19 is an example of the low shaft wear rate.

If shaft wear is your problem, or you would like to extend your shaft life, contact us about options.

Vesconite does not corrode

Vesconite is not subject to electrolytic corrosion, a major problem with traditional metallic bearing materials. While corrosion of the bearing surfaces is not normally a problem for bronze and cutless bearings, it becomes a major practical problem when replacing a cutless or bronze bearing. Usually there is some corrosion between the outside of the bronze sleeve and the housing, which often makes removal of the old bearing exceptionally difficult.

Easy removal of Vesconite bearings

Vesconite bearings are easy to remove. Since no electrolytic corrosion occurs with Vesconite, they do not seize like metallic bearings.

Vesconite does not contain any reinforcement, and old Vesconite bearings are easily removed. This is often not the case for laminated bearings: workers often struggle for hours trying to cut, hammer or burn laminated bearings out of their housings.

Safety and health

Vesconite is a safe product. It does not contain asbestos or hazardous fibres. Nor does Vesconite contain any lead or hazardous substances.

Vesconite has passed a series of stringent health tests. It is fully approved for applications in direct contact with drinking water, both in cold and hot water.

Easy to machine

Compared to metallic, cutless, bronze or synthetic bearing materials, Vesconite is very easy and safe to machine on standard metalworking and wood working machinery.

With Vesconite the size you machine is the size you get, unlike elastomers which stress relieve and change size during machining.

There are no dust or health problems when machining Vesconite, whereas these can be problems with laminates as a result of the fibre reinforcement.

Low friction Vesconite keeps lathe tooling sharp hour after hour. This is another example of the long life, low wear properties of Vesconite. If machining a bearing blunts your tooling, think what it does to your shafts.

Vesconite versus white metal

Vesconite has a higher design load limit than white metal (babbitt), a higher fatigue strength and two to three times the wear life.

Chemical resistance

In addition to its unrivalled performance in water, Vesconite has a wide range chemical resistance, including resistance to many acids, organic chemicals and solvents, hydrocarbons (including gasoline), oils and fuels. (See page 8)

If you need a bearing for a problem chemical application, contact us - we can advise whether Vesconite is suitable, or whether we can offer another of our speciality bearing materials.

Vesconite Product Range

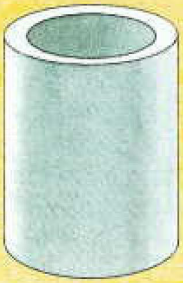
Vesconite is stocked in a wide range of sizes and shapes.

Vesconite can be obtained directly from dedicated dealerships in many parts of the world or airfreighted within days from the VescoPlastics' factory.

Vesconite is available at short notice for special marine products, whether semi-finished or finished to toleranced drawings.

Special shapes may also be injection moulded in Vesconite for cost effective OEM components.

Bearings (Tubes)



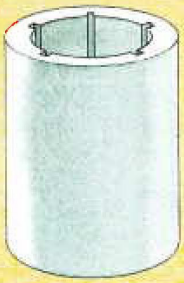
Stocked in 1 metre (39") lengths for shafts from 6 to 650 mm diameter (1/4" to 26").

Large diameter bearings (250 mm/10" and greater) are also stocked in 1.5 and 3 metre (5' and 10') lengths.

For greater economy these can be supplied to the length required, thus avoiding wastage.

Details of the full bearing stock range may be obtained from your Vesconite dealer or by completing the inquiry form on the inside back cover of this manual.

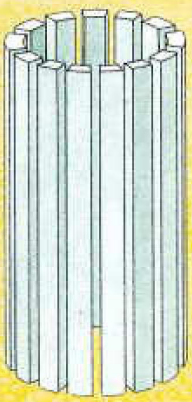
Ready-to-Fit Bearings



Ready-to-Fit strut and rudder bearings with water grooves are stocked for shafts from 25mm (1") to 50mm (2") diameters and for housings from 40mm (1 1/2") to 70mm (2 3/4").

Outside diameters can be supplied to the nearest imperial size.

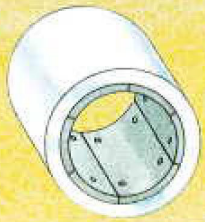
Staves



Vesconite staves for large rudder or stern tube bearings are cut and milled from plate.

Machined staves are produced in 1 metre (39") lengths or as required up to 3 metre (10') lengths.

Linings



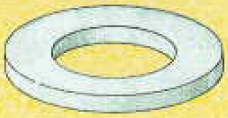
Machining and lining of sleeves and housings can be undertaken.

Solid rods

Diameters from 8 to 160 mm (5/16" to 6") are stocked in 1 metre (39") lengths.

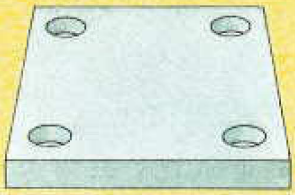
Longer lengths may be produced upon request.

Thrust Washers



Manufactured in diameters up to 715 mm (28").

Plates and Wear Strips

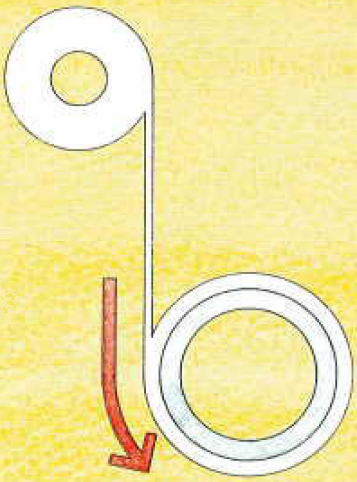


Available in accurately machined thicknesses from 3 to 50 mm (1/8" to 2"). Plates from 3 to 10 mm (0.118" to 0.394") thickness are stocked in lengths up to 1000 mm (39").

Plates from 12 to 50 mm (1/2" to 2") thickness can be produced to required lengths. Standard plate widths are 200 mm (7 7/8").

Some thicknesses are also available as plates 600 mm (23 1/2") wide.

Vesconite Superclad Bearings



Vesconite Superclad technology adds great versatility to the Vesconite stock range.

Many customers require special bearing sizes at short notice. To meet this need, a Superclad Vesconite bearing is produced.

A bearing with a suitable inside diameter is wound with a cloth membrane impregnated with an epoxy compound until the desired outside diameter is obtained.

Left to cure overnight, the bearing is ready for machining and despatch the next day.

The resulting Vesconite bearing is encased in a reinforced Superclad jacket, giving an extremely strong final structure.

The high strength of Superclad on the outside is combined with the good bearing properties of Vesconite on the inside.

Vesconite Superclad technology can quickly and economically produce bearings with practically any desired wall thickness for shafts up to 675 mm (26 1/2") diameter.

Vesconite - Chemical Resistance

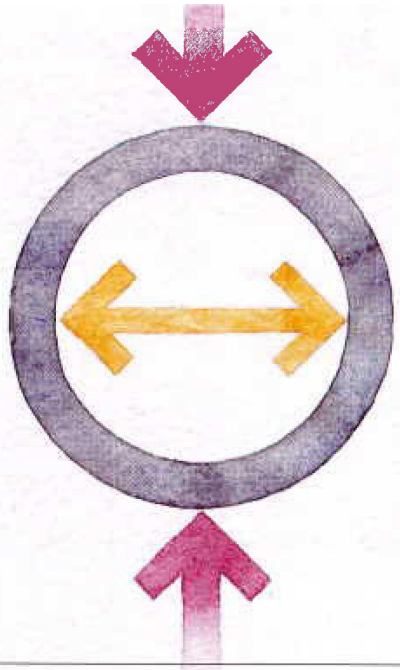
Vesconite has a wide range chemical resitance, including resistance to many acids, organic chemicals and solvents, hydrocarbons, oils and fuels, including gasoline.

If you need a bearing for a problem chemical application, contact us - we can advise whether Vesconite is suitable, or whether we can offer another of our speciality bearing materials.

Vesconite has good resistance to the following solutions at ambient temperatures

5% Acetic acid	Ethylene dichloride	30% Phosphoric acid
10% Acetic acid	Freon II	85% conc Phosphoric acid
Acetone	5% Formic acid	10% Potassium chloride
Aniline	Gasoline	10% Potassium dichromate
Benzine	Glycerol (Glycerine)	1% Potassium hydroxide
Bleaching lye	Glycol	10% Potassium permanganate
Brake fluid	Grease	Silicone fluids
Butane	Heptane	1% Soap solutions
Butyl acetate	Hexane	10% Sodium bicarbonate
10% Calcium chloride	10% Hydrochloric acid	10% Sodium bisulphite
Calcium hypochlorite	5% Hydrofluoric acid	20% Sodium carbonate
Carbon disulphide	30% Hydrogen peroxide	10% Sodium chloride
Carbon tetrachloride	Kerosene	1% Sodium hydroxide
40% Chromic acid	Methanol	10% Sodium hypochlorite
10% Citric acid	Methyl ethyl ketone	30% Sulphuric acid
Cottonseed oil	Mineral oils	Toluene
25% Detergents	Motor oils	Transformer oil
Dibutyl phthalate	10% Nitric acid	Turpentine
Diesel oil	100% Oleic acid	Vaseline
Dioxane	Olive oil	Vegetable oils
Ethanol	Paraffin	Water
Ether (diethyl-)	Perchloroethylene	White spirit
Ethyl acetate	Petrol	Xylene

Vesconite - Typical Properties



Physical properties may be altered to some extent by processing conditions.

Density / Specific gravity	1.38 $g.ml^{-1}$	1.38
Melting point	260°C	500°F
Hardness (Shore D)	84	84
Tensile strength at yield (D638)	65 MPa	9,400 psi
Tensile strength at break	62 MPa	9,000 psi
Elongation at break	26%	26%
Tangent modulus of elasticity (D790)	3400 MPa	493,000 psi
Flexural yield strength	120 MPa	17,400 psi
Deflection temperature at 1.85 MPa/268 psi	93°C	200°F
Modulus of elasticity under compression	2290 MPa	332,000 psi
Compression strength at yield	92 MPa	13,300 psi
Shear strength	49 MPa	7,100 psi
Notched impact strength charpy (D256)	33 $J.m^{-1}$	0.6 ft-lb/in
Notched impact strength IZOD	16 $J.m^{-1}$	0.3 ft-lb/in
Thermal conductivity	0.3 $W.K^{-1}.m^{-1}$	2 Btu-in/ft^2/hr/°F
Coefficient of linear thermal expansion	$6x10^{-5}mm.mm^{-1}.°C^{-1}$	$3.3x10^{-5}$ in/in/°F
Maximum moisture absorption in water at 20°C/68°F	0.5%	0.5%
Equilibrium moisture absorption in air (50% relative humidity, 23°C/73°F)	0.2%	0.2%
Dynamic unlubricated friction coefficient on steel	0.12 - 0.20	0.12 - 0.20
Dielectric strength	14 $kV.mm^{-1}$	360 kV/in
Gamma ray resistance 50% loss of properties	100 Mrads	100 Mrads

Interference Press Fits

Interference press fits are the most common method for securing Vesconite bearings.

The press fits recommended for most applications may be read off Figure 3. The graph assumes a bearing ambient temperature of 20°C (70°F) when it is machined.

Choose the press fit required for the minimum operating temperature of the bearing.

If a lower operating temperature is anticipated, contact your authorised Vesconite distributor.

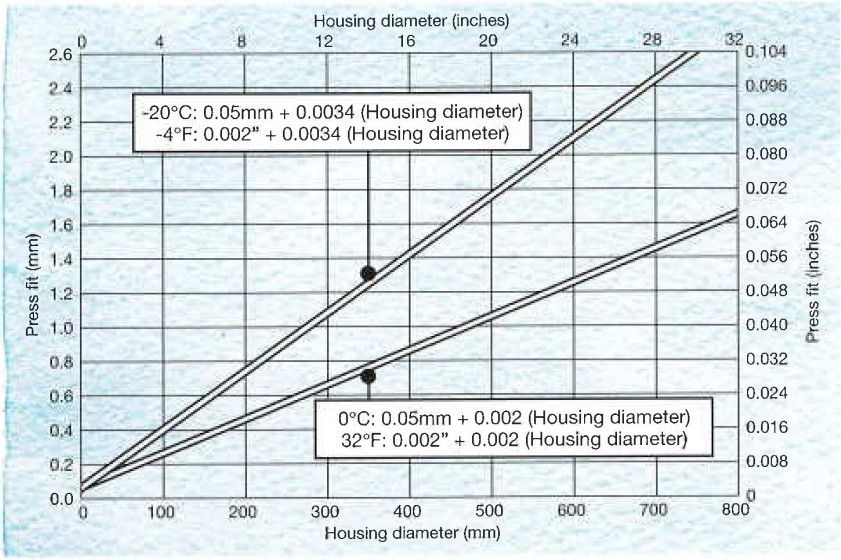


Figure 3: Press fits for rudder and stern tube bearings

Example: *A rudder neck bearing is required for a housing of 533 mm (21"). The bearing will be machined in a workshop with an ambient temperature of 20°C (70°F).*
The bearing may operate in temperatures as low as -20°C (-4°F). Specify the press fit required.
Using -20°C (-4°F) line in Figure 3, ***press fit*** *= 1.86 mm (0.073")*

Clearance for Rudder Bearings

The recommended running clearances for rudders after fitting in well aligned housings under normal conditions are given in Figure 4.

No extra clearance is needed to allow for water absorption before entering service. Vesconite does not absorb water to any appreciable extent, unlike many other synthetic materials which swell as they absorb water.

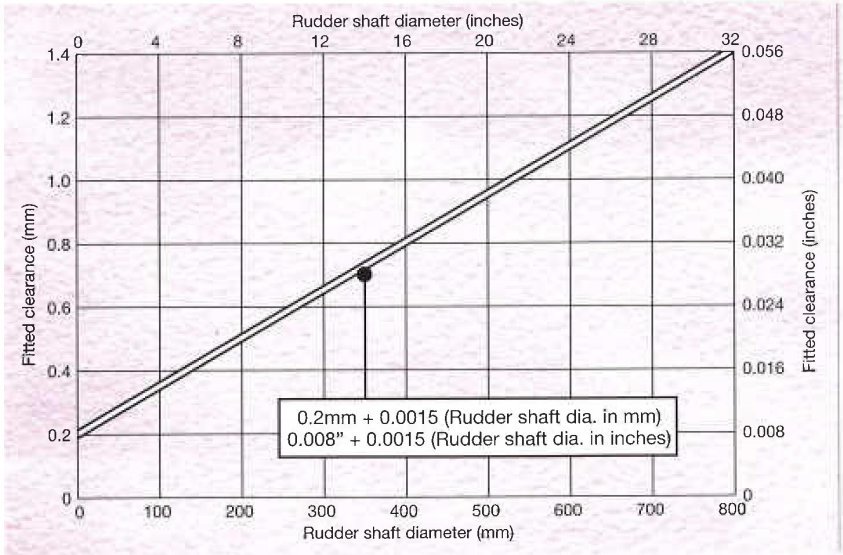


Figure 4: Fitted running clearance for rudder bearings

Example: *A rudder pintle has a diameter of 508mm (20")*
Find the fitted minimum clearance?
From Fig. 4 fitted ***running clearance*** *is 0.96mm (0.038")*

Designing Bearings

Clearance for Water Lubricated Stern Tube Bearings

The recommended fitted running clearance for water lubricated stern tube and strut bearings in well aligned housings is obtained from Figure 5.

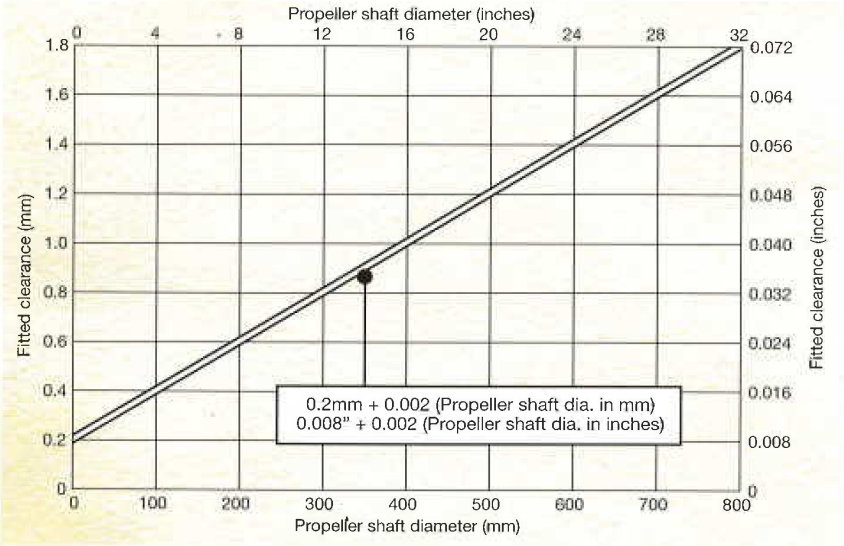


Figure 5: Fitted running clearance for water lubricated stern tube bearings

Example: *For a water lubricated stern tube bearing used for a 356 mm (14") propeller shaft, find the fitted minimum clearance.*

From Figure 5, the required ***running clearance*** *after fitting is 0.91 mm (0.036").*

Outside Diameter

The bearing outside diameter is obtained by adding the press fit to the maximum diameter of the housing.

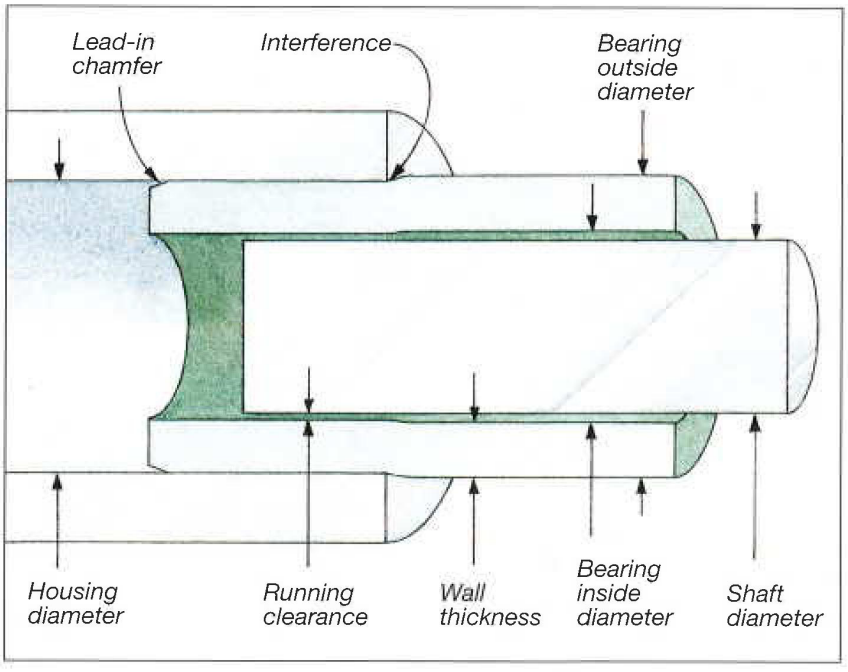
OD = housing diameter + press fit

Inside Diameter

The free standing bearing inside diameter is obtained by adding the maximum shaft diameter, the press fit multiplied by $\frac{\text{housing diameter}}{\text{shaft diameter}}$, and the running clearance.

When press fitted, the bearing inside diameter is reduced by an amount somewhat greater than the press fit. Hence the press fit is multiplied by $\frac{\text{housing diameter}}{\text{shaft diameter}}$.

This is called bore closure.



$$ID = \text{shaft dia.} + \text{running clearance} + \left(\text{press fit} \times \frac{\text{housing dia.}}{\text{shaft dia.}}\right)$$

Designing Bearings

Wall Thickness

When machining, it is best to specify and control the bearing outside diameter and wall thickness.

This is because workshop temperature changes can cause expansion and contraction of up to 0.1%.

For example a 10°C (18°F) temperature change on a 500 mm (20") diameter bearing will result in a diameter change of 0.3 mm (12 thousandths) on a free standing bearing.

If the wall thickness is controlled, diameter changes will not affect the running clearance once the bearing has been press fitted.

Calculate the wall thickness as follows: *Wall thickness = 0.5 [OD - ID]*

Example: *A water lubricated stern tube bearing fits into a 254 mm (10") housing. The stern tube is designed to carry a 203.2 mm (8") shaft. The bearing will be machined in a workshop with a temperature of 20°C (70°F).*

From Figure 3, the bearing requires a press fit of 0.56 mm (0.022").

Thus ***outside diameter*** *= 254 + 0.56 mm [10" + 0.022"]*
= 254.56 mm [10.022"]

To find the ***inside diameter*** *we require the* ***clearance****.*

From Figure 5 the ***running clearance*** *is 0.6 mm [0.024"]*

Thus ***inside diameter*** $= 203.2 + 0.56 \times \frac{254}{203.2} + 0.6$ mm
$= 204.5$ mm
$[\ 8" + 0.022" \times \frac{10"}{8"} + 0.024" = 8.052"\ ]$

Wall thickness $= 0.5\ (254.56 - 204.5) = 25.03$ mm
$[\ 0.5\ (10.022" - 8.052") = 0.985"]$

Grooves for Water Lubricated Stern Tube Bearings

Table 1 gives details of the water grooves and flow rates recommended for water lubricated bearings.

Do not grease water lubricated Vesconite stern tube bearings. Grease may block the water grooves and interfere with water flow.

If more than one bearing is used, radial recesses around the inner circumferences where the bearings join must be provided to ensure water flow even if the water grooves are not aligned.

A positive pumped flow of engine cooling water to the inboard end of the bearings is recommended to prevent abrasive particles entering the bearings, especially when operating in sandy conditions or on rivers.

If engine cooling water is used, the water temperature should not exceed 55°C (130°F) to avoid possible hydrolytic degradation of Vesconite over a long period of time.

Grooves for Rudder Bearings

Generally Vesconite rudder bearings do not need water circulation grooves. Vesconite is also suited to unlubricated operation when the movement is slow or intermittent which is the case in most rudder applications.

Initial and occasional greasing of Vesconite rudder bearings is advantageous as it increases bearing life, and grooves may be provided for this purpose.

If grooves are machined into rudder bearings, groove depth should not exceed one third of the Vesconite wall thickness.

Designing Bearings

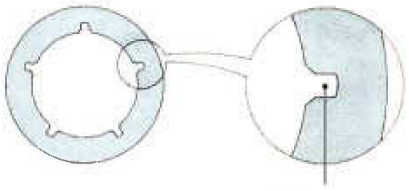
Table 1: *Groove sizes and flow rates for water lubricated stern tube bearings*

Shaft diameter		No. of grooves	*Angle between grooves	Groove width		Groove depth		Waterflow rate	
mm	inches			mm	inches	mm	inches	ℓ/min^{-1}	gal/min
60-79	2-3	7	45°	7	0.25	4	0.15	12	3.0
80-119	3-5	7	45°	9	0.30	5	0.20	18	4.5
120-159	5-6	7	45°	10	0.35	6	0.25	24	6.0
160-199	6-8	7	45°	12	0.40	7	0.30	30	8.0
200-249	8-10	7	45°	12	0.40	8	0.30	38	10.0
250-299	10-12	7	45°	14	0.50	8	0.30	45	12.0
300-349	12-14	8	40°	15	0.50	8	0.30	53	14.0
350-399	14-16	8	40°	15	0.50	8	0.30	60	16.0
400-499	16-20	9	36°	15	0.50	9	0.35	75	20.0
500-599	20-24	10	33°	18	0.50	9	0.40	90	24.0
600-699	24-28	11	30°	18	0.50	9	0.40	105	28.0
700-800	28-32	12	27°	18	0.50	9	0.40	120	32.0

* It is recommended that no groove be located in the 6 o'clock position.

'UV' groove design and recess if more than one bearing is used

The 'UV' groove design with a round groove base and a chamfered edge is recommended as it maintains a better hydrodynamic water film. Groove depth should not exceed half the Vesconite wall thickness.



'UV' groove

Design Loading

Vesconite is a high compression strength, low creep material. The compression strength of Vesconite at yield is over 90 MPa (13,000 psi). This allows for static design loads of up to 30 MPa (300 $kg.cm^{-2}$) (4,400 psi) provided the bearing is supported within a rigid housing.

Example: *A 500 mm (20") long bearing with an internal diameter of 400 mm (16") can support a load of 50 cm x 40 cm x 300 $kg.cm^{-2}$ [20" x 16" x 4,400psi] = 600 000 kgs [1,408,000lbs], that is 600 metric tons.*

Length to Diameter Ratio of Stern Tube Bearings

Traditionally, water lubricated stern tube bearings have been designed with a bearing length equal to four times the shaft diameter. Because of the high load capabilities of Vesconite, this bearing surface is more than adequate. In many applications, shorter length bearings may be used.

Machining Vesconite

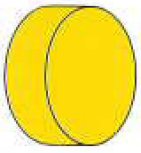
Vesconite XL bearings are easily machined on standard lathes if proper support is provided to prevent deformation and cracking.

When machining a large bearing, the machinist has many options, depending on the diameter and length of the bearing and the lathe or boring mill available.

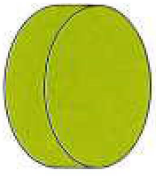
By taking the following important precaution, the machinist will find Vesconite bearings a pleasure to machine:

When chucking the bearing, always use an inside support disc machined size-for-size to the bearing inside diameter to prevent possible cracking.

Machine the support from a steel plate, disc or washer, 25 - 35 mm (1 - 1½") thick.



Support disc, machined to size.

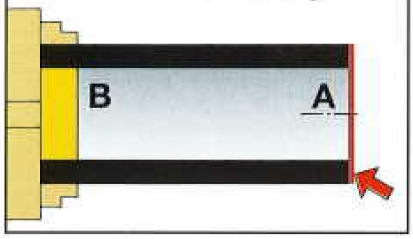


Larger diameter support disc, machined size-to-size with final bearing inside diameter.

Do not clamp Vesconite like a metal, but clamp gently and with care to avoid distortion.

1

Align and face one end of the bearing square. (A)
This helps with alignment later.
Use the internal support disc machined to size to prevent distortion and cracking.

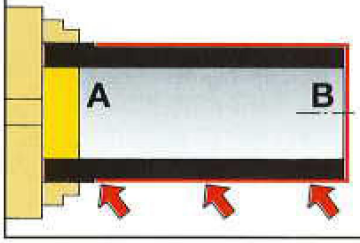


2

Swop bearing around, align and face the other end. (B)
Again use the disc to support the inside diameter.

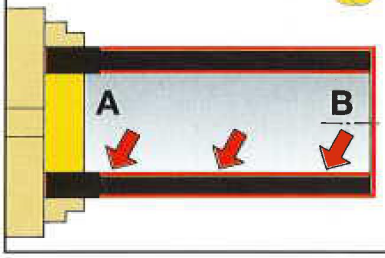
3

Machine the outside diameter of the bearing, again with the support disc in place.



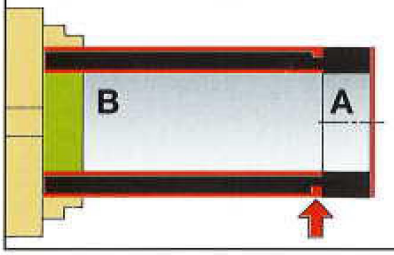
4

Machine the inside diameter, again with the support disc in place.



5

Switch bearing around to part to length.
A new disc machined size-to-size with the final bearing inside diameter will be required for support.



- When taking rough cuts, measure wall thickness as a check on accuracy and ovality.
- If more than 15mm (¾") has to be removed from either the outside or inside diameters of the bearing, first semi-finish both the inside and the outside diameters to approximately 5mm (¼") oversize.
- When machining large bearings ensure that the free end of the bearing is suitably supported.

Machining Vesconite

Machining Grooves on Centre Lathes

Use a tool up to the width of the groove required in a boring bar. Lock the chuck into position.

Move the tool through the bearing using the hand wheel or rapid advance taking a cut up to 1.5 mm ($1/16$") maximum at a time until the required groove depth is obtained.

Machining Tolerances

The following are acceptable tolerances for the bearing outside diameter and wall thickness:

Outside diameter tolerance % of outside diameter	**Wall thickness tolerance** % of wall thickness
+0.2%	+0.0%
-0.0%	-0.5%

Cutting Speeds

Up to 300m (1000') per minute

Cutting Feeds

Rough:	0.5 - 0.7mm (0.020 - 0.030") per revolution
Finish:	0.3 - 0.4mm (0.012 - 0.016") per revolution

Turning Speed Guidelines:

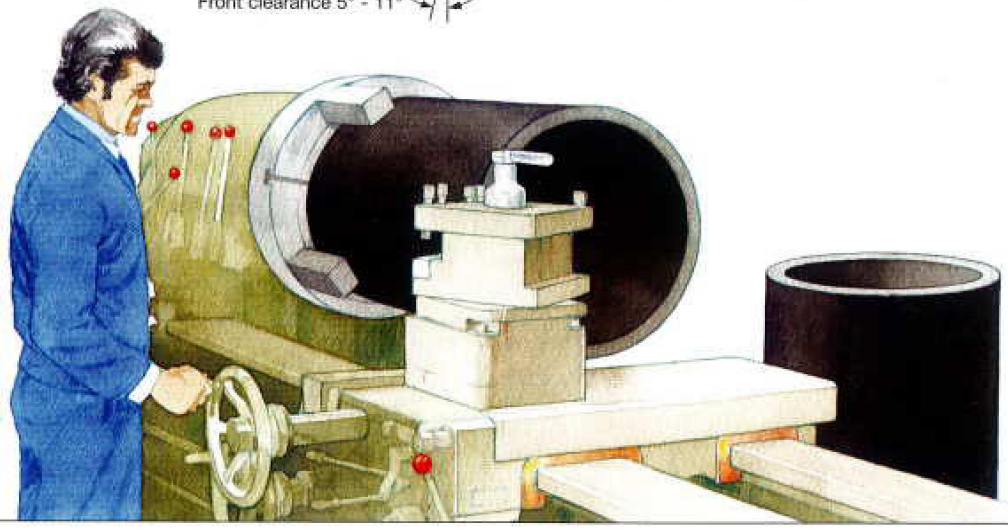
Bearing outside diameter		RPM
200 mm	8"	350
300 mm	12"	300
400 mm	16"	200
500 mm	20"	150
600 mm	24"	100
700 mm	28"	70

Cutting Tools

Use sharp high speed tools or tungsten carbide tips with high clearances and positive rake angles. Rough cuts up to 5 mm ($1/4$") deep may be taken, with a finishing cut of at least 1 mm ($1/32$").

Allow the bearing to cool before taking final cuts.

Tool Cutting Angles



Installing and Securing Vesconite Bearings

Freeze fitting is the easiest way to install Vesconite bearings. Dry ice is an ideal agent but liquid nitrogen can be used if dry ice is not available.

Using Dry Ice

Vesconite has a thermal expansion coefficient of 6 x 10^{-5} mm/mm/°C (3.3 x 10^{-5} in/in/°F).

Cooling in dry ice for two to three hours reduces bearing temperatures by 40 to 60°C (70 to 100°F). This results in a shrinkage of 1,2 mm (0.05") on a 500 mm (20") diameter bearing.

Good ventilation must be used in confined spaces to avoid possible lack of air.

Using Liquid Nitrogen

Use an insulated container as shown below. The container may be any suitably sized metal drum.

To insulate, simply wrap around with glass or rock wool, or several layers of corrugated cardboard, or bubble wrap. These may be held in place by tape, wire or strapping.

Place the bearing on wooden blocks or bricks to raise it 150 mm (6") above the bottom of the container. Do not place the bearing directly onto the floor of the container.

Place a loose fitting lid on top of the container. If the lid is made from chipboard or plywood 18 to 25 mm thick (0.75" to 1"), it will act as an insulator as well.

Slowly pour liquid nitrogen into the bottom of the container - about 50 mm (2") deep.

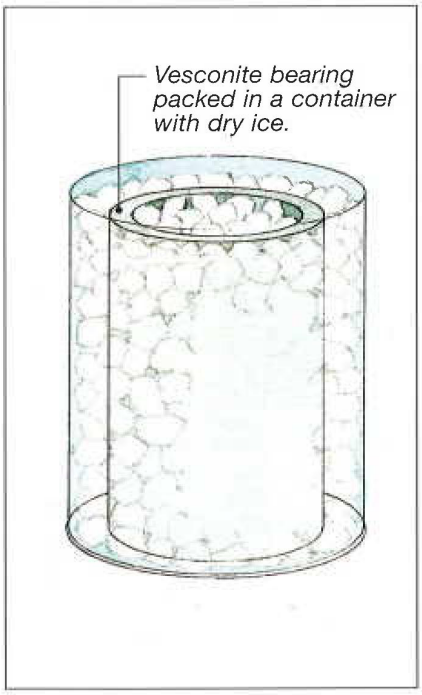
Only sufficient liquid nitrogen to cover the bottom of the container is needed.

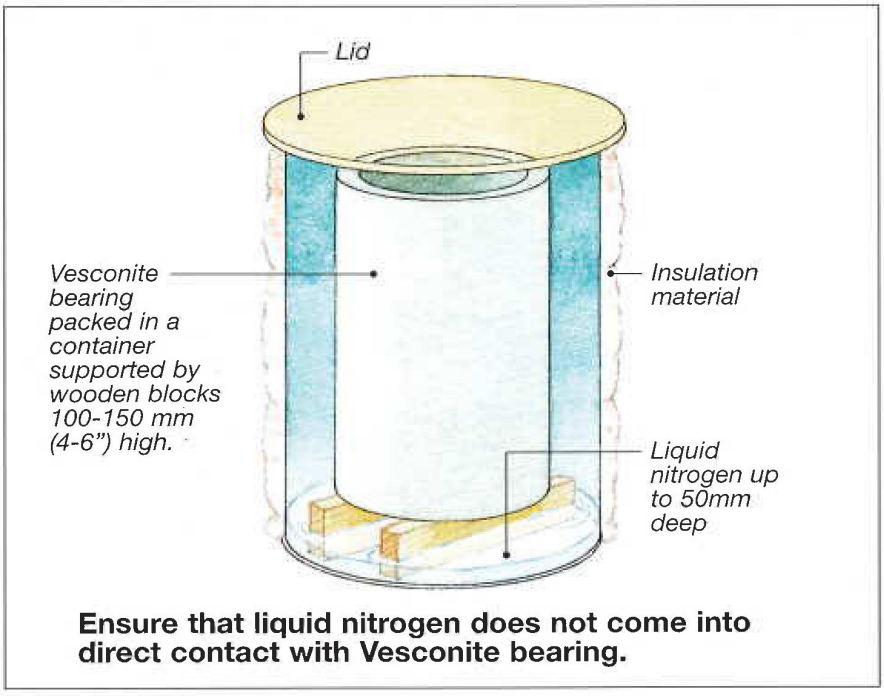
It is important to ensure that the liquid nitrogen does not come into direct contact with the Vesconite bearing.

Allow the bearing to cool for approximately 1 to 1½ hours which should be enough to shrink it sufficiently for a sliding fit.

Measure the top outside diameter with a vernier to ensure that sufficient shrinkage has occurred before removing the bearing from the container.

Use nitrogen only in well ventilated areas. Take care in handling and adhere to the general safety rules for liquid nitrogen as it can cause severe burns. Consult your supplier of liquid nitrogen for detailed precautions. Safety visors and protective clothing should be used.





Ensure that liquid nitrogen does not come into direct contact with Vesconite bearing.

Installing and Securing Vesconite Bearings

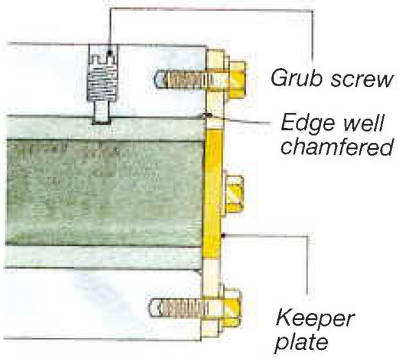
Housings

While Vesconite is a fairly rigid material, it will generally conform to the size and shape of the housing. Therefore out-of-round or out-of-line housings should be avoided, unless the housing is made round or in-line through machining.

Mechanical Securing

As a standard safety precaution, bearings should always be secured using conventional mechanical means such as keeper rings. Grub screws may be used on small bearings.

Mechanical securing to prevent possible rotation and end keeper rings are especially important for bearings that may be used in sub-zero conditions.



Adhesive Bonding

If desired, anaerobic adhesives such as Loctite 603 or 648 retaining compound may be used. Adhesive bonding is recommended when using sliding fits.

Machine a lead in chamfer of 15° to 35° on the leading edge of the bearing. Prime initially with Loctite Primer T and allow to dry.

Loctite 603 or 648 (former for smaller gaps and the latter for larger gaps) should be applied to both the Vesconite bearing and metal housing surfaces. The bearing should be pressed into place and excess adhesive wiped off.

Fitting Staves

Fitting of Vesconite staves is facilitated by cooling the staves in dry ice for 3 hours before fitting.

Shaft and Other Mating Surfaces

Metal mating surfaces must be suited to the wear conditions encountered, for example when operating in sandy conditions. **Hard shaft surfaces ensure longer shaft and bearing life.**

Hardchrome plated surfaces, seawater corrosion resistant stainless steel and admiralty and gunmetal bronze liners are generally satisfactory as mating surfaces for Vesconite.

Carbon steel and hardened steel shafts may be used as mating surfaces provided that they do not corrode under the conditions of use.

A good finish of the order of 0.5 micrometre R_a (20 micro-inches R_a) should be provided on shaft surfaces.

Rough surface finishes and corroded and scored shafts will cause wear of Vesconite bearings and should be avoided.

Pressure x Velocity (PV) Limits

All bearing materials have limits in their ability to sustain a given loading at a particular speed. This is known as the pressure x velocity limit or PV limit.

Apart from pressure and velocity, the PV limit of Vesconite depends upon operating conditions. The most significant factors in operation are whether friction is reduced through water or oil lubrication, and whether heat removal occurs either through circulating water or oil.

The recommended PV limits for Vesconite are given in Table 2. If your application has PV values higher than those shown, consult your dealer or the manufacturer.

Table 2: *Recommended Vesconite PV limits*

	PV limit	
Operating condition	MPa.m.min^{-1}	psi-ft/min
Dry - no lubrication	5	2,500
Greased on assembly	10	5,000
Lubrication at regular intervals	20	10,000
Circulating oil lubrication	40	20,000
Circulating water lubrication	200	100,000

Photograph: Safmarine