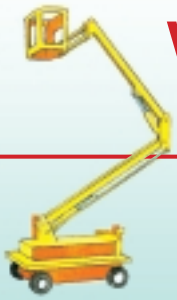
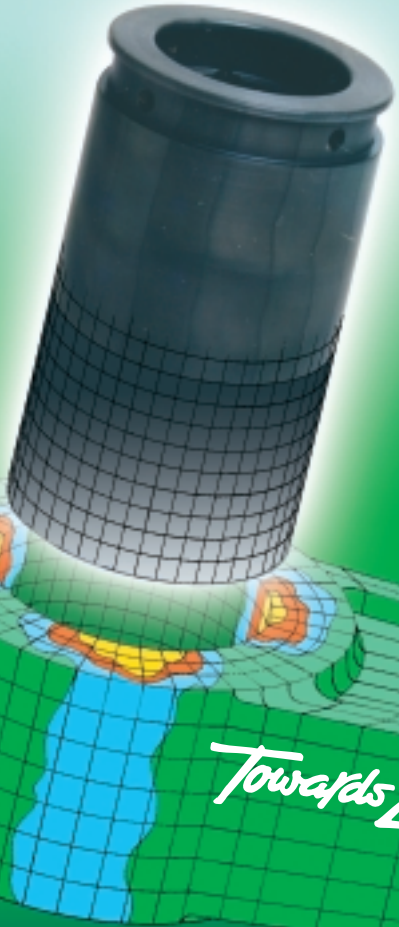
Gallagher Fluid Seals
Vesconite Design Manual





Towards Zero maintenance

GALLAGHER
Fluid Seals, Inc.

Contents

About Gallagher Fluid Seals, Inc.

Gallagher Fluid Seals, Inc. is a global distributor and manufacturer of Fluid Sealing products. Gallagher represents the strongest seal manufacturers in the world, in addition to operating its own gasket fabrication facility. Gallagher serves both OEM & MRO customers through the development of technical solutions that solve sealing challenges.

Gallagher Fluid Seals currently operates two facilities:

- Its headquarters in King of Prussia, PA
- Its gasket fabrication and sales office in East Longmeadow, MA

On January 16th 2022, Gallagher entered its 66th year in business. With three acquisitions in 2022 and more on the horizon, Gallagher has aggressive growth goals in the years to come.

ISO 9001:2000
QUALITY ASSURED

Vesconite bushes could be your answer…

- Ensure longer bush life
- Reduce maintenance
- Reduce shaft wear
- Stop greasing
- Solve problems in wet conditions

Vesconite and Vesconite Hilube are premier bushing materials designed for longer life and lower shaft wear in poorly lubricated or dirty or wet applications.

Your journey starts here …

The planet's most versatile bushes – dry, wet, dirty, greased or ungreased.

Different from bronze

- Vesconite is self lubricating
- Vesconite survives dirt

Different from nylon

- Vesconite does not soften in humid conditions or when immersed in water
- Vesconite does not swell in water

What is Vesconite?

Vesconite and Vesconite Hilube are specialised plain bearing materials made from internally lubricated low friction polymers.

Vesconite bushes give excellent wear in harsh, wet, dirty or unlubricated conditions.

Vesconite and Vesconite Hilube have proven advantages over traditional bushing materials such as bronze, acetal, nylons (whether plain or internally lubricated), nitriles, rubbers, elastomers, phenolics and laminates.

Vesconite

The internally lubricated polymer bush material, designed to operate

- under high loads
- with low speeds
- in dirty or wet conditions
- where a long life is required.

Vesconite Hilube

The advanced grade of Vesconite for

- lower friction
- longer life than standard Vesconite
- mechanical properties essentially the same as for Vesconite.

Why Vesconite and Vesconite Hilube are ideal for long life, low maintenance bushes

Low wear

Vesconite gives a low wear rate on the bush and shaft.

In dirty conditions, Vesconite Hilube running against suitably hard shafts gives a low shaft and bush wear.

Low friction

Vesconite has a low friction even when running dry.

- Vesconite's low friction applies under actual operating conditions.
- Stick-slip is minimal with Vesconite and does not occur with Vesconite Hilube.

Internally lubricated

Vesconite is compounded with internal lubricants that form an integral part of the material. This gives Vesconite a low friction and a low wear rate even when running without lubrication.

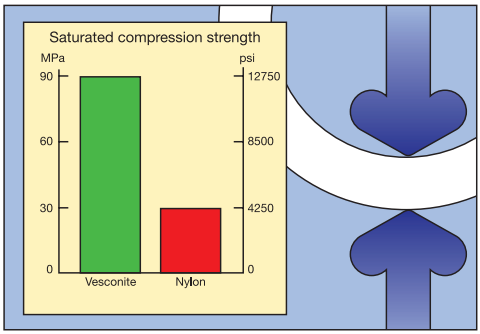
Common problems experienced

- *Bronze must be greased*
- *Lubrication is not always wanted or possible*
- *Grease on linear bearings can trap dirt*
- *Small oscillating movements do not spread grease.*

High compression strength

Vesconite has a compression strength of 90 MPa (12750 psi). The recommended design limit is 30 MPa (4250 psi) for static and slow speed applications.

- Vesconite keeps its strength even when wet
- Vesconite gives minimal compression, deformation or compression set
- Vesconite has excellent resistance to creep.



Common problems: *Nylons lose more than half of their strength and rigidity when wet, leading to creep under load.*

Low water swell

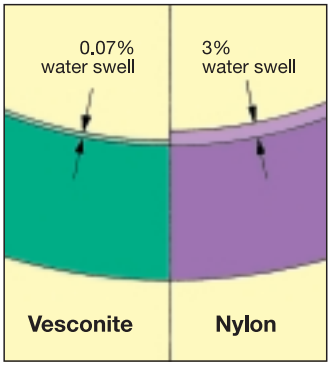
Vesconite absorbs less than 0.5% of water when immersed, giving a linear swell of less that 0.07%. In most applications this can be ignored.

This is especially important in applications that are immersed in water such as pumps, Archimedes screws, marine applications or in humid conditions.

Nylons absorb up to 9% of their mass, causing up to 3% swell and a critical loss of clearance that can lead to seizure.

To compensate for water swell, excessive clearances are used for nylons. Large clearances should be avoided because:

- *Bush wear rate increases*
- *Bush life is shortened*
- *Shafts are less stable.*



Low thermal expansion

Vesconite has a lower thermal expansion than most synthetic materials.

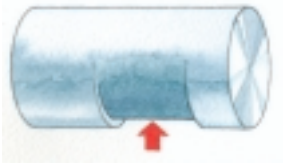
Vesconite can be precisely designed across a wide temperature range without the need for additional clearances.

Low shaft wear

Wear of expensive shafts can be a primary cost concern.

- Vesconite running against hard shafts gives low shaft wear.
- Vesconite Hilube gives even lower shaft wear.

In particular nylons are noted for wear to shafts.



Resistant to chemicals

Vesconite and Vesconite Hilube are resistant to a wide range of chemicals including acids, organic chemicals, solvents, hydrocarbons, oils and fuels.

Page 30 gives a detailed **Chemical Resistance Chart**.

No delamination

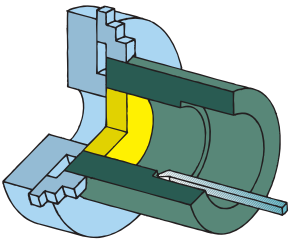
Vesconite is a homogeneous material and is not made up of bonded layers of material.

Vesconite does not delaminate when immersed in water or fluids.

Easy to machine

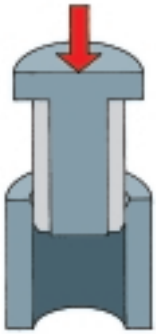
Vesconite can be easily machined on standard metalworking equipment.

Vesconite does not creep, deform or swell and machines easily to desired tolerances.



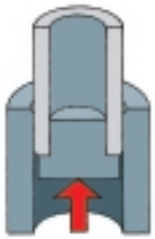
Easy to install

Vesconite bushes are easily installed on site.



Easy to remove

Vesconite does not corrode and seize in bush housings like bronze and metal backed bushes.



Safety and health

Vesconite does not contain any hazardous substances such as asbestos or fibres that make using, handling and machining unsafe.

Vesconite is approved for contact use with drinking water and food.

Environment friendly

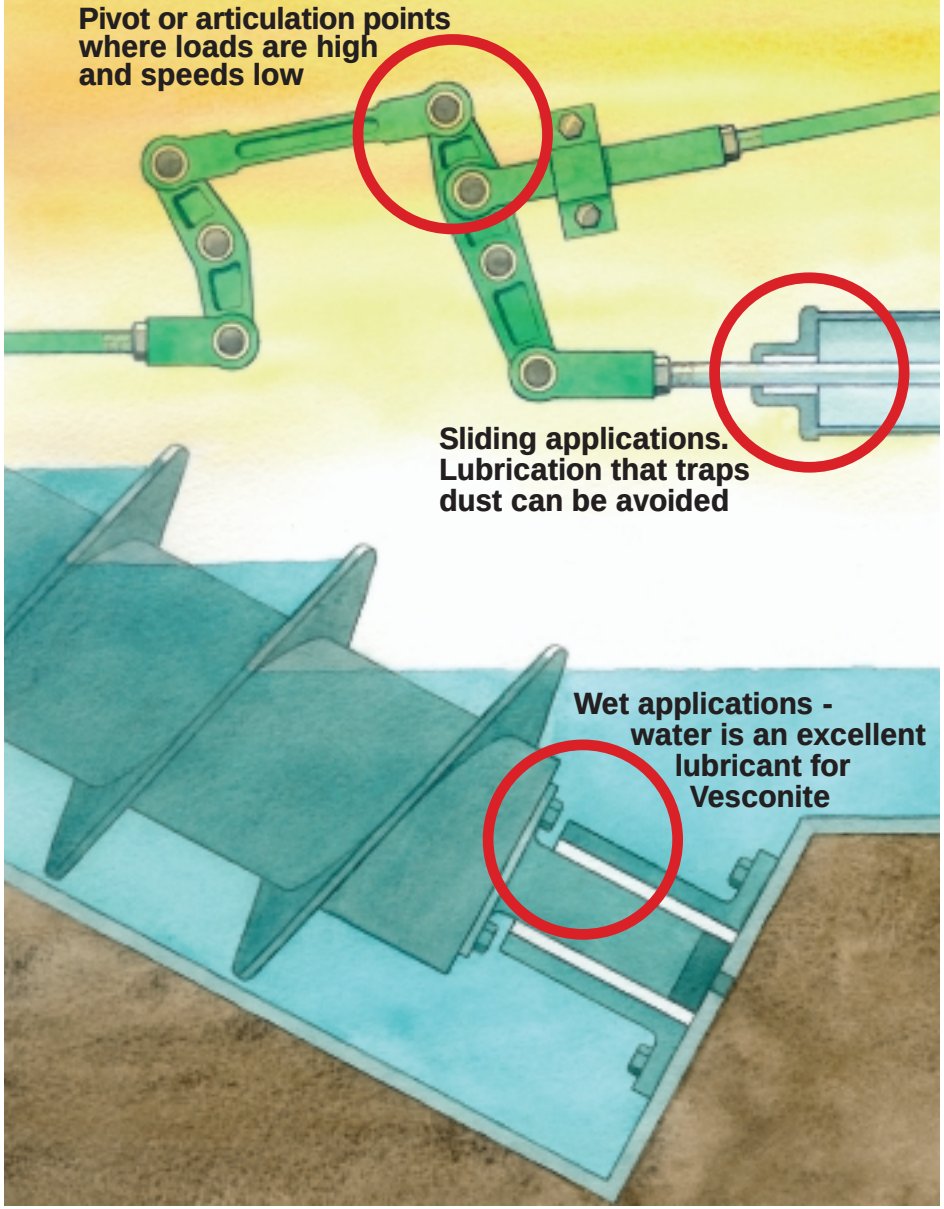
Vesconite avoids many environmental problems because oil and grease lubrication can be dispensed with.

Vesconite contains no lead, asbestos or hazardous substances.

Vesconite applications

Vesconite has been used in thousands of demanding applications, overcoming many problems experienced by traditional bushing materials.

The benefits of Vesconite are best noted in applications with high loads and low speeds and where lubrication is not possible or not desirable. These include:

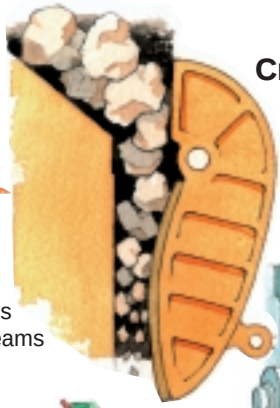


Typical Vesconite and Vesconite Hilube applications

Mining

Mines are dirty and often wet or humid.
Bushes need to give long life even though poorly maintained and often abused:

- skip pivots
- winder brake callipers
- chair lifts
- feeder systems
- battery locomotive motor axles
- bin and hopper units



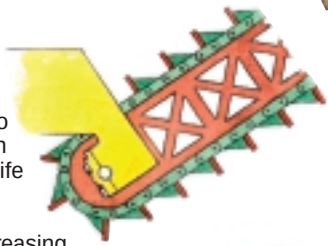
Crushers and feeders

Vesconite bushes in large double toggle jaw crushers overcome greasing problems and give significantly longer life than bronze.

Earthmoving

Long life even in dirty conditions.
Loads are high and speeds low:

- suspension systems
- pivot points
- oscillating joints
- walking beams
- back hoe joints
- H-frames

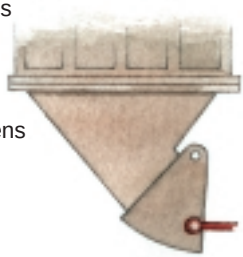


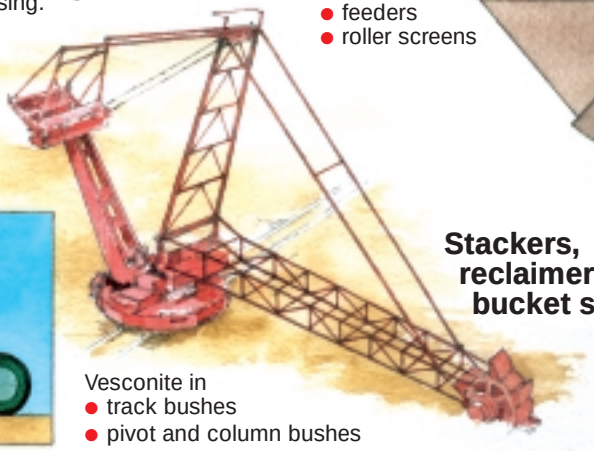
Roller chains

Bushes are difficult to maintain or replace in roller chains. A long life solution is required, especially for dirty conditions with no greasing.

Bulk solids handling

- bin hoppers
- doors
- gates
- shakers
- feeders
- roller screens



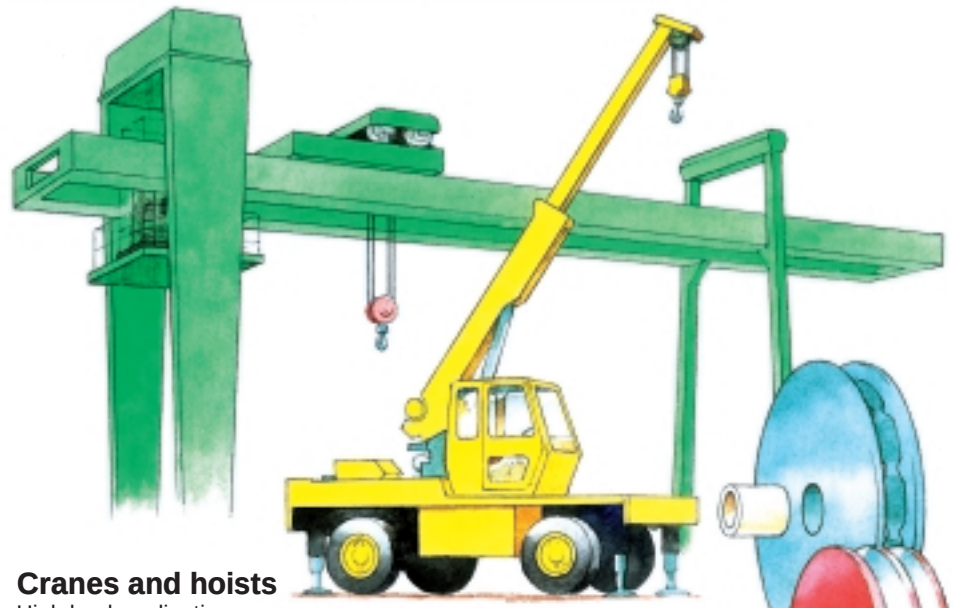


Stackers, reclaimers, bucket scoops

Vesconite in

- track bushes
- pivot and column bushes

Typical Vesconite and Vesconite Hilube applications



Cranes and hoists

High load applications
in mobile, overhead and jib cranes:

- extendable boom slides
- outrigger pivot bushes
- sheave wheel bushes
- slew bearing bushes
- crane pivot bushes

Access platforms

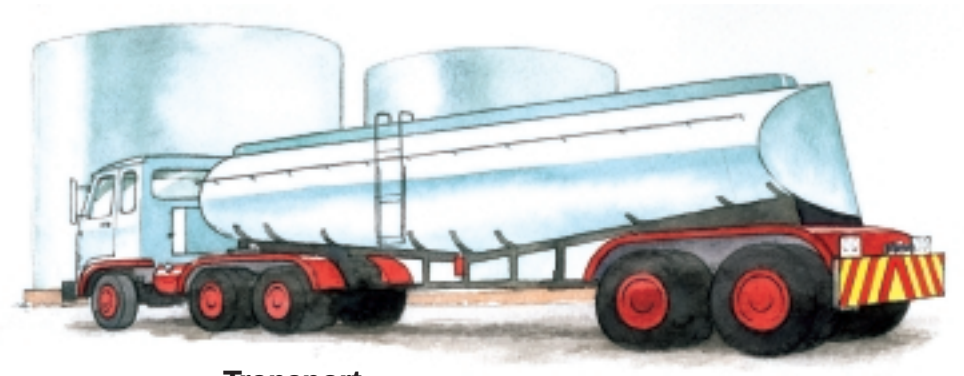
Tail and scissor lifts

Bushes are required to
take high loads. Bushes often
required to be thin walled in
compact designs.

Wheels and castors

Vesconite bushes in pivot
points and bearings for slow
moving wheels.

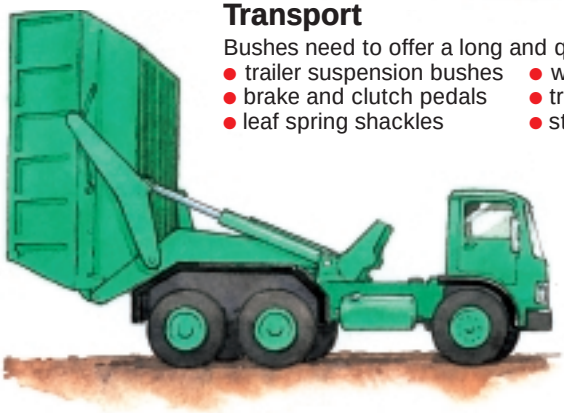
Typical Vesconite and Vesconite Hilube applications



Transport

Bushes need to offer a long and quiet life:

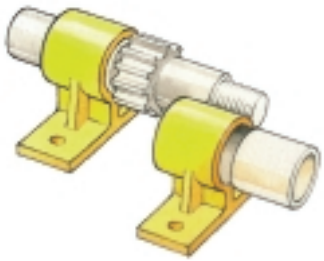
- trailer suspension bushes
- brake and clutch pedals
- leaf spring shackles
- wear discs
- trunnion bushes
- starter motors
- king pin bushes
- fifth wheel bushes
- steering columns

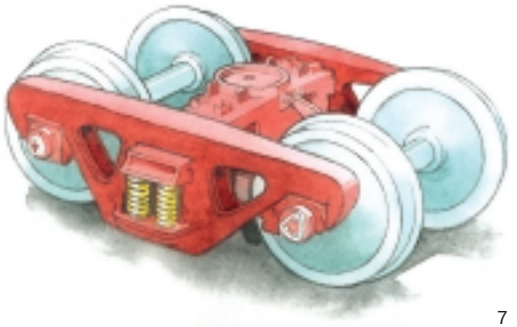


Railways

Long life suspension systems and no greasing minimise maintenance:

- locomotive and freight wagon bogie suspensions
- short trip motor axles
- bogie link systems
- pantographs
- brake rigging
- brake levers





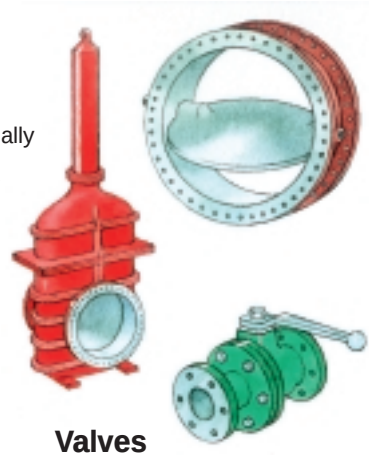
Typical Vesconite and Vesconite Hilube applications

Pumps

Vesconite bushes are suitable for operating with water or oil as a lubricant. The exceptionally low friction of Vesconite Hilube can survive a dry startup or temporary suspension of the process flow as a result of blockages.

- lineshaft bearings
- casing wear rings
- impeller wear rings
- support bearings
- impeller support bearings

A Vesconite Pump Bearing Design Manual is available



Valves

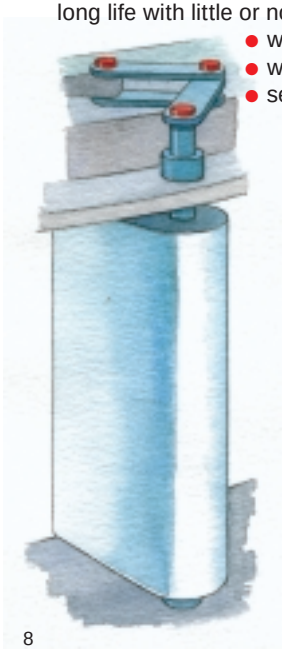
Bush material is required to withstand the range of piped fluids:

- valve stem bushes
- pivot bushes

Hydropower

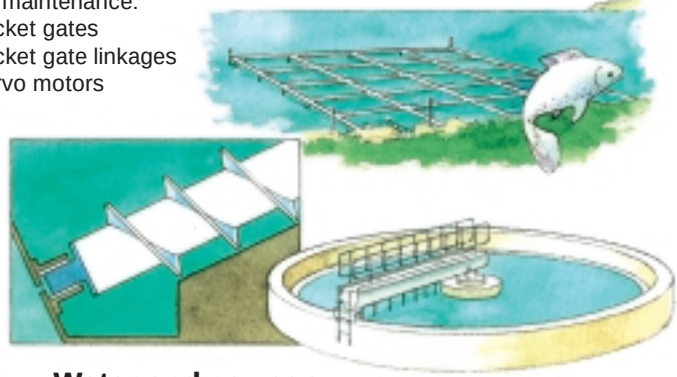
Requires components that have a long life with little or no maintenance:

- wicket gates
- wicket gate linkages
- servo motors



Fish farm platforms

Long life Vesconite platform pivot bushes



Water and sewage

Vesconite does not swell in water and water is a good lubricant. A low maintenance solution is required especially as the water may be dirty:

- Archimedes screws
- sluice gate guides
- aerators
- belt screens
- roller chains
- gates
- rake arms
- valve stems
- stirrers
- sluice gates

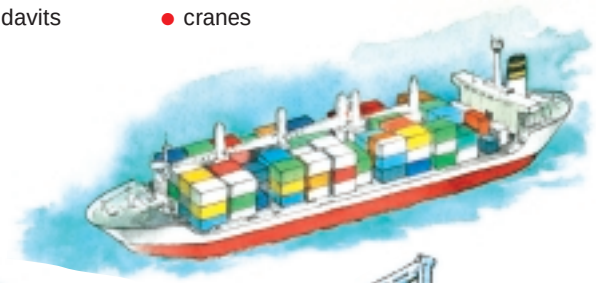
Typical Vesconite and Vesconite Hilube applications

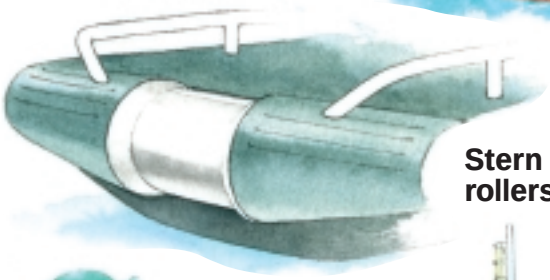
Marine

Vesconite has a high compression strength and does not swell or soften in water:

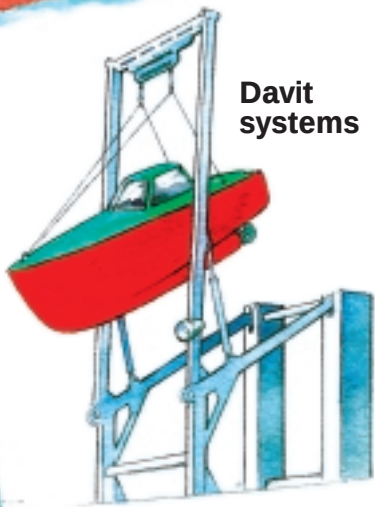
- stern tubes
- stern rollers
- hatch covers
- davits
- rudders
- bow thrusters
- winches
- cranes

A Vesconite Marine Bearing Design Manual is available





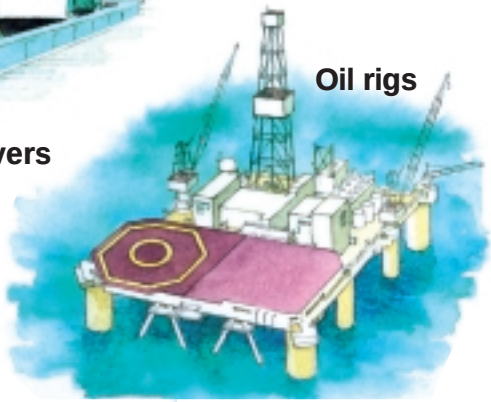
Stern rollers



Davit systems

Hatch covers

Steerable propellers

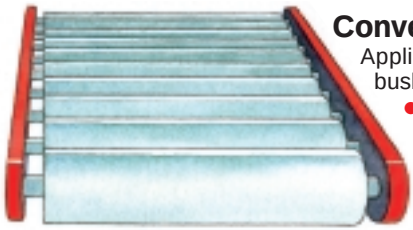


Oil rigs

Typical Vesconite and Vesconite Hilube applications

Screw conveyors

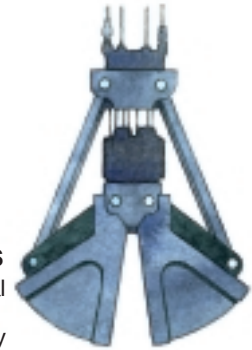
Hanger bearings experience wet or dry environments. They often come into contact with the transported medium which may be aggresive and lubrication is often not possible. Screw conveyors in dry cement plants and wood pulp plants.



Conveyors and idlers

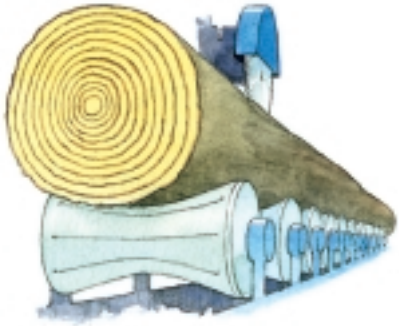
Applications requiring long life bushes under high loads.

- slow speed idlers
- feeder rollers
- castor wheels and
- pivot points



Grabs

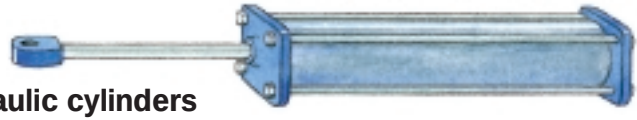
Vesconite is ideal for bushes often immersed in dirty water or dry environments and are not lubricated adequately.



Sawmills

Dirty and dusty conditions experienced in sawmills, together with the difficulty for regular greasing, require maintenance free bushes:

- rollers
- pivot points
- blade guides

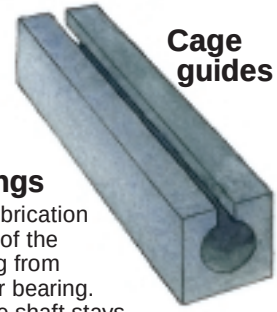


Pneumatic and hydraulic cylinders

Condensed water is a problem in compressed air sytems, but acts as a lubricant for Vesconite. Vesconite delivers a long life and low shaft wear even in the absence of oil in the air.

- nose bushes
- piston rings
- piston bearings

Cage guides



Linear bearings

Vesconite's self lubrication overcomes many of the problems resulting from lubricating a linear bearing. With Vesconite the shaft stays grease free and does not attract dust.

Typical Vesconite and Vesconite Hilube applications

Forklift trucks

Vesconite gives low wear in demanding forklift applications:

- mast tilt cylinders
- mast pivots
- steer axles
- valve and pedal levers
- side shift slides
- mast slides
- suspensions

Vesconite replaces needle roller bearings on

- king pins
- thrust washers

Pallet trucks

Vesconite for pivots and castors on pallet trucks, especially in wet conditions.

Food processing

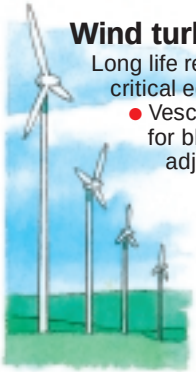
Vesconite is approved for contact use with foods and drinking water:

- scrapers and bushes in mixers
- conveyor idlers
- filling machines

Air motor vanes

Escalators and elevators

- cage guides in lifts
- escalator chain link assemblies



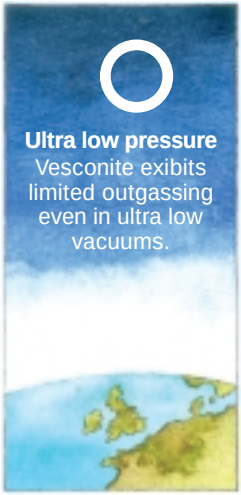
Wind turbines

Long life required in critical equipment:

- Vesconite bushes for blade pitch adjustment.

Brick and block making machines

Long life even in dirty conditions.



Ultra low pressure

Vesconite exibits limited outgassing even in ultra low vacuums.

Ultra high pressure

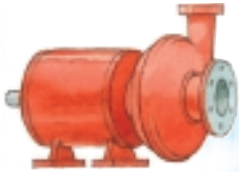
Vesconite successfully tested in underwater immersion tests to 2500 metres (8000 feet).

Typical Vesconite and Vesconite Hilube applications

Agriculture

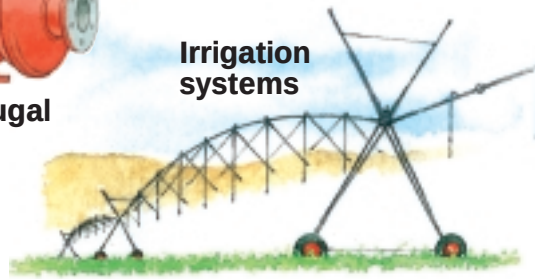
Harsh conditions in agriculture challenge many bushing materials. The environment is usually dirty, possibly wet and greasing of bushes is not always possible:

- disc ploughs
- planters
- tractors and trailers
- water wheels
- submersible borehole pumps
- replacing needle bearings



Centrifugal pumps

Irrigation systems



Windmills

Submersible pumps

Harvesters

Water wheels

Tractors and trailers

Ploughs and planters

Vesconite compared to other bushing materials

Vesconite versus bronze

Better in dirt, no grease

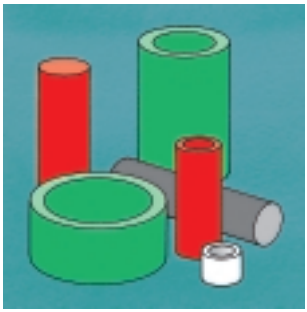
Internally lubricated Vesconite has a low friction even without lubrication and is able to offer a low wear rate even when intermittently lubricated.

Vesconite is a substantial improvement compared with bronze:

- bronze bushes must be greased
- greasing is most often not practical
- dirt and water causes high wear to bronze

Bronze is able to handle a higher static load, operating temperature and PV.

Vesconite versus nylons

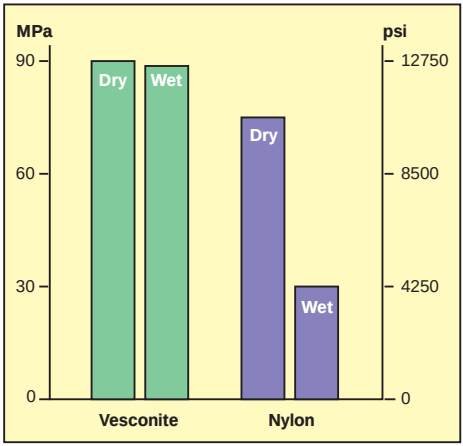


No swell, softening or seizing problems

Vesconite does not swell or soften in water, giving Vesconite bushes a more precise design and better wear.

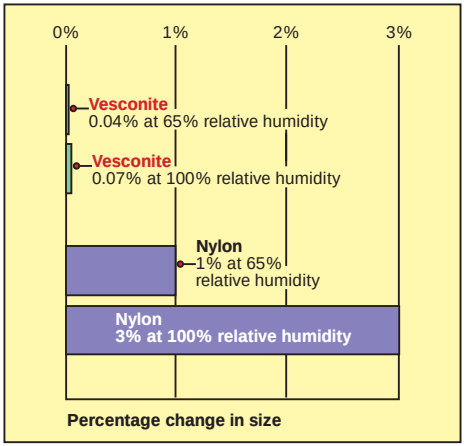
- Nylons swell, leading to loss of clearance and risk of seizure
- nylon softens significantly in water, leading to a loss of compression strength and creep
- nylon is not resistant to acids and solvents, whereas Vesconite is resistant
- Vesconite gives a better wear rate
- Vesconite results in much lower wear to expensive shafts.

Compression strength



Vesconite keeps its compression strength in humid environments.

Water swell



Vesconite does not swell in humid conditions.

Vesconite compared to other bushing materials

Vesconite versus acetal (polyacetal or POM)

Longer wear life

- Vesconite has a lower friction and gives a longer wear life than acetal.
- Vesconite has a lower water absorption and thermal expansion than acetal, so Vesconite bushes can be designed with a higher degree of precision and smaller clearances without the fear of seizing on the shaft.
- Vesconite is available in a wider range of sizes.

Vesconite versus PEEK

Save money, longer wear life

PEEK is an expensive high temperature, high strength polymer.

- Vesconite offers moderate temperature resistance and will give longer wear life and better performance at a fraction of the cost of PEEK.
- Vesconite is available in a far larger range of sizes.

Vesconite versus UHMWPE

Higher compression strength and longer wear life

UHMWPE (Ultra High Molecular Weight Polyethylene) is a low friction material, but with its low compressive strength often results in material creep. While UHMWPE is ideal for wear strips and linings in abrasive conditions, it is only suited to the most lightly loaded bushings.

Vesconite versus PTFE

Longer wear life

PTFE is an ultra-low friction material that has a good chemical resistance. This makes PTFE a good material for sliding seals but the softness of the material limits the effectiveness as a bush.

- Vesconite can carry significantly higher loads without deforming.
- Vesconite gives a better bush wear life.

To design a Vesconite bush correctly, there is the easy way and the manual way.

The easy way

- Reach out to Gallagher Fluid Seals for assistance in designing a solution for your bushings or bearings.

The manual way

- Step – by – step equations are given here for those who may require them.

Will Vesconite work?

All plain bearing materials have limits for the combination of the load and speed. This is known as the **pressure x velocity** limit or **PV** limit.

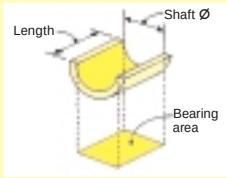
The **PV** limit is determined by the heat buildup at the bearing surface, which is influenced by a number of factors including:

- coefficient of friction between bush and shaft
- loading of bush surface (expressed as "P")
- sliding speed (expressed as "V")
- ability of bearing to lose any heat generated
- lubrication and cooling available
- dry, wet or immersed application.

Internally lubricated Vesconite and Vesconite Hilube have low friction coefficients which give a lower rate of heat buildup. These materials cannot however lose the heat generated as easily as metals.

Design: Application assessment

1. Calculate the load (P)



This is the pressure on the bush and is the load on the bush load area. The area is estimated to be the shaft diameter multiplied by the bush length.

The bush load is calculated as follows:

$$\text{Loading (P)} = \frac{\text{mass supported per bush (kg)} \times 9.8\ (\text{m.s}^{-2})}{\text{shaft diameter (mm)} \times \text{bush length (mm)}} \quad \text{(MPa) (Metric)}$$

$$\text{Loading (P)} = \frac{\text{mass supported per bush (lbs)}}{\text{shaft diameter (inches)} \times \text{bush length (inches)}} \quad \text{(psi) (Imperial)}$$

Maximum loads

Vesconite can safely be loaded to 30 MPa (4250 psi) in static and slow moving applications.

Vesconite has a compression failure limit of 90 MPa (12 750 psi) and so a safety factor of 3 is already included in the calculations.

2. Calculate the sliding speed (V)

This is the surface sliding speed between the bush and the shaft.
Maximum surface speed is **300 m/min (1, 000 ft/min)** in running dry and under a low load.

The surface speed is calculated as follows:

For rotation – rotational speed [RPM]

$$\text{Surface speed (V)} = \frac{\text{RPM} \times \pi \times \text{shaft diameter (mm)}}{1000\ (\text{mm/m})} \quad \text{m/minute} \quad \text{(Metric)}$$

$$\text{Surface speed (V)} = \frac{\text{RPM} \times \pi \times \text{shaft diameter (inches)}}{12\ (\text{inches/ft})} \quad \text{ft/minute} \quad \text{(Imperial)}$$

For oscillation – angle of oscillation [$\propto$]

$$\text{Surface speed (V)} = \frac{\propto \times 2 \times \pi \times \text{diam (mm)} \times \text{frequency (cycles/minute)}}{360 \times 1000\ (\text{mm/m})} \quad \text{(Metric)}$$

$$\text{Surface speed (V)} = \frac{\propto \times 2 \times \pi \times \text{diam (inches)} \times \text{frequency (cycles/minute)}}{360 \times 12\ (\text{inches/ft})} \quad \text{(Imperial)}$$

For linear motion – travel distance [s]

$$\text{Surface speed (V)} = \frac{\text{s (mm)} \times 2 \times \text{frequency (cycles/minute)}}{1000\ (\text{mm/m})} \quad \text{(Metric)}$$

$$\text{Surface speed (V)} = \frac{\text{s (inches)} \times 2 \times \text{frequency (cycles/minute)}}{12\ (\text{inches/ft})} \quad \text{(Imperial)}$$

Design: Application assessment

3. Consider PV limits for load and speed combinations

The level of lubrication required is determined by the **PV – Combination of Load and Speed**. This lubrication is required to dissipate the heat buildup as well as to reduce the friction coefficient between the surfaces.

The following requirements are for Vesconite and Vesconite Hilube.

	Vesconite		Vesconite Hilube	
Lubrication requirements	**MPa.m/min**	**Psi.fpm**	**MPa.m/min**	**Psi.fpm**
No lubrication required. Initial greasing greatly increases wear life	< 5	< 2 500	< 8	< 4 000
Initial lubrication when installing the bush	< 10	< 5 000	< 15	< 8 000
Regular lubrication required	< 20	< 10 000	< 25	< 12 500
Circulating oil or water lubrication required	< 40	< 20 000	< 50	< 20 000
Circulating water lubrication required	< 200	< 100 000	< 200	< 100 000

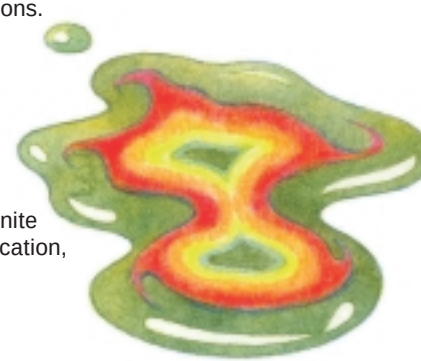
Although an application may not require lubrication, initial greasing when fitting the bush is generally an advantage. Greasing on installation will significantly improve the life of a bush as well as reduce the risk of the shaft rusting.

The above data are based on numerous tests for Vesconite performance and represent guidelines. Applications have performed successfully with operating conditions beyond the limits noted.

The above guidelines also reflect continuous operation. Vesconite can operate successfully at higher PV levels in intermittent and short term operations.

Vesconite can be lubricated by using :

- grease – organic and synthetic greases are fine, synthetic greases tend to last longer
- oils
- water – clear water and sea water are good lubricants
- because it has a good resistance to chemicals, Vesconite can be lubricated by many liquids present in the application, such as gasoline, organic chemicals and water.



Temperature rating of Vesconite

Typically Vesconite and Vesconite Hilube are limited to 100° to 120°C (212° to 248°F) in dry conditions and 60° to 70°C (140° to 158°F) in immersed conditions.

For higher operating temperatures, please contact us with details of your application.

Design: Correct sizing

Designing press fits, clearances and tolerances

Correct bush design is essential for long life bush operation. Different bushing materials have different criteria for design. Vesconite and Vesconite Hilube are superior bushing materials, and must be correctly designed to avoid premature bush failure.

When Vesconite is considered for replacing bronze bushes, a new design should be generated with the correct fits and clearances appropriate to the unique properties of Vesconite.

The most common cause of failure is inadequate clearance. If too little clearance is provided, a bush mail fail even if the application is suited to Vesconite. This may happen when Vesconite is machined to a bronze drawing specification.

Vesconite and Vesconite Hilube Size calculations

The standard design calculations for the use of Vesconite and Vesconite Hilube in applications are given below from first principles. These calculations are for free standing bushes before installation.

The same equations apply to both Vesconite and Vesconite Hilube.

1. Calculate the press fits / interference fits

The following equations are for press fitted bushes, the most common method for securing Vesconite.

Press fit = 0.05 mm + (0.002 x housing Ø) mm

Press fit = 0.002" + (0.002 x housing Ø) inches

2. Calculate the bore closure

The closure of the inside diameter when a bush is pressed into a housing is called the bore closure.

$$\text{Bore closure} = \text{press fit} \times \frac{\text{housing } Ø}{\text{shaft } Ø}$$

3. Calculate the assembly clearance

This is the difference in diameter between the fitted bush **inside diameter** and the shaft.

Assembly clearance = 0.05 mm + (0.02 x wall thickness) mm

Assembly clearance = 0.002" + (0.02 x wall thickness) inches

4. Calculate the bush dimensions

Outside diameter = housing diameter + press fit

Inside diameter = shaft diameter + bore closure + assembly clearance

Design: Correct sizing

For temperatures below 0°C (32°F), an additional press fit is required to ensure that the bush stays in place at the lower temperature.

Additional press fit = (0°C -Tmin) x 5.4 x 10^{-5} x (housing Ø) mm

Additional press fit = (32°F - Tmin) x 3 x 10^{-5} x (housing Ø) inches

Total press fit = press fit + additional press fit

Outside diameter = housing diameter + total press fit

$$\text{Bore closure} = \text{total press fit} \times \frac{\text{housing Ø}}{\text{shaft Ø}}$$

Inside diameter = shaft diameter + bore closure + assembly clearance

---

For moderate temperatures from 50° to 70°C (120° to 160°F), an extra clearance is required to allow the bush to expand without the danger of shaft seizure.

$$\text{Extra clearance} = \frac{[(\text{housing Ø})^2 - (\text{shaft Ø})^2]}{\text{shaft Ø}} \times (T_{max} - 50°C) \times 6 \times 10^{-5} \text{ mm}$$

$$\text{Extra clearance} = \frac{[(\text{housing Ø})^2 - (\text{shaft Ø})^2]}{\text{shaft Ø}} \times (T_{max} - 120°F) \times 3.3 \times 10^{-5} \text{ inches}$$

Inside diameter = shaft diameter + bore closure + assembly clearance **+ extra clearance**

For temperatures higher than 70°C (160°F), the bearing needs to be split with a minimum expansion gap.

Press fitted bushes should not be used because stress relaxation occurs which loosens the interference fit on cooling.

Expansion gap > 0.5 + (housing Ø x 3.14 x (Tmax - 20°) x 6x10^{-5}) mm

Expansion gap > 0.020" + (housing Ø x 3.14 x (Tmax - 70°) x 3.3x10^{-5}) inches

Outside diameter = housing diameter

Inside diameter = shaft diameter + assembly clearance

Bushes with an expansion gap should be mechanically secured, for example with grub screws or key ways.

Machining after installation

If it is necessary to machine the bush to size after installation, the following equations apply:

Outside diameter = housing diameter + total press fit

Inside diameter = shaft diameter + assembly clearance + extra clearance

---

Minimum and maximum wall thicknesses

It is generally recommended that the wall thickness should be about 10% of the shaft diameter with a practical range of between 5% and 20% of the shaft diameter.

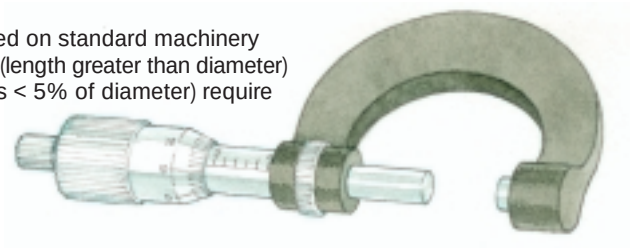
For thinner Vesconite bushes, take care when machining and fitting to avoid cracking. Bonding and mechanical securing may be required to ensure that the bush is properly secured.

Design: Tolerances and temperature compensation

Machining tolerances

Vesconite can be easily machined on standard machinery equipment. Bushes that are long (length greater than diameter) or have thin walls (wall thickness < 5% of diameter) require additional care.

Refer to the machining guidelines on page 31.



Suggested Vesconite machining tolerances	Standard	Minimum	
		Metric	Imperial
Outside diameter	± 0.1% of outside diameter	± 0.025 mm	± 0.001"
Inside diameter	± 0.1% of inside diameter	± 0.025 mm	± 0.001"
Wall thickness	+ 0.0 / -0.5% of wall thickness	+ 0.0/-0.025 mm	+ 0.0/-0.001"
Length	+ 0.0 / -0.5% of length	+ 0.0/-0.3 mm	+ 0.0/-0.01"

Specifying tolerances

Tolerances may be represented in various ways to give the upper and lower acceptable machining limits.

Examples 100.1 ±0.1 100.1 +0.1/−0.1
100.2 / 100.0 100.0 +0.0/+0.2

It is best to specify an **outside diameter tolerance** and a **wall thickness tolerance**. This reduces the risk of the stacking of tolerances that could lead to shaft seizure or a loose fit, particularly with thin walled bushes with a wall thickness less than 10% of shaft diameter.

Tolerances for Vesconite are wider than for typical metal bush tolerances. If bushes are required with closer tolerances, then it is advisable to consider the machining and operational temperatures, as discussed below.

Temperature compensation

Calculated bush dimensions assume manufacturing of the bush at 20°C (70°F). If there is a large variance between the actual machining and measuring temperatures, the resulting difference in sizes could result in incorrect bush operation or premature failure.

Sizes need to be adjusted to the machining temperature to ensure that they are correct at operational temperatures.

The *Design-a-Bearing* calculators provide the necessary information to machine a bush correctly at environmental temperatures different to ambient.

Example

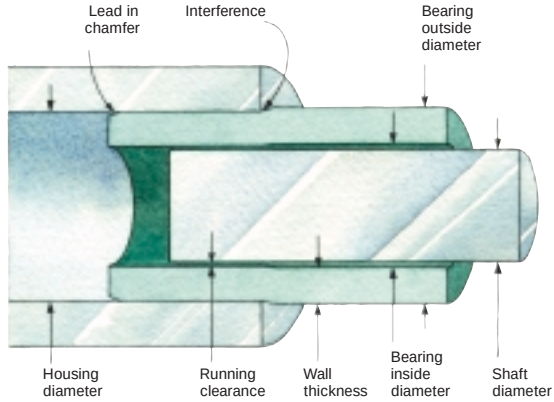
Size adjustment for various machining temperatures		
bush temp	**OD mm**	**ID mm**
5-10 °C	50.09	40.29
10-15 °C	50.11	40.30
15-20 °C	50.12	40.32
20-30 °C	50.15	40.34
30-35 °C	50.18	40.36
35-40 °C	50.19	40.37

Design: Securing bushes

Interference fits

The easiest method to secure a Vesconite bush is to use an interference fit, and may be used for bushes that operate at temperatures up to 70°C (160°F).

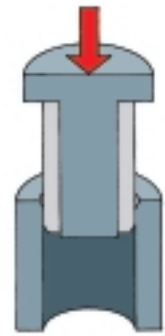
Vesconite is a rigid material and may be easily secured with an interference fit without the need for additional methods. The bush can easily be installed and removed using simple mechanical methods.



Fitting bushes with an interference fit

Fitting and removing of Vesconite bushes is easier than fitting metal backed bushes.

Do NOT heat the bush housing to aid installation as this may damage the Vesconite bush.

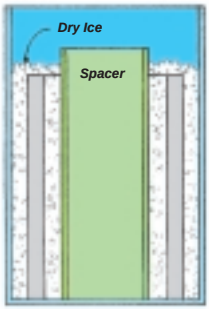


Press fitting

Vesconite bushes can be fitted using mechanical or hydraulic presses. Care needs to be taken that the bush is fitted square to the housing and is well supported, preferably with a mandrel.

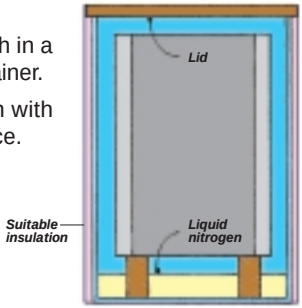
Freeze fitting

Freeze fitting helps when installing large bushes, bushes with thin walls and long bushes (length greater than the shaft diameter). Use a cold freezer, dry ice or liquid nitrogen.



Using dry ice

- Place the bush in a suitable container.
- Pack the bush with crushed dry ice.



Using liquid nitrogen

Contact the manufacturer for correct procedures.

Take care to avoid the bush coming into direct contact with the liquid nitrogen.

Measure the outside diameter of the bush before removing to ensure that the outside diameter is less than the housing size. Follow safety precautions and use personal protective equipment.

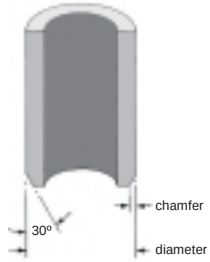
Design: Securing bushes

Chamfers and edge breaks

Lead in chamfers on the Vesconite bush and the metal housing ease installation and ensure that the bush will not be scored.

Corners should be broken to limit edge chipping and aid the installation of the shaft.

Diameter		Chamfer @ 30°	
mm	inches	mm	inches
10 - 25	1/2" - 1"	0.5	0.02"
25 - 50	1" - 2"	1	0.04"
50 - 100	2" - 4"	1.5	0.06"
100 - 250	4" - 10"	2	0.1"
>250	> 10"	3	0.15"



Mechanical securing

As an alternative to an interference fit, various mechanical securing methods may be used.

Operation of Vesconite bushes above 70°C (160°F) may result in loosening of the press fit as a result of stress relaxation. In this case the bush should be split with an expansion gap and secured mechanically to stop rotation and axial migration.

Grub or locating screws

Grub screws are a convenient and effective way to stop rotation and axial migration. The Vesconite bush should be drilled to accept the grub screw. This is to avoid excessive spot pressure being placed on the bush which could lead to cracking or distortion.

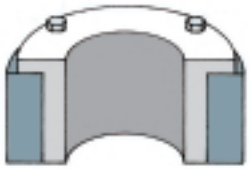
Ensure that grub screws are suitably bonded or secured into their threads so that they do not vibrate or work loose and cause damage to the equipment.

Keeper plates

Keeper plates are recommended to avoid axial movement of the bush. Care must be taken that no excessive pressure is placed on the bush.

Flanged bush secured with bolts

An advantage of using a flanged bush is that the flange allows for easy installation and removal.



Flanged bushes are usually more expensive and are not an ideal design.

Bonding

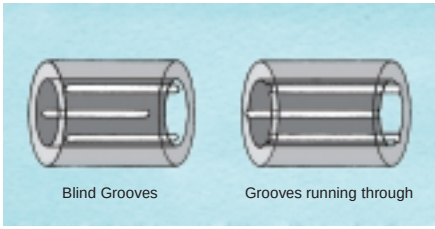
Use an epoxy, Loctite or other suitable bonding agent for metal on plastics which will sustain the expected operating temperature. Roughening both surfaces will improve the bond.

Design: Grooving

Grooves are a simple and economical way to improve bearing performance significantly.

Straight grooves

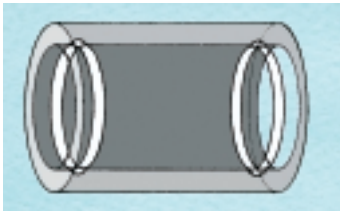
- Higher speed applications
- Running blind – especially in dirty conditions to keep dirt out of the bearing.
- Running through – used when a continuous water or oil flow through the bearing is required in a demanding application.



Circular grooves (at the bush ends or in the centre)

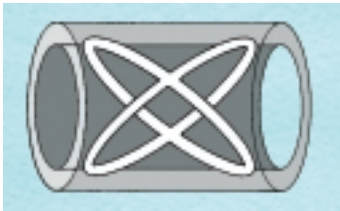
These grooves can be used for:

- Grease and oil distribution.
- Dirt trap – the dirt stays in the grooves rather than on the bearing surface.
- To contain seals if required.



Spiral, loop and figure-of-eight

These may be required to distribute grease across the bearing surface. Because of the self lubricating properties of Vesconite, the shape and quantity of these grooves is less critical than with a bronze bearing.

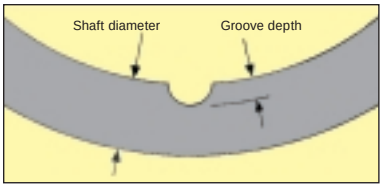


Combinations

- Various combinations can be used.
- Circular grooves at either end with straight or spiral grooves.
- Circular grooves in the centre to distribute the lubricant to the other grooves. Holes are often added to link up with an external dedicated greasing system.

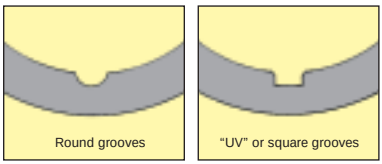
Groove depth

Should not be more than half of the wall thickness. Usually a minimum depth of 2 mm is advised to form an effective grease and dirt trap.



Groove shape

Can be square or round. Typically grooves are twice as wide as they are deep.



Design: Types of bushes

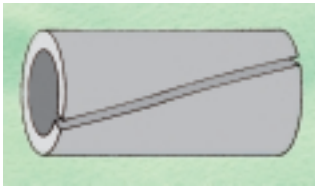
Split bushes – required for certain applications.

Single split

A single split may be required to install the bush into a stepped housing. The bush is squeezed and inserted into the housing. After the shaft is installed the bush cannot fall out.

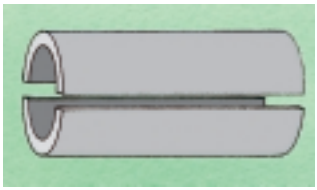
Split the bush at an angle to improve the contact area.

Typical wall thickness is about 3% of diameter.



Double split

A double split bush – bush in two halves – may be required where the operational temperatures are high or to facilitate installation.

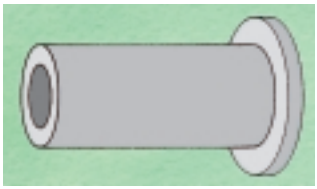


Flanged bushes

These can be single or double flanged.

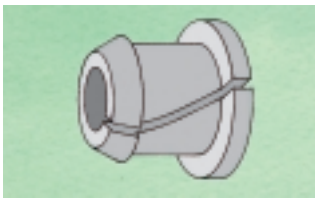
The flange may be required for holding the bush in the housing or for axial thrust.

Sometimes it is more cost effective to have a bush with a separate thrust washer.



Clip-in-bushes

A useful design primarily for linear bushes often installed into thin plates. These are usually thin walled with an angular split. After inserting into the housing and placing the shaft in position, the bush cannot move axially.



Bushes with small assembly clearances

Where a small assembly clearance is required, consider the following options:

- The wall thickness should be as thin as possible. Much of the assembly clearance requirement is determined by the wall thickness and is a characteristic of the expansion properties of Vesconite.
- On thin walled bushes, specify size and tolerance on outside diameter and wall thickness.
- Install the bush into the housing and then finally machine. This avoids stacking of tolerances and closer clearances can be achieved with confidence.

Design: Types of bushes

Bushes in dirty conditions

Dirt in a bush application accelerates wear and should be avoided wherever possible. Grease applied to bushes in dirty applications may trap dust on the wearing surface and result in faster wear. Because Vesconite (and more so Vesconite Hilube) is internally lubricated, greasing can often be avoided and the dirt trap problem is also limited.

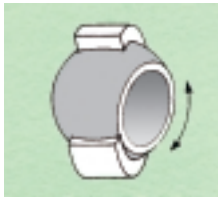
If lubrication is required in dirty conditions consider the following options:

- Use the deep grooves to trap dirt away from the bearing surface
- Seal bush using o-rings or felt seals to reduce the entry of dirt
- Constantly flush the bearing with clean water, oil or air etc.

Self aligning bushes

Applications may call for self aligning bushes.

The Vesconite bush is inserted into a spherical steel housing which allows the shaft to rotate in the bush and the misalignment is taken up by the spherical outer diameter.



Design: Housing and shafts

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.

Design: Approximate comparison of hardness scales

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 conditions, Vesconite Hilube running against hard shafts gives the best performance.

Ideal shaft materials

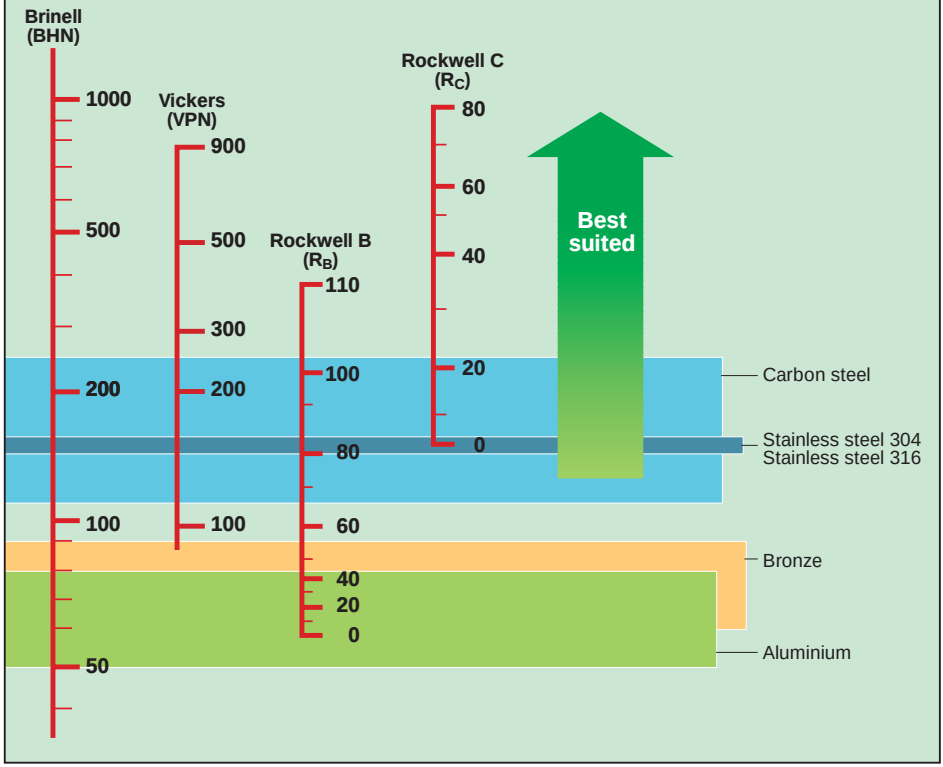
- Hardchrome plated surfaces
- Hardnesses > 50 Rockwell (C) are ideal (Brinell 480, Vickers 510).

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.



Design: Housings and shafts

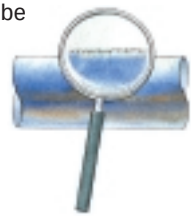
Surface finishes

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.

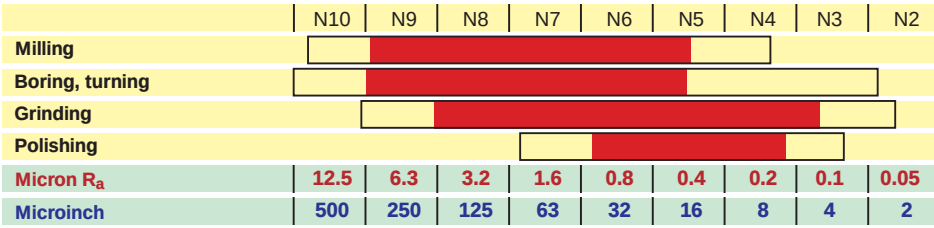
A recommended ground finish of 0.5 µm R_a (20 microinch R_a) is ideal. Shaft roughness should not exceed 2.5 µm R_a (100 microinch R_a).

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.

Typical surface finishes for common machining methods



Housings 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.

Stock availabilty

A wide range of Vesconite and Vesconite Hilube stock shapes are available from centres worldwide.

Vesconite and Vesconite Hilube can be supplied as standard stock shapes or as final machined custom components.

Tubes / bushings

Stocked in standard 1 metre (39") lengths for shafts from 6 to 650 mm diameter (1/4" to 26") in a wide range of standard sizes.

- Vesconite – more than 150 bushing sizes
- Vesconite Hilube – more than 50 bushing sizes

Rods

Stocked in standard 1 metre (39") lengths in diameters from 8 to 135 mm (5/16" to 5½")

Plates

Standard 1 metre (39") lengths stocked in widths up to 600 mm (23") wide and 50 mm (2") thick.

Moulded parts

Bushes can be injection moulded by Vesconite into finished or a semi-finished form for cost effective solutions on larger quantity requirements.

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		☺

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		☺

Machining guidelines for Vesconite

Vesconite and Vesconite Hilube are easily machined to fine tolerances on standard metal working equipment.

Vesconite should not be clamped like a metal, but should be clamped carefully to avoid distortion.

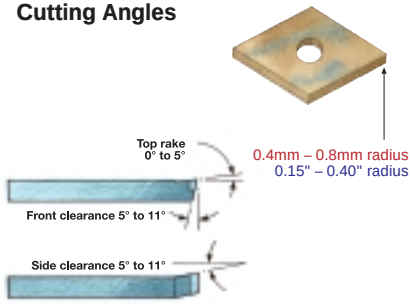
Cooling water should be used where possible to cool the cutting surface.

Take cuts no more than 2 mm (0.1") deep.

Allow the bush to cool before taking the final cut.

Cutting speeds - maximum of 300 m/min (1000 fpm)

Cutting Angles



Diameter mm	< 50	50-100	100-150	150-200	200-250	250-300	300-400	400-500
Diameter inches	< 2"	2-4"	4-6"	6-8"	8-10"	10-12"	12-16"	16-20"
RPM	600-2000	500-600	450	350	240	240	160	120

Cutting Feeds

Rough turning: 0,5 - 0,7 mm per revolution 0.020" - 0.030" per revolution

Finish turning: 0,3 - 0,4 mm per revolution 0.012" - 0.016" per revolution

Machining straight and flanged bushes in small quantities

STEP 1 **Cut to length** Allow extra length for chucking, parting and facing, usually 25 mm (1").

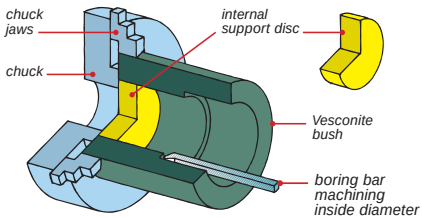
Cut bushing to length with a cut-off saw.

STEP 2 **Chuck with internal support disc** Set the bush squarely in the chuck.

Use an internal support disc machined to size, made of any available material, approximately 10 to 25 mm thick ($1/2$" to 1").

Tighten the chuck lightly - only enough to support the bush. Vesconite should not be clamped like a metal.

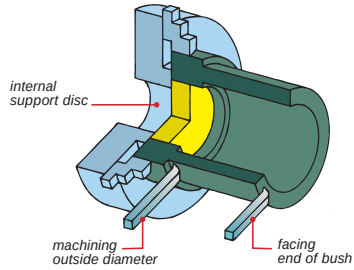
STEP 3 **Machine inside diameter** using a boring bar. Ensure that there is no excessive build-up of shavings inside the bush.



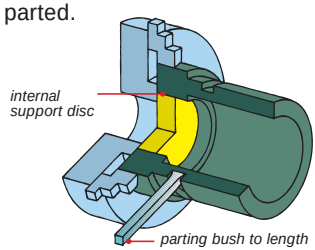
STEP 4 **Machine outside diameter** with an external turning tool.

Machine flange outside diameter if needed.

Face the end of the bush.



STEP 5 **Part to length** using a parting tool. Ensure that bush does not fall when parted.



Typical properties of Vesconite and Vesconite Hilube

		Metric	*Imperial*
Compressive yield strength		**89 MPa**	**12,750 psi**
Design load (static, oscillating or occasional movements)		**30 MPa**	**4,250 psi**
Linear expansion at 65% relative humidity		**0.04%**	**0.04%**
Linear expansion - saturated		**0.07%**	**0.07%**
Guide maximum operating temperature	Dry	**100° - 120°C**	**212° - 248°F**
	Wet	**60° - 70°C**	**140° - 158°F**
Thermal coefficient of expansion		**6 x 10^{-5} mm/mm/°C**	**3.3 x 10^{-5} in/in/°F**
Density / specific gravity		**1.38 g/ml**	**1.38**
Modulus of elasticity		**2.2 GPa**	**493 000 psi**
Poisson's ratio (oriented)		**0.37-0.44**	**0.37-0.44**

Disclaimer

- This design manual is based upon many years of experience of Vesconite in manufacturing and designing polymeric bearing materials. Experience shows that no two applications are the same in every detail so the Companies encourage that every application be treated as individual and unique.
- This information is offered in good faith as part of our client service, but favorable results cannot be guaranteed. This information is intended for use by persons with technical skill, at their discretion and risk. The purchasers must determine the suitability of the goods for their intended purpose.
- The Companies reserve the right to change or amend any recommendation or specification without notice.
- Goods are supplied on the express condition that the Companies' liability is limited to the replacement of defective goods or materials.
- The Companies do not hold themselves responsible for any damage, incidental or consequential loss suffered as a result of the use of goods supplied.

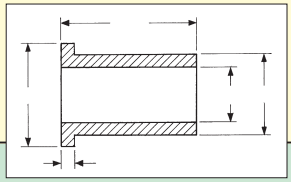
Application assessment and / or request for quotation

Please complete the form and send it to GFSsales@gallagherseals.com
If possible include a cross section or assembly diagram showing bearing location.

Bush size ☐ mm ☐ inches Bush length .....

Outside diameter..... Inside diameter .....

Flange diameter ..... Flange length .....



Loading ☐ kg ☐ lbs

Load ..... Number of bushes carrying load .....

Speeds ☐ Rotating RPM .....

☐ Oscillating Degrees..... Frequency.....

☐ Linear Distance ..... Frequency .....

Operating temperatures ☐ °C ☐ °F

Maximum temp ..... Minimum temp ..... Operating Temp .....

Lubrication ☐ None ☐ Initial ☐ Regular ☐ Continuous

☐ Oil ☐ Grease ☐ Water

Chemical exposure ☐ Acids ☐ Alkalis ☐ Steam

Details.....

Mating surface ☐ Mild steel ☐ Stainless Smoothness .....

Current material

☐ Bronze ☐ Nylon ☐ Acetal ☐ PEEK ☐ Unknown

☐ Other .....

Reasons for change ☐ Longer life ☐ Less lubrication ☐ Shaft wear

Application description .....

Part description ..... Part number.....

Quantity per order ..... Quantity per year.....

Contact information

Contact .....

Company .....

e-mail ..... Website www. .....

Postal address .....

.....

City..... Postal / zip code.....

State..... Country.....

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