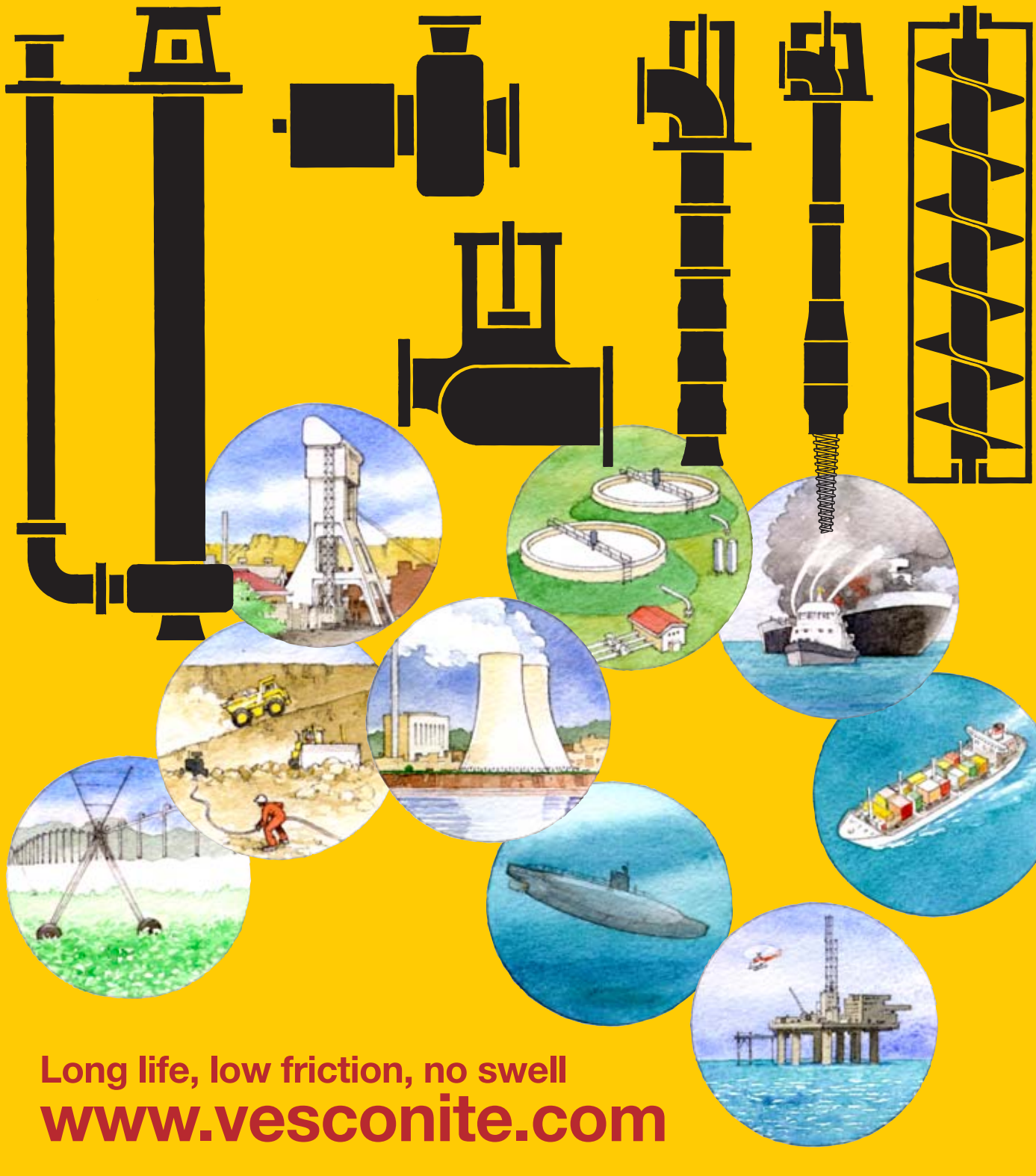
Vesconite and Vesconite Hilube

Pump Bearing Design Manual



Long life, low friction, no swell

www.vesconite.com

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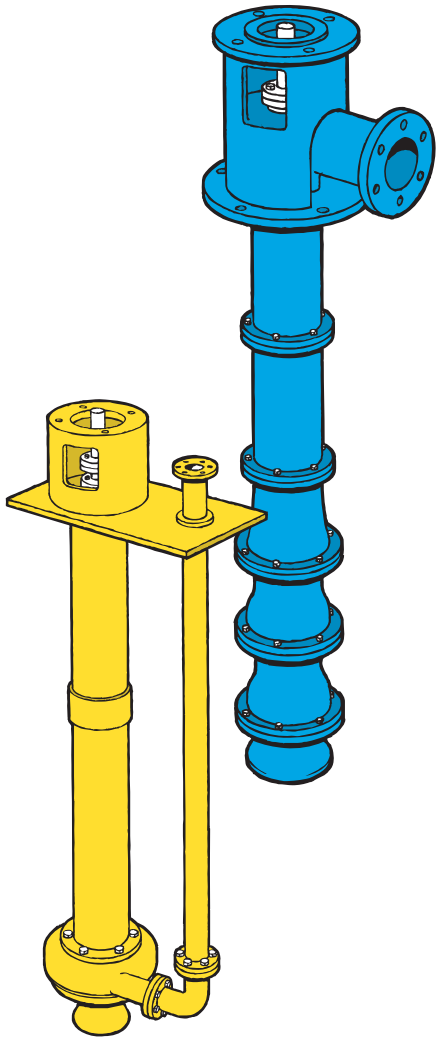


VescoPlastics company profile

The development of Vesconite by VescoPlastics began in 1968 in an attempt to find a plain bearing material suitable for use in exceptionally harsh, dirty and wet conditions found in the surrounding ultra deep mines.

Vesconite Hilube was developed later to enhance the performance of standard Vesconite.

Hitemp 150 was developed as a material resistant to higher temperatures.

Today VescoPlastics is a supplier of low friction, long life, low wear bearing materials, supplied to many industries in over 50 countries worldwide. Industries include pumps, railways, mining, heavy transport, earthmoving and marine.

VescoPlastics consists of a dedicated manufacturing plant including extrusion and injection moulding facilities as well as a well equipped machine shop experienced in machining Vesconite to finished bearing sizes and tolerances. Manufacturing processes are controlled by strict quality standards that ensure products that are consistent in properties and size.

VescoPlastics has many years experience of bearing applications in many critical industries and is able to advise customers on specific application requirements.

Vesconite pump components

Vesconite Hilube bearings

Vesconite and Vesconite Hilube support and lineshaft bearings

Vesconite and Vesconite Hilube wear rings

Vesconite Hilube stuffing box bearing with lantern ring

Hitemp 150 pump bowl bearing with lantern ring

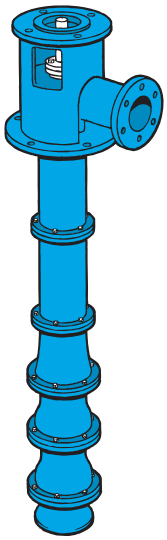
Hitemp 150 split bearing

Vesconite lantern restrictors

Fitting your pump – Summary examples

Vesconite and Vesconite Hilube offer significant advantages in a number of pump applications.

Vertical spindle turbine pumps



Top stuffing box bearings

- Vesconite Hilube is ideal for dry start up conditions
- Closer running clearance means reduced seal wear

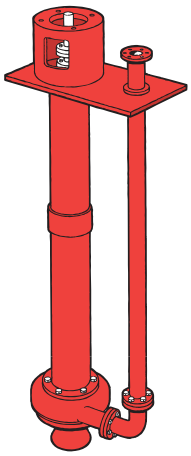
Lineshaft and pump bowl bearings

- Long life
- Can be lubricated with process water as well as oil
- Vesconite Hilube able to survive dry running conditions
- Closer running clearance means less shaft run out and vibration

Suction cover bearings

- Good wear life even in dirty conditions
- Can be lubricated with process water rather than dedicated grease or oil supply

Vertical spindle sump pumps



Shaft support bearings

- Can be lubricated with water or process fluids as well as grease or oil
- Able to survive temporary suspension of lubrication during start up or pump snoring

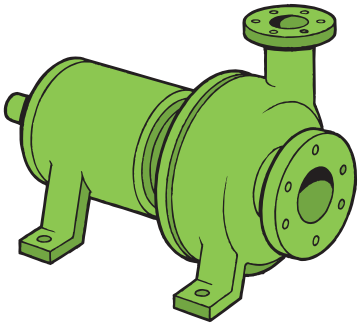
Impeller support bearings

- Close running clearances
- Low wear
- Can run dry

Wear rings

- Close running clearances improve pump efficiency

Centrifugal pumps



Support bearings

- Low wear rate
- Closer clearances give a stable shaft and lower seal wear

Lantern rings

- Low friction gives ability to survive temporary suspension of lubrication water
- Dimensional stability allows for closely defined clearances to regulate water flow

Impeller and casing wear rings

- Low friction and low water swell allows smaller running clearances giving better pump efficiency

What is Vesconite?

Vesconite and Vesconite Hilube are specialized plain bearing materials made from internally lubricated low friction polymers. Vesconite bearings give excellent wear in harsh, wet, dirty or unlubricated conditions.

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

Vesconite
– low friction, long life, well proven

The internally lubricated long life bearing material that has been proven in thousands of critical applications. Originally developed to overcome bearing problems caused by water swell of traditional non-metallic bearing materials.

Vesconite Hilube
– lowest friction, longest wear life, lowest shaft wear

The advanced grade of Vesconite with a lower friction, lower wear rate and a greater ability to run dry.

Vesconite Hilube has the same dimensional stability, mechanical properties and chemical resistance as Vesconite.

Hitemp 150
– high temperature, abrasion resistant

A low wear bearing material specially formulated for higher temperature resistance, Hitemp 150 can run at elevated temperatures up to 150°C (300°F).

Hitemp 150 also has exceptional abrasion resistance and is well suited to pump applications of media with suspended dirt particles.

Hitemp 150 may be the material of choice when corroded or rough shafts cannot be avoided.

Why Vesconite and Vesconite Hilube are ideal for pump bearings

Low friction
Low shaft wear
Easy to install and remove
High compression strength
Resistant to chemicals
Able to run dry
Negligible water swell
No delamination
Safety and health
Drinking water approval
Low thermal expansion
Environmentally friendly
Easy to machine

Low friction

Vesconite is compounded with internal lubricants to produce a material with a low coefficient of friction. This low friction is maintained even when lubrication or water is not present.

Vesconite's low friction applies not only under laboratory test conditions, but also under actual operating conditions. Stick-slip does not occur with Vesconite bearings even if pumps have been in standby mode for long periods of time without operating. This can reduce the requirement to prime bearings before starting a pump. This is critically important for emergency type pumps such as fire pumps, settler pumps and flood pumps.

Able to run dry

Pump bearings often need to withstand dry running for short intervals, for example at start up or if the pump inlet becomes blocked. Vesconite and Vesconite Hilube's internal lubricants give them a very low friction even when lubrication is not present.

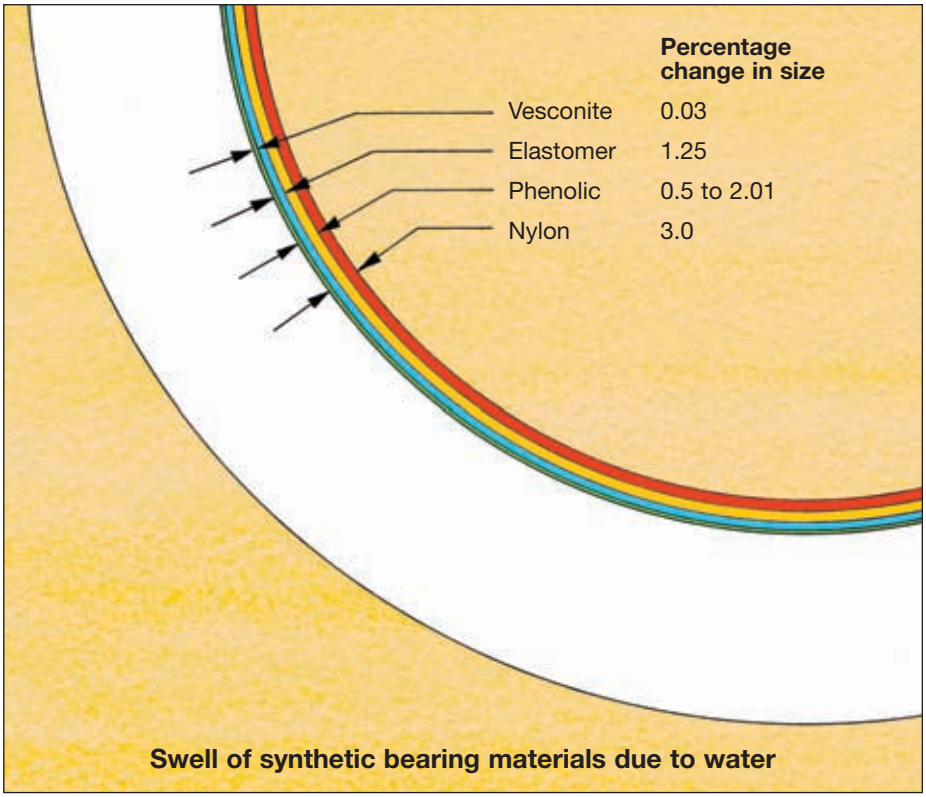
Vesconite can survive operating conditions where lubrication is delayed or intermittent without damaging the bearing. Many bearing materials operate well under well lubricated situations, but fail when lubrication is not present.

Negligible water swell

Vesconite does not swell or soften in water, whereas most synthetic materials swell in water. Vesconite bearings can be machined accurately to size and maintain these sizes even when immersed.

To compensate for the water swell and to avoid the risk of seizures, excessive clearances are used. With Vesconite, close clearances can be maintained, reducing vibration and shaft run out. Large clearances should be avoided because:

- Bearing wear rate increases
- Bearing life is shortened
- Shaft vibration increases, making the shaft less stable.



Swell of synthetic bearing materials due to water

Drinking water approval

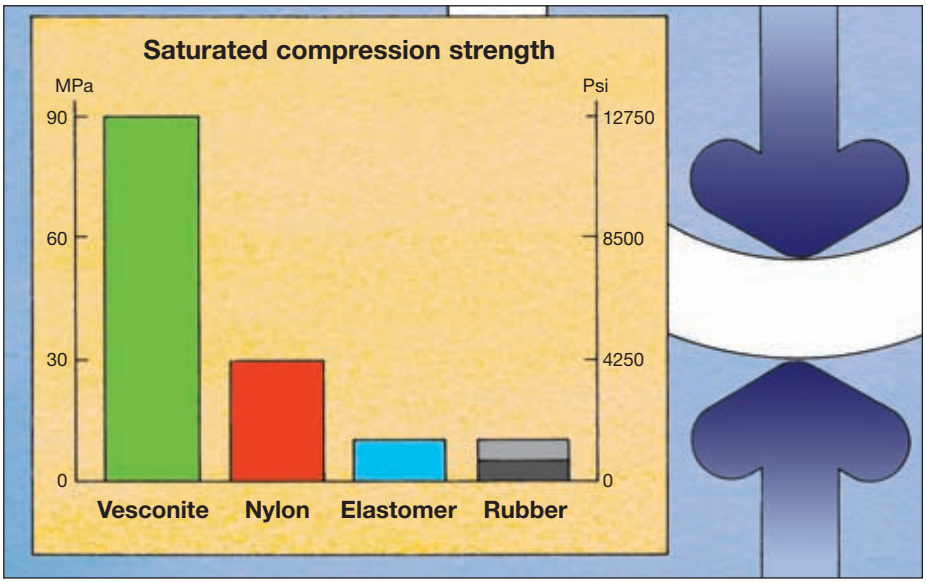
Vesconite and Vesconite Hilube have undergone extensive testing and have been approved by an independent water quality authority for hot and cold drinking water applications.

Vesconite bearings can be used in continuous full contact drinking water applications.

High compression strength

Vesconite keeps its strength even when wet and does not creep under high loads. Loads on Vesconite bearings do not result in compression, deformation or compression set. This means that the shaft is more stable.

High load capacity Vesconite bearings offer better load capacity than many traditional rubber or elastomer bearings.



Low shaft wear

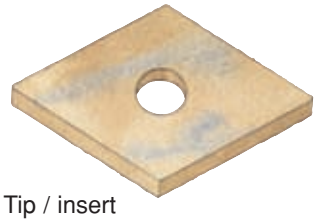
Wear of expensive shafts can be more of a problem than wear of a bearing because of the cost of the shaft. Shaft wear is especially severe in dirty operating conditions. Appropriately designed hard shafts running in Vesconite bearings exhibit exceptionally low wear. Vesconite Hilube further reduces shaft wear due to its lower friction. In particular nylons and many rubber materials are noted for damage caused to shafts.

Easy to install and remove

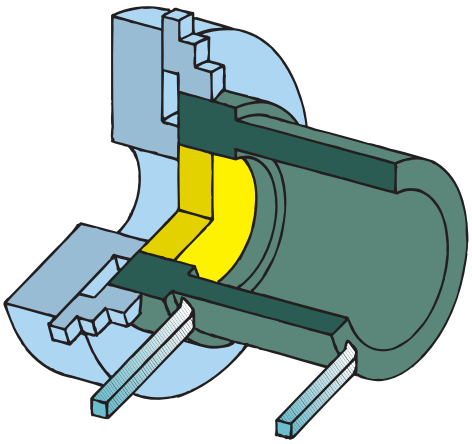
Vesconite bearings are easy to install and remove without the need for expensive equipment. Bearings can be easily installed on site with a minimum of effort and equipment, using simple mechanical methods.

Vesconite does not corrode and seize in bearing housings, unlike bronze and metal backed bearings which become difficult to remove.

Easy to machine



Tip / insert



Vesconite can be easily machined on standard metalworking or woodworking equipment. Vesconite does not creep, deform or swell and machines easily to desired tolerances.

No delamination

Delamination is the peeling off of layers of a laminated bearing material. This often happens in immersed conditions where water or liquid penetrates the exposed micro-channels that are formed by the cloth reinforcing material. Swelling occurs along the micro channel surfaces causing stresses between the layers of the laminate, resulting in the layers peeling off.

Vesconite is a homogeneous material with no lamination reinforcement and so does not delaminate.

Resistant to chemicals

In addition to its excellent performance in water, Vesconite and Vesconite Hilube are resistant to a wide range of chemicals including acids, organic chemicals, solvents, hydrocarbons, oils and fuels. Page 18 gives a detailed chemical resistance chart.

Vesconite and Vesconite Hilube bearings can therefore be lubricated by a range of pumped media. Mixtures of water, oils and fuels do not damage Vesconite bearings.

Safety and health

Vesconite does not contain any hazardous substances such as asbestos or fibres that make using, handling and machining unsafe. Vesconite is an exceptionally clean material to machine and possesses no fibre or dust hazards.

Low thermal expansion

Vesconite bearings do not change size significantly as the operating temperature changes, so close clearances can be maintained across a wide temperature range.

This means that Vesconite bearings can be designed with minimal running clearances without danger of shaft seizures.

Environmentally friendly

Environmental problems caused by oil or grease lubrication can be avoided. This means simpler pump design and operation, with great cost savings.

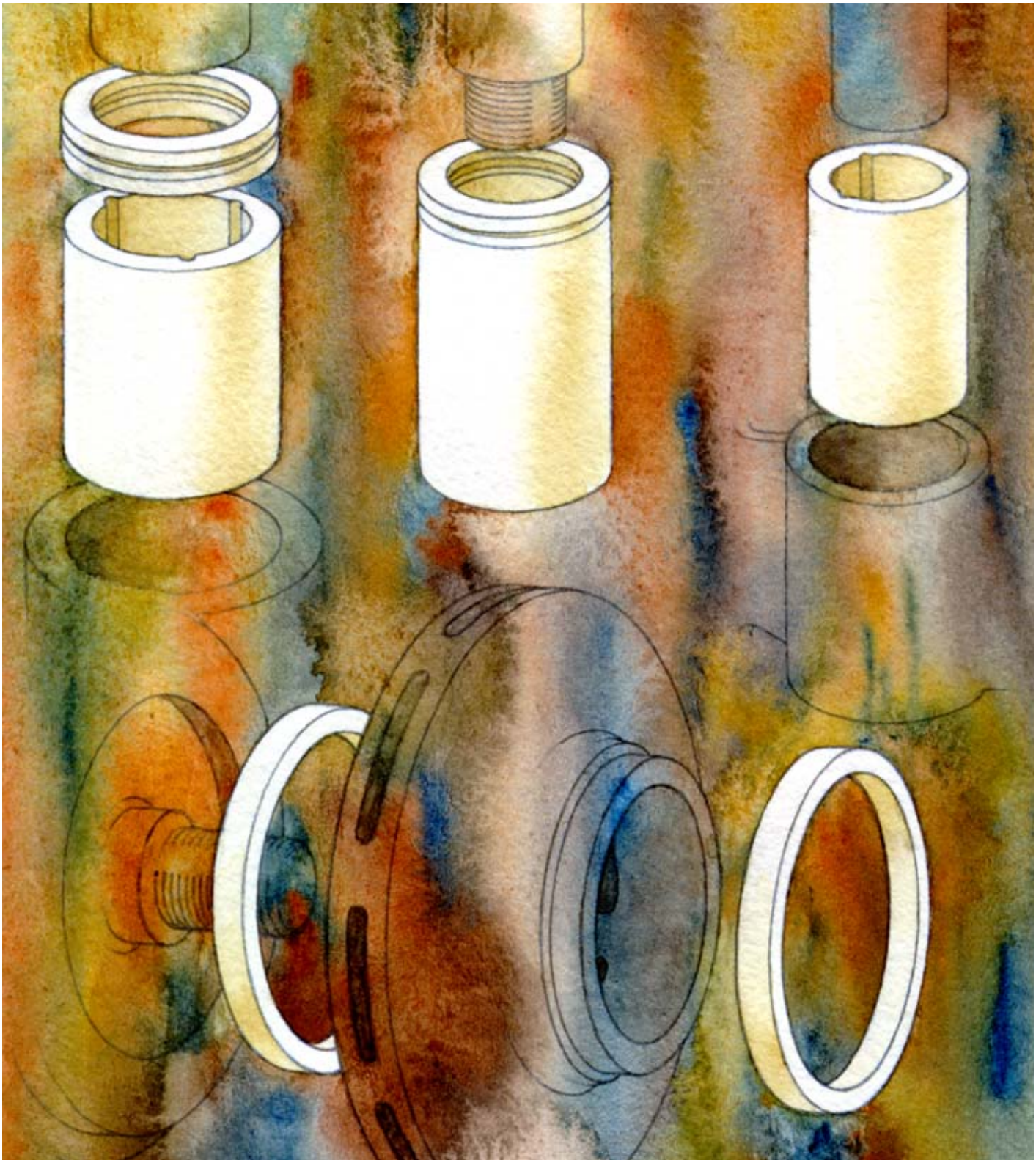
The good chemical resistance of Vesconite and Vesconite Hilube means that a large range of pumped media can be used to lubricate the bearings.

Vesconite and Vesconite Hilube fitted to your pump

There are many pump designs, each with its own unique demands for its area of operation.

But all pump users require reliable bearings and wear rings. Pumps are often used in critical applications where bearings failure must not happen as the consequential results could be extremely serious.

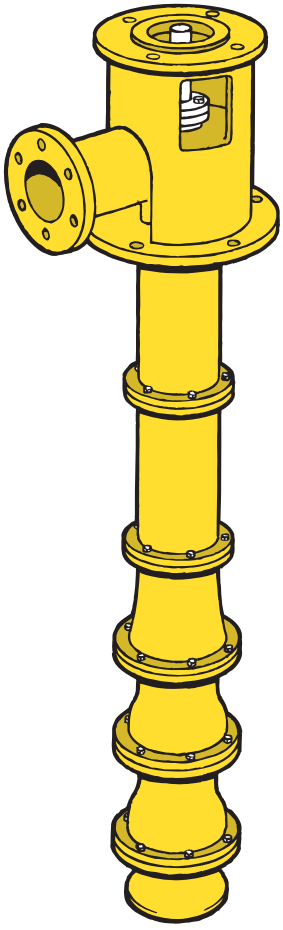
Vesconite bearings provide the performance, reliability and long life desired by pump manufacturers and end users in a variety of pump bearing applications.



Vertical spindle, axial flow, mixed flow, turbine and propellor pumps

These pumps are generally used to pump high volumes of water at low pressure heads, often in critical applications or as emergency standby pumps where reliability and long life are important. Maintenance on these pumps can be difficult and expensive. Examples include:

- Power station cooling water pumps
- High volume fire fighting pumps
- Top up water pumps
- Submersible bore hole pumps
- Waste water pumps
- River abstraction pumps



Stuffing box bearings

Stuffing box bearings lack the water flow experienced by lineshaft bearings. Vesconite bearings offer a low friction and therefore an ability to perform with only a limited water flow.

Vesconite Hilube bearings can survive a dry start up of the pump as well as giving a long bearing life in the absence of lubrication through the bearing.

Water flow through stuffing box bearings can be ensured using a pressure feed line or a low pressure dump line. A lantern ring groove can be added to the bearing to allow a well distributed flow across the bearing.

Vesconite bearings can be manufactured to close running clearances which do not change considerably due to temperature variations. Nor will Vesconite swell so the danger of shaft seizure is avoided.

Because of the closer running clearance, the shaft is more stable. Greater shaft stability and less vibration means that seals and external roller bearings are able to operate more effectively and last longer.

Lineshaft and pump bowl bearings

Many bearing materials operate adequately when a good water flow is present through the bearing. This flow is not always present on start up or can be interrupted due to a blocked inlet to the pump. This situation is a problem to bearing materials that require an uninterrupted water flow.

The dry running ability of Vesconite allows bearings to survive these conditions with no permanent damage. Vesconite and Vesconite Hilube are internally lubricated with advanced lubricants that give them the ability to withstand a temporary suspension of water lubrication.

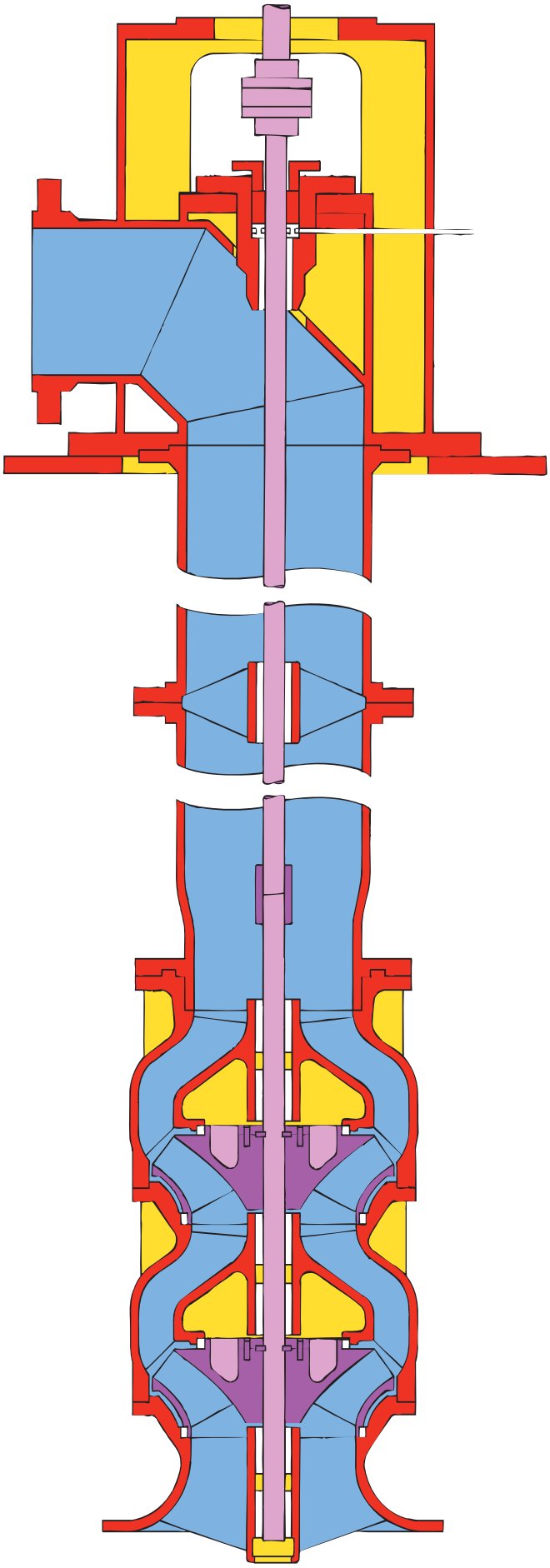
Vesconite allows for high precision, long life and reliable product or external feed lubricated bearings.

Vesconite bearings can be lubricated with water or a range of pumped product which limits the requirement for cumbersome oil lubrication systems and the environmental hazard associated with these systems.

Vesconite can be lubricated with oil in the case of oil lubricated pumps.

The internal lubrication and high strength of Vesconite allows fewer or shorter bearings to be used.

Closer running clearances ensure more stable shaft operation with less vibration.



Suction cover bearings

Suction cover bearings usually experience high concentrations of dirt particles from the water source especially in river water applications. To overcome wear caused by this dirt, suction cover bearings are often sealed and grease or oil lubricated. Grease or oil may be fed from the surface through long lubrication lines along the length of the pump.

In addition to the complex grease or oil lines and the required lubrication system, a big disadvantage is that any grease or oil leaking from the bearing contaminates the process water.

Vesconite can be lubricated with process water fed from an upper stage rather than from a dedicated oil or water lubrication system from the surface. Often cumbersome grease lubrication lines and systems can be done away with and grease pollution avoided.

Where suction cover bearings are water lubricated, the upstream side of the bearing is sealed to prevent dirty water from entering the bearing. Water is fed either from an upper stage or from a dedicated supply into the bearing usually using a lantern ring groove in the bearing. The downstream side of the bearing is open and the water is exhausted into the pump flow.

Where a totally sealed bearing is required, Vesconite can be lubricated with grease or oil.

Impeller and casing wear rings

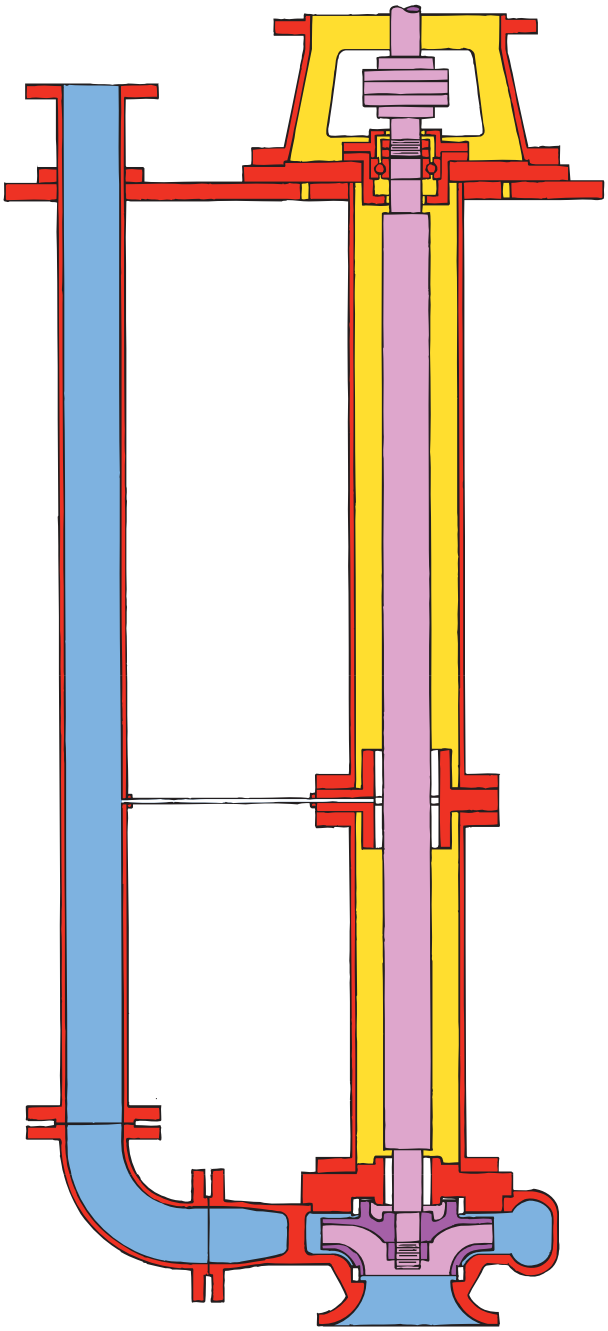
Vesconite can be used for efficient impeller and casing wear rings. Due to its self lubricating properties, Vesconite can run with a smaller running clearance than metal wear rings. Instantaneous contact with the casing or impeller wear ring does not cause damage to the Vesconite or to the mating surface.

The closer running clearance means an efficiency improvement due to a lower by-pass.

Vertical spindle sump pumps

Sump pumps can be used to pump a variety of fluids including clear water, hot liquids, chemically aggressive fluids and to dirty and abrasive liquids with high concentrations of particles or fibres. Examples include:

- Sump drainage pumps
- Vertical cantilever slurry pumps



Intermediate shaft support bearings

When pump shafts are long, intermediate bearings are required to support the shaft. These bearings are often lubricated by dedicated grease supply lines from the surface.

Vesconite shaft support bearings can be lubricated using a dedicated lubrication supply or process water fed from the pump discharge pipe with no need for additional lubrication systems.

Especially on long pumps that are used in a harsh environment, lubrication lines are often broken off at installation or during operation.

Vesconite bearings can be designed with close running clearances. This means a more stable shaft and less shaft run out.

The self lubrication of Vesconite allows successful operation of the bearing even when the water flow from the discharge pipe is temporarily suspended. The dry running ability of Vesconite reduces the need to prime the pump before start up.

Impeller support bearings

Impeller support bearings are often fully exposed to the harsh liquids that are being pumped. These bearings are immersed in the medium but lack the flow of lubrication often required by bearing materials.

Vesconite bearings can resist many chemically harsh pumped media.

Where pump snoring occurs, Vesconite's self lubrication allows the bearing to run for a time without damage caused to the shaft or bearing by the lack of lubrication.

Close running clearances allow for stable impeller operation with reduced vibration.

Where the pumped medium is especially dirty or hot and the bearings are not isolated from the media, Hitemp 150 is the material of choice. Hitemp 150 is a material designed for high temperature applications with the added advantage of good abrasion resistance.

Wear rings

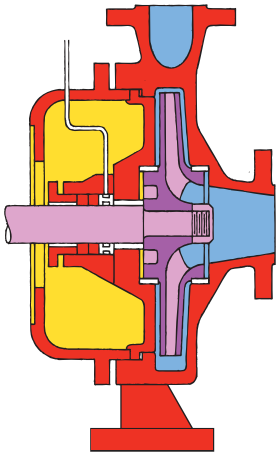
Vesconite wear rings can be designed with closer running clearances improving the pump efficiency due to a lower bypass.

Centrifugal pumps

Examples include:

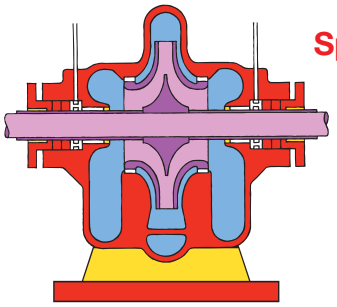
- Multistage mining pumps
- Process pumps
- Slurry pumps
- In line process pumps
- Split case pumps

Some specific applications include:



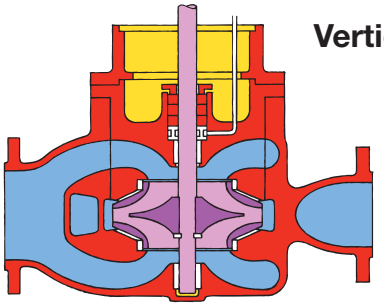
Overhung process pumps

- Support bearings
- Impeller and casing wear rings



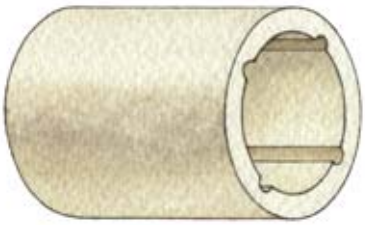
Split case pumps

- Support bearings
- Lantern rings
- Impeller and casing wear rings



Vertical in line pumps

- Support bearings
- Impeller and casing wear rings

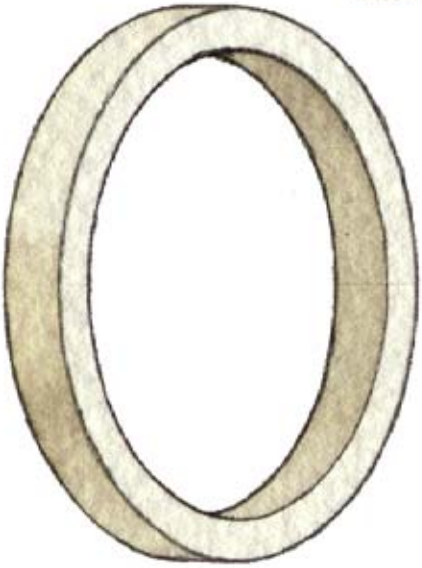


Support bearings

Vesconite bearings can be designed with close running clearances reducing shaft vibration and improving external bearing life.

Vesconite long life bearings ensure that expensive removal and repair of pumps is limited.

Support bearings can be grooved bearings when there is a water flow through the bearing. Bearings may not require grooves where the bearing is immersed in the pumped medium and does not require much cooling.



Lantern rings

Lantern rings are used as part of a shaft sealing system to evenly distribute water around the pump shaft and are used especially in slurry pumps.

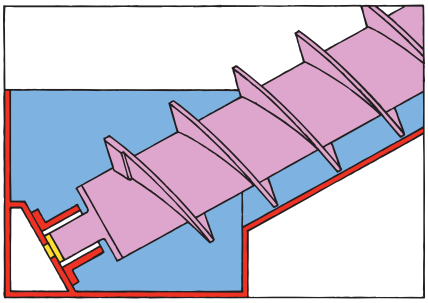
The dimensional stability of Vesconite allows for stable running clearances so that a desired water flow rate may be achieved. Due to their low friction, Vesconite rings can survive even when the water supply is temporarily suspended.

Impeller and casing wear rings

Vesconite wear rings can be designed to run with smaller clearances between the ring and impeller or casing. This means a higher pumping efficiency due to a lower by-pass.

If the Vesconite wear ring happens to contact with the housing no damage is caused. The wear ring will conform to the new size and re-establish a close clearance.

Archimedes screws



Water lubricated end support and intermediate bearings

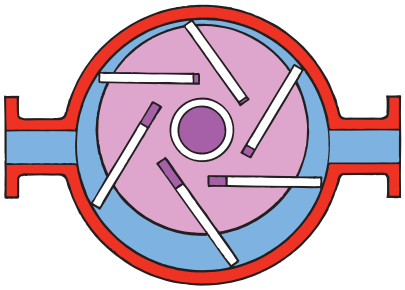
Flushed Vesconite bearings perform well even in harsh chemical or dirty environments. Vesconite's high loading capacity coupled with low friction gives low wear rate bearings.

Vesconite can be flushed with water rather than lubricated with environmentally polluting oils and greases.

Bearings are usually grooved to ensure an adequate flow of water through the bearing.

Vane pumps, compressors and air motors

Vesconite vanes showed good wear life in many applications, are not easily damaged or cracked like carbon vanes and are resistant to a variety of pumped media.



Gear pumps

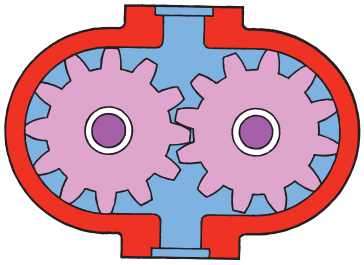
Pump bodies and gears

The dimensional stability, good resistance to a variety of chemicals and low wear rate make Vesconite well suited to pump bodies and pump gears

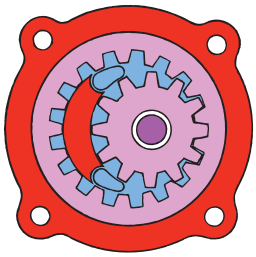
Support bearings

The low friction, long life properties of Vesconite give a long life for support bearings.

The low friction of Vesconite Hilube allows successful operation even when running dry for a short time.



External gear pumps



Internal gear pumps

Other immersed applications

Aerators, thickeners, mixers, hydroelectric turbines and flow gates all benefit from using Vesconite bearings.

Vesconite does not swell in water and therefore can maintain close running clearances without the danger of seizure in many immersed applications.

Vesconite has a very low wear rate especially when lubricated with water. This reduces maintenance on many of these difficult to maintain applications.

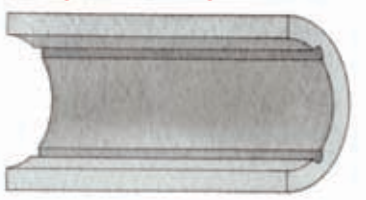
Technical Design

Correct bearing design is essential to long life bearing operation. Different bearing materials have different criteria for design. Vesconite and Vesconite Hilube are superior bearing materials. However, if these materials are designed incorrectly, premature bearing failure may occur.

Grooving of bearings

Many pump bearings require effective cooling of the bearing surface because of the frictional heat generated by high rotational speeds. Pump bearings often require cooling by either process fluids or dedicated lubrication systems through correctly designed grooves.

Straight, axial or longitudinal grooves



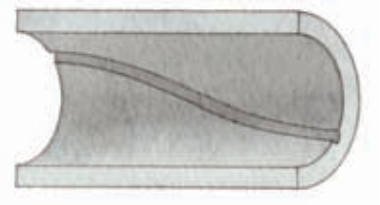
Generally straight grooves are used for lineshaft bearings on vertical turbine pumps. The pumped medium passes through the axial grooves to provide a constantly refreshing cooling film.

It is important that these bearings are not greased as the grease may block the channels. This will limit the water flow through the bearing, possibly leading to overheating of the bearing.

Typical groove design for straight grooves

Shaft diameter		No. of	Size - mm		Size - inches		Water flow rate	
mm	inches	grooves	width	depth	width	depth	l/min^{-1}	gal/min^{-1}
20-30	1 – 1½	3	6	2.5	0.25	0.1	4	1.0
31-50	1½ – 2	4	8	3	0.30	0.125	8	2.0
51-80	2 – 3	6	8	3	0.30	0.125	12	3.0
81-120	3 – 5	6	10	3.5	0.40	0.15	18	4.5
121-160	5 – 7	8	12	4	0.50	0.20	24	6.0
161-200	7 – 8	10	12	4	0.50	0.20	30	8.0

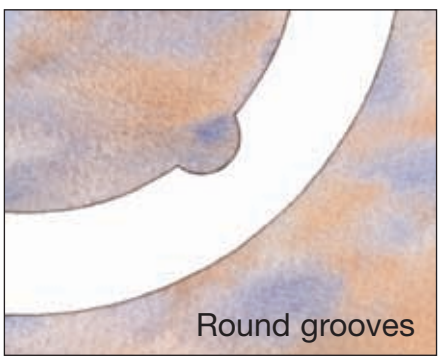
Spiral grooves

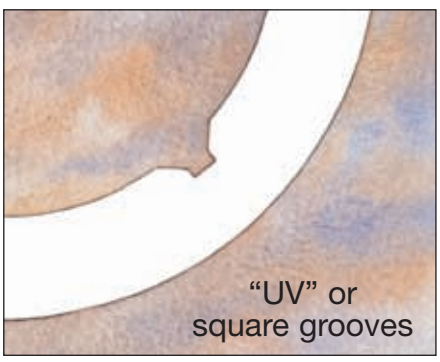


Spiral grooves can be used as an alternative to straight grooves. They can be used on slower moving shafts or where the bearing is immersed in the pumped product. A similar number and size of grooves as noted in the above table for straight grooves needs to be used for spiral grooves.

Straight grooves are usually recommended for pump bearing applications.

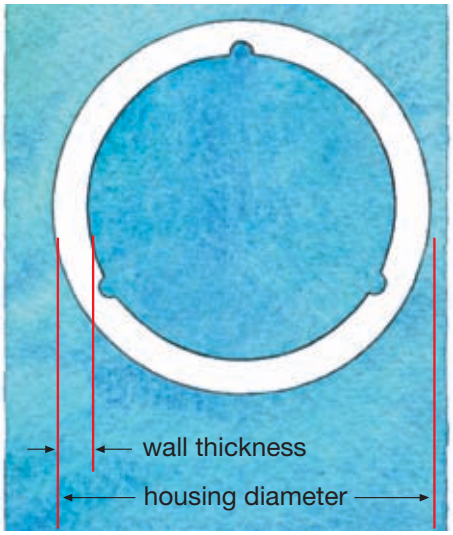
Groove shape and depth





Grooves should preferably be greater than 2.5 mm (0.1") deep to avoid blockages by sand or coarse debris. As a general rule the depth of grooves should be less than half the wall thickness of the Vesconite bearing.

When a thin wall thickness limits groove depth, extra grooves can be added to ensure adequate flow.



Wall thickness

It is generally recommended that the wall thickness should be greater than 5% of the housing diameter.

For thinner Vesconite bearings, care will be required when machining or fitting to avoid cracking. Bonding and mechanical securing can be used to ensure that the bearing is properly secured.

Designing for dirty conditions

Suspended dirt particles significantly increase wear of all bearing materials and cause wear to expensive shafts. This is a common problem especially on pump suction cover bearings when pumping dirty river or process water.

To overcome this problem, suction cover bearings are often sealed and lubricated with grease or oil from a dedicated supply. But this additional system is cumbersome and is prone to damage especially during pump installation or removal. It may cause environmental problems, especially if there is an oil leak.

In dirty conditions, Vesconite can be lubricated with:

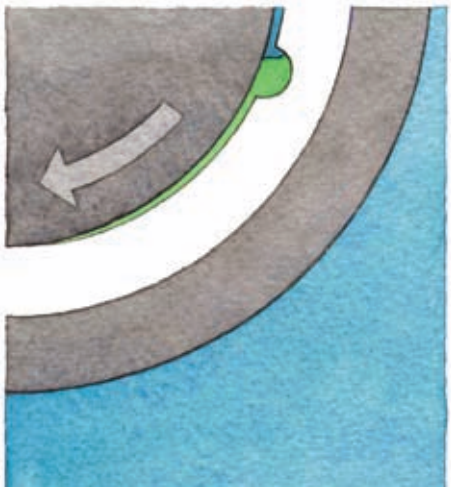
i) Process water, thus dispensing with grease and oil lubrication systems. This is achieved using a feed from an upper stage when using a multi-stage vertical spindle turbine pump.

ii) Clean water feed. This is advised when the pumped medium is very dirty.

Water fed Vesconite bearings are usually sealed at the upstream side and open at the downstream side. Water (process water or a dedicated supply) is fed into the bearing often using a lantern ring, and after flowing through the bearing it is exhausted into the pump flow.

iii) Grease or oil. Vesconite performs well with oil or grease lubrication.

In dirty conditions, Vesconite Hilube bearings are preferred as they give a low wear rate and much reduced shaft wear, especially when running against suitably hardened shafts.



Dry start and running of pump bearings

Pump bearings generally require a lubrication film to remove the heat resulting from the high sliding speeds and bearing loading. Water or other pumped media is drawn through the grooves and over the bearing surface to provide effective cooling.

Traditional bearing materials operate acceptably as long as this cooling flow is present. This flow can easily be interrupted during start up conditions or due to blocked inlets, causing bearing damage or even leading to failure and pump downtime.

Vesconite is internally lubricated giving a low friction which allows the bearing to cope with high loads and speeds.

The internal lubricant of Vesconite Hilube gives a very low friction and a greater ability to deal with these conditions.

At start up, typical vertical spindle pumps may require the upper lineshaft bearings and the stuffing box bearing to run dry for a time before water reaches the bearing.

The bearings can be primed before start up, but this is often neither easy nor convenient to achieve.

Tests have been conducted on Vesconite Hilube bearings to determine their ability to run dry under typical pump operating conditions. Vesconite Hilube survived for well over one minute without bearing damage.

This is far better than alternative water lubricated pump bearing materials, many of which melt down or burn within seconds. Ninety percent of dry start up specifications require only one minute dry running time.

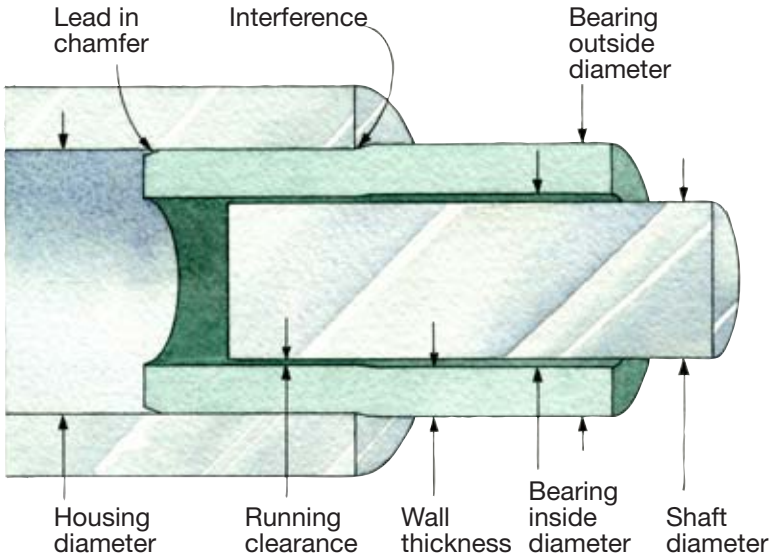
Pumps operating with Vesconite or Vesconite Hilube do not require pre-lubrication of the bearings and can run dry for a time without the danger of bearing damage.

Securing pump bearings

Interference fits

Using an interference fit is the easiest method to secure a Vesconite bearing when the bearing operates 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 bearing can easily be installed and removed using simple mechanical methods.



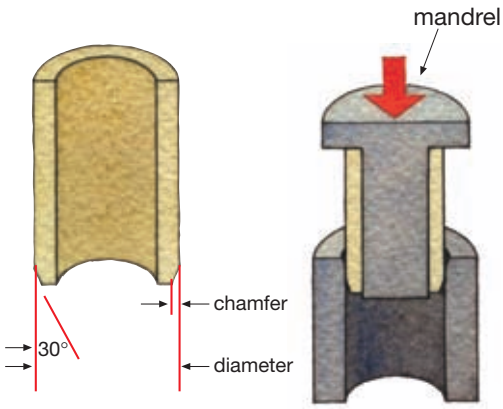
Fitting bearings

Fitting and removal of Vesconite bearings is easier than metal backed bearings.

Press fitting

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

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



Diameter		Chamfer @ 30°	
mm	inches	mm	inches
10 – 20	½ – 1	0.5	0.02
20 – 50	1½ – 2	1	0.04
50 – 100	2 – 4	1.5	0.06
100 – 250	4 – 10	2	0.1
>250	> 10	3	0.15

Freeze fitting

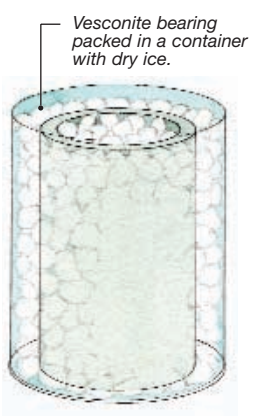
Freeze fitting greatly helps with installation of long bearings (length greater than the shaft diameter), large bearings and bearings with thin walls.

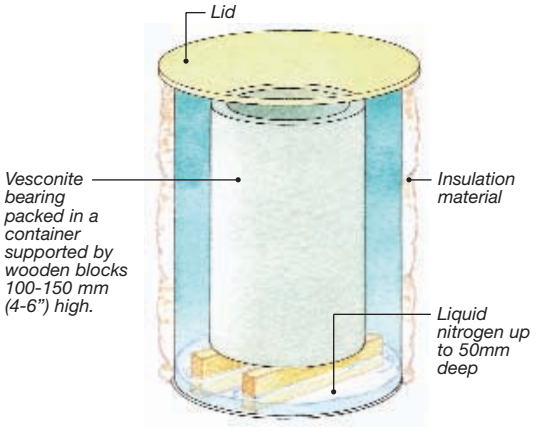
This can be done using a cold freezer (-40°C, -40°F preferably) or with dry ice.

When using dry ice, pack the bearing on the inside and outside with dry ice in an insulated container. The bearing will shrink to less than the housing diameter which allows for an easy slide fit.

Liquid nitrogen can be used. Take great care to ensure that the bearing does not come into direct contact with the liquid nitrogen. Place the bearing on wooden blocks in an appropriately insulated container. Pour some liquid nitrogen into the bottom of the container to below the level of the bearing and allow to cool. Vesconite should not be immersed in liquid nitrogen.

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





Mechanical securing

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

Operation of Vesconite bearings above 70°C (160°F) may result in loosening of the press fit. In this case the bearing should be split and secured mechanically to stop rotation and axial migration.

Bonding

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

The disadvantage of this method is that the bond will need to be broken when the bearing is removed.

Keeper plates

Keeper plates are recommended to avoid axial movement of the bearing. Take care that no excessive pressure is placed on the bearing.

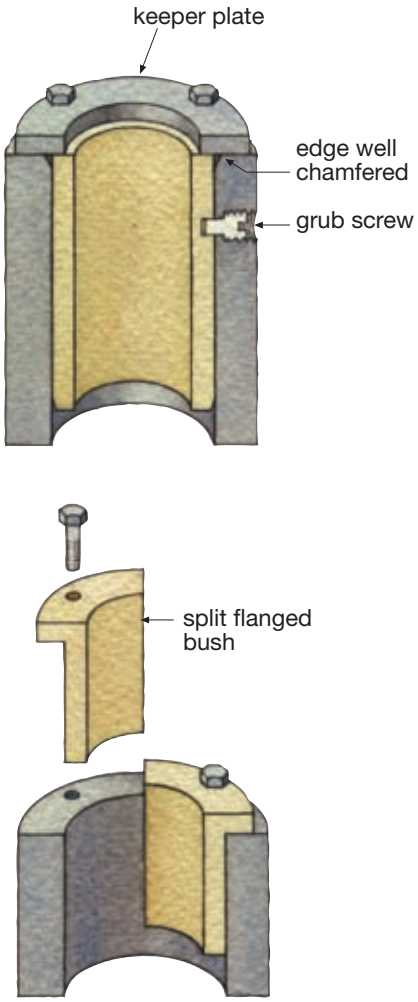
Grub or locating screws

Grub screws are a convenient and effective way to stop rotation and axial migration. The Vesconite bearing should be drilled to accept the grub screw. This is to avoid excessive spot pressure being placed on the bearing 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 pump.

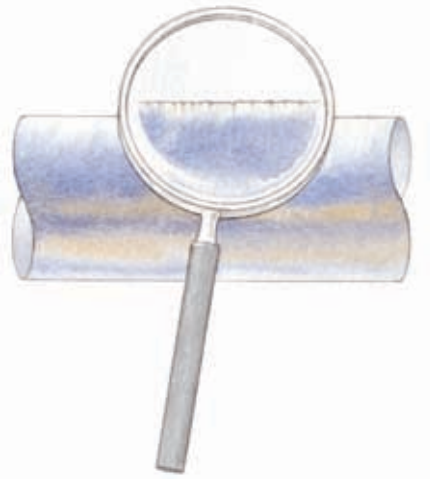
Flanged bearing secured with bolts

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



Housings and shafts

Shaft materials



Metal mating surfaces must suit the media and wear conditions encountered. When operating in sandy or abrasive conditions, hard shaft surfaces ensure longer shaft as well as bearing life.

Hardchrome plated surfaces are ideal.

As a general rule, the harder the shaft surface, the better the results that will be achieved with Vesconite bearings.

Shaft hardnesses of Rc > 50 are ideal, however the hardness of a 316 stainless steel is usually acceptable.

Corrosion resistant stainless steels 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 they do not corrode under the conditions of use.

Housings and casings materials

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

Machining tolerances

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

Housing / shaft diameter in mm

ISO tolerances

			10 - 18	18 - 30	30 - 50	50 - 80	80 - 120	120 - 180	180 - 250	250 - 315
Housing	H7	Upper (mm)	+0.018	+0.021	+0.025	+0.030	+0.035	+0.040	+0.046	+0.052
		Lower (mm)	0	0	0	0	0	0	0	0
Shaft	H7	Upper (mm)	0	0	0	0	0	0	0	0
		Lower (mm)	-0.018	-0.021	-0.025	-0.030	-0.035	-0.040	-0.046	-0.052

Housing / shaft diameter in inches

ISO tolerances converted to inch measurements

			0.4 - 0.7	0.7 - 1.2	1.2 - 2.0	2.0 - 3.15	3.15 - 4.72	4.72 - 7.1	7.1 - 10.0	10.0 - 12.4
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

Since synthetic materials such as Vesconite and Vesconite Hilube have a wider tolerance specification, metal mating surfaces machined to closer tolerances than this standard are seldom required.

Surface finishes of shafts

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

A recommended ground finish of 0.5 µm Ra (0.002 microinch Ra) is ideal. Shaft roughness should not exceed 2.5 µm Ra (0.010 microinch Ra).

For solid drawn shafts which have axial tool marks, roughness should be less than 0.5 µm Ra (0.002 microinch Ra).

Shafts should be round and not oval.

Where shafts with a tendency to corrosion cannot be avoided, Hitemp 150 may be considered as a possible solution.

Surface finishes of housings and casings

The surface finish on the housing is not critical as there is no movement after installation. To facilitate installing the bearing the housing surface should be smooth. Lead in chamfers are advised to avoid scoring or shaving of the bearing during installation.

Ovality of the housing needs to be avoided. If housing ovality presents a problem then it is best to install the bearing and then machine the inside diameter to size after installation.

Surface finishes of Vesconite bearings

The Vesconite bearing surface finish is not critical on account of its lower hardness compared to the metal mating surface. A standard machined surface is sufficient.

Typical properties of Vesconite and Vesconite Hilube

		Metric	Imperial
Maximum 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	Immersed	80°C	175°F
	Dry or grease / oil lubricated	100°C	212°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

Temperature rating of Vesconite

Typically Vesconite and Vesconite Hilube are limited to 80°C (175°F) in immersed conditions and 100°C (212°F) in dry conditions.

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

Hitemp 150 is designed for immersed temperatures of up to 125°C (250°F) and 150°C (300°F) in dry conditions.

Chemical resistance chart

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 an estimate at the concentrations noted at ambient temperature of 25°C (77°F).

The aggressiveness of chemical solutions generally increases with higher concentrations and temperatures. While general guidelines may be provided, every application needs to be considered individually.

It is recommended to check the resistance 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 sulfate	50	☺
Amyl acetate		😐
Amyl alcohol		☺
Aniline		☺

Chemical Name	%	
Anti freeze		☺
Aqua regia		☹
ASTM Oils		☺
Barium chloride		☺
Barium salts		☺
Benzaldehyde		☺
Benzene		☺
Benzyl alcohol		☺
Benzyl chloride		☺
Bleaching lye		☺
Bleaching solution		☺
Boric acid		☺
Brake fluid		☺
Bromine		😐
Butane		☺
Butanol		☺

Chemical Name	%	
Butyl acetate		☺
Butyl amine		😐
Butyl chloride		😐
Butyric acid		☺
Calcium chloride		☺
Calcium hypochlorite		☺
Calypsol greases		☺
Carbon disulphide		☺
Carbon tetrachloride		☺
Caster oil		☺
Cellosolve		☺
Chloride of lime		☺
Chlorine (gas-dry)		☺
Chlorine dioxide		☺
Chlorine in water		😐
Chloroacetic acid		😐

Chemical Name	%	
Chlorobenzene		☺
Chloroform		😐
Chlorosulfonic acid		☹
Chromic acid	40	☺
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		☺
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	☹

Chemical Name	%	
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		☹
Methylene chloride		☹
Mineral oils		☺
n-Hexane		☺
Nickel chloride		☺
Nitric acid	10	☺
Nitric acid	40	☹
Nitrobenzene		☺
Octane		☺
Oil of cloves		☺
Oleic acid	100	☺
Olive oil		☺
Oxalic acid		☺
Ozone (gas)		😐
Paraffin		☺
Perchloroethylene		☺
Petrol		☺
Phenol		😐
Potassium bichromate	10	☺
Potassium bromide		☺
Potassium carbonate		☺
Potassium chloride	10	☺
Potassium dichromate	10	☺
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	☺

Chemical Name	%	
Sodium borate		☺
Sodium carbonate	20	☺
Sodium chloride	25	☺
Sodium hydroxide	1	☺
Sodium hydroxide	10	😐
Sodium hydroxide	60	☹
Sodium hypochlorite	20	☺
Sodium nitrate	10	☺
Stannic chloride		☺
Stearic acid		☺
Sucrose		☺
Sulfur dioxide (gas)		☺
Sulfuric acid	10	☺
Sulfuric acid	70	😐
Sulfuric acid	96	☹
Tea		☺
Teterahydrofurane		☺
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 sulfate		☺

Vesconite and Vesconite Hilube Size Calculations

The easiest way to dimension Vesconite bearings is to use the internet online Design-a-Bearing calculators on **www.vesconite.com**.

Within seconds Design-a-Bearing gives the correct interference fits, running clearances, groove sizing and tolerances across a wide range of operating temperatures.

The standard design calculations for the use of Vesconite and Vesconite Hilube in pump 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.

Interference fits/ Press fits

The most common method for securing a Vesconite bearing. Calculated as:

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

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

Bore closure

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

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

Assembly clearance

This is the difference in diameter between the bearing inside diameter and the shaft.

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

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

Calculation of the bearing dimensions

Outside diameter = housing diameter + total press fit

Inside diameter = shaft diameter + bore closure + assembly clearance

Worked example - Design a bearing for the following housing and shaft sizes:

Metric	Inches
Housing size: 75 mm Shaft size: 50 mm	Housing size: 3” Shaft size: 2”
Press fit = 0.05 + 0.002 x 75 mm = 0.20 mm	Press fit = 0.002” + 0.002” x 3” = 0.008”
Bore closure = $0.20 \times \frac{75}{50}$ mm = 0.30 mm	Bore closure = $0.008 \times \frac{3”}{2”}$ = 0.012”
Assembly clearance = 0.05 + [0.02 x 0.5 x (75 – 50)] mm = 0.30 mm	Assembly clearance = 0.002 + [0.02 x 0.5 x (3 – 2)]” = 0.012”
Outside diameter = 75 + 0.20 mm = 75.20 mm	Outside diameter = 3 + 0.008” = 3.008”
Inside diameter = 50 + 0.30 + 0.30 mm = 50.60 mm	Inside diameter = 2 + 0.012 + 0.012” = 2.024”

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

Extra clearance = $[(\text{Housing diameter})^2 - (\text{Shaft diameter})^2] \times (T_{max} - 50°) \times 6 \times 10^{-5}$ mm

$$\text{Extra clearance} = \frac{[(\text{Housing diameter})^2 - (\text{Shaft diameter})^2] \times (T_{max} - 120°) \times 3.3 \times 10^{-5} \text{ inches}}{\text{Shaft diameter}}$$

Inside diameter = shaft diameter + bore closure + assembly clearance + additional clearance

If Tmax = 60°C

$$\text{Extra clearance} = \frac{(75^2 - 50^2) \times (60° - 50°) \times 6 \times 10^{-5} \text{ mm}}{50}$$

$$= 0.04 \text{ mm}$$

If Tmax = 140°F

$$\text{Extra clearance} = \frac{(3^2 - 2^2) \times (140° - 120°) \times 3.3 \times 10^{-5}\text{“}}{2}$$

$$= 0.0017\text{”}$$

For temperatures higher than 70°C (160°F), a minimum expansion gap is required

Expansion Gap > 0.5 + [Housing diameter x 3.14 x (Tmax-20°) x 6 x 10^{-5}] mm

Expansion Gap > 0.020” + [Housing diameter x 3.14 x (Tmax-70°) x 3.3x10^{-5}]”

Outside diameter = housing diameter
Inside diameter = shaft diameter + assembly clearance

If Tmax = 80°C
Expansion Gap > 0.5 + 75 x 3.14 x (80° - 20°) x 6x10^{-5} mm
= 1.3 mm
Outside diameter = Housing diameter

Tmax = 175°F
Expansion Gap > 0.02” + 3 x 3.14 x (175° - 70°) x 3.3x10^{-5}”
= 0.053”
Outside diameter = Housing diameter

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

Additional press fit = (0 -Tmin) x 5.4 x 10^{-5} x Housing diameter mm

Additional press fit = (32 - Tmin) x 3.0 x 10^{-5} x Housing diameter inches

Total press fit = standard press fit + additional press fit
Outside diameter = housing diameter + total press fit
Inside diameter = shaft diameter + bore closure + assembly clearance

If Tmin = -20°C
Extra press fit = [0°-(-20°)] x 5.4 x 10^{-5} x 75 mm
= 0.08 mm
Total press fit = 0.2 + 0.08 mm
= 0.28 mm

If Tmin = -4°F
Extra press fit = [32° - (-4°)] x 3.0 x 10^{-5} x 3”
= 0.003”
Total press fit = 0.008 + 0.003”
= 0.011”

Machining after installation

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

Outside diameter = housing diameter + total press fit
Inside diameter = shaft diameter + assembly clearance + extra clearance

Outside diameter = 70 + 0.19 mm
= 70.19 mm
Inside diameter = 50 + 0.25 + 0.27 mm
= 50.52 mm

Outside diameter = 3 + 0.008”
= 3.008”
Inside diameter = 2 + 0.012 “
= 2.012”

Machining Tolerances

Vesconite can be machined on standard machining equipment.

Bearings that are long (length greater than diameter) or have thin walls require additional care.

Suggested Vesconite machining tolerances are:

	Standard	Minimum	
		mm	inches
Outside diameter tolerance	± 0.1%	± 0.025	0.001
Inside diameter tolerance	± 0.1%	± 0.025	0.001
Wall thickness tolerance	+ 0.0 / -0.5%	+ 0.0 / -0.025	0.0 / -0.001
Length tolerance	+ 0.0 / -0.5%	+ 0.0 / -0.3	+ 0.0 / -0.01

It is usually 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. This is most applicable on thin bearings and wear rings.

The tolerances advised on Vesconite are wider than for typical metal tolerances due to the higher thermal expansion rate of Vesconite. If bearings are designed with smaller tolerances, then it is advisable to consider the machining and checking temperatures.

Where fine tolerances are required as can be the case with wear rings, first fit the Vesconite into the casing and then machine to size.

Temperature compensation

The bearing dimensions calculated above assume measurement of the bearing at 20°C (70°F). If there is a large variance between the actual machining and operation temperatures, the resulting difference in sizing could result in incorrect bearing operation or premature failure.

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

Machining guidelines for Vesconite

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

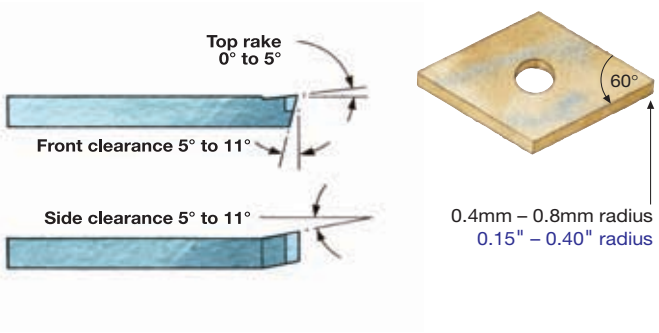
Vesconite should not be clamped like a metal, but should be clamped carefully to avoid distortion.

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

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

Allow the bush to cool before taking the final cut.

Cutting Angles



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

Diameter mm	0-50	50-100	100-150	150-200	200-250	250-300	300-400	400-500
Diameter inches	0-2"	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 — 0.25" - 0.35" per revolution

Finish turning: 0,4 - 0,4 mm per revolution — 0.15" - 0.25" 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.

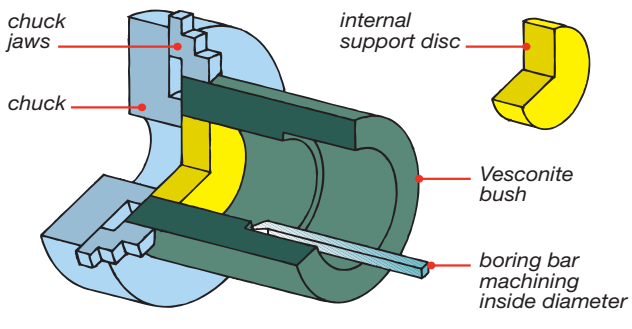
Use an internal support disc machined to size, made of any available material, approximately 10 to 25 mm thick ($1/2$" to 1").

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

STEP 3 Machine inside diameter

Machine bush inside diameter using a boring bar. Ensure that there is not an excessive build-up of shavings inside the bush.

Grooves may be added at this stage if required.

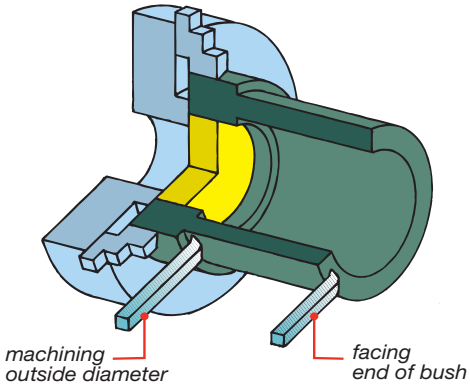


STEP 4 Machine outside diameter

Machine bush outside diameter using an external turning tool.

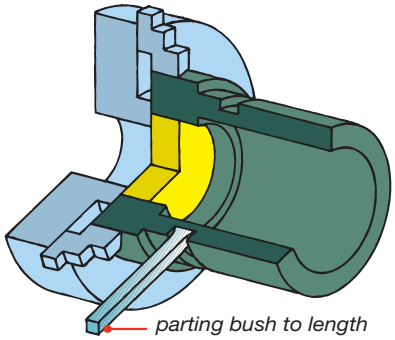
Machine flange outside diameter if needed.

Face the end of the bush.



STEP 5 Part to length

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



Stock availability

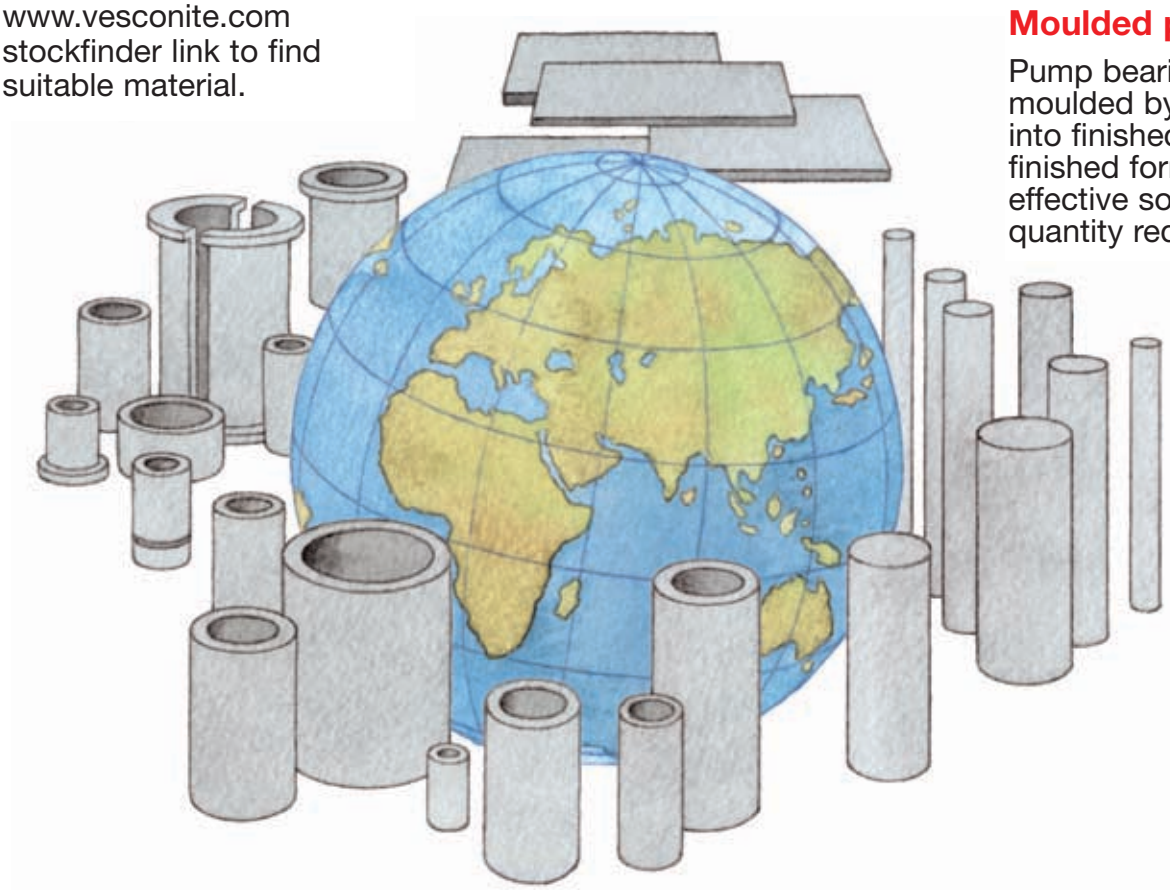
A large range of Vesconite and Vesconite Hilube stock shapes are available from centers worldwide to manufacture pump bearings. Vesconite and Vesconite Hilube can be supplied as standard stock shapes at short notice or as final machined custom components. Use the www.vesconite.com stockfinder link to find suitable material.

Tubes / bushings

Stocked in 1 meter (39”) lengths for shafts from 6 to 650 mm diameter (1/2” to 26”) in a large range of standard sizes.

Vesconite – More than 150 bushing sizes

Vesconite Hilube – More than 50 bushing sizes



Rods

Stocked in 1 meter (39”) lengths in diameters from 8 to 160 mm (5/16” to 6”)

Plates

Stocked in widths up to 600 mm (23”) wide and 50 mm (2”) thick. Ideal for machining large diameter wear rings.

Moulded parts

Pump bearings can be moulded by VescoPlastics into finished or a semi-finished form for cost effective solutions on larger quantity requirements.

Disclaimer

This design manual is based upon many years of experience of VescoPlastics and VescoPlastics Sales (the Companies) 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 favourable results cannot be guaranteed. This information is intended for use by persons with technical skill, at their discretion and risk. The purchaser must determine the suitability of the goods for their intended purpose.

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.

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

What www.vesconite.com can do for you

Stock finder
Find the closest Vesconite and Vesconite Hilube stocks near you to meet the requirements of your application.

Prototypes, inquiries and quotes
Testing Vesconite in your application may be the only way to demonstrate the long life of Vesconite. If you would like VescoPlastics to assess your application, fill in the details and submit for a prompt assessment or a quotation for your components.

Application success stories
Vesconite has been successful many times before. Details of many successful applications of Vesconite and Vesconite Hilube fitted to pumps and other industries.

Design-a-bearing calculators
Design your pump bearing quickly and correctly with on-line calculators in metric units or inches.
Design-a-Bearing will specify the correct fits, clearances and machining tolerances for bearing parameters interted.

Bulletin board
Other industries including railways, marine, transport, mining....

Material Safety Data Sheets
Safety information and drinking water certificates.

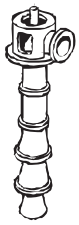
Frequently asked questions

Other useful information
Home page available in various languages including, Finnish, Portuguese, Russian, Afrikaans, German, French, Italian, Chinese, Spanish....

Application assessment or quotation

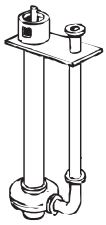
Please comlete the form and fax to **+27 11 616 22 22** or **+27 11 615 38 10**.

If possible include a cross section or assembly diagram showing pump design and bearing location.



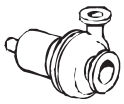
Axial flow / mixed flow

- ☐ Lineshaft
- ☐ Pump bowl
- ☐ Stuffing box
- ☐ Suction cover



Sump

- ☐ Impeller support
- ☐ Shaft support
- ☐ Wear ring



Centrifugal

- ☐ Wear ring
- ☐ Support bearing

Split case

- ☐ Wear ring
- ☐ Support bearing
- ☐ Lantern ring

Submersible

- ☐ Lineshaft

In line

- ☐ Wear ring
- ☐ Support bearing

Other (specify) .....

Pumped product ☐ Water ☐ Other (specify) ..... ☐ Clean ☐ Dirty (specify) .....

Bearing size ☐ mm ☐ inches

Split bearing required ☐ Yes ☐ No

Housing/casing diameter .....

Flange diameter (if required) .....

Shaft/impeller diameter .....

Flange thickness .....

Bearing length .....

Number of bearings .....

Operational conditions

Rotational speed (RPM) .....

Maximum temperature ☐ °C ☐ °F .....

Load ☐ kg ☐ lbs .....

Minimum temperature ☐ °C ☐ °F .....

Current material used

☐ Bronze ☐ Elastomer ☐ Rubber ☐ Cutlass ☐ Other (specify) .....

Lubrication ☐ Product ☐ Water ☐ Grease ☐ Oil ☐ None

Contact details

Company .....

Contact Name .....

E-mail .....

Website www .....

Address .....

Country .....

Postal / Zip code .....

Telephone + ( ) .....

Fax + ( ) .....

Please quote quantity per order .....

Quantity per year .....

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