THORDON

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ENVIRONMENTALLY FRIENDLY BEARING SOLUTIONS

NEW PROPELLER SHAFT COATING COMPLEMENTS WATER LUBRICATED BEARINGS

Thordon Bearings Inc., a world leader in grease and oil-free bearing solutions has announced the introduction of Thor-Coat, a new proprietary shaft coating specially formulated to address the recognized risk of traditional coating failures on water lubricated propeller shafts.

Thor-Coat was specifically developed to complement Thordon's COMPAC water lubricated propeller shaft bearing system with the objective of providing corrosion protection for a minimum ten-year period in service. Thor-Coat addresses the issue of current shaft coating systems not being sufficiently reliable to allow extension of shaft withdrawal periods beyond five years. Thordon is also working closely with the Classification Societies to develop approval for other techniques, such as borescoping, that facilitate inspection of the bearings and coating without withdrawing the shaft.

A toughened, 2-part epoxy coating, Thor-Coat is up to nine times more flexible than existing products currently approved for use as propeller shaft coatings. Thor-Coat was subjected to the full-scale 180° bend test and did not crack whereas all other products tested showed initial cracking at a much lower bend angle. In a propeller shaft application, or in other similar applications where a coating must be durable, yet flexible, Thor-Coat's enhanced elasticity and toughness will provide corrosion protection over longer service periods. Easily applied on a rotating lathe to a thickness of 2mm (0.08"), application is straightforward, as Thor-Coat is a one-coat product.

Should Thor-Coat suffer impact damage, it tends to fail locally resulting in some of the coating remaining on the shaft continuing to offer corrosion protection. If the coating is damaged to the point where corrosion does occur, the corrosion is limited to the damaged area only and will not migrate along the shaft under the coating to unexposed areas. Localized damage can be easily repaired if necessary.

Thor-Coat currently has provisional approval from Lloyd's Register, ABS and Bureau Veritas while being noted by DNV. Other Classification Society approvals are pending and expected shortly. Nw

Easily applying one coat Thor-Coat using a doctor blade mounted on a lathe

Thor-Coat applied to propeller shaft of Santa Elena, a 3,000 DWT tanker, at Malta Drydocks

THIS ISSUE

GREASE FREE THORPLAS® FOR KAPLAN RUNNER BLADE BUSHINGS

In April 2005, operators at Alabama Electric Cooperative's 3-MW Gantt hydroelectric plant on the Conecuh River in Alabama, U.S.A., decided to replace the four runner blade trunnion bushings in the vertical Kaplan turbine of Unit 4. The bushings reduce friction when the runner blade pitch varies according to head and flow.

The powerhouse originally contained three vertical Francis turbines. In 1984, Alabama Electric replaced Units 1 and 2 with a single 2-MW vertical Kaplan unit (Unit 4). Unit 3 remains in service.

For Unit 4, Alabama Electric selected a bushing manufactured by Thordon Bearings. The bushing is the company's new ThorPlas®, a grease and oil-free engineered (i.e., non-elastomer) thermoplastic bearing.

"We chose the Thordon bushing because we have been using a Thordon turbine main guide bearing without any problems since 1984," says Wes Thomasson, a mechanical engineer in the central generation section of Alabama Electric.

ThorPlas® is a crystalline, premium grade, homogeneous, engineered thermoplastic bushing that is self-lubricating and can accept operation pressures up to 31 MPa (4,500 psi) without the need for metal backing, says Ingrid A. Muschta, P.Eng., Product Manager for Thordon.

"ThorPlas® has demonstrated exceptional wear and abrasion resistance and has one of the lowest wear rates among nearly all rigid polymers, "says Muschta. "Due to its ratio of static to dynamic co-efficient of friction, it does not exhibit any stick slip effect. Instead, it provides a smooth, quiet, stable operation in demanding applications such as wicket gate trunnion bearings."

The material has good thermal stability (minimal to no changes due to temperature) and low water absorption (minimal to no changes due to exposure to water), which allow for tighter installed clearances, Muschta says. Furthermore, she says it is easy and safe to machine because it produces no hazardous dust and releases no dangerous byproducts.

Alabama Electric's Thomasson says the fact that the bearing is self-lubricating was the most important characteristic in its selection. "The runner location is not easily accessed," he says. "You have to stop the unit, put down headgates or stoplogs, dewater the pit, and climb in there. And even then it's still not easy to get to the bearings. It was not designed to be lubricated.

He also appreciates the environmentally friendly nature of ThorPlas®. "If you used one with grease and the seal failed, you could contaminate the stream," he says.

Thomasson cited ease of installation as another key factor in choosing the Thordon product. According to Muschta, the product is installed using a "freeze fit" or "shrink fit" method. "Due to its coefficient of thermal expansion, ThorPlas® will contract or shrink somewhat when cooled," she says. "You can then place the bearing into the housing by slipping it or lightly pressing it in."

Thomasson reports no problems so far. "The bushings are easy to work with," he says. "And in the year they have been in use at the plant, they have been trouble free." NW

Alabama Electric installed ThorPlas® runner blade trunnion bushings for their Kaplan turbine

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TANKER TO BULKER CONVERSION SPECIFIES

In mid-2005 CSL International Inc (CSLI) invited Thordon Bearings to study the existing oil-lubricated sterntube system of its recently purchased 23 year-old tanker *Cabot*. The US-based company, part of Canada's CSL Group, planned to convert the ship into a self-unloading bulk carrier at the Shan Hai Guan Shipyard in China.

A key element of the project specification called for the conversion of the original oil-lubricated white metal propeller shaft bearings into a water-lubricated system guaranteeing zero risk of oil pollution from leaking sterntubes.

After reviewing all the drawings, Thordon prepared a conversion design proposal for CSLI, which then worked with the yard to finalise the project. All preparatory work was carried out while the ship was still afloat, and conversion of the existing system and installation of the Thordon COMPAC water-lubricated propeller shaft bearing system completed during dockings for the forebody conversion.

The new water-lubricated system was designed for a propeller shaft diameter of 590mm and a shaft liner diameter of 645mm, the COMPAC bearings having length/diameter ratios of 2:1 aft and 1:1 forward.

COMPAC bearing cooled in liquid nitrogen and ready for freeze fit

Thordon Water Quality Package installed on CSL Acadian

Support for the yard, owner and Thordon was provided by Thordon's authorised distributor in China, Proco Marine Technology & Eng. Co. Ltd. Thordon's Manager of Engineering, Ken Ogle, who oversaw the project from start to finish, was also present during the system installation.

The overall conversion project was completed in March 2006, the former 67,208 dwt tanker *Cabot* emerging as the 74,000 dwt bulker *CSL Acadian* and arriving on the US west coast in mid-April.

"Thordon's approach and understanding of this project's needs were first class and their expertise in this field contributed to a smooth and fast turnaround," said Mr. Louis Martel, Vice President Technical Operations of CSLI.

Delivery of the bronze liner, seal and Thordon Water Quality Package took two months. Based on the *Cabot/CSL Acadian* project, a sterntube conversion could be easily completed in a week to 10 days if all parts are at the shipyard. Projects can be conveniently scheduled to match the tailshaft survey cycle.

In planning conversions from a whitemetal/oil-lubricated system to a COMPAC system, Thordon requires details of the existing sterntube and shaft arrangements, bearing drawings, shaft alignment and loading calculations, and the tailshaft drawing. A typical project calls for:

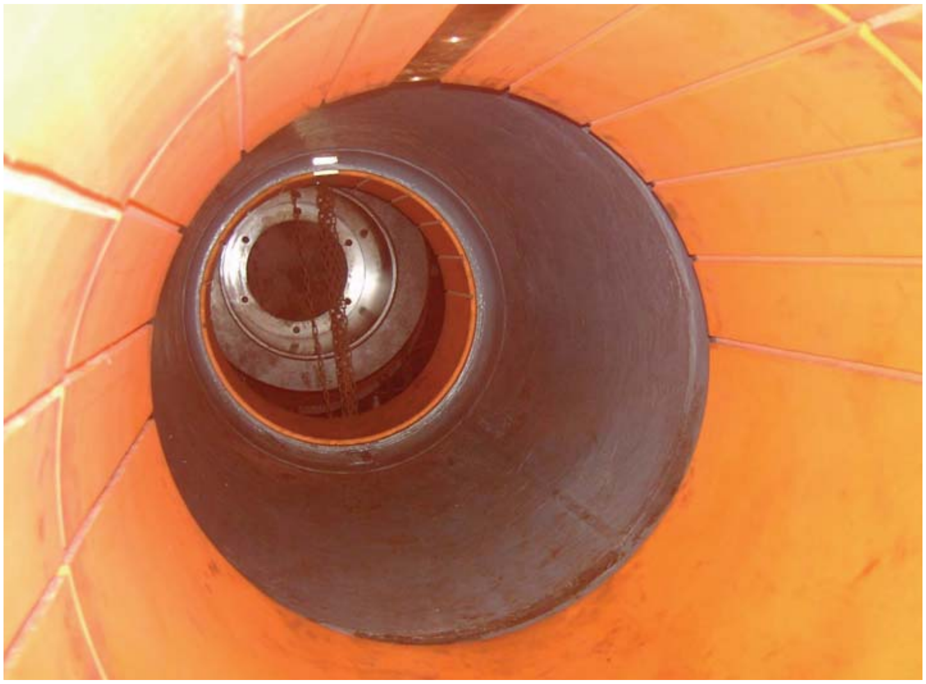
- assessment of the original bearing loading condition
- conversion design package and work procedure paper
- Thordon COMPAC water-lubricated bearings
- bronze shaft liners
- Class-approved shaft coating
- water-lubricated forward seal
- Thordon self-cleaning Water Quality Package

In a Thordon COMPAC bearing system, sea water is typically pumped by a maintenance-free self-contained pumping set from a sea chest through the Water Quality Package, which removes abrasive solids from the water supply (down to 40-50 microns) and ensures a flow for bearing lubrication and cooling. The flow is monitored by low flow alarms. Water enters the forward seal, flows through the COMPAC bearings and exits at the stern of the ship (there is no aft seal).

Clasification Society approved Thor-Coat shaft coating can provide tough corrosion protection for the propeller shaft, extending the period between shaft withdrawals.

Shaft liners are typically produced from gunmetal, bronze, Inconel 625 or stainless steel. Only a forward seal is

COMPAC TO REPLACE OIL LUBRICATED STERNTUBE



COMPAC fitted to stern tube

required, which can be a face seal, lip seal or stuffing box.

Operational benefits for shipowners in specifying a Thordon COMPAC water-lubricated bearing system at the newbuilding stage or by retrofit include:

- Zero pollution risk (oil is eliminated from the sterntube)
- Controlled bearing environment using the Water Quality Package, guaranteeing a 10-year bearing wear life
- Reduced seal maintenance costs (forward seal only)
- Ease of maintenance
- No emergency dockings (long predictable wear life)
- Survivability (non-catastrophic failure mode allows ship to get to port).

Among over 460 diverse commercial and naval references for its water-lubricated COMPAC propeller shaft bearings, Thordon highlights:

Seven (+ three on order) Princess Cruises' ships, including *Grand Princess*, equipped since 1998; Chemikalien Seetransport's LNG carrier *Cinderella* (since 1996); Algoma Central Corporation's tanker *Algonova* (since 1997); Gypsum Transportation's bulk carrier *Gypsum Centennial* (since 2000); Disney Cruises' *Disney Magic* and sistership (since 1997 and 1998); two Grimaldi Group cruiseferries (since 2001); four BP Shipping tankers; Moby Lines' ferry *Moby Rider* (since 1997); three Staten Island ferries; and 12 Flinter Groningen-owned feeder container ships. NW

MAKING A CASE FOR NON-METALLIC PUMP BEARINGS

This article will discuss some of the issues associated with vertical pump bearings in general, and non-metallic bearings specifically. Non-metallic bearings may not be the best answer in every case but have been an excellent choice for a great many applications worldwide. In general, these will be product lubricated bearings thus precluding additional contaminants (oils, greases) infiltrating the pumped fluid.

Non-metallic materials include rubbers, synthetic rubbers (elastomers), plastics, graphite based materials, ceramics and lignum vitae.

Design

When selecting bearings for a given application, there are many design issues to be considered involving aspects from both bearing and pump design. Bearings in a vertical pump are a necessary machine component forming the basic support structure for the power transmission system from the driver to the impeller(s). This system must be designed and selected with all the pertinent mechanical aspects considered to ensure that the overall performance will be satisfactory for the pump operating life. If the pump design and operating conditions are not carefully explored, the bearings being the weak link in the chain will indicate distress well before other components in the pump are affected. This is true whether the issue belongs specifically to the bearings or the pump.

Bearing Considerations

The typical length of non-metallic bearings conforms to L/D ratios ranging from 1 to 1.5. Bearing stiffness values for the general range of pump shaft sizes will be equivalent to metallic bearings from a shaft and column dynamics standpoint.

Loading of vertical pump bearings is difficult to analyze in general. It will normally be fairly light establishing bearing stability as a significant issue. While typical pump speeds are not high enough to develop serious observable instability effects, such activity may have detrimental outcomes on the life of a bearing.

Grooves in the bearing will tend to develop centering forces and small side loads may result from the stack up of tolerances during the assembly stage. For this situation, minor assembly offsets may be a good thing, resulting in improved operating stability.

Bearing clearances must be adequate to allow free running of the bearings but not so large as to compromise the important shaft support mechanism provided by the bearing. Typical running clearances will be 0.0015 mm/mm (0.00006 in./in.) of shaft diameter with a minimum of 0.08 mm (0.0031 in.). In the case of non-metallic materials, consideration must be made for fluid absorption and thermal expansion. These allowances, although less for Thordon than for most other materials, must be considered and may be minimized by reducing wall thickness to minimum values. In any case, the operational dynamics of the pump will be dependant on establishing correct running clearances between the shaft and bearing.

Standard pump sleeve materials such as 400 or 300 series stainless steels will function well with Thordon. For salt or brackish water applications, better corrosion resistance will be experienced with the 300 series or duplex type stainless steels. If significant abrasives are present in the pump fluid, enhanced life of the bearing system will be achieved with hardened sleeves. In such case, superior performance has been achieved with Thordon GM2401 material mated with nickel chrome boron (NiCrB) coated shaft sleeves.

In general, grooves should be provided to allow adequate flow through the bearing and to allow easy passage of any abrasive particulate debris. Some smaller bearings (under 50 mm or 2 in. shaft dia.) operating in clean fluids may work well without grooves. In either case, the recommended supply of clean water must flow through the bearing to ensure adequate lubrication and cooling.

Pump Issues

Bearing spacing is the province of the pump designer, but is often an issue for pump re-builders if bearings of different materials are contemplated. The preferred design approach is to provide a shaft/bearing system stiffness having the first bending critical of the shafting above the operating speed by a margin of 10 to

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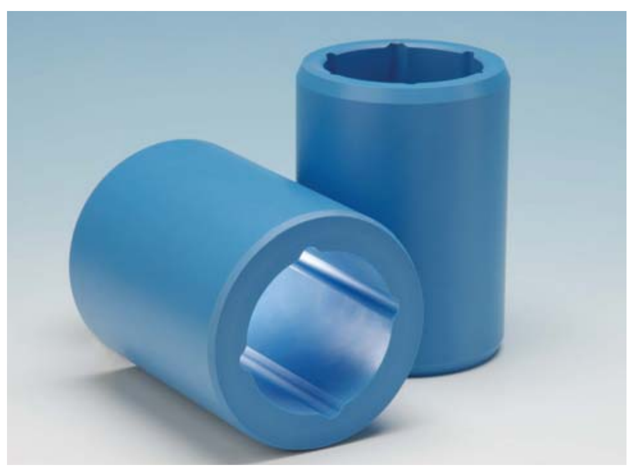

ThorPlas® pump bearings offer a broader chemical compatibility and higher operating temperatures than other Thordon grades

...continued from page 5

Elastomeric Thordon SXL pump bearings offer excellent load distribution, low coefficient of friction and dry start-up capability

20% (stiff shaft design). However, for small shafting using more flexible bearings such as rubber, it has been well accepted to design based on the operating speed falling between the first and second bending critical speed (flexible shaft design).

The above shafting criticals must be determined using the stiffness values for the actual bearings and support system in use. The stiffness of a Thordon bearing will be large enough in comparison with typical shaft bending stiffness to be considered equivalent to a metal bearing for establishing spacing requirements. Use of a less stiff rubber material may require closer spacing of the bearings or a change in philosophy to the flexible shaft design.

Most of the installed vertical pumps worldwide do not have any lateral structural support below the pump mounting floor. This means that the casing holding the bearings, which are supporting the shafting, is itself quite flexible and subject to the possibility of resonance in the operating speed range. If this issue is not carefully investigated in the design of the machine, the bearings may suffer odd wear patterns which may not be easily interpreted.

Many vertical pumps are located in sumps without proper attention to approach velocities, or clearance guidelines provided in the literature for bottom, back wall, sidewall, or neighboring pumps. This may result in cavitation and/or separation producing excessive turbulence in operation. In addition, if minimum submergence recommendations by pump manufacturers are contravened, vortexing may be generated allowing air to be entrained in the suction flow with associated undesired machine vibrations.

Many pumps are operated across the performance curve without appropriate consideration for the best efficiency point. If a pump is highly throttled, or allowed to run out well beyond best efficiency point, excessive vibration can again result with possible overheating and damage of product lubricated bearings.

It is common practice to dynamically balance impellers of vertical pumps to ensure smooth operation without vibration. However, if an impeller core shifts in the casting process, it will not only result in mechanical unbalance, but hydraulic unbalance as well. No amount of dynamic balancing can correct for the latter condition which may lead to excessive vibration and shorter bearing life.

Advantages of Non-Metallic Bearings

There are several advantages offered by non-metallic bearings such as impact capability, low friction, self-lubricating qualities, edge loading capability. Most non-metallics, Thordon included, offer significant electrical resistance. As a consequence stray currents will not be a factor in bearing erosion, and a connection point is not provided for galvanic activity.

The significant advantages of using non-metallic pump bearings will ensure many years of excellent service life provided the various design issues imposed upon the pump and system are carefully investigated and considered in the pump design or re-build stage prior to putting the machine into service.

Written by:
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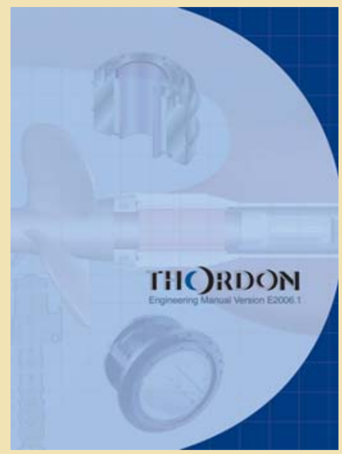
NOW AVAILABLE!



***New* Thordon Engineering Manual Version E2006.1**

Thordon Bearings has released its new Engineering Manual Version E2006.1 covering all Thordon elastomeric grades: XL, SXL, HPSXL, COMPAC and Composite/GM2401 (ThorPlas® will be covered in a separate Engineering Manual). This new version includes an update of technical information based on the most recent test data, and presents new material including technical updates, addition of HPSXL and COMPAC, chemical resistance chart as well as an expanded problems and causes section.

If you do not have your copy, please contact your local Thordon distributor or visit our website to order or download it: www.thordonbearings.com