February/March 2016 **www.mpropulsion.com**

marine propulsion
& auxiliary machinery

published by riviera

"IMO's approach treats testing as an absolute. That is moving the goalposts too far for our industry"

Peter Hall, chief executive, IBIA, **see page 71**

Bearing up to changes in the environment

Advances in material science and hydrodynamics are behind the shipping industry's return to the seawater-lubricated propeller shaft bearing

After a 60-year hiatus in which oil lubricated propeller shafts have largely dominated the marine propulsion market, the seawater lubricated alternative is enjoying a renaissance. The commercial fleet's turn-around is due largely to the revised United States Environmental Protection Agency's Vessel General Permit (VGP) requirement which entered into force in December 2013.

The amount of operational oil that leaks from ships' propeller shaft bearings has been well documented and has led to the introduction of stringent environmental regulations, particularly in polar and US coastal waters. But advances in polymer science have been able to increase bearing wear life and reduce ship maintenance costs considerably.

Classification societies delivered a boost for the seawater lubricated bearing system, when DNV GL, Lloyd's Register (LR), Bureau Veritas (BV) and China Classification Society (CCS) recently revised their rules to allow the shaft to remain in place if certain monitoring conditions are met. The amended class notations mean that the shaft does not have to be withdrawn for inspection for over 18 years, or longer.

The decision by class is indicative of the advancement made in materials science. However, not all seawater lubricated bearing technologies are the same. For example, Thordon Bearings uses polymer technology for its Compac seawater lubricated propeller shaft bearing. This is quite different from water lubricated bearing technologies based on phenolic laminate, which has a longevity not dissimilar to the lignum vitae bearings of yesteryear.

When Thordon tested its Compac polymer bearings against others made from phenolic resin the difference was dramatic. While developments in polymer science have had a positive impact on bearing wear life, so too has the hydrodynamic research carried out by the Canadian company In his paper *Developments in Seawater Lubricated Propeller Shaft Bearings for Commercial Ships*, Thordon Bearings' engineering director, Ken Ogle, says the hydrodynamic lubrication of a journal type bearing requires:

- relative motion of the surfaces to be separated,
- a 'wedging action' provided by the shaft eccentricity, and
- a suitable fluid to create a lubricating film.

If the film thickness is less than three times the average height of the asperities (the roughness of the surface area) then the bearing will frequently come into contact with the shaft. But if the film thickness is greater than three times the average height of the asperities, then the bearing is operating in the hydrodynamic regime, where there is little contact between the shaft and the bearing. With no grooves on the bottom half of the Compac bearing, a smooth loaded section of the bearing is created. This gives the Compac system an advantage over other water lubricated grooved bearings in that it allows the bearing, which is elastomeric (having both viscosity and elasticity), to establish a stable hydrodynamic film at lower shaft revolutions per minute.

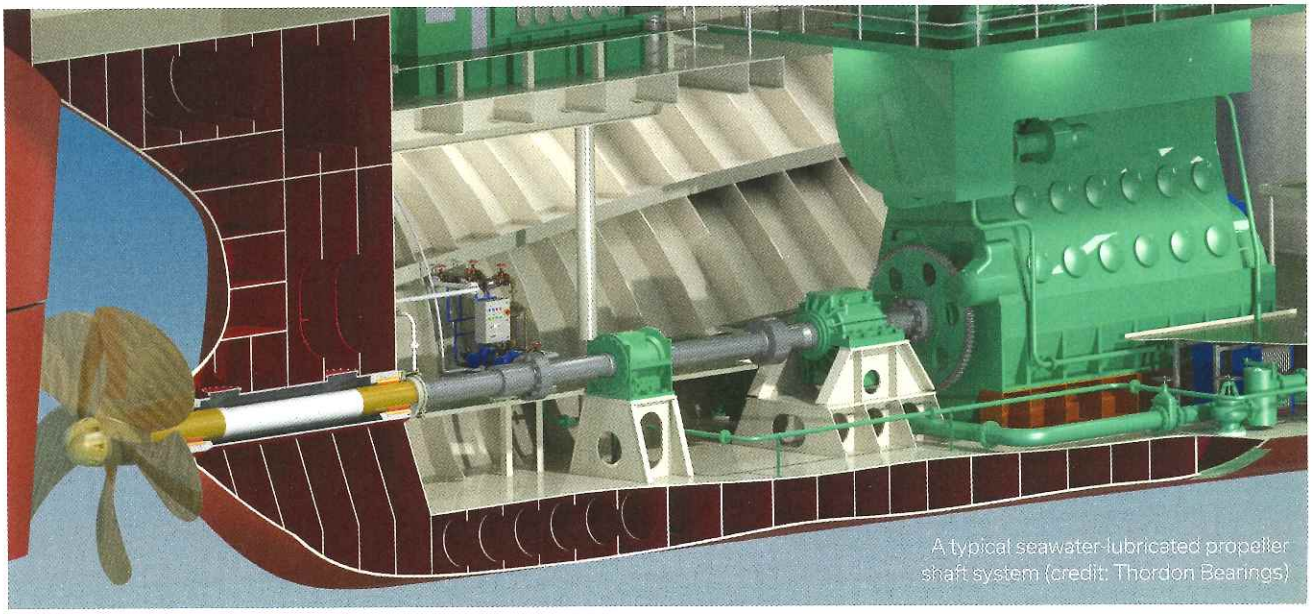
Thordon's elastomeric polymer bearing is also available with a tapered key bearing design that allows the bearing to be removed for inspection or replacement in a few hours, without removing the shaft or carrier.

A further factor to be considered when specifying a seawater lubricated shaft system is an anti-corrosion coating to protect the propeller shaft. According to Thordon Bearings this is the weak point of an open water lubricated bearing system, because of the tendency to develop cracks during service operation.

Existing marine epoxy systems use fibreglass tape in an attempt to produce a reliable covering. Thordon's solution, introduced in 2006, is Thor-Coat, a toughened, modified epoxy coating that is applied between the bronze liners. The company is nearing the completion of a new shaft corrosion protection system and hopes to be able to make further announcements about this in coming months. MP

For more on seawater-based lubrication, see page 46

China's COSCO has ordered 20 seawater-lubricated propeller shaft bearing systems (credit: Thordon Bearings)



A typical seawater-lubricated propeller shaft system (credit: Thordon Bearings)

New rules offer opportunity for water lubrication

Could the latest rules make the use of oil for lubricating tail shafts a thing of the past?

The recent publication by DNV GL of new rules for voluntary class notations governing the design and follow-up monitoring of water-lubricated stern tubes waives the requirement to withdraw and inspect the tail shaft and bearing every five years. This is believed by some to represent a major opportunity for manufacturers of water-lubricated tail shafts.

The new notation allows extended inspection periods for propeller shafts that use seawater-lubricated bearings. DNV GL's new voluntary TMON notation for open loop water-lubricated propeller shafts follows similar rule revisions by Lloyd's Register (LR), Bureau Veritas (BV) and China Classification Society (CCS).

The DNV GL class notations for water-lubricated tail shafts – TMON (closed loop water) and TMON (open loop water) – now allow unlimited intervals between tail shaft withdrawal surveys based on condition monitoring of the tail shaft, bearings and lubricant system. The new class notations are available for both existing vessels and newbuilds.

As long as DNV GL requirements are complied with in the design and operational phase, the tail shaft withdrawal survey will not have a pre-determined interval.

The condition monitoring-based survey process (no withdrawal of shaft) also enables operators to consider water-lubricated systems as a compatible alternative for meeting the increasing industry focus on environmentally friendly systems, such as the United States Environmental Protection Agency's Vessel General Permit requirements.

Thordon Bearings commercial director Andy Edwards said: "As long as certain condition monitoring criteria are met, DNV GL's new rules mean that propeller shafts operating water-lubricated bearings no longer need to be withdrawn for inspection every five years. There will be no pre-determined intervals between shaft withdrawal surveys.

"The five-year shaft inspection rules that were previously stipulated in most shaft condition monitoring notations were a major deterrent to the wider take up of the water-lubricated system. But now that the world's leading classification society has revised its rules we can present

a viable and proven alternative to oil-lubricated propeller shafts."

DNV GL said that the evolution of its new TMON rule has been facilitated in conjunction with a combination of:

- A continuous focus on developing reliable customer-centric classification products without compromising safety.
- In-house experience from projects, historic data and discussions with the key industry stakeholders.
- Increasing focus on and demand for inherently environmentally friendly systems, such as water lubricated systems.
- Satisfactory availability of technology to support the DNV GL classification philosophy – for example, remote bearing wear down sensors, alternative means of inspection by borescopes, removable bearing segments, and coating quality.

DNV GL recommended in the latest edition of its Technical and Regulatory News bulletin that shipowners consider the condition-based notation for water-lubricated tail shafts at their next drydocking.

Craig Carter, Thordon Bearings' head of marketing and customer service, said: "This is a major breakthrough for fleet-wide conversion back to the environmentally and operationally more efficient water-lubricated propeller shaft bearing. Like the recently revised shaft condition monitoring rules released by LR, CSS and BV, DNV GL's new TMON notations are indicative of the significant advancements made in polymer technology and the ability of these seawater-lubricated bearing systems to prevent further environmental damage from operational oil leakage."

Combined, the DNV GL, LR, BV and CCS classed fleets account for more than 40,000 vessels, 95 per cent of which continue to operate with oil-based propeller shaft bearing systems.

Thordon Bearings designs and manufactures a complete range of non-metallic sleeve bearing solutions for the marine, clean power generation, pump, offshore oil, and other industrial markets. The polymer bearings operate pollution free without oil or grease.

The effectiveness of such systems can be seen from the fact that after nine years of operation in the harsh, abrasive waters of Alaska's Yukon River in the USA, aboard Inland Barge Service's push boat *Ramona*, Thordon Bearings' RiverTough water-lubricated tail shaft bearing system has emerged completely free of wear and tear.

The exceptional performance of the RiverTough bearings in waters renowned for their high content of gritty glacial silt came to light when the 16m workboat's cracked struts underwent repair in drydock.

Charles Hnilicka, the owner of Inland Barge Service, said: "In the spring of 2011 we were doing some hot work on one of the struts and decided to change the bearing since everything was apart. We did not have to and could have reinstalled the original bearing after the hot work, but we had a spare set.

"When we took it out, the RiverTough bearing and sleeves had no appreciable wear and tear, which was amazing considering the environment in which Ramona operates."

The 1971-built push boat provides an invaluable service delivering freight and consumer goods to communities along the Yukon River and its tributaries.

These shallow waters, usually only navigable between May and October, are fed by rain and glacial melt containing highly abrasive silt and ground rocks, called glacial till, that can severely damage other propeller shaft systems.

Since 2003, when Inland Barge Service replaced single-screw *Ramona*'s rubber bearings, Thordon's polymer system has undertaken over 2,000 hours of operation per year in some very abrasive environments.

"I have not seen anything like it," said Mr Hnilicka. "When we used rubber bearings we were lucky to get a full operational season out of them before they needed replacing."

Scott Groves, Thordon Bearings' business development manager, said: "We have data from workboats operating on the Mississippi River showing typical RiverTough wear rates of 0.075mm to 0.1mm in 6,000 to 7,000 hours of annual use, but this is the first time we have received data from a vessel operating in the high north. The feedback from Inland Barge Service provides clear evidence of RiverTough's superior wear life in very abrasive water conditions. They routinely outlast rubber bearings by a factor of two or more."

Todd Terry, president of Pacific Marine Equipment, Thordon Bearings' Seattle-based distributor, said Inland Barge Service is among a growing number of workboat and small craft operators to covert from rubber tail shaft bearings to the RiverTough solution.

"In 2001, we supplied the water-lubricated bearing system to HamiltonJet's *Yukon Queen*. The vessel ran from 2001 to around 2010 when it was sold and left the river. HamiltonJet reported that the RiverTough bearing worked exceedingly well in this application. Since then, we have supplied the Interlake Steamship Co, Riverway Transport, American Commercial Lines, Ingram Barge Line, Blessey Marine Services and Eckstein Marine." MP

Thordon Bearings' RiverTough routinely outperforms rubber bearings, even in highly abrasive waters (credit: Thordon Bearings)