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A REVIEW ON THE MODELLING AND EXPERIMENTATION OF JOURNAL BEARING USING ELASTOMERS

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ABSTRACT

When it comes to the water-lubricated systems, Thordon Bearings have emerged as a potential solution, providing a long-term and environmentally responsible replacement for conventional oil-based lubricants. Examining the effectiveness and advantages of thordon Bearings in water-lubricated applications is the goal of this study. To ascertain the operating limits and performance characteristics of thornton bearings under various working circumstances, the process includes laboratory testing. Ansys software is utilized for analysis, while Solid Works software is used for 3D modeling. According to a literature review, Thordon Bearings often exhibit higher resistance to chemical corrosion, lowering the likelihood of system failures and upkeep requirements. It is planned to do additional research by altering the design parameters.

I. INTRODUCTION

A bearing in general, is a component of a machine that limits relative motion into desired motion by lessening friction created between the moving elements. The major function of the bearings is to keep the objects in relative motion from coming into direct contact with one another. In the end, friction, heat generation, and bearing wear and failure are all reduced or prevented by bearings. The performance requirements for modern journal bearings are constantly increasing, and the material used must be environmentally benign. Today's bearings are intended to operate at greater temperatures while supporting heavier loads and generating less friction over an extended period of time. Historically, a manual analysis of bearing was a time-consuming process but now it is an effortless process because there were so many simulations software available in the market. Bearing also depends on the initial conditions like initial roughness, loading, lubrication, and material too. Bearings are necessary for the proper operation of all moving parts in vehicles and machinery. Bearings support heavy loads, improve vehicle efficiency, and lessen friction. Bearings are used in many important sub-systems, including engines, gears, transmissions, wheels, steering, electrical motors, and pumps, among others. The most common problems caused by bearing failure are wear and strain, frictional losses, and power transmission losses. Long-term use, improper lubrication, inappropriate materials, etc. all contribute to the failure of the bearing function. In order to improve the performance a review is done to suggest a suitable material for bearing construction. During this review, so many materials from the initial stage of manufacturing to the present generation were seen. In the recent advances in bearing manufacturing elastomers are mostly used for bearings. Among them, THORDON is chosen most widely. THORDON, is a highly machinable material that is composite of rubber and resin, mechanical strength, and chemical resistance. THORDON material is utilized in a variety of uses, including pumps, pivot joints, screw conveyors, agitators.

Objective of the review:

1. To examine and understand the necessity of emergency of new materials in the bearing production.
2. To understand the uses of elastomers in the construction of bearing.
3. To suggest THORDON in the production of bearing.

Necessity of new material:

Why are elastomers necessary to use now? Elastomers are widely used because they are entirely consumable, self-lubricating, and lightweight. Elastomers like Thordon XL, Thordon SXL, HPSXL, and others are Thordon's elastometric bearing grades that replacing steel and phosphor bronze as the material of choice. These elastomers are self-lubricating and have great mechanical strength, thermal resistance, and chemical resistance.

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Additionally, the wear and friction caused by these elastomers are reduced. In order to understand the need for elastomers, we must first examine marine applications. In order to operate better, bearings generally need to be lubricated, but when using them in water, we need to make additional provisions for their lubrication. While this is going on, the vast majority of the bearings used today are metallic bearings that are prone to corrosion which is a major problem that the marine industry is facing today. This corrosion reduces the strength of the bearing and weakens the bearing thus reduces the life of the bearing.

II. LITERATURE SURVEY

Wei (2022) experimented the elastomeric bearing by placing it between the bridge deck and pier. The material used is Low Damp Rubber Bearing (LDRB) and High Damp Rubber Bearing (HDRB) to investigate the coupled effect of isolated bridge. The results shown that from the coupled effects point of view, deck displacement is sensitive to the combined effects of pier height and LDRB, while bearing displacement is affected by the interaction of pier height and HDRB [1]. Yong Yuan (2022) mainly focused on the mechanical properties and the shear constitutive model of the PUE material and the new bearings. Four isolation bearings with different design parameters made from the PUE material were produced to evaluate the vertical bearing capacity and horizontal shear performance. The results showed that the new bearing made from the new PUE featured a large vertical capacity and excellent elasticity recovery ability. Its ultimate strength is over 3 times and has a high damping ratio [2]. Dinesh Reddy (2022) proposed the effect of transition and eccentricity ratios on the load bearing ability and speed of journal bearings used in marine propulsion systems is investigated. A computational fluid dynamics (CFD) model is used to simulate the flow of water in the bearing and the resulting pressure distribution. The results show that the load bearing ability of the bearing decreases as the transition ratio and eccentricity ratio increase. The speed of the bearing also decreases as the transition ratio and eccentricity ratio increase [3]. Kepeng Wu (2022) studied the tribological properties on three different materials i.e.., Tenmat, Thordon SXL, and Ben Teng Group (BTG) Rubber. The experimental results shown that, under the same working conditions, BTG rubber has excellent tribological properties than the other two materials (BTG Rubber > Thordon sxl > Tenmat). BTG Rubber is best suited in low-speed working conditions and Tenmat and Thordon sxl are suited for high-speed working conditions [4]. Ying Liu et al.(2021) investigated the properties under different load carrying capacities and journal rotation speeds. Computational fluid dynamics is used for simulation and the results of eccentric ratio is compared with the experimented results. The results of the experiment suggested the direct relationship between eccentric ratio and rotational speed (directly proportional). In different journal speeds, the relative clearance had little impact on the maximum water film pressure and load carrying capacity [5]. G. Auger et al.(2021) provided the two case studies showing the successful implementation of water lubricated turbine guide bearings in Francis and Kaplan turbines. In the first case study, a Francis turbine upgraded with thordon SXl material and runs for 3 years without any problems. In the second case study, a Kaplan turbine has been upgraded with water lubricated bearing and experienced a reduction in maintenance costs. The results of these two cases provided a more reliable, cost-effective, and environmental solution than oil lubricated bearings [6]. Hao Zhang et al.(2021) proposed to investigate the temperature field evolution of water lubricated stern bearings under hydrodynamic lubrication. The approach involves obtaining the friction coefficient of the bearing under different operating conditions, calculating the heat flux density using the friction coefficient, and then using a computational fluid dynamics (CFD) simulation to calculate the temperature field in the bearing. The results of the CFD simulation show that the maximum temperature of the bearing decreases as the water inlet velocity increases and increases as the bearing load increases [7]. You-Qiang Wang (2021) performed experimental studies on the tribological properties of the thordon bearings have been conducted under different load and velocity using the apparatus. These bearings have excellent performance against wear and can resist the abrasion of solid particles floating in the seawater. Therefore, seawater temperature has a strong influence on the friction coefficient of seawater lubricated thordon bearings. The friction coefficient increases sharply with increasing temperature [8].Dai Chunhui (2021) have modified UHMWPE/PI materials, and the samples were tested for wear and tear in the real seawater environment of microbes and sediments to verify whether the polymer materials can meet the design requirements of wading sliding friction pairs under deep sea conditions. The experimental results show that the materials have lower friction coefficient and better wear resistance

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than Thordon and Feroform materials and are very suitable for deep sea environment [9]. Lao Xingheng (2020) stated that UHMWPE/PI polymer composites were prepared by adding Polyimide (PI) to Ultrahigh Molecular Weight polyethylene (UHMWPE). The friction coefficient and wear height of the composites were lower than those of other materials in artificial seawater. The friction property of the specimen in artificial seawater environment is better than that of Thordon and Tenmat by using UHMWPE as pin and tin bronze as disc. The modified UHMWPE composites are very promising as a water lubricated bearing [10]. Yassin Masrur (2020) proposed that the purpose of this paper is the prediction of the behavior of multilayer elastomeric bearings by finite analysis. In this paper he takes spherical thrust bearing and plain thrust bearing. The results proved that the plain thrust bearings have good stiffness and low friction than spherical thrust bearings [11]. Yong yuan (2020) describes the mechanical properties and shear constitutive model of the high-capacity polyurethane elastomeric bearing. In this paper he developed high vertical capacity bridge isolation bearing using PUE material. Four isolation bearings with different design parameters are made from PUE material. The results proved that the PUE material has viscoplastic property [12]. Wojciech Litwin (2020) experimentally research on water lubricated three layer sliding bearing (PTFE/NBR/bras) with lubrication and its comparison with a Nitrile Butadiene rubber bearing. The results proved that the three-layer bearing has a lower coefficient of friction than Nitrile butadiene rubber and it has a long-lasting durability and also high quality [13]. YouQiang wang (2020) performed the characteristics and outline of water-lubricated Thordon bearing. Thordon material is used in water-lubricated bearings due to high load and wear resistance. The results show that there is a optimum bearing radius clearence which leads to the smallest friction coefficient for water lubricated thordon bearings [14]. Hao Zhang et al. (2019) proposed to investigate the temperature field evolution of water lubricated stern bearings under hydrodynamic lubrication. The approach involves obtaining the friction coefficient of the bearing under different operating conditions, calculating the heat flux density using the friction coefficient, and then using a computational fluid dynamics (CFD) simulation to calculate the temperature field in the bearing. The results of the CFD simulation show that the maximum temperature of the bearing decreases as the water inlet velocity increases and increases as the bearing load increases [15]. Qiren Huang (2019) had taken three different polyurethane-polyethylene (PU-PEW) wax and compared with pure PU and Thordon on friction, wear and wear morphology .The results proved that PU-PEW1 has low friction coefficient ,low wear and better surface smooth than Thordon and pure PU due to the composition of 4, 4′ -Methylene-bis (3-chloro-2, 6-diethylaniline) (M-CDEA) [16].

III. RESULTS AND DISCUSSIONS FROM THE REVIEW

The Wei (2022) results shown that from the coupled effects point of view, deck displacement is sensitive to the combined effects of pier height and LDRB, while bearing displacement is affected by the interaction of pier height and HDRB. The Yong Yuan (2022) The results showed that the new bearing made from the new PUE featured a large vertical capacity and excellent elasticity recovery ability. Its ultimate strength is over 3 times and has a high damping ratio. The Dinesh Reddy (2022) results show that the load bearing ability of the bearing decreases as the transition ratio and eccentricity ratio increase. The speed of the bearing also decreases as the transition ratio and eccentricity ratio increase. The Kepeng Wu (2022)Results shown that rubber is best suited in low-speed working conditions and Tenmat and Thordon sxl are suited for high-speed working conditions. The Ying Liu et al.(2021) The results of the experiment suggested the direct relationship between eccentric ratio and rotational speed (directly proportional). In different journal speeds, the relative clearance had little impact on the maximum water film pressure and load carrying capacity. G. Auger et al.(2021) The results of these two cases provided a more reliable, cost-effective, and environmental solution than oil lubricated bearings. Hao Zhang et al.(2021) the results of the CFD simulation show that the maximum temperature of the bearing decreases as the water inlet velocity increases and increases as the bearing load increases. You-Qiang Wang (2021) , seawater temperature has a strong influence on the friction coefficient of seawater lubricated thordon bearings. The friction coefficient increases sharply with increasing temperature. Dai Chunhui (2021) the experimental results show that the materials have lower friction coefficient and better wear resistance than Thordon and Feroform materials and are very suitable for deep sea environment. Lao Xingheng (2020) The results proved that the plain thrust bearings have good stiffness and low friction than spherical thrust bearings. Yassin Masrur (2020)the results proved that the plain thrust bearings have good stiffness and low friction than

spherical thrust bearings. Yong yuan (2020) the results proved that the PUE material has viscoplastic property. Wojciech Litwin (2020) The results proved that the three-layer bearing has a lower coefficient of friction than Nitrile butadiene rubber and it has a long-lasting durability and also high quality. YouQiang wang (2020) The results show that there is a optimum bearing radius clearence which leads to the smallest friction coefficient for water lubricated thordon bearings. Hao Zhang et al. (2019) The results of the CFD simulation show that the maximum temperature of the bearing decreases as the water inlet velocity increases and increases as the bearing load increases. Qiren Huang (2019) The results proved that PU-PEW1 has low friction coefficient ,low wear and better surface smooth than Thordon and pure PU due to the composition of 4, 4′ - Methylene-bis (3-chloro-2, 6-diethylaniline) (M-CDEA).

IV. CONCLUSION

In this review, by going through all the papers it was found that polymers are the most used materials in the bearing production industries in the recent years because of their exclusive properties like superior thermal resistance, mechanical resistance, wear resistance besides those these having corrosion resistance too. In the meanwhile, for the metal bearings it need to provide special lubrication arrangements because without lubrication the friction generation, wear and tear will be extremely high but it will not get any such problems with elastomers because elastomers are self-lubricated. Analysis was done on different elastomers but among them THORDON shows higher efficiencies with different collaborations that is with metals and elastomer combinations. Remaining elastomers get also exhibit good efficiencies when they are working with same type elastomers but when it was investigated collaborations with other materials their efficiencies are not that much effective when compare with THORDON elastomer. So, by this review it was concluded that THORDON elastomer is most suitable to manufacture bearings.

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