WATER LUBRICATED HYBRID PROPELLER SHAFT BEARINGS WITH POLYMER BEARING BUSH

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ABSTRACT
The article deals with water lubricated hybrid marine propeller shaft bearing which was designed and built at the Faculty of Ocean Engineering and Ship Technology of the Gdansk (Poland) University of Technology. The article contains the following parts:
• Description of the test stand, the simulated working conditions, and tested bearings’ specifications.
• Results of the conducted measurements. The results of the experimental work include: graphs of friction coefficient, pressures in the water hydrodynamic film and shaft trajectory.
• Comparison of hybrid bearing with two others bearings. Typical main shaft bearing with grooved bearing bush working in a semi fluid friction conditions and hydrodynamic bearing with cull bearing bush (without any grooves).

The work’s essential conclusion is that fluid film lubrication is possible also in hybrid bearings with grooves. As it was proven under simulated working conditions hydrodynamic lubrication does not take place in typical bearing with grooved bearing bush.

INTRODUCTION
The main shaft bearings are one of the most important component of ship’s power unit. Durability of the power unit and safety of shipping entirely depend on their reliability and durability.

The reason for conducting the experimental and theoretical investigations of the main shaft bearings was to find the answer to the question whether it is possible to achieve water fluid film lubrication.

DESCRIPTION OF THE TEST STAND
The test stand was built during the years 2001-2002 at the Gdansk University of Technology.
One of the main requirements set at the designing stage was the possibility of measuring the pressure in the lubricating film between the shaft and the bearing in at least a few transversal planes. It was decided not to install many pressure sensors on the perimeter of the bearing, as we would need too many sensors and measuring channels for it. Instead, it was decided to install just one sensor situated in the turning shaft. To make it possible to measure the pressure in a number of transversal planes the shaft was made longer, and we also made it possible to shift the bearing in relation to the shaft. Such solution had significant advantage. Pressure measurements in the lubricating film can be conducted in any place, and by changing the amount of the recorded samples per one turning of the shaft a precise view of the pressure field in the bearing can be achieved.

In the construction of the test stand we can define three main units, which were assembled in a rigid frame:
• main shaft (diameter 100 mm) unit,
• examined bearing unit,
• and the measuring unit.

SIMULATED WORKING CONDITIONS
The measurements were conducted for different working conditions of the bearing created by changing of the following parameters:
• rotation speed ranging from 1 to 11 rev/s (sliding speed up to 3.5 m/s),
• static radial load, from 1 to 5 kN (load up to 1.66 MPa),
• water pressure supplied to the bearing changing in the scope between 0 to 0.4 MPa.

DESCRIPTION OF THE EXAMINED BEARINGS
Three different bearing bushes were tested:
• typical composite bearing bush with five longitudinal grooves, diameter clearance 0.6 mm (relative clearance 0.006),
• polyamide full bearing bush (without any grooves), diameter clearance 0.3 mm (relative clearance 0.003),
• hybrid bearing bush with five longitudinal grooves, diameter clearance 0.6 mm (relative clearance 0.006).

All this three bearings had the same length of 300 mm (ratio length to internal diameter was 3).

MEASUREMENT POSIBILITIES
The measuring unit consists of three independent systems, with different functions. These are as follow:
• Water film pressure measuring unit.
• Shaft center trajectory measuring unit.
• Friction force measuring unit.
• Water lubricating the bearing measuring unit (temperature, pressure, and the water flow).

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RESULTS OF THE CONDUCTED MEASUREMENTS – BEARING BUSH WITH GROOVES

This typical bearing often can be seen in marine or hydro power industry. The tests prove that in this kind of bearing hydrodynamic lubrication does not take place in the range of simulated working conditions. One of numbers charts can be seen below (Fig. 1). Measured coefficient of friction was not lower than 0.01.

![Fig. 1. Pressure in water film in the middle length of the bearing with grooved bearing bush, load 5kN (1.66 MPa), rotation speed 5, 9, 11 rev/s](image1)

RESULTS OF THE CONDUCTED MEASUREMENTS – FULL BEARING BUSH

Bearing with full bearing bush was specially desiged for hydrodynamic lubrication and in fact it did take place. One of numbers charts can be see below (figure 2). Measured coefficient of friction was about 0.002.

![Fig. 2. Pressure in water film in the middle length of the bearing with full bearing bush, load 5kN (1.66 MPa), rotation speed 5, 9, 11 rev/s](image2)

RESULTS OF THE CONDUCTED MEASUREMENTS – HYBRID BEARING

The hybrid bearing was designed following conducting numerical calculations. As it was predicted fluid film appeared and the coefficient of friction was about 0.002 and less.

![Fig. 3. Pressure in water film in the middle length of the bearing (hybrid bearing), load 5kN (1.66 MPa), rotation speed 3, 7, 9, 11 rev/s](image3)

CONCLUSION

One of the most important conclusion is that fluid film lubrication is possible in water lubricated bearings with grooved bearing bush. It has to be remembered that grooves are necessary because of the need for increased water flow as well as accumulation of dirt and wear product.

REFERENCES

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