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OPPORTUNITIES ANALYSIS OF REGENERATION OF PLANE FRONT PLATE THRUSTER ON A UNIVERSAL LATHE

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Abstract

The bow thrusters are devices, which make vessels manoeuvring much easier especially in the harbours or the straits with high intensity of the traffic vessels. The long-term exploitation of these devices causes damages, mainly for its propeller blades. The cavitation is the main cause of its damages. Technical condition of all thrusters components mainly taking into account blades are subjected to periodic inspection according to classification societies. In this article have been included examples of bad condition of the thruster blades caused by cavitation process or mechanical damages. These damages can be dangerous enough to turn off the device and make the vessel be out of exploitation. The thruster blades repairing are a very complicated and hazardous venture. The blades are large sized, unbalanced, heavy components and difficult to be mounted in lathes. The main aim of this work is to identify opportunities of thruster blades repair process. The article presents technological problems of blade regeneration with the lathe as a complicated solid, which causes very big problems with the setting axis the component. The thesis presents methods of attach propeller blades using the special handle and tusk lathes. Among others, research allowed defining operation rotating velocity, and other parameters related to mechanical regeneration. The researches have shown that presented method in practice allows for secure mechanical regeneration of blades thrusters.

Keywords: *bow thrusters, regeneration, lathing*

1. Introduction

Thrusters are used to change the direction, position or maintaining the desired position of the watercraft. The change of the position of the vessel on the port side or starboard side with the use of thrusters is performed by the return jet of water, which is produced by propeller, which is placed in a special bore. Thrusters are placed on the bow and stern of the vessel. The use of these devices gives greater manoeuvrability vessel. The thrusters act by rejecting water, which allows precise positioning, repositioning, also during standstill. A typical thruster is used in addition to passive rudder and is composed of three main parts:

- propeller (pump impeller),
- engine mount,
- passageway (tunnel).

The article concerns the problems associated with the regeneration of thruster's wings, which are subject to wear in connection with their exploitation. This particularly applies to front surface of the wing. Therefore, a team of specialists from the company "Rolls Royce" and students of the Scientific Society "Nautica" Faculty of Mechanical Engineering of Gdynia Maritime University

have developed and elaborate innovative special holder for universal lathe this handle allows for a central mounting propeller wing in the lathe and very precise machining of the wing front surface.

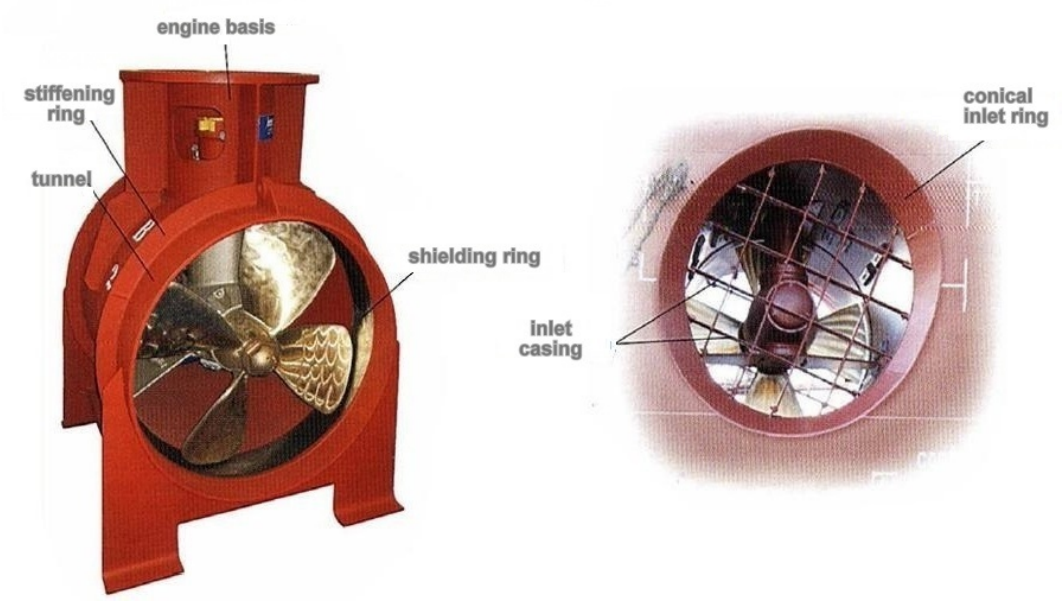

Fig. 1. Exemplary thruster's model

2. Purpose machining of thrusters wings

Due to the difficult conditions which propellers work in and sea water, among other they are made of copper alloys. These alloys are resistant to corrosion during the working in seawater, but their execution cost is high, so if the propeller is not completely destroyed, a cheaper alternative is its repairing and again preparation for exploitation. Due to the specific working conditions, the propellers are exposed to cavitation erosion, which leads to the destruction of the material from which they are constructed. Thrusters, which executive element is a propeller are also exposed to this occurrence, especially slit cavitation.

The large damages are observed on the edges of the wing. This is due to the formation of cavitation at these locations because of the gap between the cooperating screw and the passage in which it resides. Among other method of regeneration, the grinding of surfaces to obtain their adequate roughness is used. With adjustable propellers, another important element is the frontal wing surface, which is fitted into the propeller's hub. Huge water pressure forces that act on the wing during exploitation may cause its partial deformation.

Cavitation on the other hand in scientific terms, is produced by the growth and disappearance of the bubbles, contain a vapour of the liquid, which is caused by the variables field of pressure in case of the propellers both sides of the wing. In the area of reduced pressure conditions bubbles are grow below the critical value and then begin to decrease, in consequence this causes to sudden their surface of the wing tearing, this occurrence is called implosion. As a result of this occurrence comes to wrench the material particles from the surface of propellers wing, which leads to the mechanical destruction of propeller [1-3].

3. Analysis of the possibilities of the propellers wing machining using a universal lathe thruster

Due to the need to reduce the time of repair work of the thruster's wings, the idea of the frontal propellers wing surface machining on a lathe universal helm appears. This method allows you to optimize the working time of regeneration frontal propellers wing plane compared with the

traditional treatment for boring-milling machine and provides an alternative method of treatment for the company, if the need arises. Unfortunately, the problem with this type of method is correct and accurate positioning of the work-piece in the axis of propellers wing cut so that the treatment would be as effective as possible.

An example of the location of propellers wing in the lathe shown below in diagram (Fig. 2).

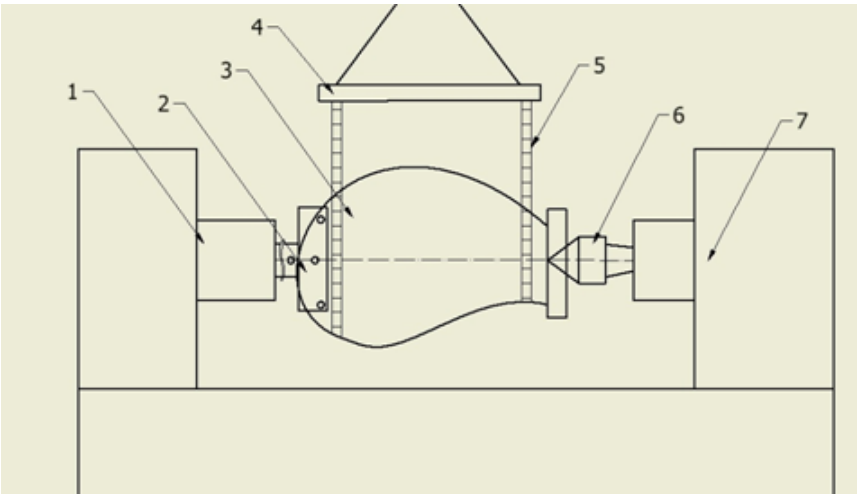

Fig. 2. Method of affixing propeller's wing in the lathe: 1. spindle, 2. handle, 3. workpiece, 4. mounting strip, 5. straps, 6. dead centre, 7. tailstock

4. Processing technology of the propeller's wing with the use of an universal lathe

Machining lathe propeller's wing is difficult because of the shape and the weight of approx. 180 kg [4]. The propeller's wing is mounted from the spindle of the lathe in a dedicated holder, which was created on the base on extensive investigations and experience. The propeller's wing surface which undergone treatment, is on the side of the rocking support, which is canine lathe.

The regeneration process grounds on turning the propeller's wing face in the way, which ensures subsequent accurate fit and accurate contact of adjacent surfaces of the hub and the propeller when carried out a complete regeneration of both propeller's wing and the hub. The research and analysis made it possible to determine the lathe spindle speed at which treatment is correct propeller's wing and secure. Based on a series of studies it was designed: separations holes for screws in the holder, the tightening torque of the screws, the strength of the bolts, and other values needed for the construction of the handle [4]. Furthermore, the term vector of inertia, main moment of inertia forces, or moments caused reactions in supports allowed for the proper execution of the lathe chuck. The practical study on the working stand, led to selecting the right parameters associated with machining such as: maximum depth of cut, feed and lathing force.

Special attention was paid for safe and secure mounting of propeller's wing in a special holder on the side-clamping spindle. The correct and complete regeneration of propeller's wing provides a better seal at the contact patch-hub, which protects the propeller from falling into sea water into the interior of the hub, at the same time it provides adequate roughness surface in contact. The surface of the propellers wing, which undergoes treatment, is shown below the computer-designed model (Fig. 3).

5. The handle with controllable pitch for sheets of propeller regeneration using a universal lathe

During the positioning propeller's wing, screws with large mass care should be taken to avoid damaging. For this purpose, the fastening screws are equipped with a brass overlay cap to prevent denting or scratching propellers wing during the mounting. Propeller's wing is mounted rigidly in

the holder also. Centering bushing and handle reinforcing elements are welded to the body and are also designed to make possible to fix a larger part of the airfoil surface in the holder. The prototype of the handle is shown in Fig. 4.

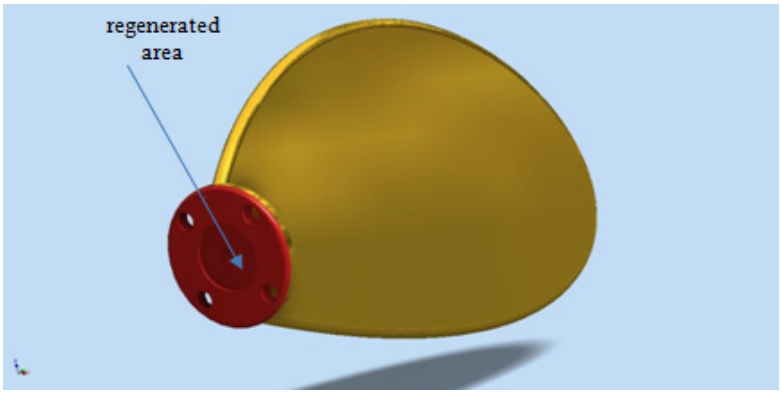

Fig. 3. The area to be treated

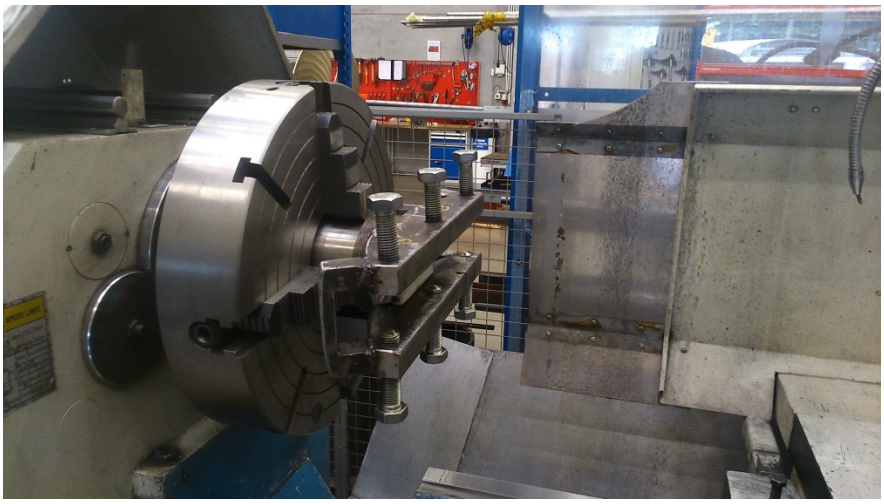

Fig. 4. The prototype handle for the processing of propellers wing thruster is mounted in the lathe

Computer model of the handle is shown in Fig. 5.

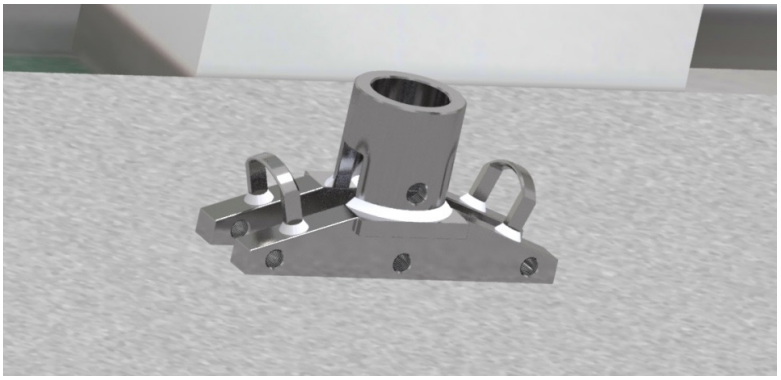

Fig. 5. Holder model for regeneration wing propellers on the universal lathe

The handle is composed of: centering sleeve (1), the body (2) reinforcement elements (3), fixing screws placed in threaded holes (4) M24x3 6H [1], the holes, three on each side, are drilled in the body. The additional bolts based in the threaded hole (5) M24x3 6H [1] of centering sleeve served as additional protection. The draft is of shown on Fig. 6.

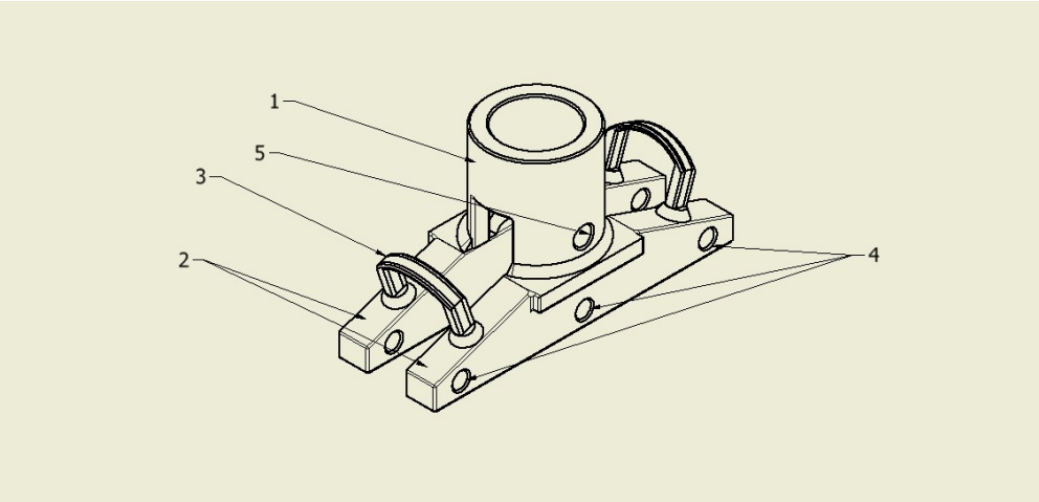

Fig. 6. The handle is for mounting propellers wing thruster

6. Abrasive processing of the wing propellers

The ships` propellers, with screw propellers as a main executive element, are working in specific and difficult conditions, which are marine waters.

Propeller bodies are covered with numerous algae and shellfish, and screw itself is exposed to the surface corrosion. During the propellers` repairing, all the contaminants are removed from the propellers` body, they are processed by grinding, and painting with specially designed paints. The wing propeller and also a hub are treated with an abrasive, but the process is more complex. The aim of the treatment, which is carried, is accurate cleaning of the wing propeller and the hub, while maintaining a minimum surface roughness. The condition of the wing propeller`s surface has an impact on the efficiency of the propeller. Grinding propellers are carried out manually or with the help of the automated station, that controls the whole process of surface treatment of the wing propellers. The wing propellers after complete treatment are shown in Fig. 7.

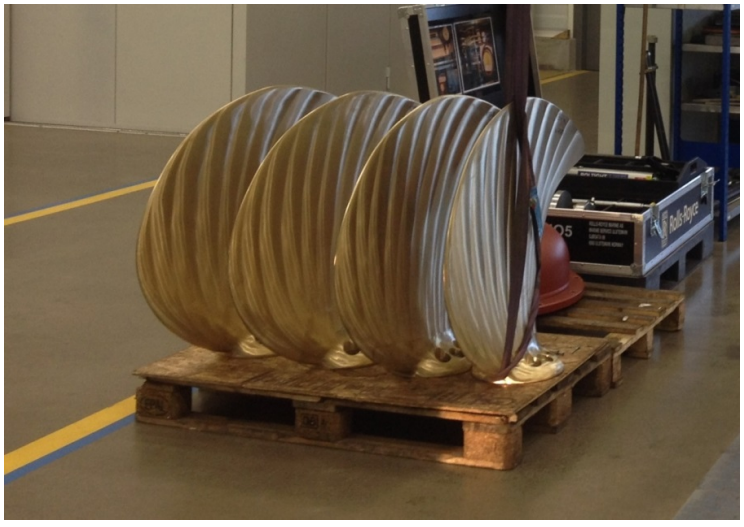

Fig. 7. Wing thruster after finishing abrasive treatment

6. Summary

The regeneration process of the wing propellers thrusters require high accuracy and shorten the operation time. The use of universal lathes instead boring-milling machines ensure those objectives.

The designed handle allows faster execution of the frontal wing propeller surface machining of propeller and ensures precise positioning of the axis of the work piece relative to the blade of the lathe. Manufactured using the special bracket provides security for the operator. Properly carried out the regeneration process provides significant extends the life of thruster and reducing total cost exploitation of the ship.

The research and analysis of regeneration wing propellers allowed working out the innovative method of regenerating surface of the wing propeller. This method consists of the treating the front part (or face) of surface wing propeller, mounted in a holder on the lathe. For this purpose, it was designed and manufactured a special handle to the lathe, allowing the correct and safe mounting heavy wing propeller and its exact machining.

Several studies on the research station, allow you to choose the appropriate machining parameters such as rotation velocity, lathing strength, depth of cut, feed section, tightening torques, the strength of the bolt, and the other values needed to handle design. Because of the fact that the propeller high efficiency is associated with the state of the front of surface wing propellers, a series of studies allowed for the appropriate selection of parameters during the regeneration of wing propellers that ensure a minimal surface roughness.

This method was verified in practice and was used to regeneration of the wing propellers by the Service Centre Rolls Royce in Gdynia. Processing of the wing propeller and surface grinding are only few of many repair processes. The obtaining a proper surface roughness and maintaining correct geometry of the shape of the wing propeller are the main goals of the repair process. The great importance of the regeneration process is to get the feet wing propeller proper surface roughness and correct its balancing, which has a significant impact on the following operation of the entire propeller.

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