

DESCRIPTION

SHIP PROPULSION DEVICE

Technical Field

[0001]

The present invention relates to a ship propulsion device comprising a propeller and an energy-saving appendage located ahead of the propeller.

Background Art

[0002]

Known is a fact that forward movement of a ship produces a vertical vortex (a bilge vortex) around a stern, which is problematic in that propulsion efficiency cannot be significantly enhanced because of such vertical vortex.

[0003]

Thus, proposed is an energy-saving appendage such as so-called Super Stream Duct (SSD, registered trademark) located ahead of a propeller for improvement of a flow field around the propeller to thereby enhance an energy-saving effect and further proposed is setting of a pitch of the propeller to improve propulsion efficiency (Patent Literatures 1 and 2).

[0004]

Propeller blades disclosed in Patent Literature 1 have a gradually decreased pitch similar to that in conventional propellers such that the pitch is maximum at blade roots, is decreased along a radius of the propeller and is minimum at blade tips. Propeller blades disclosed in Patent Literature 2 have a pitch locally minimal at a radial position corresponding to a radius of a duct at a rear end thereof.

Citation List

Patent Literature

[0005]

Patent Literature 1: JP 5230852 B

Patent Literature 2: JPH 10-264890 A

Summary of Invention

Technical Problems

[0006]

However, neither of the propeller blades in Patent Literatures 1 and 2 has a pitch distribution suited to the energy-saving appendage located ahead of the propeller. Thus, an energy-saving effect by the energy-saving appendage is not sufficiently produced, possibly resulting in not significantly enhanced propulsion efficiency of the

propeller.

[0007]

An object of the invention is to significantly enhance propulsion efficiency in a ship propulsion device comprising a propeller and an energy-saving appendage located ahead of the propeller.

Solution to Problems

[0008]

A ship propulsion device according to the invention comprises a propeller and an energy-saving appendage located ahead of the propeller and having a curved surface with a radius smaller than that of said propeller,

blades of said propeller having a pitch with a pitch distribution such that the pitch has a local minimal point at a position radially inward of the radius of the energy-saving appendage.

[0009]

In the ship propulsion device, the radius of the energy-saving appendage may be not less than 50% and not more than 80% of the radius of the propeller.

[0010]

In the ship propulsion device, the local minimal point is in a position radially outwardly away from an axis of the propeller by not less than 50% and not more

than 100% of the radius of the energy-saving appendage.

[0011]

In the ship propulsion device, the pitch of the blades of the propeller at the local minimal point is not less than 80% and less than 100% of a value obtained by liner interpolation of the pitch at blade tips and roots of the propeller.

Advantageous Effects of Invention

[0012]

A ship propulsion device according to the invention can exhibit an effect of significantly enhancing propulsion efficiency.

Brief Description of Drawings

[0013]

Fig. 1 is a side view diagrammatically showing a propulsion device according to the invention attached to a stern of a ship;

Fig. 2 is a diagram showing a pitch of blades in a radial direction of a propeller according to the invention together with those of Patent Literatures 1 and 2 for comparison;

Fig. 3 is a diagram for explanation of an effect of the blades with the pitch according to the invention shown

in Fig. 2;

Fig. 4 is a perspective view, looking from backward of a stern, of a model ship for a VLCC with the structure according to the invention; and

Fig. 5 is a graph showing a relationship between a ship velocity and a propeller torque measured in model tests.

Description of Embodiment

[0014]

An embodiment of the invention will be described in conjunction with the attached drawings.

[0015]

Fig. 1 is a side view diagrammatically showing a propulsion device according to the invention attached to a stern of a ship. In Fig. 1, reference numeral 1 denotes a propeller projected backward of a stern 2 of a ship; and 3, blades mounted on a boss 4 of the propeller 1. Reference numeral 5 denotes an energy-saving appendage on the stern 2 in a position ahead of the propeller 1. Shown in Fig. 1 is a case where the energy-saving appendage 5 is in the form of a stern duct 6.

[0016]

The energy-saving appendage 5 is inherently such that the energy-saving appendage 5 itself produces thrust

force and/or improves a flow field around the propeller 1 so as to obtain an energy-saving effect, not serving for direct enhancement of performances of the propeller 1. The invention provides technique for directly enhancing efficiency of the propeller 1 located backward of the energy-saving appendage 5.

[0017]

Fig. 1 shows the case where the energy-saving appendage 5 is the stern duct 6 having a curved surface (circularly curved surface) with a radius R smaller than a radius r of the propeller 1. The radius R of the stern duct 6 at a rear end thereof is of a size not less than 50% and not more than 80% of the radius r of the propeller 1. Fig. 2 shows a case where the radius R of the stern duct 6 is 60% of the radius r of the propeller 1.

[0018]

In the above, explanation has been made in the case where the energy-saving appendage 5 is the stern duct 6. The energy-saving appendage 5 may be the stern duct 6 with the circularly curved surface partly cut out into an arcuate body.

[0019]

The blades 3 of the propeller 1 has a pitch with a pitch distribution as shown by solid line 7 in Fig. 2

that has a local minimal point S in a position radially inward of the radius R of the stern duct 6.

[0020]

The local minimal point S of the pitch is in a position radially outwardly away from an axis O of the propeller 1 by not less than 50% and not more than 100% of the radius R of the stern duct 6 as the energy-saving appendage 5. Specifically, in the case of Fig. 2, the local minimal point S of the pitch is away from the axis O by not less than 30% and not more than 60% of the radius r of the propeller 1.

[0021]

The local minimal point S of the pitch in the blades 3 of the propeller 1 is in a range of not less than 80% and less than 100% of a value obtained by linear interpolation of the pitch at blade tips 3a and roots 3b in the blades 3 of the propeller 1.

[0022]

In Fig. 2, conventional cases are also shown for comparison in addition to the case according to the invention shown by the solid line 7. Specifically, dotted line A shows a case of a conventional propeller as in the propeller 1 of Patent Literature 1 with a gradually decreased pitch such that the pitch is maximum at the blade roots 3b and is minimum at the blade tips

3a. Two-dot chain line B shows an improved conventional case as in the propeller of Patent Literature 2 such that the pitch of the blades of the propeller is locally minimal in a radial position corresponding to the radius R of the duct at a rear end thereof.

[0023]

Fig. 1 shows a wake at the stern 2 of the ship with the stern duct 6, and vectors in the wake show flow velocities around the propeller 1 in terms of a hull fixed coordinate. The flow velocities shown by the vectors are forward velocities v_a of the propeller 1. The ship with the stern duct 6 is characteristic in that an inner forward velocity v_{a1} inward of the radius R of the stern duct 6 is considerably lower than an outer forward velocity v_{a2} outward of the radius R of the stern duct 6.

[0024]

Generally, performances of the propeller 1 in an uniform flow is different from those in an inhomogeneous flow. Thus, it is considered that none of conventional propellers has optimum pitches in the wake radially inside of the radius R of the stern duct 6, which lowers the efficiency.

[0025]

Fig. 3 shows inflow velocity into section of the

blade 3 in the propeller 1 with the radius r . A geometric inflow angle β depends on a ratio between the forward velocity v_a and a revolution velocity $2\pi nr$ (where n is a number of revolutions). A geometric attack angle is adjusted for optimization by the pitch of the blade 3; however, if the forward velocity v_a presupposed upon designing is higher than an actual one, the optimization is conducted on the basis of too much geometric inflow angle β , resulting in too much geometric pitch angle of the blade 3 in comparison with an actual optimum value (affection by a propeller induced velocity induced by the propeller itself is excluded here for simplified explanation). It is considered in conventional propellers that the pitch is too much in radial positions of the blade corresponding to a zone with especially low forward velocity v_a due to the stern duct 6.

[0026]

Thus, the propeller 1 according to the invention is provided with portions smaller in blade pitch than those of the conventional propellers at radial positions corresponding to the zone with the especially low inner forward velocity v_{a1} due to the stern duct 6, thereby attaining approach to real optimal geometric attack angle and improving the propeller efficiency in the wake in the ship with the stern duct 6.

[0027]

Fig. 4 shows a model ship 8 for a very large crude oil carrier (VLCC) or super tanker with the structure according to the invention. The model ship 8 is arranged in a ship-type test bath (not shown) to carry out effect-verification tests. In Fig. 4, parts similar to those shown in Fig. 1 are indicated by the same reference numerals and duplicated explanation thereon is omitted. In Fig. 4, reference numeral 9 denotes a helm.

[0028]

Fig. 5 is a graph showing a relationship between ship velocity and propeller torque measured in the effect-verification tests on the model ship 8 shown in Fig. 4. Ship velocity defined on an abscissa in Fig. 5 is non-dimensional Froude number F obtained by the following equation on flow of fluid with free surface where L is typical length of a body in the flow; U , a velocity; and g , a gravitational acceleration.

$$F = \frac{U}{\sqrt{gL}} \quad \dots (1)$$

[0029]

Propeller torque defined on an ordinate in Fig. 5 is $\Delta Q = \{(\text{propeller torque of the invention}) - (\text{conventional propeller torque})\} / (\text{conventional propeller torque})$.

[0030]

According to Fig. 5, it can be considered that improved performances in blade section of the propeller according to the invention bring about decrease in torque when one and the same ship velocity and thrust condition.

[0031]

Specifically, it is noted in Fig. 5 that the propeller toques are considerably lowered in lower ship velocities with Froude number F being 0.13-0.14 in comparison with the ship velocity with Froude number F being 0.15. Thus, designing of an actual ship in consideration of ship velocities with the effect shown in Fig. 5 can set high propulsion efficiency of the ship and can reduce fuel consumption.

[0032]

As mentioned in the above, in the structure with the energy-saving appendage 5 ahead of the propeller 1, the pitch of the blades 3 of the propeller 1 has a pitch distribution that has a local minimal point S in a radial position inward of the radius R of the energy-saving appendage 5, which can significantly enhance propulsion efficiency of the ship.

Industrial Applicability

[0033]

A ship propulsion device according to the invention can be effectively applied to a ship to which enhanced propulsion efficiency is requested.

Reference Signs List

[0034]

- 1 propeller
- 3 blade
- 3a blade tip
- 3b blade root
- 5 energy-saving appendage
- 6 stern duct (energy-saving appendage)
- 7 solid line (pitch distribution)
- O axis
- r radius of propeller
- R radius of stern duct
- S local minimal point

CLAIMS

1. A ship propulsion device comprising a propeller and an energy-saving appendage located ahead of the propeller and having a curved surface with a radius smaller than that of said propeller,

blades of said propeller having a pitch with a pitch distribution such that the pitch has a local minimal point at a radial position inward of the radius of said energy-saving appendage.

2. The ship propulsion device as claimed in claim 1 wherein the radius of said energy-saving appendage is not less than 50% and not more than 80% of the radius of said propeller.

3. The ship propulsion device as claimed in claim 1 wherein said local minimal point is in a position radially outwardly away from an axis of said propeller by not less than 50% and not more than 100% of the radius of said energy-saving appendage.

4. The ship propulsion device as claimed in claim 2 wherein said local minimal point is in a position radially outwardly away from an axis of said propeller by

not less than 50% and not more than 100% of the radius of said energy-saving appendage.

5. The ship propulsion device as claimed in any one of claims 1-4 wherein the pitch of the blades of said propeller at said local minimal point is not less than 80% and less than 100% of a value obtained by linear interpolation of the pitch at blade tips and roots of said propeller.