A diffuser-type endplate propeller for driving a hull is provided. The diffuser-type endplate propeller includes a propeller hub and a plurality of blades. The propeller hub is connected to a transmission shaft of the hull. Each of blades respectively has a blade-body and an endplate connected to each other, wherein each of the blade-bodies is connected to the propeller hub and extends outward from the propeller hub to the corresponding endplate, each the endplate bends from the corresponding blade-body to extend towards a stern of the hull, each of the endplates has a leading edge and a trailing edge, each the leading edge keeps a first distance from an axis of the propeller hub, each the trailing edge keeps a second distance from the axis of the propeller hub, and the first distance is less than the second distance.
FIG. 5B
DIFFUSER-TYPE ENDPLEATE PROPELLER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefits of Taiwan application serial no. 102120356, filed on Jun. 7, 2013. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention generally relates to a propeller, and more particularly, to a diffuser-type endplate propeller.

[0004] 2. Description of Related Art

[0005] Most of the current ships use propellers to drive fluid to produce sail powers. Specifically, when a propeller blade rotates, there is a pressure difference existing between a high-pressure side-surface and a low-pressure side-surface of the propeller blade, and the pressure difference forms a thrust to make the ship proceed on water surface.

[0006] Among various current designs of the endplate propeller, the following two types are more common: tip vortex free (TVF) propeller and contracted loaded tip (CLT) propeller. For the TVF propeller, the endplate thereof is tangential to the cylindrical surface of the propeller blade-tip. That is during the rotation of the propeller, the endplate becomes a portion of the cylindrical surface to reduce the viscous resistance of the endplate. However, when fluid passes through a general propeller, it would produce contracted wake flows at the blade-tips, so that the successive developers further make the endplate contracted by design, i.e., for the new designed CLT propeller, the leading edge radius of the endplate is greater than the radius of the trailing edge. It should be noted that both the TVF propeller and the CLT propeller are able to effectively prevent the fluid at the high-pressure side-surfaces of the propeller blades from flowing to the low-pressure side-surfaces so as to keep the loads of the blade-tips and suppress the intensity of the tip vortex. Accordingly, a quite portion of the thrust produced by the above-mentioned TVF propeller or CLT propeller is provided by the high-pressure side-surfaces of the propeller blades, which reduces the probability for the low-pressure side-surface of the propeller to produce cavitation.

[0007] In fact however, it is found when the CLT propeller rotates under the uniform inflow condition, no matter a propeller blade turns to any circumferential position, the sheet cavitation phenomenon is always produced at the outer-sides of the endplate so as to rise up the resistance on the endplate and reduce the efficiency of the propeller. As a result, it may generate the hull vibration and noise. Obviously, it is quite unhelpful for a low-vibration and low-noise design of ship. Another more serious trouble is that if a CLT propeller is applied to a hull based on the inclined-shaft design, for example, a speedboat, the CLT propeller under an inclined-shaft inflow condition has a more serious cavitation phenomenon occurred at the endplate of a blade when the blade turns to the upper-vertical position.

SUMMARY OF THE INVENTION

[0008] Accordingly, the present invention is directed to a diffuser-type endplate propeller under an inclined-shaft inflow condition which can largely reduce even eliminate the sheet cavitation phenomenon produced by the endplates no matter the propeller blades turn to any angle positions.

[0009] An embodiment of the present invention provides a diffuser-type endplate propeller for driving a hull. The diffuser-type endplate propeller includes a propeller hub and a plurality of blades. The propeller hub is connected to a transmission shaft of the hull. Each of blades respectively has a blade-body and an endplate connected to each other, wherein each of the blade-bodies is connected to the propeller hub and extends outward from the propeller hub to the corresponding endplate, each the endplate bends from the corresponding blade-body to extend towards the stern of the hull, each of the endplates has a leading edge and a trailing edge, each the leading edge keeps a first distance from the axis of the propeller hub, each the trailing edge keeps a second distance from the axis of the propeller hub, and the first distance is less than the second distance.

[0010] In an embodiment of the present invention, the above-mentioned diffuser-type endplate propeller is configured to drive the hull for proceeding towards a sailing direction, wherein the axis of the propeller hub is not parallel to the sailing direction.

[0011] In an embodiment of the present invention, the above-mentioned blades are disposed and radially arranged on the propeller hub.

[0012] In an embodiment of the present invention, the above-mentioned diffuser-type endplate propeller is integrally molded.

[0013] In an embodiment of the present invention, when the above-mentioned diffuser-type endplate propeller rotates, the rotating tracks of the leading edges form a cylindrical surface, a negative angle of attack is present between each the endplate and the cylindrical surface formed by the leading edges.

[0014] In an embodiment of the present invention, the above-mentioned angle of attack is -1°.

[0015] Based on the depiction above, since the endplate propeller of the invention is a diffuser-type endplate propeller, i.e., when the diffuser-type endplate propeller is rotating, it does not produce sheet cavitation phenomenon at the endplates, so that the invention improves the efficiency of the endplate propeller and reduces the hull vibration and noise.

[0016] In order to make the features and advantages of the present invention more comprehensible, the present invention is further described in detail in the following with reference to the embodiments and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a schematic partial diagram showing a diffuser-type endplate propeller connected to a hull in an embodiment of the invention.

[0018] FIG. 2 is a three-dimensional diagram of the diffuser-type endplate propeller of FIG. 1.

[0019] FIG. 3 is a front-view diagram of the diffuser-type endplate propeller in FIG. 1 in the angle of view towards the stern of the hull.

[0020] FIG. 4 is a diagram showing the diffuser-type endplate propeller of FIG. 2 in clockwise rotating.

[0021] FIG. 5A is a diagram showing the inflow velocity at the inclined-shaft for the diffuser-type endplate propeller of FIG. 1.

[0022] FIG. 5B is a diagram showing the diffuser-type endplate propeller of FIG. 5A in clockwise rotating along the X axis.
Fig. 5C is a diagram showing the inflow velocity at the endplate for the diffuser-type endplate propeller of Fig. 5A, wherein the propeller turns to the 0° circumferential position.

Fig. 5D is a diagram showing the inflow velocity at the cylindrical endplate for a conventional propeller under an inclined-shaft inflow condition, wherein the propeller turns to the 0° circumferential position.

Fig. 5E is a diagram showing the inflow velocity at the cylindrical endplate for a diffuser-type endplate propeller of Fig. 5A, wherein the propeller turns to the 180° circumferential position.

Fig. 5F is a diagram showing the inflow velocity at the cylindrical endplate for a conventional propeller under an inclined-shaft inflow condition, wherein the propeller turns to the 180° circumferential position.

DESCRIPTION OF THE EMBODIMENTS

In the following, the depicted embodiments together with the included drawings are intended to explain the feasibility of the present invention, wherein for better understanding and clear illustrating, the proportions or the angles between parts are amplified or shrunk appropriately so that the proportions or the angles herein are to describe, not to limit, the present invention.

Fig. 1 is a schematic partial diagram showing a diffuser-type endplate propeller connected to a hull in an embodiment of the invention. Fig. 2 is a three-dimensional diagram of the diffuser-type endplate propeller of Fig. 1 and Fig. 3 is a front-view diagram of the diffuser-type endplate propeller in Fig. 1 in the angle of view towards the stern of the hull. Referring to Figs. 1-3, a diffuser-type endplate propeller 100 of the embodiment is able to drive a hull 20, and the diffuser-type endplate propeller 100 includes a propeller hub 110 and a plurality of blades 120. The propeller hub 110 is connected to a transmission shaft 22 of the hull 20. Each of the blades 120 respectively has a blade-body 122 and a endplate 124 connected to each other, in which each blade-body 122 is connected to the propeller hub 110 and extends outward from the propeller hub 110 to the corresponding endplate 124, and each the endplate 124 bends from the corresponding blade-body 122 to extend towards a stern 24 of the hull. Each the endplate 124 has a leading edge 124a and an trailing edge 124b, in which the leading edge 124a keeps a first distance D1 from an axis L of the propeller hub 110, the trailing edge 124b keeps a second distance D2 from the axis L of the propeller hub 110, and the first distance D1 is less than the second distance D2.

The diffuser-type endplate propeller 100 of the embodiment is installed, for example, at the bottom of the hull 20 and operated under an inclined-shaft condition. In more details, the diffuser-type endplate propeller 100 is connected to an end of the transmission shaft 22 through the propeller hub 110, while another end of the transmission shaft 22 is connected to the engine in the hull 20 (not shown). When the engine is running, the transmission shaft 22 is driven to rotate the diffuser-type endplate propeller 100, and, by means of the rotating of the blades 120, the water flow is back pushed towards the stern 24 so as to produce a forward reaction for driving the hull 20 to proceed in a sailing direction A2, in which the axis L of the propeller hub 110 is not parallel to the sailing direction A2.

In general, the quantity of the blades 120 is two to six. In the embodiment, there are, for example, four blades 120, which are disposed and radially arranged on the propeller hub 110. On the other hand, the diffuser-type endplate propeller 100 is fabricated in, for example, casting process by using metallic material or composite materials. In other words, the propeller hub 110 and the blades 120 can be integrally molded to have better rigidity to withstand the pressure of the water flow.

Continuing to Figs. 1 and 2, the blade-body 122 of a blade 120 can further include a high-pressure side-surface towards the stern 24 and a low-pressure side-surface back from the stern 24, in which the most portion of the thrust produced by the diffuser-type endplate propeller 100 is provided by the high-pressure side-surface. It should be noted that since the diffuser-type endplate propeller 100 in the embodiment, for example, rotates clockwise and the endplates 124 can prevent the water flow moved by the rotations of the blades 120 from flowing to the low-pressure side-surfaces at the blade-tips so as to ensure the diffuser-type endplate propeller 100 having good efficiency and effectively suppress the tip vortex.

In the embodiment, the leading edge 124a is, for example, for guiding the water flow of the high-pressure side-surface of the propeller to flow to the trailing edge 124b along the inner-side of the endplate 124, and then, guiding the water flow out of the high-pressure side-surface through the trailing edge 124b. In more details, the endplate 124 of the embodiment chordwise extends to the trailing edge 124b from the leading edge 124a, in which the leading edge 124a keeps a first distance D1 from the axis L, the trailing edge 124b keeps a second distance D2 from the axis L, and the first distance D1 is less than the second distance D2, and further thus, the endplate 124 has a diffused shape chordwise.

Fig. 4 is a diagram showing the diffuser-type endplate propeller of Fig. 2 in clockwise rotating. Referring to Fig. 4, when the diffuser-type endplate propeller 100 rotates clockwise, the rotating track of the leading edge 124a forms a cylindrical surface S1, and a negative angle of attack (the diffuser angle) α is present between each the endplate 124 and the leading edge 124a. In more details, the leading edge 124a and the cylindrical surface S1 has a boundary line L1, the endplate 124 is located at the boundary line L1 and has a first section C1 along the chord of the endplate 124, while the cylindrical surface S1 has a second section C2 on the boundary line L1, the included angle of the first section C1 and the second section C2 is just the above-mentioned angle of attack α. In the embodiment, the above-mentioned angle of attack α is, for example, −1°, which means the endplate 124 of the embodiment has a negative angle of attack.

Fig. 5A is a diagram showing the inflow velocity at the inclined-shaft for the diffuser-type endplate propeller of Fig. 1. Fig. 5B is a diagram showing the diffuser-type endplate propeller of Fig. 5A in clockwise rotating along the X axis. Fig. 5C is a diagram showing the inflow velocity at the endplate for the diffuser-type endplate propeller of Fig. 5A, wherein the propeller turns to the 0° circumferential position. Fig. 5D is a diagram showing the inflow velocity at the cylindrical endplate for a conventional propeller under an inclined-shaft inflow condition, wherein the propeller turns to the 0° circumferential position. Fig. 5E is a diagram showing the inflow velocity at the endplate for the diffuser-type endplate propeller of Fig. 5A, wherein the propeller turns to the 180° circumferential position. Fig. 5F is a diagram showing the inflow velocity at the cylindrical endplate for a conventional propeller under an inclined-shaft inflow condition,
wherein the propeller turns to the 180° circumferential position. Referring to FIG. 5A, the actual experiments prove when the diffuser-type endplate propeller 100 rotates under an inclined-shaft condition, the diffuser-type endplate 124 not only prevents the water flow of the high-pressure side-surface from flowing to the low-pressure side-surface, but also eliminates the sheet cavitation phenomenon produced by the endplates 124 no matter the propeller blades 120 turn to any angle positions.

[0035] In more details, the axis L of the propeller hub 110 has an inclined-shaft angle Φ towards the sailing direction A2 of the hull, in which the inclined-shaft angle Φ ranges, for example, between 8° and 12°, and the propeller is suitable for a high-speed boat such as a speedboat. The hull 20 in sailing produces a propeller inflow V1, in which the propeller inflow V1 enters the diffuser-type endplate propeller 100 in a direction opposite to the sailing direction A2, and the propeller inflow V1 has an included angle towards the axis L, i.e. the inclined-shaft angle Φ. The propeller inflow V1 can be resolved into a first inflow component V1 cos Φ parallel to the axis L and a second inflow component V1 sin Φ vertical to the axis L. The second inflow component V1 sin Φ enables the endplate 124 turning to the 0° circumferential position to increase the actual angle of attack or to the 180° circumferential position to decrease the actual angle of attack.

[0036] As shown by FIGS. 5B-5F, the diffuser-type endplate propeller 100 rotates in a peripheral velocity wR around the X axis, wherein the peripheral velocity wR produces an opposite cylindrical tangential inflow velocity wR1 and the peripheral velocity wR is equal to the cylindrical tangential inflow velocity wR1. When the blade 120 turns to the 0° circumferential position, the cylindrical tangential inflow velocity wR1 and the second inflow component V1 sin Φ together form a first actual angle of attack α1 produced by the inclined-shaft inflow at the endplate 124. It should be noted that, under the same condition, for a conventional uncontracted and diffused cylindrical endplate 220, the cylindrical tangential inflow velocity wR1 and the second inflow component V1 sin Φ together form a first cylindrical angle of attack of attack α1 produced by the inclined-shaft inflow at the cylindrical endplate 220, in which the first cylindrical endplate angle of attack α1 is positive.

[0037] On the other hand, when the blade 120 turns to the 180° circumferential position, the cylindrical tangential inflow velocity wR1 and the second inflow component V1 sin Φ together form a second actual angle of attack α2 produced by the inclined-shaft inflow at the endplate 124. It should be noted that, under the same condition, for a conventional uncontracted and diffused cylindrical endplate 220, the cylindrical tangential inflow velocity wR1 and the second inflow component V1 sin Φ together form a second cylindrical endplate angle of attack α2 produced by the inclined-shaft inflow at the cylindrical endplate 220, in which the second cylindrical endplate angle of attack α2 is negative. Specifically, the first cylindrical endplate angle of attack α1 and the second cylindrical endplate angle of attack α2 have the same absolute values but they are positive and negative respectively. Since in the diffuser-type endplate propeller 100 of the invention, the angle of attack α of the endplate 124 of the blade 120 is −1° by design, so that when the blade 120 turns to the 0° circumferential position, the first actual angle of attack α1 of the endplate 124 is less than the first cylindrical endplate angle of attack all by 1°, and the decreased actual angle of attack of the endplate 124 reduces the sheet cavitation phenomenon produced at the low-pressure side-surface.

[0038] In addition, when the blade 120 turns to the 180° circumferential position, although the second actual angle of attack α2 caused by the inclined-shaft inflow is negative and the angle of attack α of the endplate 124 is also negative by design so as to increase the included angle (negative one) between the actual inflow and the endplate 124 at the time and to make the pressure at the inner-surface of endplate 124 of the endplate 124 lower than the pressure at the outer-surface of endplate 124. However, the inner-surface of endplate 124 contacts the high-pressure side-surface of the propeller and the immersed depth of the endplate 124 at the 180° circumferential position is deeper, therefore, no cavitation phenomenon occurs which thus effectively improves the efficiency of the endplate propeller and suppresses the vibration and noise induced by the propeller.

[0039] In summary, the diffuser-type endplate propeller of the invention can prevent the flow at the high-pressure side-surface from back-flowing to the low-pressure side-surface. Especially in the inclined-shaft situation, the diffuser-type endplate propeller of the invention can largely reduce the serious extent of cavitation on the outer side of the endplate, even can eliminate cavitation on the endplate. As a result, the invention can significantly improves the efficiency of the propeller and largely reduce the vibration and noise produced by the propeller.

[0040] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A diffuser-type endplate propeller, configured to drive a hull and comprising:
   a propeller hub, connected to a transmission shaft of the hull; and
   a plurality of blades, respectively having a blade-body and an endplate connected to each other, wherein each of the blade-bodies is connected to the propeller hub and extends outward from the propeller hub to each the endplate, each the endplate bends from the corresponding blade-body to extend towards a stern of the hull, each of the endplates has a leading edge and an trailing edge, the leading edge keeps a first distance from an axis of the propeller hub, the trailing edge keeps a second distance from the axis of the propeller hub, and the first distance is less than the second distance.

2. The diffuser-type endplate propeller according to claim 1, configured to drive the hull for proceeding towards a sailing direction, wherein the axis of the propeller hub is not parallel to the sailing direction.

3. The diffuser-type endplate propeller according to claim 1, wherein the blades are disposed and radially arranged on the propeller hub.

4. The diffuser-type endplate propeller according to claim 1, which is integrally molded.

5. The diffuser-type endplate propeller according to claim 1, wherein when the diffuser-type endplate propeller rotates, the rotating tracks of the leading edges form a cylindrical surface, a negative angle of attack is present between each the
endplate and the cylindrical surface formed by the leading edges.

6. The diffuser-type endplate propeller according to claim 5, wherein the angle of attack is -1°.

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