

AIR LUBRICATION SYSTEM OF A SHIP

FIELD

[0001] The present invention relates to an air lubrication system for ships. More particularly, the present invention relates to an air lubrication system for ships, which can form an air layer having a high volume fraction of air in a central region of a ship.

BACKGROUND

[0002] During navigation, a ship is affected by frictional resistance, which is a kind of friction caused by viscosity of water. In order to reduce frictional resistance affecting navigation of the ship, studies have been made on an air lubrication method.

[0003] In the air lubrication method, a portion of the hull surface dipped in sea water is covered with an air layer in order to reduce frictional resistance of the ship caused by viscosity of water by converting contact between the hull surface covered with air and the sea water into contact with air and the sea water.

[0004] An air lubrication system adopting the air lubrication method is aimed at forming air bubbles by ejecting air to the bottom surface of the ship through multiple orifices typically formed on the bottom surface such that frictional resistance due to contact between the hull and the sea water can be reduced through such air bubbles.

[0005] However, ships adopting the conventional air lubrication system do not employ the air lubrication system in order to achieve reduction in frictional resistance by ejecting air toward the ship bottom, or employ the air lubrication system to form an air layer over the entire region of the ship bottom.

[0006] Moreover, in ships adopting the conventional air lubrication system, an air cushion is formed above a propeller and cavitation occurs on the propeller to increase fluctuating pressure induced by the propeller, thereby causing deterioration in efficiency of the propeller, increase in noise from the propeller, and deterioration in reduction of frictional resistance by the air lubrication system in a harsh marine environment.

[0007] Therefore, there is a need for development of an air lubrication system for ships, which can achieve improvement in operation efficiency of a propeller and

reduction of noise from the propeller through reduction of fluctuating pressure induced by the propeller and can achieve reduction of frictional resistance in a harsh marine environment.

SUMMARY

[0008] It is an object of the present invention to provide an air lubrication system for ships, which has an optimal arrangement of multiple air lubrication devices and thus can achieve improvement in operation efficiency of a propeller and reduction of noise from the propeller through reduction in fluctuating pressure induced by the propeller while allowing reduction of frictional resistance in a harsh marine environment.

[0009] It is another object of the present invention to provide an air lubrication method for ships using an air lubrication system for generating air bubbles on a ship bottom, wherein the air lubrication method provides an optimal arrangement of multiple air lubrication devices and thus can achieve improvement in operation efficiency of a propeller and reduction of noise from the propeller through reduction in fluctuating pressure induced by the propeller while allowing reduction of frictional resistance in a harsh marine environment.

[0010] In accordance with one aspect of the present invention, an air lubrication system for ships adapted to generate air bubbles on a ship bottom includes: a front air ejection port disposed in a bow region of a ship; and a rear air ejection port disposed at the rear of the front air ejection port in the bow region of the ship, wherein the front air ejection port and the rear air ejection port extend predetermined lengths, respectively, in a transverse direction of the ship, and a region in which the front air ejection port is disposed and a region in which the rear air ejection port is disposed share an overlapping area in a longitudinal direction of the ship.

[0011] According to embodiments of the present invention, the air lubrication system can improve operation efficiency of a propeller through reduction in fluctuating pressure induced by the propeller.

[0012] In addition, according to embodiments of the present invention, the air lubrication system can reduce noise from the propeller.

[0013] Further, according to embodiments of the present invention, the air lubrication system can achieve reduction of frictional resistance in a harsh marine environment.

DRAWINGS

[0014] The above and other aspects, features, and advantages of the present invention will become apparent from the detailed description of the following embodiments in conjunction with the accompanying drawings:

[0015] FIG. 1 to FIG. 3 are views of an air lubrication system for ships according to one embodiment of the present invention. FIG. 2 shows a bow region of the ship and FIG. 3 shows a region covered by an air layer formed by air ejected through each air ejection port.

[0016] FIG. 4 and FIG. 5 show volume fractions of air in air layers formed by air lubrication systems for ships, respectively, as expressed by results of numerical analysis based on computational fluid dynamics. Specifically, FIG. 4 shows a result of numerical analysis of an air lubrication system for ships according to a comparative example and FIG. 5 shows a result of numerical analysis of the air lubrication system for ships according to the embodiment of the present invention.

[0017] FIG. 6 shows output results of flow analysis of the air lubrication system for ships according to the embodiment of the present invention at a sea state of Beaufort (BF) scale 5, and FIG. 7 shows friction drag of the air lubrication system for ships according to the embodiment of the present invention at a sea state of BF scale 5.

[0018] FIG. 8 shows the degree of reduction in fluctuating pressure during operation of the air lubrication system for ships according to the embodiment of the present invention, and FIG. 9 shows the degree of net power saving of the air lubrication system for ships according to the embodiment of the present invention at a sea state of BF scale 5 to 8.

DETAILED DESCRIPTION

[0019] Hereinafter, embodiments of the present invention will be described in detail. It should be understood that the present invention is not limited to the following

embodiments and may be embodied in different ways, and that the embodiments are provided for complete disclosure and thorough understanding of the present invention by those skilled in the art.

[0020] It will be understood that, when an element such as a layer, film, region or substrate is referred to as being placed "on" or "under" another element, it can be directly placed on the other element, or intervening layer(s) may also be present. In addition, spatially relative terms, such as "upper" and "lower", are defined from the observer's point of view, and, when the observer's point of view is changed, "upper (portion)" may mean "lower (portion)", or vice versa.

[0021] It will be noted that like components will be denoted by like reference numerals throughout the specification and the accompanying drawings. In addition, it will be understood that the terms "includes", "comprises", "including", and/or "comprising" when used in this specification, specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups.

[0022] In accordance with one aspect of the present invention, there is provided an air lubrication system for ships, which is adapted to generate air bubbles on a ship bottom, the air lubrication system including: a front air ejection port disposed in a bow region of a ship; and a rear air ejection port disposed at the rear of the front air ejection port in the bow region of the ship, wherein the front air ejection port and the rear air ejection port extend predetermined lengths, respectively, in a transverse direction of the ship, and a region in which the front air ejection port is disposed and a region in which the rear air ejection port is disposed share an overlapping area in a longitudinal direction of the ship.

[0023] When viewed in the longitudinal direction of the ship, the region in which the front air ejection port is disposed may be present in the region in which the rear air ejection port is disposed.

[0024] Assuming the width of the ship is B, the width of the region in which the rear air ejection port is disposed may be 0.5 B or less.

[0025] A center of the front air ejection port and a center of the rear air ejection port may be located on a common line in the longitudinal direction of the ship.

[0026] Here, the common line may be a longitudinal center line of the ship with reference to a thickness-wise center of the ship.

[0027] Assuming a stern is 0 LOA and a bow is 1.0 LOA with reference to the overall length of the ship, the rear air ejection port may be separated a distance of 0.1 LOA or less from the front air ejection port.

[0028] Here, the front air ejection port may be disposed between 0.7 LOA and 0.85 LOA.

[0029] In accordance with another aspect of the present invention, an air lubrication method for ships using an air lubrication system for generating air bubbles on a ship bottom includes ejecting air through a front air ejection port disposed in a bow region of a ship and a rear air ejection port disposed at the rear of the front air ejection port in the bow region of the ship, wherein an air layer formed by air ejected through the front air ejection port is incorporated into an air layer formed by air ejected from the rear air ejection port to increase a volume fraction of air in an air layer formed in a central region of the ship extending in a longitudinal direction of the ship.

[0030] A center of the front air ejection port and a center of the rear air ejection port may be located on a longitudinal center line of the ship with reference to a thickness-wise center of the ship to increase the volume fraction of air in the air layer formed in the central region of the ship extending in the longitudinal direction of the ship.

[0031] The rear air ejection port may be separated a distance of 0.1 LOA or less from the front air ejection port. Assuming the width of the ship is B, the width of the air layer formed by air ejected through the rear air ejection port may be 0.5B or less. Assuming a stern is 0 LOA and a bow is 1.0 LOA with reference to the overall length of the ship, a starting point of the air layer formed by air ejected through the front air ejection port may be located between 0.7 LOA and 0.85 LOA.

[0032] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0033] FIG. 1 to FIG. 3 are views of an air lubrication system for ships according to one embodiment of the present invention. FIG. 2 shows a bow region of the ship and FIG. 3 shows a region covered by an air layer formed by air ejected through each air ejection port.

[0034] Referring to FIG. 1, an air lubrication system for ships, which is adapted to generate air bubbles on a ship bottom 1, includes a front air ejection port 10 and a rear air ejection port 20.

[0035] In the present invention, a propeller is disposed in the vicinity of a stern of a ship, that is, 0 LOA, and is not shown in FIG. 1.

[0036] The front air ejection port 10 and the rear air ejection port 20 are adapted to generate air bubbles on the ship bottom 1, for example, the base of the ship, and may be disposed in the bow region 2 of the ship. In addition, the front air ejection port 10 may be closer to a bow of the ship than the rear air ejection port 20. Herein, the bow region 2 of the ship refers to a region ranging from 0.5 LOA to 1.0 LOA when the stern of the ship is 0 LOA and the bow of the ship is 1.0 LOA with reference to the overall length of the ship.

[0037] The front air ejection port 10 and the rear air ejection port 20 are configured to allow air from an air-jet device (not shown) to be discharged outside the ship therethrough, and may be operated to eject air therethrough by a bow region controller (not shown). For example, compressed air formed by a compressor (not shown) may be supplied to the air-jet device (not shown) and then discharged to the ship bottom 1 through the front air ejection port 10 and the rear air ejection port 20. For example, the front air ejection port 10 and the rear air ejection port 20 may be connected to a common air-jet device. Alternatively, the front air ejection port 10 may be provided to a front air-jet device (not shown) and the rear air ejection port 20 may be provided to a rear air-jet device (not shown). For example, the air lubrication system may include a front controller (not shown) and a rear controller (not shown) which control the front air-jet device (not shown) and the rear air-jet device (not shown), respectively. Accordingly, the air lubrication system may include a front compressor (not shown) and a rear compressor (not shown). Alternatively, the air lubrication system may include a controller (not shown) controlling both the front air-jet device (not shown) and the rear air-jet device (not shown). Accordingly, the air lubrication system may be configured such that compressed air formed by the compressor (not shown) is supplied to the front air-jet device (not shown) and the rear air-jet device (not shown), or compressed air formed by the front compressor (not shown) is supplied to the front air-jet device (not shown) and compressed air formed by the rear compressor (not shown) is supplied to the rear air-jet device (not shown).

[0038] The front air ejection port 10 and the rear air ejection port 20 may extend predetermined lengths, respectively, in a transverse direction of the ship, wherein a region in which the front air ejection port 10 is disposed and a region in which the rear air ejection port 20 is disposed may share an overlapping area in a longitudinal direction of the ship. That is, when viewed in the longitudinal direction of the ship, the width of the front air ejection port may overlap the width of the rear air ejection port.

[0039] Accordingly, it is possible to increase the volume fraction of air in the overlapping area.

[0040] When viewed in the longitudinal direction of the ship, the region in which the front air ejection port 10 is disposed may be present in the region in which the rear air ejection port 20 is disposed.

[0041] Accordingly, the front air ejection port 10 having a predetermined length in the transverse direction of the ship can be disposed in a region of the ship bottom 1 requiring a high volume fraction of air, whereby a region of the ship bottom 1 having a high volume fraction of air can be maximized with a minimum number of air ejection ports disposed.

[0042] A center of the front air ejection port 10 and a center of the rear air ejection port 20 may be located on a common line in the longitudinal direction of the ship. For example, the common line may be a longitudinal center line 3 of the ship with reference to a thickness-wise center of the ship.

[0043] That is, with the front air ejection port 10 and the rear air ejection port 20, the centers of which are located on the center line 3 of the ship, an air layer formed on the ship bottom 1 can be symmetrical with respect to the center line 3 of the ship, thereby preventing unnecessary generation of resistance affecting navigation of the ship while allowing an air layer having a high volume fraction of air to be formed over the ship bottom, including the stern.

[0044] Referring to FIG. 2, assuming the width of the ship is B , the region in which the rear air ejection port 20 is disposed may have a width of $0.5B$ or less, for example, $0.3B$ or less. For example, the width of the region in which the front air ejection port 10 is disposed may be 0.2 to 0.6 times that of the region in which the rear air ejection port 20 is disposed.

[0045] Within this range, the volume fraction of air in an air layer formed over the central region of the ship, including the stern, can be increased with a minimum length of air ejection ports and a minimum amount of air ejected, whereby reduction of frictional resistance can be achieved in a harsh marine environment while reducing fluctuating pressure induced by the propeller and noise from the propeller. Herein, the central region of the ship may refer to the longitudinal center line described above with reference to FIG. 1 and FIG. 2 and a region around the center line.

[0046] When the stern is 0 LOA and the bow is 1.0 LOA with reference to the overall length of the ship, the rear air ejection port 20 may be separated a distance d of 0.1 LOA or less from the front air ejection port 10.

[0047] Within this range, it is possible to effectively increase the volume fraction of air in an air layer formed in an overlapping area between the region in which the rear air ejection port 20 is disposed and the region in which the front air ejection port 10 is disposed, as viewed in the longitudinal direction of the ship.

[0048] Here, the front air ejection port 10 may be disposed between 0.7 LOA and 0.85 LOA.

[0049] Within this range, it is possible to effectively increase the volume fraction of air in the air layer formed over the central region of the ship, including the stern, thereby achieving reduction of frictional resistance in a harsh marine environment with a minimum length of air ejection ports and a minimum amount of air ejected while reducing fluctuating pressure induced by the propeller and noise from the propeller.

[0050] Referring to FIG. 3, through the optimal arrangement of the front air ejection port 10 and the rear air ejection port 20 as described above, an air layer 12 formed by air ejected through the front air ejection port 10 can be incorporated into an air layer 22 formed by air ejected through the rear air ejection port 20, thereby increasing the volume fraction of air in the air layer formed in the central region of the ship extending in the longitudinal direction of the ship.

[0051] In accordance with another aspect of the present invention, there is provided an air lubrication method for ships using an air lubrication system for generating air bubbles on a ship bottom 1, wherein the air lubrication method can increase the volume fraction of air in an air layer formed in a central region of the ship extending in a

longitudinal direction of the ship. Since the components and effects of the air lubrication system for ships described with reference to FIG. 1 to FIG. 3 can be applied to the air lubrication method, repeated description will be omitted.

[0052] In the air lubrication method, air is ejected through both a front air ejection port 10 disposed in a bow region 2 and a rear air ejection port 20 disposed at the rear of the front air ejection port 10 in the bow region 2, wherein an air layer formed by air ejected through the front air ejection port is incorporated into an air layer formed by air ejected through the rear air ejection port 20.

[0053] For example, the front air ejection port 10 and the rear air ejection port 20 may be driven at all times during navigation of the ship, that is, may allow air to be ejected therethrough at all times. As used herein, the term "driven" may mean that the air ejection ports are operated to discharge air therethrough.

[0054] For example, the front air ejection port 10 and the rear air ejection port 20 may be selectively driven depending on marine environments experienced by the ship during navigation.

[0055] For example, in a gentle marine environment in which the wave height falls within a predetermined range, only the rear air ejection port 20 is driven and, in a rough marine environment in which the wave height exceeds the predetermined range, the front air ejection port 10 is further driven, thereby achieving reduction of frictional resistance in a harsh marine environment with maximum energy efficiency and a minimum amount of air ejected while reducing fluctuating pressure induced by the propeller and noise from the propeller.

[0056] A center of the front air ejection port 10 and a center of the rear air ejection port 20 may be located on a longitudinal center line 3 of the ship with reference to a thickness-wise center of the ship, thereby increasing the volume fraction of air in an air layer formed at the central region of the ship extending in the longitudinal direction of the ship.

[0057] The rear air ejection port may be separated a distance of 0.1 LOA or less from the front air ejection port. In addition, assuming the width of the ship is B, the air layer formed by air ejected through the rear air ejection port may have a width of 0.5B or less. Further, assuming a stern is 0 LOA and a bow is 1.0 LOA with reference to the overall

length of the ship, a starting point of the air layer formed by air ejected through the front air ejection port may be located between 0.7 LOA and 0.85 LOA. In this way, it is possible to increase the volume fraction of air in an air layer formed at the central region of the ship extending in the longitudinal direction of the ship and to allow the air layer having a volume fraction of air to extend to the stern, at which the propeller is disposed, thereby reducing fluctuating pressure induced by the propeller and noise from the propeller.

[0058] For example, orifices of each of the front air ejection port 10 and the rear air ejection port 20 may be configured to be reclosable and opening/closing of the orifices of the rear air ejection port 20 may be controlled such that the width of the air layer formed by air ejected through the rear air ejection port 20 is 0.5 B or less.

[0059] For example, the front air ejection port 10 and the rear air ejection port 20 may be disposed through the ship bottom 1 to have predetermined lengths and widths, respectively, wherein orifices of each of the front air ejection port 10 and the rear air ejection port 20 may be configured to be reclosable and opening/closing of the orifices of the front air ejection port 10 may be controlled such that a starting point of the air layer formed by air ejected through the front air ejection port 20 is located between 0.7 LOA to 0.85 LOA.

[0060] FIG. 4 and FIG. 5 show volume fractions of air in air layers formed by air lubrication systems for ships, respectively, as expressed by results of numerical analysis based on computational fluid dynamics. Specifically, FIG. 4 shows a result of numerical analysis of an air lubrication system for ships according to a comparative example and FIG. 5 shows a result of numerical analysis of the air lubrication system for ships according to the embodiments of the present invention.

[0061] Here, "volume fraction of air" refers to a proportion by volume of air in an air layer. A volume fraction of air of 1 indicates that the air layer is fully filled with air, and volume fraction of air of 0 indicates that the air layer is fully filled with water.

[0062] Referring to FIG. 4, in the air lubrication system for ships according to the comparative example, a single air ejection port is disposed such that only one air layer is formed along the length of the ship or multiple air ejection ports are alternately arranged such that air layers formed thereby do not overlap one another, causing difficulty in securing a volume fraction of air over a certain level. Accordingly, the air lubrication

system for ships according to the comparative example has a problem of sudden deterioration in frictional resistance reduction performance due to difficulty in maintaining an appropriate level of volume fraction of air.

[0063] Referring to FIG 5, in the air lubrication system for ships according to the embodiments of the present invention, the front air ejection port and the rear air ejection port are disposed at the center of the ship in the bow region of the ship such that air layers formed thereby overlap each other. Accordingly, the air lubrication system for ships according to the embodiment of the present invention can secure a high volume fraction of air in the central region of the ship, as compared with the air lubrication system for ships according to the comparative example.

[0064] As such, the air lubrication system for ships according to the embodiment of the present invention allows an air layer having a high volume fraction of air to be formed in the central region of the hull bottom, that is, around the center line of the ship, to secure a high level of volume fraction of air, thereby effectively reducing frictional resistance in spite of disturbances at sea, such as tidal currents, sea currents, waves.

[0065] Further, in the air lubrication system of the ship according to the embodiment of the present invention, ejection of air is concentrated in the central region of the ship, thereby allowing an air layer having a high volume fraction of air to move to the stern and to serve as an air cushion covering the propeller disposed at the stern. As a result, cavitation generated by propeller blades can be effectively suppressed and fluctuating pressure and underwater radiated noise induced by generation and collapse of cavitation bubbles can be remarkably reduced. As such, through reduction in fluctuating pressure acting on the propeller blades, operation efficiency of the propeller can be improved, thereby improving energy efficiency of the ship in operation.

[0066] FIG. 6 shows output results of flow analysis of the air lubrication system for ships according to the embodiment of the present invention at a sea state of Beaufort (BF) scale 5, and FIG. 7 shows friction drag of the air lubrication system for ships according to the embodiment of the present invention at a sea state of BF scale 5.

[0067] Referring to FIG. 6 and FIG. 7, the air lubrication system for ships according to the embodiments of the present invention allows a stable air layer to be formed

over the ship bottom, including the stern, even in a harsh marine environment in which the hull undergoes rolling motion.

[0068] FIG. 8 shows the degree of reduction in fluctuating pressure during operation of the air lubrication system for ships according to the embodiments of the present invention, and FIG. 9 shows the degree of net power saving of the air lubrication system for ships according to the embodiments of the present invention in a sea state of BF scale 5 to 8. Specifically, FIG. 8 is a graph comparing fluctuating pressure between Off and On of the air lubrication system (ALS), as measured in a test run thereof, wherein PP1 and PP2 denote measurement points near a transom on the top of the propeller, respectively.

[0069] Referring to FIG. 8, it can be seen that, with the front air ejection port 10 and the rear air ejection port 20 disposed in an overlapping manner at the center of the ship in the bow region 1 as shown in FIG. 1 to FIG. 3, the air lubrication system for ships according to the embodiments of the present invention allows an air layer having a high volume fraction of air to be formed over the central region of the ship, including the stern, whereby an air cushion can be formed over the propeller to suppress cavitation on the propeller surface, thereby effectively reducing fluctuating pressure induced by the propeller.

[0070] In addition, through suppression of cavitation by air delivered to the propeller surface, the air lubrication system for ships according to the embodiments of the present invention can reduce underwater radiated noise from the propeller.

[0071] Further, through air ejection concentrated in the central region of the ship, the air lubrication system for ships according to the embodiments of the present invention, can prevent ejected air from leaking out through an outer surface of the hull even in a harsh marine environment, such as strong tidal currents, rough sea waves, or the like, thereby significantly reducing frictional resistance even in harsh marine environments.

[0072] Referring to FIG. 9, it can be seen that the air lubrication system for ships according to the embodiments of the present invention can achieve net power saving at a sea state of up to BF scale 6.

[0073] Although some embodiments have been described herein, it should be understood that these embodiments are provided for illustration only and are not to be

construed in any way as limiting the present invention. The scope of the present invention should be defined by the appended claims and equivalents thereto.

[0074] For example, the drawings schematically show each component as a subject to aid in understanding, and the thickness, length, number, and the like of each component shown in the drawings may be different from the actual ones depending on the procedure of creating the drawings. In addition, the material, shape, dimensions, and the like of each component described in the above embodiments are given for illustration only and are not to be construed in any way as limiting the present invention, and various changes can be made by those skilled in the art without substantially departing from the spirit and scope of the present invention.

[0075] <List of Reference numeral>

- 1: Ship bottom
- 2: Bow region of ship
- 3: Center line of ship
- 10: Front air ejection port
- 20: Rear air ejection port
- 11: Width of front air ejection port
- 21: Width of rear air ejection port
- 12: Air layer formed by front air ejection port
- 22: Air layer formed by rear air ejection port

What is claimed is:

1. An air lubrication system for ships adapted to generate air bubbles on a ship bottom, the air lubrication system comprising:
 - a front air ejection port disposed in a bow region of a ship; and
 - a rear air ejection port disposed at the rear of the front air ejection port in the bow region of the ship,wherein the front air ejection port and the rear air ejection port extend predetermined lengths, respectively, in a transverse direction of the ship, and
 - a region in which the front air ejection port is disposed and a region in which the rear air ejection port is disposed share an overlapping area in a longitudinal direction of the ship.
2. The air lubrication system according to claim 1, wherein, when viewed in the longitudinal direction of the ship, the region in which the front air ejection port is disposed is present in the region in which the rear air ejection port is disposed.
3. The air lubrication system according to claim 2, wherein, assuming a width of the ship is B, the region in which the rear air ejection port is disposed has a width of 0.5 B or less.
4. The air lubrication system according to claim 2, wherein a center of the front air ejection port and a center of the rear air ejection port are located on a common line in the longitudinal direction of the ship.
5. The air lubrication system according to claim 4, wherein the common line is a longitudinal center line of the ship with reference to a thickness-wise center of the ship.
6. The air lubrication system according to claim 3, wherein, assuming a stern is 0 LOA and a bow is 1.0 LOA with reference to the overall length of the ship, the rear air ejection port is separated a distance of 0.1 LOA or less from the front air ejection port.

7. The air lubrication system according to claim 6, wherein the front air ejection port is disposed between 0.7 LOA and 0.85 LOA.

8. An air lubrication method for ships using an air lubrication system for generating air bubbles on a ship bottom, the method comprising: ejecting air through a front air ejection port disposed in a bow region of a ship and a rear air ejection port disposed at the rear of the front air ejection port in the bow region of the ship, wherein an air layer formed by air ejected through the front air ejection port is incorporated into an air layer formed by air ejected from the rear air ejection port to increase the volume fraction of air in an air layer formed in a central region of the ship extending in a longitudinal direction of the ship.

9. The air lubrication method according to claim 8, wherein a center of the front air ejection port and a center of the rear air ejection port are located on a longitudinal center line of the ship with reference to a thickness-wise center of the ship to increase the volume fraction of air in the air layer formed in the central region of the ship extending in the longitudinal direction of the ship.

10. The air lubrication method according to claim 9, wherein:

the rear air ejection port is separated a distance of 0.1 LOA or less from the front air ejection port;

the air layer formed by air ejected through the rear air ejection port has a width of 0.5B or less assuming a width of the ship is B; and

a starting point of the air layer formed by air ejected through the front air ejection port is located between 0.7 LOA and 0.85 LOA, assuming a stern is 0 LOA and a bow is 1.0 LOA with reference to the overall length of the ship.