

AIR LUBRICATION SYSTEM FOR SHIPS

FIELD

[0001] The present invention relates to an air lubrication system, and more particularly to an air lubrication system for ships, which can reduce frictional resistance of a ship by ejecting compressed air to a ship bottom.

BACKGROUND

[0002] During navigation, a ship is generally affected by frictional resistance between a hull surface and water. Since such frictional resistance occupies most resistance applied to the hull, reduction in frictional resistance becomes a very important issue with increasing hull size.

[0003] As an example of energy saving technology, an air lubrication technology reduces frictional resistance by supplying air bubbles to the bottom of the hull. Due to substantial effects in energy saving, the air lubrication technology is known to be very effective in suppression of carbon dioxide emission from a ship through reduction in engine load of the ship.

[0004] Since frictional resistance of the ship is proportional to a submerged surface area thereof, the air lubrication technology reduces the submerged surface area, on which water contacts the hull surface, by forming an air layer on the hull surface, thereby reducing the frictional resistance of the hull.

[0005] Since formation of the air layer is greatly affected by hull movement according to a navigation speed of the ship and sea conditions, it is necessary to ensure uniform supply of air to the bottom of the ship even under various navigation speeds and hull movements in order to reduce frictional resistance through stable formation of the air layer.

[0006] Moreover, continuous compression and supply of air to the bottom of the hull is performed in order to form and maintain a stable air layer on the bottom of the hull, thereby inevitably consuming a significant amount of energy in a compressor that

compresses air. Therefore, there is a need for a solution that can save energy for generation of compressed air used in the air lubrication system.

[0007] It should be noted that the above description is provided for understanding of the background of the invention and is not a description of a well-known conventional technique in the art to which the present invention pertains.

SUMMARY

[0008] It is an object of the present disclosure to provide an air lubrication system for ships, which ejects compressed air to a surface of a ship bottom in order to reduce frictional resistance generated upon navigation of a ship and can reduce power consumption in operation of a compressor adapted to generate the compressed air.

[0009] In accordance with one aspect of the present disclosure, an air lubrication system for ships adapted to reduce frictional resistance applied to a hull of a ship during navigation of the ship includes: multiple air chambers disposed on a ship bottom; and a main supply line adapted to supply compressed air to the multiple air chambers, wherein at least part of scavenge air to be supplied to the main engine is supplied to the multiple air chambers, further comprising: an air compressor disposed on the main supply line upstream of a connection point of a scavenge air bypass line to the main supply line and generating compressed air; and a first valve disposed between the air compressor and the connection point of the scavenge air bypass line to the main supply line, wherein the ship is provided with a turbocharger compressing suctioned air using an emission gas discharged from the main engine and a scavenge air supply line connecting the turbocharger to the main engine to supply the compressed air as scavenge air of the main engine, and further comprises the scavenge air bypass line branched off of the scavenge air supply line and connected to the main supply line, wherein when the amount of the scavenge air supplied to the main supply line through the scavenge air bypass line is small or when pressure of air supplied to the multiple air chambers is low, the air compressor is

operated and the first valve is open to provide a sufficient amount of the compressed air to mix with the scavenge air to form a stream of air, and the stream of air is applied to the multiple air chambers through the main supply line.

[0010] The ship may be provided with a turbocharger compressing suctioned air using an emission gas discharged from the main engine and a scavenge air supply line connecting the turbocharger to the main engine to supply the compressed air as scavenge air of the main engine.

[0011] The ship may further include a scavenge air bypass line branched off of the scavenge air supply line and connected to the main supply line.

[0012] The ship may further include an air cooler disposed on the main supply line and cooling the air supplied to the multiple air chambers.

[0013] The scavenge air bypass line may be disposed upstream of the cooler on the main supply line.

[0014] The ship may further include: an air compressor disposed on the main supply line upstream of a connection point of the scavenge air bypass line to the main supply line and generating compressed air; and a first valve disposed between the

connection point of the scavenge air bypass line to the main supply line and the air compressor.

[0015] The scavenge air supply line may be provided with a cooler cooling the air compressed through the turbocharger and a scavenge air receiver disposed downstream of the cooler and storing the scavenge air.

[0016] The scavenge air bypass line may be branched between the cooler and the scavenge air receiver.

[0017] The ship may further include a scavenge valve disposed on the scavenge air bypass line and controlling supply of the scavenge air to the main supply line.

[0018] The scavenge valve may be controlled to be shut off in an IMO Nox III Mode or under low load conditions of the main engine.

[0019] The ship may further include: an overboard discharge line branched off of the main supply line and adapted to discharge the compressed air from the ship instead of supplying the compressed air to the multiple air chambers; and a blow-off valve disposed on the overboard discharge line.

[0020] According to examples of the present disclosure, the air lubrication system for ships ejects compressed air to the surface of the ship bottom in order to reduce frictional resistance during navigation of the ship and supplies at least part of scavenge air to the multiple air chambers instead of supplying all of the scavenge air to the main engine in order to reduce power consumption through reduction in operation time of the air compressor.

[0021] In addition, according to the examples of the present disclosure, the scavenge valve is disposed on the scavenge air bypass line branched off of the scavenge air supply line to open or close the scavenge air bypass line as needed, thereby protecting the main engine while minimizing inefficient operation thereof.

DRAWINGS

[0022] 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:

[0023] FIG. 1 is a schematic view of a typical air lubrication system for ships;
and

[0024] FIG. 2 is a schematic view of an air lubrication system for ships
according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0025] Hereinafter, embodiments of the present invention will be described in
detail with reference to the accompanying drawings. Like components will be denoted by
like reference numerals throughout the specification.

[0026] FIG. 2 is a schematic view of an air lubrication system for ships
according to one embodiment of the present invention.

[0027] Referring to FIG. 2, an air lubrication system for ships according to one
embodiment of the present invention includes multiple air chambers 10 and an air supply
unit 20.

[0028] The multiple air chambers 10 may be disposed on a ship bottom and
may be provided with multiple air outlets (not shown), through which air is discharged to
the surface of the ship bottom, respectively.

[0029] Referring to FIG. 2, the air supply unit 20 may include an air compressor
21 generating compressed air, a main supply line L1 connected to the air compressor 21
to supply the compressed air to the multiple air chambers 10, and a first valve 22 disposed on
the main supply line L1.

[0030] The air lubrication system according to the embodiment may supply
compressed air to the multiple air chambers 10 through the air supply unit 20 and may form
an air layer on the surface of the ship bottom through air bubbles formed thereon to reduce
frictional resistance of a hull.

[0031] Here, the ship inevitably suffers from significant energy consumption
upon continuous operation of the air compressor 21 for stable formation of the air layer on
the surface of the ship bottom.

[0032] Specifically, a separate air compressor is disposed inside the hull to eject
compressed air to the surface of the ship bottom and requires large quantities of power for
operation of the compressor, thereby counteracting the effects of the air lubrication system

which reduces power consumption through reduction in frictional resistance applied to the hull.

[0033] That is, the ship suffers reduction in energy efficiency due to significant power consumption due to continuous operation of a large capacity compressor corresponding to the quantity of power reduced through reduction in frictional resistance applied to the hull by forming air bubbles on the surface of the ship bottom during navigation of the ship.

[0034] Referring to FIG. 2, an emission gas discharged from a main engine ME of the ship is stored in an emission gas receiver ER and at least part of the emission gas discharged from the emission gas receiver ER may be supplied to a turbocharger TC.

[0035] The turbocharger TC serves to compress suctioned air using the emission gas discharged from the main engine ME and may generate drive force of a turbine (not shown) using pressure of the emission gas.

[0036] In this embodiment, the turbocharger TC may be connected to the main engine ME via a scavenge air supply line L2.

[0037] The scavenge air supply line L2 may serve to supply the air compressed through the turbocharger TC as scavenge air of the main engine ME.

[0038] Here, since the air suctioned through the turbocharger TC generates heat in the course of compression, the scavenge air supply line L2 may be provided with a cooler C to cool the air compressed through the turbocharger TC.

[0039] In addition, a scavenge air receiver SR adapted to store the scavenge air may be disposed downstream of the cooler C on the scavenge air supply line L2.

[0040] That is, the air compressed through the turbocharger TC may be cooled through the cooler C and supplied to the scavenge air receiver SR.

[0041] The air lubrication system according to the embodiment ejects the compressed air to the surface of the ship bottom in order to reduce frictional resistance during navigation of the ship and supplies at least part of the scavenge air to the multiple air chambers 10 instead of the main engine ME in order to reduce power consumption through reduction in operation time of the air compressor 21.

[0042] The air lubrication system according to the embodiment may further include a scavenge air bypass line L3 branched off of the scavenge air supply line L2 and connected to the main supply line L1.

[0043] Preferably, the scavenge air bypass line L3 is branched off of the scavenge air supply line L2 between the cooler C and the scavenge air receiver SR disposed on the scavenge air supply line L2.

[0044] The air lubrication system according to the embodiment may further include an air cooler 23 disposed on the main supply line L1 and cooling air supplied to the multiple air chambers 10.

[0045] Here, the scavenge air bypass line L3 is preferably disposed upstream of the air cooler 23 on the main supply line L1.

[0046] In addition, a scavenge valve 30 may be disposed on the scavenge air bypass line L3 to control supply of the scavenge air to the main supply line L1.

[0047] For reference, in accordance with MARPOL ANNEX VI Regulation 13 amendment, for keel-mounted vessels after January 1, 2016, the main engine and diesel generator engines must satisfy IMO NOx Tier III upon operation in an emission control area (ECA).

[0048] The scavenge valve 30 may control supply of the scavenge air in the IMO NOx Tier III Mode or under low load conditions of the main engine ME.

[0049] Here, the IMO NOx Tier III Mode may mean a navigation mode for satisfaction of IMO NOx Tier III upon operation in the emission control area.

[0050] According to this embodiment, the scavenge valve 30 opens or closes the scavenge air bypass line L3, as needed, thereby not only protecting the main engine ME but also minimizing inefficient operation.

[0051] As shown in FIG. 2, in the air lubrication system according to the embodiment, the air compressor 21 may be disposed (installed) on the main supply line L1 upstream of a connection point of the scavenge air bypass line L3 to the main supply line L1, and the first valve 22 may be disposed on the main supply line L1 between the air compressor 21 and the connection point of the scavenge air bypass line L3 to the main supply line L1.

[0052] Here, the first valve 22 may serve to control compressed air generated in the air compressor 10 to be supplied to the multiple air chambers 10.

[0053] When the scavenge air is supplied to the main supply line L1 through the scavenge air bypass line L3, the air lubrication system according to the embodiment closes the first valve 22 to stop operation of the air compressor 210.

[0054] In addition, when the amount of the scavenge air supplied to the main supply line L1 through the scavenge air bypass line L3 is small or when the pressure of air supplied to the multiple air chambers 10 is low, the air lubrication system opens the first valve 22 to operate the air compressor 21 such that a sufficient amount of compressed air can be supplied to the multiple air chambers 10.

[0055] In this embodiment, the air compressor 21 may be disposed in a front deck warehouse or may be disposed in an engine room (not shown) or on a main deck above the engine room in consideration of an installation location of the main engine ME.

[0056] The air supply unit 20 may further include multiple assistant lines SL1 connected to the main supply line L1 in parallel and multiple parallel lines SL2 branched off of each of the multiple assistant lines SL1 and connected to the multiple air chambers 10 in parallel.

[0057] As shown in FIG. 2 the multiple air chambers 10 are connected in parallel to the multiple assistant lines LS1 to form at least one group and each of the multiple assistant lines LS1 may be provided with a flow meter 24 and a second valve 25.

[0058] The second valve 25 serves to control the flow rate of air supplied from the assistant lines SL1 to the parallel lines SL2 and may be disposed downstream of the flow meter 24 on the assistant lines LS1.

[0059] Further, as in the multiple assistant lines LS1, each of the multiple parallel lines SL2 may be provided with a flow meter (not shown) and a third valve 26.

[0060] In this embodiment, each of the second valve 25 and the third valve 26 may include an electronically controlled valve (not shown).

[0061] The air lubrication system according to the embodiment may further include an overboard discharge line L4 branched off of the main supply line L1 and adapted to discharge the compressed air from the hull, instead of supplying the compressed air to

the multiple air chambers 10, and a blow-off valve 27 disposed on the overboard discharge line L4.

[0062] As shown in FIG. 2, the overboard discharge line L4 may be disposed upstream of the multiple air chambers 10. Preferably, the overboard discharge line L4 is disposed downstream of the air cooler 23 on the main supply line L1.

[0063] According to this embodiment, the blow-off valve 27 may be controlled to discharge the compressed air to the outside of the hull, that is, to the atmosphere, instead of supplying the compressed air to the multiple air chambers 10, when the ship is at anchor or turns.

[0064] The air lubrication system according to the embodiment can reduce frictional resistance during navigation of the ship by ejecting the compressed air to the surface of the ship bottom to and can reduce power consumption through reduction in operation time of the air compressor 21 by supplying at least part of scavenge air to the multiple air chambers instead of supplying all of the scavenge air to the main engine ME.

[0065] In addition, the scavenge valve 30 is disposed on the scavenge air bypass line branched off of the scavenge air supply line to open or close the scavenge air bypass line, as needed, thereby not only protecting the main engine but also minimizing inefficient operation.

[0066] Although some embodiments have been described herein, it should be understood by those skilled in the art that that various modifications, variations, and alterations can be made by those skilled in the art without departing from the spirit and scope of the present invention. Therefore, it should be understood that the above embodiments and the accompanying drawings are given by way of illustration only and the present invention is not intended to be unduly limited thereby. The scope of the present invention should be defined by the appended claims and equivalents thereto.

[0067] <List of Reference Numeral>

10: Air chamber	20: Air supply unit
21: Air compressor	22: First valve
23: Air cooler	24: Flow meter
25: Second valve	26: Third valve
27: Blow-off valve	30: scavenge valve

C: Cooler	ER: Emission gas receiver
ME: Main engine	SR: Scavenge air receiver
TC: Turbocharger	L1: Main supply line
L2: Scavenge air supply line	L3: Scavenge air bypass line
L4: Overboard discharge line	SL1: Assistant line
SL2: Parallel line	

What is claimed is:

1. An air lubrication system for ships adapted to reduce frictional resistance applied to a hull of a ship during navigation of the ship, the air lubrication system comprising:

multiple air chambers disposed on a ship bottom; and
a main supply line adapted to supply compressed air to the multiple air chambers,
wherein at least part of scavenge air to be supplied to a main engine is supplied to the multiple air chambers,

further comprising:
an air compressor disposed on the main supply line upstream of a connection point of a scavenge air bypass line to the main supply line and generating compressed air; and
a first valve disposed between the air compressor and the connection point of the scavenge air bypass line to the main supply line,

wherein the ship is provided with a turbocharger compressing suctioned air using an emission gas discharged from the main engine and a scavenge air supply line connecting the turbocharger to the main engine to supply the compressed air as scavenge air of the main engine, and further comprises the scavenge air bypass line branched off of the scavenge air supply line and connected to the main supply line,

wherein when the amount of the scavenge air supplied to the main supply line through the scavenge air bypass line is small or when pressure of air supplied to the multiple air chambers is low, the air compressor is operated and the first valve is open to provide a sufficient amount of the compressed air to mix with the scavenge air to form a stream of air, and the stream of air is applied to the multiple air chambers through the main supply line.

2. The air lubrication system for ships according to claim 1, further comprising:

an air cooler disposed on the main supply line and cooling the air supplied to the multiple air chambers,

wherein the scavenge air bypass line is disposed upstream of the cooler on the main supply line.

3. The air lubrication system for ships according to claim 1, wherein the scavenge air supply line is provided with a cooler cooling the air compressed through the turbocharger and a scavenge air receiver disposed downstream of the cooler and storing the scavenge air,

the scavenge air bypass line being branched between the cooler and the scavenge air receiver.

4. The air lubrication system for ships according to claim 1, further comprising:
a scavenge valve disposed on the scavenge air bypass line and controlling supply of the scavenge air to the main supply line.

5. The air lubrication system for ships according to claim 4, wherein the scavenge valve is controlled to be shut off in an IMO Nox Tier III Mode or under low load conditions of the main engine.

6. The air lubrication system for ships according to claim 1, further comprising:
an overboard discharge line branched off of the main supply line and adapted to discharge the compressed air from the ship instead of supplying the compressed air to the multiple air chambers; and

a blow-off valve disposed on the overboard discharge line.