

SHIP ENGINE OPERATING METHOD

【TECHNICAL FIELD】

[1] The present invention relates to a ship engine operation method for a ship equipped with multiple engines.

【BACKGROUND ART】

[2] Among engines used in ships, a dual fuel (DF) engine can use natural gas as fuel. The DF engine is an engine capable of being fueled by both natural gas and fuel oil and may be divided into a four-stroke power generation engine and a two-stroke main propulsion engine.

[3] The four-stroke power generation engine is commonly called a DF engine and is connected to a generator and thus the load thereof depends on the generator. When equipment associated with the generator requires more electric power, torque required for the generator increases and rpm of the generator thus decreases. As a result, a governor of the engine injects more fuel into the engine to compensate for reduction in rpm, such that the rotational speed of the engine is maintained at a previous level. That is, the load of the engine depends on the rotational speed and torque of the engine, and is adjusted by adjusting the torque of the engine while maintaining the rotational speed of the engine at a constant level. Such a four-stroke DF engine uses an Otto cycle, in which fuel and combustion air are compressed by a piston moving upward.

[4] Examples of the two-stroke main propulsion DF engine include X-DF engines, ME-GI engines and the like, and such a two-stroke main propulsion DF engine is used to propel a ship and thus is connected to a propeller rather than to a generator. The two-stroke DF engine uses a diesel cycle, in which a fuel is injected directly into a combustion chamber near the top dead point of a piston. The ME-GI engine, which is a high-pressure two-stroke DF engine, is fueled by natural gas at a high pressure of about 300 bar to about 350 bar.

[5] On the other hand, a 34DF engine is characterized by being operated by evenly and alternately igniting plural cylinders rather than by continuously igniting a specific cylinder among the plural cylinders.

【DISCLOSURE】

【Technical Problem】

[6] In the field of ships equipped with multiple engines capable of being fueled by both natural gas and fuel oil, efforts have been made to minimize engine fuel costs, such as how to adjust loads of multiple engines, in what ratio natural gas and fuel oil are supplied, and the like.

[7] Recently, as a way to reduce engine fuel costs, there have been developed a skip firing technique, that is, a method in which, when an engine is operated at a low load, some cylinders in the engine are inactivated to increase the loads of the other cylinders in operation.

[8] It is an aspect of the present invention to provide a ship engine operation method which allows both efficient engine operation and reduction in fuel costs by integrating such a skip firing technique into operation of multiple engines.

【Technical Solution】

[9] In accordance with one aspect of the present invention, there is provided a ship engine operation method for a ship equipped with multiple engines, the ship engine operation method including: step 1) in which, when load demand of the ship is greater than or equal to 90% and less than or equal to 125%, one engine is operated in a skip firing mode, another engine is operated in a normal mode, and the other engines are idled.

[10] The engine operating in the skip firing mode may carry a constant load of 25% or less and the engine operating in the normal mode may carry the remaining load demand of the ship and a variation in load demand of the ship.

[11] The ship engine operation method may further include: step 2) in which, when the load demand of the ship changes from 125% or less to greater than 125%, the engine operating in the skip firing mode (hereinafter referred to as a "first engine") temporarily carries a portion of the load demand exceeding 125% and then one idled engine (hereinafter referred to as a "third engine") is started; and step 3) in which the first engine is operated in the skip firing mode at a load of 25% or less again and the engine operating in the normal mode (hereinafter referred to as a "second engine") and the third engine carry the remaining load demand of the ship.

[12] In step 2), the first engine may be temporarily operated in the normal mode upon temporarily carrying the portion of the load demand exceeding 125% and, in step 3), the second engine and the third engine may be operated in the normal mode.

[13] In step 3), the second engine and the third engine may equally share the remaining load demand of the ship.

[14] The ship engine operation method may further include: step 4) in which, when the load demand of the ship, having exceeded 125%, begins to decrease, loads of the second engine and the third engine are gradually reduced; and step 5) in which, when the load demand of the ship decreases to 125% or less, the third engine is stopped.

[15] In step 4), the first engine may be operated in the skip firing mode.

[16] In step 4), the second engine and the third engine may equally share the remaining load demand of the ship.

[17] In step 5), the first engine may carry a constant load of 25% or less in the skip firing mode and the second engine may carry the remaining load demand of the ship and a variation in load demand of the ship.

[18] In step 5), the second engine may be operated in the normal mode.

[19] The ship may include four engines capable of operation in the skip firing mode, wherein one engine is on standby and the other three engines are normally operated.

[20] The multiple engines may be 34DF engines.

[21] In accordance with another aspect of the present invention, there is provided a ship engine operation method for a ship equipped with multiple engines, wherein

one engine is operated in a skip firing mode at a load of 25% or less and the other engines are idled or are operated in a normal mode at a load of greater than 25%.

[22] The engine operating in the skip firing mode may remain at a constant load and an engine operating in the normal mode may carry the remaining load demand of the ship and a variation in load demand of the ship.

[23] The engine operating in the normal mode may include plural engines, wherein the plural engines may equally share the remaining load demand of the ship.

【Advantageous Effects】

[24] According to the present invention, an engine can achieve improvement in fuel efficiency without affecting the lifespan and maintenance cycle of the engine while significantly reducing emission of harmful substances, such as greenhouse gases, CO and NO_x.

【DESCRIPTION OF DRAWINGS】

[25] FIG. 1 is a graph depicting one exemplary embodiment of the present invention in which two engines are operated.

【BEST MODE】

[26] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. A ship employing a ship engine operation method according to the present invention may include various ships such as LNG carriers, LNG-fueled ships, drilling ships, and offshore structures. Although an engine to which the ship engine operation method according to the present invention is applied may be a 34DF engine, it should be understood that the present invention is not limited thereto and may be applied to any engines capable of being fueled by both fuel oil and natural gas. It should be understood that the following embodiments can be modified in various ways and do not limit the scope of the present invention.

[27]

[28] A ship engine operation method according to one embodiment of the present invention includes step 1) in which, when load demand of a ship is greater than or equal to 90% and less than or equal to 125%, one of multiple engines is operated in a skip firing mode, another engine is operated in a normal mode, and the other engines are idled.

[29] When the load demand of the ship is 25% or less, it is desirable that only one engine be driven to operate in the skip firing mode. In addition, when the load demand of the ship is greater than 25% and less than 90%, only one engine may be driven to carry the entire load demand of the ship in the normal mode, or two engines may be driven such that one engine operates in the skip firing mode at a load of 25% or less and the other engine operates in the normal mode to carry the remaining load demand of the ship.

[30] In the ship engine operation method according to this embodiment, an engine in the skip firing mode may operate at a load of 25% or less, and an engine in the normal mode may operate at a load of greater than 25%. The engine operating in the normal mode carries the entire load demand of the ship, excluding a share of the load demand carried by the engine operating in the skip firing mode, and preferably also carries a variation in load demand of the ship. Herein, the variation in load demand of the ship means that the load demand of the ship continues to vary depending on the operational conditions of the ship.

[31] Herein, the load demand of the ship is expressed based on the assumption that a maximum load of one engine is 100%. For example, if the load demand of the ship is 200%, this means that two engines need to operate at maximum load.

[32] Although the number of engines mounted in the ship is not particularly restricted, the ship generally includes four engines capable of operation in the skip firing mode, wherein one engine is on standby and the other three engines are normally used. Now, the present invention will be described using an example in which the ship engine operation method according to this embodiment is applied to three engines. It will be understood that, although the terms "first engine", "second engine", and "third engine" are used herein, these terms are only used to distinguish

one engine from the other engines and neither indicates a specific installation order nor represents specific engines in each step of the ship engine operation method.

[33] For example, the explanation that, in step 1), a first engine is operated at a load of 100%, a second engine is operated at a load of 25%, and a third engine is operated at a load of 100% and, in step 2), the first engine is operated at a load of 100%, the second engine is operated at a load of 60%, and the third engine is operated at a load of 100% means that, in step 1), any one of the three engines is operated at a load of 25% and, in step 2), any one of the three engines is operated at a load of 60%, rather than necessarily meaning that the engine operating at a load of 25% in step 1) is the same as the engine operating at a load of 60% in step 2).

[34]

[35] FIG. 1 is a graph depicting one exemplary embodiment of the present invention in which two engines are operated. In FIG. 1, X denotes a time point where a low load optimization sharing mode is activated (On) and Y denotes a time point where the low load optimization sharing mode is inactivated (Off). Herein, the low load optimization sharing mode refers to a mode in which one of multiple engines is operated at a load of 25% or less.

[36] Referring to FIG. 1, for example, when the load demand of the ship is about 120%, the two engines may each operate at a load of about 60% (before X and after Y), or the low load optimization sharing mode may be activated such that one engine operates at a load of 25% or less, as shown in graph b of FIG. 1, and the other engine carries the remaining load, as shown in graph a of FIG. 1 (between X and Y).

[37] In addition, in the ship engine operation method according to this embodiment, an engine intended to operate at a load of 25% or less may be operated in the skip firing mode, as shown in graph b of FIG. 1, and an engine intended to carry the remaining load may be operated in the normal mode to also carry a variation in load demand of the ship, as shown in graph a of FIG. 1.

[38]

[39] The ship engine operation method according to this embodiment may further include: step 2) in which, when the load demand of the ship changes from 125% or less to greater than 125%, the engine operating in the skip firing mode (hereinafter

referred to as a "first engine") temporarily carries a portion of the load demand exceeding 125% and the idled engine (hereinafter referred to as a "third engine") is started; and step 3) in which the first engine is operated in the skip firing mode again at a load of 25% or less and the engine operating in the normal mode (hereinafter referred to as a "second engine") and the third engine carry the remaining load demand of the ship.

[40] Now, steps 2) and 3) will be described using an example in which the load demand of the ship changes from about 120% to about 150% while the second engine is operated in the normal mode at a load of about 98% and the first engine is operated in the skip firing mode at a load of about 22%.

[41] In step 2), the second engine remains in the normal mode at a load of about 98%. The first engine is switched from the skip firing mode to the normal mode and is operated at a load of about 52% to further carry a load of about 30%, that is, an increase in load demand of the ship, and the third engine is started. However, the first engine is just temporarily operated in the normal mode to carry the increase in load demand, and the process immediately proceeds to step 3) in which the first engine is operated in the skip firing mode at a load of 25% or less and the second and third engines carry the remaining load demand of the ship.

[42] In step 3), the second engine and the third engine are preferably operated in the normal mode and may equally share the remaining load demand of the ship. For example, when the load demand of the ship is about 150% and the first engine is operated at a load of about 22%, the second and third engines may each be operated at a load of about 64%.

[43]

[44] If the load demand of the ship exceeds 225%, it is desirable that all the three engines be operated in the normal mode. Although the three engines may equally share the load demand of the ship, it is desirable that some engines be operated at a maximum load and the other carry the remaining load demand of the ship in order to reduce fuel costs. For example, when the load demand of the ship is 260%, it is desirable that the first to third engines be operated at a load of 100%, 60%, and 100%, respectively.

[45] If the load demand of the ship decreases to 225% or less, it is desirable that the first engine be operated in the skip firing mode at a load of 25% or less and the second and third engines carry the remaining load demand of the ship. Preferably, an engine carrying the least share of the load demand of the ship when the load demand of the ship exceeds 225% is operated in the skip firing mode when the load demand of the ship decreases to 225% or less, without being limited thereto. In addition, the second and third engines are preferably operated in the normal mode to equally share the remaining load demand of the ship. Further, it is desirable that the loads of the three engines be gradually and alternately reduced toward respective target load values, rather than being reduced all at once.

[46]

[47] The ship engine operation method according to this embodiment may further include: step 4) in which, when the load demand of the ship, having exceeded 125%, begins to decrease, loads of the second and third engines are gradually reduced; and step 5) in which, when the load demand of the ship decreases to 125% or less, the third engine is stopped.

[48] When the load demand of the ship, having exceeded 125%, begins to decrease, the loads of the second and third engines are gradually reduced, and, when the load demand of the ship decreases to 125% or less and thus one engine can carry the remaining load demand of the ship even though another engine is operated in the skip firing mode and the other engine is stopped, the third engine is stopped.

[49] In step 4), the first engine may be operated in the skip firing mode. In addition, it is desirable that the second and third engines be operated in the normal mode to equally share the remaining load demand of the ship.

[50] In step 5), the second engine may be operated in the normal mode. In addition, the first engine operating in the skip firing mode may carry a constant load of 25% or less and the second engine may carry both the remaining load demand of the ship and a variation in load demand of the ship.

[51] In steps 4) and 5), preferably, the loads of the three engines are also reduced in a gradual and alternate manner toward respective target load values, rather than being reduced all at once, and then the third engine is stopped.

[52]

[53] 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, and that various modifications, changes, alterations, and equivalent embodiments can be made by those skilled in the art without departing from the spirit and scope of the invention.

【CLAIMS】**【Claim 1】**

A ship engine operation method for a ship equipped with multiple engines, comprising:
step 1) in which, when load demand of the ship is greater than or equal to 90% and less than or equal to 125%, one engine is operated in a skip firing mode, another engine is operated in a normal mode, and the other engines are idled, and

when load demand of the ship is less than or equal 225%, at least one of the multiple engines operating in the skip firing mode, and when load demand of the ship is greater than 225%, all of the engines operated are operated in a normal mode.

【Claim 2】

The ship engine operation method according to claim 1, further comprising:

step 2) in which, when the load demand of the ship changes from 125% or less to greater than 125%, the engine operating in the skip firing mode (hereinafter referred to as a "first engine") temporarily carries a portion of the load demand exceeding 125% and then one idled engine (hereinafter referred to as a "third engine") is started; and

step 3) in which the first engine is operated in the skip firing mode at a load of 25% or less again and the engine operating in the normal mode (hereinafter referred to as a "second engine") and the third engine carry the remaining load demand of the ship.

【Claim 3】

The ship engine operation method according to claim 2, wherein, in step 2), the first engine is temporarily operated in the normal mode upon temporarily carrying the portion of the load demand exceeding 125% and, in step 3), the second engine and the third engine are operated in the normal mode.

【Claim 4】

The ship engine operation method according to claim 3, wherein, in step 3), the second engine and the third engine equally share the remaining load demand of the ship.

【Claim 5】

The ship engine operation method according to claim 2, further comprising:

step 4) in which, when the load demand of the ship, having exceeded 125%, begins to

decrease, loads of the second engine and the third engine are gradually reduced; and

step 5) in which, when the load demand of the ship decreases to 125% or less, the third engine is stopped.

【Claim 6】

The ship engine operation method according to claim 5, wherein, in step 4), the first engine is operated in the skip firing mode.

【Claim 7】

The ship engine operation method according to claim 5, wherein, in step 4), the second engine and the third engine equally share the remaining load demand of the ship.

【Claim 8】

The ship engine operation method according to claim 5, wherein, in step 5), the first engine carries a constant load of 25% or less in the skip firing mode and the second engine carries the remaining load demand of the ship and a variation in load demand of the ship.

【Claim 9】

The ship engine operation method according to claim 8, wherein, in step 5), the second engine is operated in the normal mode.

【Claim 10】

The ship engine operation method according to any one of claims 1 to 9, wherein the ship comprises four engines capable of operation in the skip firing mode, one engine being on standby and the other three engines being normally operated.

【Claim 11】

The engine operation method according to any one of claims 1 to 9, wherein the multiple engines are 34DF engines.