

DESCRIPTION

METHOD AND APPARATUS FOR PREVENTION OF SCUFFING IN
INTERNAL COMBUSTION ENGINE FOR VESSEL

Technical Field

[0001]

The present invention relates to a method and an apparatus for prevention of scuffing in an internal combustion engine for a vessel.

Background Art

[0002]

Generally with respect to an internal combustion engine for a vessel, fuel stored in a fuel tank is pumped by a fuel pump and is supplied through fuel injection valves into respective cylinders in the engine.

[0003]

General technical level on fuel supply to an internal combustion engine for a vessel is disclosed, for example, in Patent Literature 1.

[Patent Literature 1] JP 2004-308528A

Summary of Invention

Technical Problems

[0004]

When an engine speed is varied, for example, upon arrival in or leaving from a port or during passage through a canal, a sliding state of a piston ring becomes severe against a cylinder liner, resulting in scratches on a sliding surface of the liner. This tends to cause so-called scuffing during succeeding operations; however, conventionally no special consideration has been taken during such engine speed variation.

[0005]

Moreover, fuel contains hard ceramic particles such as alumina and silica used as reforming catalysts for the fuel, so that evacuation of the fuel reduced in stored quantity in a fuel tank through a bottom of the tank also brings about evacuation of high concentration of hard particles deposited on the bottom of the tank together with the fuel. The evacuated hard particles, which cannot be completely removed by a fuel purifier or filter, enter in large quantity into the engine. Especially when the hard particles enter in large quantity into the engine during engine speed variation, the sliding state of the piston ring becomes further severe against the cylinder liner, resulting in formation of initiation points of scuffing. And, disadvantageously, scuffing is generated in succeeding high-load operations.

[0006]

The invention was made in view of the above and has its object to provide a method and an apparatus for prevention of scuffing in an internal combustion engine for a vessel which can alleviate a sliding state of a piston ring from becoming severe against a cylinder liner during engine speed variation and can prevent generation of scuffing.

Solution to Problems

[0007]

The invention is directed to a method for prevention of scuffing in an internal combustion engine for a vessel wherein fuel stored in a fuel tank is evacuated, is pumped by a fuel pump and is supplied through fuel injection valves into respective cylinders in the engine,

the method which comprises detecting and monitoring an engine speed, fuel with fuel level higher than a preset value being supplied into the respective cylinders in the engine while a scuffing inhibitor is supplied into the respective cylinders.

[0008]

In the above-mentioned construction, the engine speed is detected and monitored, the fuel with the fuel level higher than the preset value and with a low concentration

of hard particles being supplied into the respective cylinders in the engine while the scuffing inhibitor is supplied into the respective cylinders.

[0009]

As a result, during engine speed variation, the hard particles are prevented from entering in large quantity into the engine while the scuffing inhibitor is supplied into the respective cylinders in the engine, so that the sliding state of the piston ring is alleviated from becoming severe against the cylinder liner and initiation points of scuffing become hard to form and no scuffing is generated in the succeeding high-load operations.

[0010]

In said prevention method, a plurality of fuel tanks may be provided for evacuation of the fuel from any desired fuel tank; if there exists the fuel tank with the fuel level being reduced below the preset value, the fuel can be supplied into the respective cylinders in the engine preferentially from said fuel tank with the fuel level being reduced below the preset value during stable engine speed; during engine speed variation, the fuel can be supplied into the respective cylinders in the engine from the fuel tank with the fuel level being higher than the preset value.

[0011]

In said prevention method, said scuffing inhibitor may be lubricant injected into the respective cylinders in the engine, lubricant injection rate being increased during engine speed variation.

[0012]

In said prevention method, abrasive may be used as said scuffing inhibitor, the fuel having the abrasive mixed therewith may be supplied into the respective cylinders in the engine during a period from engine speed variation till the engine speed becoming stable.

[0013]

The invention is also directed to an apparatus for prevention of scuffing in an internal combustion engine for a vessel wherein fuel stored in a fuel tank is evacuated, is pumped by a fuel pump and is supplied through fuel injection valves into respective cylinders of the engine,

the apparatus comprising a speed detector for detecting an engine speed and an engine speed monitor for monitoring the engine speed detected by said speed detector, the fuel with fuel level higher than a preset value being supplied into respective cylinders in the engine while a scuffing inhibitor is supplied into the respective cylinders in the engine.

[0014]

In said prevention apparatus, the engine speed is detected by the speed detector, the engine speed detected by said speed detector being monitored by the engine speed monitor, the fuel with the fuel level higher than the preset value and with a low concentration of hard particles being supplied into the respective cylinders in the engine while the scuffing inhibitor is supplied into the respective cylinders in the engine.

[0015]

As a result, during engine speed variation, the hard particles are prevented from entering in large quantity into the engine while the scuffing inhibitor is supplied into respective cylinders in the engine, so that the sliding state of the piston ring does not become severe against the cylinder liner, initiation points of scuffing become hard to form, and no scuffing is generated in succeeding high-load operations.

[0016]

Said prevention apparatus may comprise
a plurality of fuel tanks,
an evacuation line with evacuation valves for
evacuation of the fuel from any desired fuel tank,
level detectors each for detecting the fuel level of
a corresponding fuel tank and
a fuel tank potential switchover indicator for

indicating, in cases where existence of the fuel tank with the fuel level being reduced below the preset value is revealed on the basis of the detection signals from said level detectors, and during stable engine speed revealed on the basis of the engine speed monitor signal from said engine speed monitor, potential supply of the fuel into the respective cylinders in the engine preferentially from said fuel tank with the fuel level being reduced below the preset value,

the fuel being supplied to the respective cylinders in the engine from the fuel tank with the fuel level higher than the preset value during engine speed variation revealed on the basis of the engine speed monitor signal from said engine speed monitor.

[0017]

The above prevention apparatus may comprise
a lubricant tank with lubricant stored as said
scuffing inhibitor,

a lubricant injection line with a lubricant input mechanism and a lubricant input control mechanism for injection of the lubricant stored in said lubricant tank into the respective cylinders in the engine,

a lubricant injection rate controller for outputting an opening degree command signal for increase of lubricant injection rate to said lubricant input control mechanism

in the lubricant injection line during engine speed variation revealed on the basis of the engine speed monitor signal from said engine speed monitor.

[0018]

Said prevention apparatus may comprise
an abrasive tank with abrasive stored as said
scuffing inhibitor,

an abrasive mixing line with an abrasive pump and an
abrasive mixing valve for mixing of the abrasive stored in
said abrasive tank into the fuel and

an abrasive mixing controller for outputting a
mixing command signal to the abrasive mixing valve in said
abrasive mixing line, during a period from engine speed
variation till the engine speed becoming stable, on the
basis of the monitor signal from said engine speed monitor.

Advantageous Effects of Invention

[0019]

A method and an apparatus for prevention of scuffing
in an internal combustion engine for a vessel according to
the invention have excellent effects and advantages that
during engine speed variation or during a period from just
thereafter till the engine speed becoming stable, the
sliding state of the piston ring can be alleviated from
becoming severe against the cylinder liner and generation

of the scuffing can be prevented.

Brief Description of Drawings

[0020]

Fig. 1 is an overall schematic diagram showing a first embodiment of the invention;

Fig. 2 is a diagram showing an example of stable engine speed monitored by an engine speed monitor in the first embodiment of the invention;

Fig. 3 is a diagram showing an example of engine speed variation monitored by the engine speed monitor in the first embodiment of the invention;

Fig. 4 is an overall schematic diagram showing a second embodiment of the invention; and

Fig. 5 is an overall schematic diagram showing a third embodiment of the invention.

Reference Signs List

- 1 fuel tank
- 2 evacuation line
- 3 fuel pump
- 6 fuel injection valve
- 7 engine
- 8 cylinder
- 9 evacuation valve

- 10 level detector
- 10a detection signal
- 11 speed detector
- 11a detection signal
- 12 engine speed monitor
- 12a engine speed monitor signal
- 13 fuel tank potential switchover indicator
- 14 lubricant tank
- 15 lubricant pump (lubricant input mechanism)
- 16 lubricant flow rate control valve (lubricant input control mechanism)
- 17 lubricant injection line
- 18 lubricant injection rate controller
- 18a opening degree command signal
- 19 abrasive tank
- 20 abrasive pump
- 21 abrasive mixing valve
- 22 abrasive mixing line
- 23 abrasive mixing controller
- 23a mixing command signal

Description of Embodiments

[0022]

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

[0023]

Fig. 1 shows a first embodiment of the invention in which, with respect to an internal combustion engine for a vessel with fuel stored in a fuel tank 1 being evacuated through a bottom of the tank 1 into an evacuation line 2, pumped by a fuel pump 3 and supplied through a settling tank 4, a supply pump 5 and fuel injection valves 6 into respective cylinders 8 in an engine 7, a plurality of (three in the example of Fig. 1) fuel tanks 1 filled with fuel are installed and the evacuation line 2 is provided with evacuation valves 9 so that fuel may be evacuated from any desired tank 1. Each of the fuel tanks 1 is provided with a level detector 10 for detection of fuel level. The engine 7 is provided with a speed detector 11 for detection of the engine speed and an engine speed monitor 12 for monitoring of an engine speed detection signal 11a from the detector 11. Further provided is a fuel tank potential switchover indicator 13 which, in cases where existence of the fuel tank 1 with fuel level being reduced below a preset value is revealed on the basis of the detection signals 10a from the level detectors 10 and only during stable engine speed under a smooth water condition (a condition of no ruffling water surface) which is revealed on the basis of an engine speed monitor signal 12a from the engine speed monitor 12,

indicates potential supply of the fuel into the respective cylinders 8 in the engine 7 from the fuel tank 1 with the fuel level being reduced below the preset value; the indicator 13 is constructed such that the fuel is supplied into the respective cylinders 8 in the engine 7 from the fuel tank 1 with the fuel level being not reduced below the preset value, i.e., from the tank 1 with the fuel level being higher than the preset value during engine speed variation revealed on the basis of the signal 12a from the monitor 12. Since an amount of hard particles contained in fuel will differ depending upon kind of the fuel and therefore the preset value of the fuel level in the fuel tank 1 will differ depending upon kind of the fuel, the preset value is preliminarily determined such that searches are preliminarily made as to for example shape and concentration analyses of the hard particles to determine as the preset value a lower limit where the hard particles can be kept in a low concentration upon evacuation of the fuel from the fuel tank 1.

[0024]

The state of stable engine speed means that, for example as shown in Fig. 2, the engine speed variation per unit time (an hour) is less than 3%; the state of the engine speed variation means that, for example as shown in Fig. 3, the engine speed variation per unit time (an hour)

is 15% or more.

[0025]

Since fuel cannot be replenished to the fuel tanks in a ship under way, a total capacity of the fuel tanks 1 is to sufficiently cover one marine navigation distance, fuel being replenished to the tanks before a fuel level of the fuel tank 1 from which fuel is finally evacuated is reduced below the preset value.

[0026]

Next, mode of operation of the above embodiment will be disclosed.

[0027]

In the embodiment, among the plural fuel tanks 1 filled with fuel, the evacuation valve 9 of any desired fuel tank 1 is opened so that the fuel is evacuated through the bottom of the fuel tank 1 into the evacuation line 2 and is pumped by the fuel pump 3 to a settling tank 4, the fuel once stored in the settling tank 4 being pumped by the supply pump 5 into the fuel injection valves 6 from which the fuel is injected into the respective cylinders 8 in the engine 7.

[0028]

In this case, the speed of the engine 7 is detected by the speed detector 11 and the detection signal 11a therefrom is inputted into the engine speed monitor 12

where the detection signal 11a of the engine speed detected by the detector 11 is monitored so that a crew can know whether the engine speed is stable or varied now, the engine speed monitor signal 12a from the monitor 12 being inputted into the fuel tank potential switchover indicator 13.

[0029]

The fuel levels of the fuel tanks 1 are detected by the level detectors 10, respectively, and the fuel level detection signals 10a from the level detectors 10 are inputted into the fuel tank potential switchover indicator 13; in the indicator 13, it is determined from the detection signals 10a from the level detectors 10 whether there exists the fuel tank 1 with the fuel level being reduced below the preset value. If there exists the fuel tank 1 with the fuel level being reduced below the preset value as shown by imaginary line in Fig. 1, the indicator 13 indicates potential supply of the fuel into the respective cylinders 8 in the engine 7 preferentially from the fuel tank 1 with the fuel level being reduced below the preset value during stable engine speed on smooth water which fact is revealed on the basis of the engine speed monitor signal 12a from the engine speed monitor 12.

[0030]

In a case where at this moment the fuel is being

evacuated from the fuel tank 1 with the fuel level being not reduced below the preset value, the crew opens the evacuation valve 9 of the fuel tank 1 with the fuel level being reduced below the preset value and closes the evacuation valves 9 of the other fuel tanks 1 only when the indicator 13 indicates potential supply of the fuel into the respective cylinders 8 from the fuel tank 1 with the fuel level being reduced below the preset value. As a result, the fuel is supplied into the respective cylinders 8 in the engine 7 from the fuel tank 1 with the fuel level being reduced below the preset value.

[0031]

It is to be noted that even if the fuel with a great amount of hard particles is supplied to the respective cylinders 8 in the engine 7 from the fuel tank 1 with the fuel level being reduced below the preset value during stable engine speed in, for example, smooth water, the sliding state of the piston ring does not become so severe against the cylinder liner and there is little fear for generation of scuffing.

[0032]

On the other hand, during engine speed variation revealed on the basis of the engine speed monitor signal 12a from the engine speed monitor 12, the fuel tank potential switchover indicator 13 becomes not indicative

of potential supply of the fuel into the respective cylinders 8 in the engine 7 from the fuel tank 1 with the fuel level being reduced below the preset value, so that the crew closes the evacuation valve 9 of the tank 1 with the fuel level being reduced below the preset value and opens any one of the other tanks 1 each with the fuel level being not reduced below the preset value. As a result, the fuel is supplied from the fuel tank 1 with the fuel level being not reduced below the preset value and with no high concentration of hard particles accumulated on the bottom through the fuel pump 3, settling tank 4, supply pump 5 and fuel injection valves 6 into the respective cylinders 8 in the engine 7.

[0033]

As a result, during engine speed variation, the hard particles do not enter in large quantity into the engine 7 and the sliding state of the piston ring against the cylinder liner becomes not severe, so that initiation points for generation of scuffing becomes difficult to form and no scuffing occurs in the succeeding high-load operations.

[0034]

Thus, during engine speed variation upon arrival in and leaving from a port or during passage through a canal, the sliding state of the piston ring can be alleviated

from becoming sever against the cylinder liner and generation of scuffing can be prevented.

[0035]

Fig. 4 shows a second embodiment of the invention in which parts similar to those in Fig. 1 are represented by the same reference numerals. Although its fundamental structure is similar to that in Fig. 1, this embodiment is characterized in that, as shown in Fig. 4, it comprises

a lubricant tank 14 with lubricant stored as scuffing inhibitor,

a lubricant injection line 17 with a lubricant pump 15 as lubricant input mechanism and with a lubricant flow rate control valve 16 as lubricant input control mechanism for injection of lubricant stored in the lubricant tank 14 into the respective cylinders 8 in the engine 7 and

a lubricant injection rate controller 18 which outputs an opening degree command signal 18a for increasing a lubricant injection rate of the lubricant flow rate control valve 16 in the lubricant injection line 17 during engine speed variation (see Fig. 3) revealed on the basis of the engine speed monitor signal 12a from the engine speed monitor 12.

[0036]

In the embodiment shown in Fig. 4, the engine speed is detected by the speed detector 11, the engine speed

detected by the speed detector 11 being monitored by the engine speed monitor 12. During engine speed variation revealed on the basis of the engine speed monitor signal 12a from the engine speed monitor 12, the opening degree command signal 18a is outputted from the lubricant injection rate controller 18 into the lubricant flow rate control valve 16 in lubricant injection line 17 so as to increase the lubricant injection rate, so that the lubricant as scuffing inhibitor in an amount more than that during stable engine speed is supplied into the respective cylinders 8 in the engine 7.

[0037]

It is to be noted that, when the lubricant injection rate during stable engine speed (see Fig. 2) is, say, on the order of 1 g/kw-h, the lubricant injection rate increased to 1.5 g/kw-h or so becomes effective during engine speed variation.

[0038]

As a result, during engine speed variation, the lubricant as scuffing inhibitor is supplied in an amount more than that during stable engine speed into the respective cylinders 8 in the engine 7, so that lubrication is facilitated; even if the hard particles exist in much quantity, they may be washed away by the lubricant, so that the sliding state of the piston ring

becomes not severe against the cylinder liner, initiation points of scuffing becoming hard to form, no scuffing being generated in succeeding high-load operations.

[0039]

Thus, also in the embodiment shown in Fig. 4, just like the embodiment shown in Fig. 1, during engine speed variation, for example, upon arrival in and leaving from a port or during passage through a canal, the sliding state of the piston ring can be alleviated from becoming severe against the cylinder liner, generation of scuffing being prevented.

[0040]

Fig. 5 shows a third embodiment of the invention in which parts similar to those in Figs. 1 and 4 are represented by the same reference numerals. Although its fundamental structure is similar to that in Figs. 1 and 4, the embodiment is characterized in that it comprises, as shown in Fig. 5,

an abrasive tank 19 with slurry-like abrasive stored as scuffing inhibitor,

an abrasive mixing line 22 with an abrasive pump 20 and an abrasive mixing valve 21 for mixing of an abrasive stored in the abrasive tank 19 into the fuel and

an abrasive mixing controller 23 which outputs a mixing command signal 23a to the abrasive mixing valve 21

in the abrasive mixing line 22 during or after engine speed variation based on the engine speed monitor signal 12a from the engine speed monitor 12.

[0041]

The abrasive used may be generally so-called engine compound or the like which generates fine abrasive particles upon combustion of the fuel in the respective cylinders 8 in the engine 7.

[0042]

In the embodiment shown in Fig. 5, the engine speed is detected by the speed detector 11, the engine speed detected by the speed detector 11 being monitored by the engine speed monitor 12. During or after engine speed variation revealed on the basis of the engine speed monitor signal 12a from the engine speed monitor 12, a mixing command signal 23a is outputted from an abrasive mixing controller 23 to an abrasive mixing valve 21 in an abrasive mixing line 22, the abrasive as scuffing inhibitor being supplied together with the fuel into the respective cylinders 8 in the engine 7.

[0043]

It is to be noted to be effective that an mixed amount of abrasive during the engine speed variation or during a period from completion of engine speed variation till the engine speed becoming stable is 3% or so of the

fuel supply amount at that time.

[0044]

As a result, during engine speed variation or during a period from completion of engine speed variation till the engine speed becoming stable, the abrasive as scuffing inhibitor is supplied together with the fuel into the respective cylinders 8 in the engine 7, so that upon combustion of the fuel minute abrasive particles are generated to grind and remove initiation points of scuffing and no scuffing is generated in succeeding high-load operations.

[0045]

Thus, in the embodiment shown in Fig. 5, during engine speed variation upon, for example, arrival in and leaving from a port or during passage through a canal or during a period from completion of engine speed variation till the engine speed becoming stable, the sliding state of the piston ring can be alleviated from becoming severe against the cylinder liner and generation of scuffing can be prevented.

[0046]

It is to be understood that a method and an apparatus for prevention of scuffing in an internal combustion engine for a vessel according to the present invention are not limited to the above-mentioned embodiments and that

various changes and modifications may be made without departing from the scope of the claims of the invention.

For example, the number of the fuel tank may be two or more than three. The embodiments shown in Figs. 1, 4 and 5 may be worked not only singularly but also in combination.

CLAIMS

1. A method for prevention of scuffing in an internal combustion engine for a vessel wherein fuel stored in a fuel tank is evacuated through a bottom thereof, is pumped by a fuel pump and is supplied via fuel injection valves into respective cylinders in the engine,

said method which comprises providing a plurality of fuel tanks for evacuation of the fuel from any desired fuel tank and

in cases where there exists the fuel tank with a fuel level reduced below a preset value, detecting and monitoring engine speed, supplying the fuel from said fuel tank with the fuel level reduced below the preset value into the respective cylinders in the engine only during stable engine speed under a smooth water condition and supplying the fuel with a low concentration of hard particles from the fuel tank with said fuel level not reduced below the preset value into the respective cylinders in the engine with a scuffing inhibitor being supplied into the respective cylinders in the engine during engine speed variation.

2. A method for prevention of scuffing in an internal combustion engine for a vessel as claimed in claim 1 wherein said scuffing inhibitor is lubricant injected into the respective cylinders in the engine, lubricant injection rate being increased during engine speed variation.

3. A method for prevention of scuffing in an internal combustion engine for a vessel as claimed in claim 1 wherein said scuffing inhibitor is abrasive mixed into the fuel, the fuel having the abrasive mixed therewith being supplied into the respective cylinders in the engine during or after engine speed variation.

4. An apparatus for prevention of scuffing in an internal

combustion engine for a vessel wherein fuel stored in a fuel tank is evacuated through a bottom thereof, is pumped by a fuel pump and is supplied via fuel injection valves into respective cylinders in the engine,

said apparatus comprising
 a plurality of fuel tanks,
 a speed detector for detecting an engine speed,
 an engine speed monitor for monitoring the engine speed detected by said speed detector,

an evacuation line with evacuation valves for evacuation of the fuel from any desired fuel tank,

level detectors each for detecting the fuel level of the corresponding fuel tank and

a fuel tank potential switchover indicator for indicating, in cases where existence of the fuel tank with the fuel level reduced below a preset value is revealed on the basis of detection signals from said level detectors and only during stable engine speed under a smooth water condition revealed on the basis of an engine speed monitor signal from said engine speed monitor, potential supply of the fuel into the respective cylinders in the engine from said fuel tank with the fuel level reduced below the preset value,

the fuel with a low concentration of hard particles from the fuel tank with the fuel level being not reduced below the preset value into the respective cylinders in the engine with a scuffing inhibitor being supplied into the respective cylinders in the engine during engine speed variation on the basis of the engine speed monitor signal from said engine speed monitor.

5. An apparatus for prevention of scuffing in an internal combustion engine for a vessel as claimed in claim 4 comprising
 a lubricant tank with lubricant stored as said scuffing inhibitor,

a lubricant injection line with a lubricant input mechanism and a lubricant input control mechanism for injection of the

lubricant stored in said lubricant tank into the respective cylinders in the engine,

a lubricant injection rate controller for outputting an opening degree command signal for increase of lubricant injection rate to said lubricant input control mechanism in the lubricant injection line during engine speed variation on the basis of the engine speed monitor signal from said engine speed monitor.

6. An apparatus for prevention of scuffing in an internal combustion engine for a vessel as claimed in claim 4 comprising

an abrasive tank with abrasive stored as said scuffing inhibitor,

an abrasive mixing line with an abrasive pump and an abrasive mixing valve for mixing of the abrasive stored in said abrasive tank into the fuel and

an abrasive mixing controller for outputting a mixing command signal to the abrasive mixing valve in said abrasive mixing line, during or after engine speed variation, on the basis of the engine speed monitor signal from said engine speed monitor.