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(1/6)

Subject : Notice for Using Low Sulfur / Low Viscosity Fuel Oil	Application	UEC Diesel Engine
	Type	All UEC
	No.	USI-10003E
General		

Generally, the sulfur content in fuel oil is well recommended to be from 1.5 to 3.5% as marine engine fuel oil, however nowadays it is increased to have the opportunities when lower sulfur content fuel oil is supplied due to an environment compliance, and the inconvenience on engines supposedly caused by the supply of this kind of fuel oil has been reported.

Regarding the notice for using low sulfur fuel oil less than 1.5%, please refer to our Service Information USI-10011 & USI-10013, furthermore, for low sulfur fuel oil (distillate fuel oil) in which sulfur content is extremely low and also, viscosity is low, please pay attention to the following matters.

According to the California Air Resources Board (CARB), it is compulsory to use MDO (Marine Diesel Oil) and MGO (Marine Gas Oil) as low sulfur / low viscosity fuel oil. MDO and MGO can be used if the countermeasures described on the next page are carried out.

1. Background

International Marine Organization (IMO) plans to reduce the sulfur content regulation value of fuel oil step by step, which has become 1.0 % or less from July 1st 2010 and has become 0.1% or less in and after 2015 in Sulfur Emission Control Areas (SECA), and or less to 3.5% or less in and after 2012 and will become 0.5% or less in and after 2020 or 2025 (it will be decided in 2018) in General Areas (Global).

In addition, in EU Exclusive Economic Zone (EEZ), the sulfur content regulation value of fuel oil will become 1.5% or less from 2020.

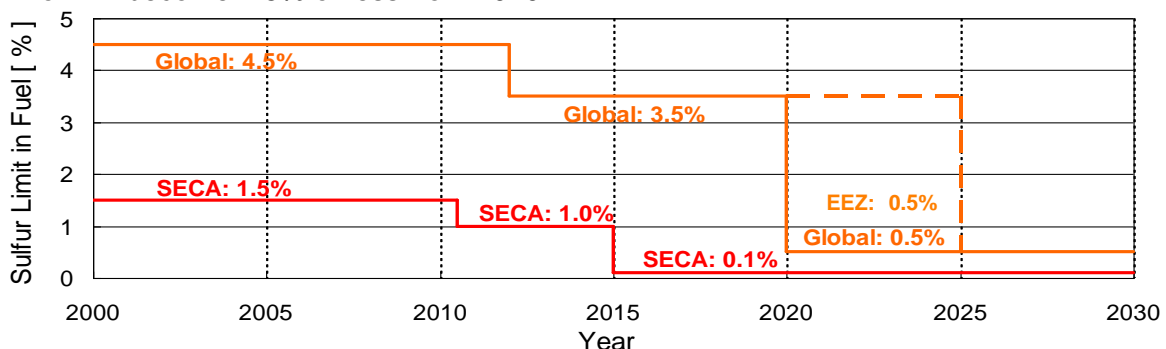


Fig. 1: IMO sulfur content regulation value of fuel oil

Also, in California Air Resources Board (CARB), 1.5% or less of sulfur content in MGO (Marine Gas Oil) or 0.5% or less of that in MDO (Marine Diesel Oil) has been regulated from July 2009; 1.0% or less of that in MGO or 0.5% or less of that MDO from August 2012, furthermore, it has strengthened the regulation to 0.1% or less of that in MGO or MDO in and after 2014.

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Plan record	Newly issued 13th Dec. 2017 MSI-0960 Rev.6 (19th Apr.2016) / No.0323 (30th May 2016)	Approved	<i>T. Yamamoto</i>	SERVICE ENGINEERING DEPARTMENT
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2. Notice
(1) Fuel oil properties :

At present, many of general low sulfur fuel oils mean Distillate fuel oils such as MDO and MGO in many cases, and the viscosities (40°C) of MGO are specified as min. 1.4mm²/s for DMX, min. 2.0mm²/s for DMA, min. 3.0mm²/s for DMZ, and the viscosity of MDO is specified as min. 2.0mm²/s for DMB, in ISO 8217/2010.

Table 1: Distillate marine fuels (extracted from ISO 8217/2010)

Characteristic	Category ISO-F-				
	DMX	DMA	DMZ	DMB	
Kinematic viscosity @ 40°C	mm ² /s max.	5.500	6.000	6.000	11.00
	mm ² /s min.	1.400	2.000	3.000	2.000
Density @ 15°C	kg/m ³ max.	-	890.0	890.0	900.0
Sulfur ※	% (m/m) max.	1.00	1.50	1.50	2.00
Carbon residue: micro method on the 10% volume distillation residue	mass % max.	0.30	0.30	0.30	-
Carbon residue: micro method	mass % max.	-	-	-	0.30
Ash	% (m/m) max.	0.010	0.010	0.010	0.010

※ : Notwithstanding the limits given, the purchaser shall define the maximum sulfur content in accordance with relevant statutory limitations. See ISO8217 annex C.

These distillate fuel oils are low viscosity and the viscosity affects oil film formation between plunger and barrel of fuel oil injection pump; therefore, if it is difficult to obtain proper viscosity, there is a possibility of sticking of the plunger. Also, if the viscosity is too low, the efficiency of fuel oil injection pump drops (an increase in fuel oil leak), there is a possibility that the engine does not start when the clearance between plunger and barrel enlarges due to wear of them.

Therefore please keep kinematic viscosity to 2mm²/s or more in order to prevent the above inconvenience. If it is difficult to obtain a viscosity of 2mm²/s or more at the engine inlet, it is recommended to install a cooler (chiller if necessary) in the fuel oil system as shown in Fig.2. Regarding the installation of cooling system, please consult to discussion with cooling system maker, building shipyard and cooling system installation company (Repair dock etc.) is recommended.

And according to the fuel oil maximum consumption of cooling system, please refer to the capacity of fuel oil circulating pump.

In addition, since a drop in the viscosity of fuel oil affects reliability of bearings such as pumps in fuel oil system, it is recommended to consult with the hull builder side on this problem.

And it has been reported from one vessel in service that the main engine could not be increased the speed due to scavenging press. limit under changing the fuel oil from heavy fuel oil to low viscosity low sulfur fuel oil. This incident might be caused by excessive leaking from clearance between plunger and barrel of fuel injection pump due to very low fuel viscosity because of forgetting to stop the steam of FO heating steam trace under changing the fuel oil. In this situation, the LI (load indicator) tended to increase, however, the engine speed could not be increased due to scavenging limit. In this connection, in case of changing the fuel oil from heavy fuel oil to low viscosity low sulfur fuel oil, the heating steam is to be stopped under changing the fuel oil from heavy fuel oil to low viscosity low sulfur fuel oil with monitoring the viscosity.

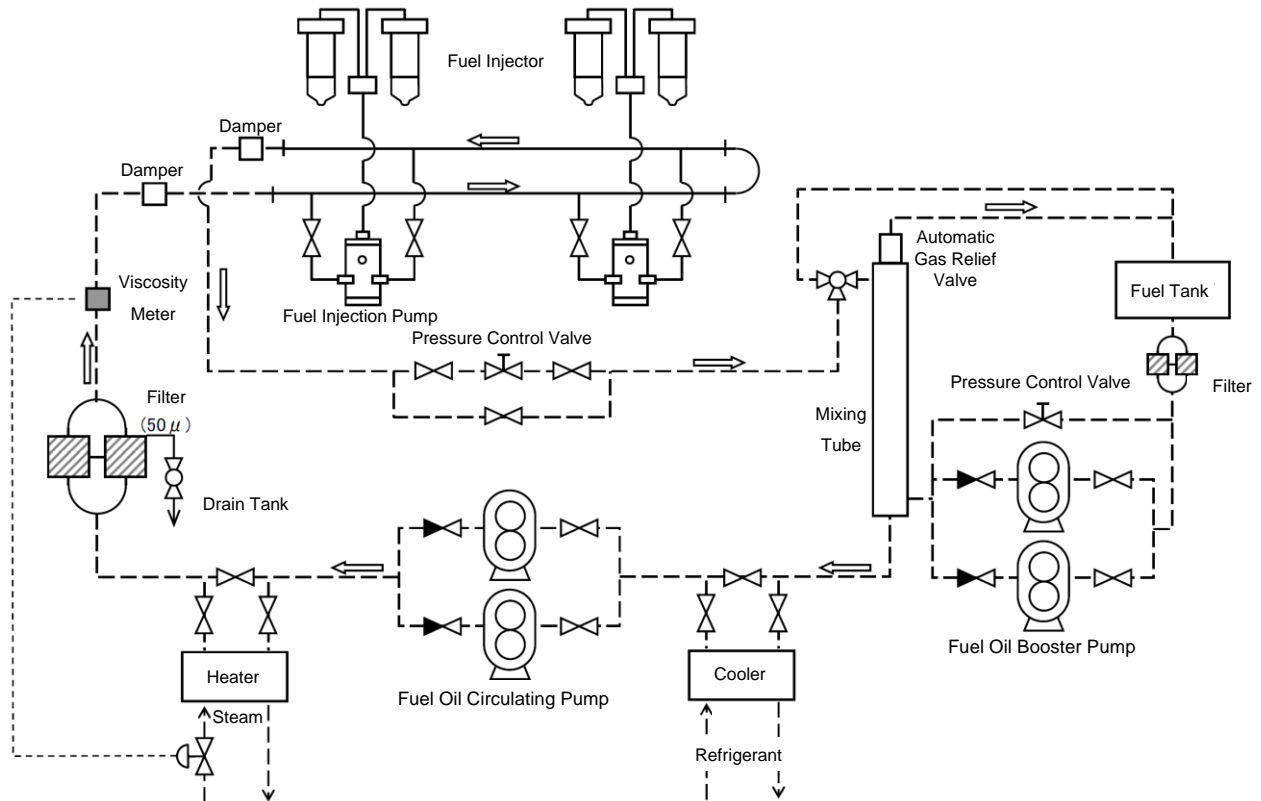


Fig. 2: Example of Cooler Installation in Fuel Oil System

(2) Fuel oil Lubricity :

It is recommended that the fuel oil lubricity is less than 520 μ m in High Frequency Reciprocating Rig (HFRR) test regulated on ISO8217/2012 DMA, DMZ, DMB.

When the above (1) and (2) properties cannot be maintained, the addition of lubricity improver to the fuel oil should be considered.

Remarks: In case of use the lubricity improver (additive), please ask the additive manufacturer.

(3) Selection of cylinder oil:

For the selection of cylinder oil meeting low sulfur content in fuel oil, if low sulfur fuel is continuously used for a long time, lower BN cylinder oil might be applied after confirming ring/liner condition mentioned in the above Service Information USI-10011, USI-10013 & USI-10004. For the selection of cylinder oil, since not only its neutralization property but also extreme pressure property and detergent dispersant property become important factors, please use the cylinder oils equivalent to conventionally used brand cylinder oils whose extreme pressure property and detergent dispersant property have been confirmed.

(4) A drop in adaptability to initial running-in properties due to low sulfur content:

If piston ring and cylinder liner are renewed, sufficient running-in period has to be set for the engine operation.

For the procedure of running-in operation, please refer to the operation manual (Group 025-03) of the engine instruction book.

(5) Affinity of heavy fuel oil for low sulfur fuel oil:

Affinity of heavy fuel oil for low sulfur fuel oil (low aromaticity) is bad by which there are some cases where sludge is generated; therefore, it is recommended to confirm the affinity of heavy fuel oil for low sulfur fuel oil in advance.

(6) Changeover from low sulfur distillate fuel oil to heavy fuel oil / from heavy fuel to low sulfur distillate fuel oil:

Please changeover fuel oils by paying attention to the following two points particularly.

- The changeover of fuel oils have to be carried out at 30% or more and 50% or less of engine full load (67% or more and 79% or less of engine full speed) and also, after warming up the engine sufficiently.

[However, if the changeover load can be raised up due to the experience of this ship, fuel oils can be changed over less than 75% engine full load (91% engine full speed)].

- Please carry out temperature control so that a change in fuel oil temperature the heating speed of 1 to 2°C in a minute in order to prevent a rapid change in fuel oil temperature.

① From low sulfur distillate fuel oil to heavy fuel oil;

- Carry out the changeover procedure of fuel oils, while referring to the operation manual (Group 026-01) of the engine instruction book.

- Heat the heavy fuel oil until its viscosity at the fuel pump inlet of the engine reaches 13 to 18mm²/s.

- The heating of distillate fuel oil and heavy fuel oil shall be done gradually as the heating speed of 1 to 2°C in a minute.

Depending on the treatment temperature of the purifier, the temperature of the heavy fuel oil service tank is not specified, but 75~95°C is given as for information.

- The valve operation shall be done quickly for no fuel counter flow due to the tank head difference or others..

- When using the device controlling the temperature with the viscometer, operate the heater manually for distillate fuel oil heating and for heating for a certain period after the change-over to heavy fuel oil, because its viscosity is low.

- In case the viscosity exceeds 5mm²/s, the cooler shall be stopped moderately (if it's equipped) after adjusting the flow rate of fuel and/or cooling medium. Then, the fuel temperature gradient at the engine inlet shall be 1~2°C/ minute.

② From heavy fuel oil to low sulfur distillate fuel oil;

- Carry out the changeover procedure of fuel oils, while referring to the operation manual (Group 026-02) of the engine instruction book.

- The cooling of fuel oil shall be done gradually as the cooling speed of 1 to 2°C in a minute.

- The valve operation shall be done quickly for no fuel counter flow due to the tank head difference or others.

- Especially, if the engine is stopped by emergency stop or other during the change-over or operation with heavy fuel oil, the heater shall work until the change-over from heavy fuel oil to distillate fuel oil is completed. The heavy fuel oil existing in the injection pipe also shall be drained by the opening of the fuel injection valve air vent, and if necessary, the fuel injection valve shall be dismantled for cleaning.

- The engine inlet temperature usually does not change suddenly, but if the temperature change of more than 20°C occurs, adjust the temperature change by operating the heater manually because the fuel oil injection pump may stick at plunger and barrel.
- If the engine is stopped before the heavy fuel oil has not been completely changed over to low sulfur distillate fuel oil, it results in sticking of fuel oil injection pump and fuel oil injection valve; therefore, its fuel changeover time has to be taken sufficiently.
- In case the viscosity is lower than 10mm²/s, the cooler shall be started moderately (if it's equipped) after adjusting the flow rate of fuel and/or cooling medium. Then, the fuel temperature gradient at the engine inlet shall be 1 ~ 2°C/ minute.

(7) Increase of Pmax(maximum combustion pressure) due to low sulfur fuel oil use

In general, low sulfur fuel oil tends to be higher side in low calorific value (Hu).

When fuel with higher low calorific value fuel is used, Pmax tends to increase.

Therefore, in case of low sulfur value fuel use, it is necessary to measure the Pmax_(AC) for all cylinder units and compare with shop trial Pmax_(ST) value under same operating load. If measured Pmax_(AC) is over the shop trial value Pmax_(ST), it is necessary to adjust it so that Pmax_(AC) becomes less than the shop trial value Pmax_(ST).

(Pmax_(AC): measured on board , Pmax_(ST) : measured at shop trial)

As for the Pmax adjustment procedure, please refer to the instruction book (Operating Instruction) Group 007 Item 01.

(8) Suitable operation way of purifier against specific gravity of low sulfur fuel oil

In the low sulfur fuel oil, lower specific gravity fuel oil may exist in comparison with general heavy fuel oil.

In case of using the lower specific gravity fuel oil, please consider the change of gravity disc depending on necessity.

(9) Waxy low sulfur fuel oil under low temperature condition

It is reported that there is a fuel oil which becomes wax in a low temperature condition in the low sulfur fuel oil (distillate fuel oil in particular), and such a waxy fuel oil caused clogging line filter and accumulating wax deposit in the tank.

Against the above problem, since heating of the fuel oil in tanks and the heating of the filter etc. are introduced by following CIMAC guideline, please refer them.

01 | 2015 CIMAC Guideline "Cold flow properties of marine fuel oils"

06 | 2015 CIMAC Position Paper "New 0.10% Sulphur marine (ECA) fuels"

3. Others

Furthermore, low sulfur heavy fuel oil is generally residual oil containing catalytic particles (FCC) of the fuel refine process; therefore, please note the following points, also.

- (1) Effect on running performances between ring and liner due to FCC mixing with fuel oil:
Please control FCC (aluminum + silicon) less than 7 (mg/kg) at engine inlet. In particular, diameters of recent FCC particles have a tendency to become finer than conventional ones. It was reported as an example that the maximum diameter of FCC confirmed in the troubled engine was about 20 μm . Taking the above in mind, it is important to do suitable pre-treatment of fuel oil and operation of filters at engine inlet.

- (2) Effect on ignitability and combustibility of fuel oil:
In low sulfur residual oils containing catalytic particles of the fuel refine process through desulfurization process, there are many flame resistance low-grade fuel oils by which combustion trouble occurs in the engine. Therefore, it is thought that the ignitability and combustibility of the fuel oil have to be evaluated by the Fuel ignition Analyzer of FIA-100 used by NK, etc., before using such a residual oil.
In addition, for simplified judging method, please refer to our Service Information USI-10010.