UE SERVICE INFORMATION

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Subject :	Application	UEC Diesel Engine
Notice for the compliant fuel oils 0.5% or less sulfur content	Type	All UEC
	No.	USI-10020E Rev.3
	If necessary	

In order to reduce Sulfur Oxides(SOx) and Particular Matters(PM) emitted from ships, sulfur content in fuel oils has been regulated by MARPOL 73/78 (International Convention for the Prevention of Pollutant from Ships) Annex VI-14.1.3. After January 1st 2015, the sulfur content in fuel oils was regulated below 0.1% in the Emission Control Areas(ECA), and it was further regulated globally below 0.5% from 3.5% after January 1st 2020 except for the above ECA.

This new regulation, applied for not only newly built ships but also in-service ones while the NOx regulation has been applied for newly built ones, will request all the ships using the following measures to meet the regulation;

- Distillate fuel oils currently available in the market, such as MGO(Marine Gas Oil) or MDO(Marine Diesel Oil) having less than 0.5% sulfur content
- Compliant fuel oils specially provided with 0.5% or less sulfur content for this regulation as called VLSFO(Very Low Sulfur Fuel Oil)
- Proper treatment system or device, as defined EGCS (Exhaust Gas Cleaning System)

This service information describes how to apply the compliant fuel oils 0.5% or less sulfur content, VLSFO.

It is recommended to refer below guideline and also relevant information/guidance issued by classification society and/or concerned authorities.

・CIMAC Guideline: "Marine fuel handling in connection to stability and compatibility"
・Class NK : "Guidance for onboard use of Compliant Fuel Oil with SOx regulation from 2020"
・Lloyd's Register : "Guidance for shipowners and operators on MARPOL Annex VI Sulphur Regulation."

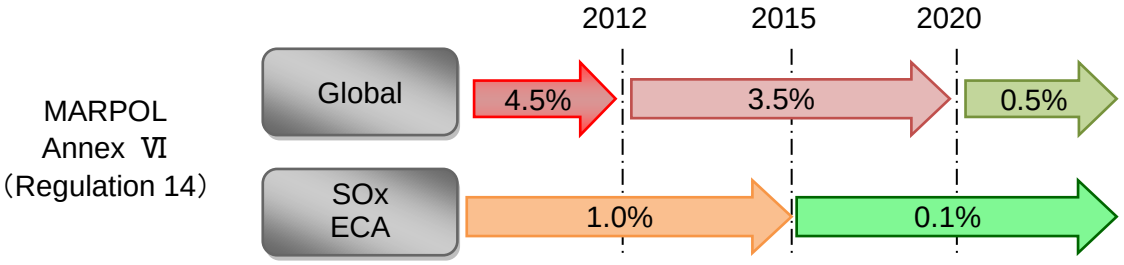

Fig. 1 Sulfur Content regulation by MARPOL

【Remarks】
Marine fuel oils are specified by ISO8217 as Distillate Fuel(DM) and Residual Fuel(RM).
ISO8217 is being revised according to the new SOx regulation. Until ISO8217 will revised, Publicly Available Specification, ISO PAS23263 issued in September, 2019 is valid.
This PAS's validity is limited in three years, a revised ISO8217 will be issued in 2022.

Plan record				
	Newly issued 29th Mar. 2019 (T.Y, T.N, K.I) Rev.1 P3 correction of errors 4th Apr.2019(T.Y, T.N, K.I) Rev.2 Updated 24th Jan. 2020(T.Y, K.K, K.I) Rev.3 P4 Updated 7th Jul. 2020	Approved	K. Yoshida	SERVICE ENGINEERING DEPARTMENT
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		Designed	K.Imanaka	DATE OF REVISED: 7th Jul. 2020

(1) Important points when using compliant fuel oils

Compliant fuel oils with sulfur content of 0.5% or less, as defined compliant fuel oils, are expected to supply to the market through various refinery processes blended by low sulfur base oils. Their properties can have wide range by production area, oil company, and refinery plant. Each bunker fuel may have different properties in extreme cases. When comparing the existing residual fuel oils, compliant fuel oils are expected to have a wide variation with their kinematic viscosity, cat-fines, ignition property, cold flow property and specific gravity, to those special attentions paid.

1) Sulfur content

Sulfur in fuel oil forms Sulfur Oxides(SOx) when burned and will turn into sulfuric acid by composing with water in air. This is known as acid corrosion of combustion chamber components. To avoid acid corrosion (low temperature corrosion), cylinder oils containing alkalinity, such as Base Number 100, are used to neutralize sulfuric acid. By reducing the sulfur content of fuel oil from 3.5% to 0.5% or less, composed sulfuric acid amount will become smaller and the risk of sulfuric acid corrosion will tend to be less. Base Number of cylinder oil shall be adjusted according to sulfur content of fuel oil to prevent from possible negative effects, excessive hard deposit formation by chemical reaction of bases and fuel oil. Thus, cylinder oil shall be selected having proper BN and good detergency and dispersancy. (Refer to the service information USI-10004 ”Lubricating oil list for UEC engines”)

2) Kinematic viscosity

Excessively high kinematic viscosity may result fuel pump damage due to excessive pressure rise, and cause improper fuel spray formation and poor combustion subsequently.

Considerably low viscosity can cause wear down of running surfaces of fuel pump plunger/barrel and needle valve of fuel injection valve due to poor oil film formation. In the worst case, seizure can happen on the above engine components. Low viscosity can also cause bigger fuel oil leakage from fuel pump and/or fuel injection valve, and the bigger fuel oil leakage by wear-downed fuel pump plunger/barrel can result in engine starting failure.

Viscosity of compliant fuel oil may vary bunkering by bunkering, so it is necessary to monitor that viscosity of each bunkering is controlled as specified. (recommended: between 3mm^2/sec and 18mm^2/sec, acceptable: between 2mm^2/sec and 18mm^2/sec)

Upper limit of fuel oil heating temperatures for UE engines is 150℃ and the lower is not specified, however, cold flow property must be assured as mentioned later.

Thus, pay special attentions for the following items;

- In case automatic viscosity controller is equipped, it is very important to operate the controller by monitoring the viscosity. When re-bunkering, make sure that the controller is working properly to adjust specified viscosity.

- In case of manually controlled viscosity controller, it is requested to set the temperature manually after every bunkering to adjust the viscosity as specified referring temperature-viscosity diagram. Reconfirmation using viscometer is also recommended. If viscometer is not equipped, it is strongly recommended to install it.
- If lower viscosity(less than 2mm^2/sec) is expected, fuel oil cooler or chiller shall be provided to secure specified viscosity. Fuel oil shall be selected, when adjusting the temperature, set the temperature (pour point + 10℃ to be targeted) to avoid waxing.
  (Refer to the service information USI-10003 “Notice for Using Low Sulfur / Low Viscosity Fuel Oil”)
- When using low viscosity compliant fuel oil, there is a possibility that fuel supply pump and/or booster pump cannot deliver the normal operating pressure due to inside leakage of the pumps. The leakage amount will differ by pump’s specification. When changing fuel oils with lower viscosity one, engine inlet fuel oil pressure shall be watched.
- Rapid fuel oil change may cause rapid temperature change, which can result seizure of plunger/barrel of fuel pump. Temperature change speed shall be adjusted at 1～2℃/min. not only for changing from distillate to residual oil but also changing with different viscosity compliant fuel oils.

3) Cat Fines

Clarified Oil(CLO) which is fractionated by fluid catalytic cracking(FCC) is one of candidate of low sulfur base oils. CLO is produced by filtration of FCC slurry to eliminate FCC fines(Cat Fine). If cat fines are not eliminated sufficiently, a lot of cat fines can remain in compliant fuel oil. Cat fine has a diameter of 5～25 μm and is composed of Aluminum/Silicon oxides with a very high hardness almost the same as abrasive powder and harder than steel. Once cat fines intrude into the running surfaces of piston ring and cylinder liner, deep scratches can ruin the cylinder oil film formation resulting in scuffing and gas blow-by. Excessive cylinder liner wear may happen eventually. Not only piston ring/cylinder liner but also fuel pump(plunger/barrel) and fuel injection valve(needle valve) can also be affected as shorter life time due to abrasive of running surfaces. Piston stuffing box rings can be worn down due to damaged running surface of piston rod. This can be detected by increase of piston stuffing box drain amount. Running conditions of piston ring/cylinder liner can be evaluated to a certain extent by analyzing piston under-side drain. Generally, Fe content of 50ppm or below by analysis result is recognized in normal. Over 100ppm can be a sign of abrasive wear of cylinder liner and inspection of fuel oil supply system and piston ring/cylinder liner is recommended in the earliest opportunity.

(If sampling cock is not equipped on the piston under-side drain line, and drain sampling is necessary, please contact us.)

Upper limit of Al + Si content is specified in ISO8217. In ISO8217(2017), it is limited at 60ppm or less, however, recommendation for UE engines are less than 30ppm as bunker and less than 7ppm at engine inlet. If fuel oils containing high Al+Si are used, following actions to be taken;

- Frequent drainage of settling tank and service tank (several times per day)
- Run all the purifiers in-parallel with their minimum flow against their nominal capacities. Keep the proper temperature based on the viscosity of the fuel to eliminate cat fines and impurities. Use proper gravity disc according to fuel oil specific gravity.
  (Please consult with purifier manufacturer in detail.)
- Use fuel oil filter(s) appropriately. Do not by-pass filter(s)
- Back-wash drain oil of filter(s) should not be returned to engine.

Adequate pre-treatment will prevent from cat fine damages.
(Refer to the service information USI-10013 " Prevention of inadaptability due to use of FCC fuel oil")

Just after changing storage tanks, relatively high-dense cat fines settled on the tank bottom could be suctioned by transfer pump. In rough sea conditions, they might be circulated by hull swing. In these cases, it is known that back-washing interval becomes shorter than usual, and fuel oil conditions can be monitored. In those cases, use the fuel oils pre-treated properly by the above treatment.

4) Ignition and combustion

Light Cycle Oil(LCO) is also a candidate of low sulfur base oils for compliant fuel oil together with the said CLO. LCO and CLO contain a lot of Aromatics, and there is a possibility of poor ignition and combustion property.

Slow speed two-stroke UE engines have an advantage for this matter thanks to longer combustion duration. High/Middle speed engines are easily influenced by ignition, and poor combustion at low load, such as diesel knocking, can happen.

ISO 8217 gives a guidance on this issue as CCAI(Calculated Carbon Aromatic Index).
Less than 850 is recommended for UE engines. Estimated Cetane Number(ECN), which is calculated by FCA test, is also an effective index to evaluate ignition property of distillate and residual fuels. (Refer to CIMAC "Fuel Quality Guide – Ignition and Combustion")

5) Cold flow property

When using compliant fuel oil which is inferior in cold flow property, filter clogging by wax, difficulty of transfer by solidification can limit fuel oil supply to engine resulting in output shortage or engine stop. Once fuel oils are waxed, tremendous efforts, re-heating or removal of sludge by hand will be required.

Cold flow property is mainly defined by Pour Point(PP), it is generally recommended to heat the fuel oil at more than 10℃ above the PP. Cold Filter Plugging Point(CFPP) is also regarded as an index to avoid filter plugging. Heating more than CFPP is recommended.

When using compliant fuel oils those do not require heating, proper fuel oil selection is necessary so that PP is lower than operating temperature (atmospheric temperature, sea water temperature, engine room temperature and lower limit of storage tank temperature) considering the environmental conditions.

6) Specific gravity

As mentioned the above, compliant fuel oil may contain harmful cat fines, sufficient pre-treatment by centrifugal purification is effective to eliminate cat fines. To operate centrifugal purifier effectively, adjustment of gravity disk according to fuel oil specific gravity is important. If not, expected performance could not be obtained.

7) Stability and compatibility

Fuel oil stability has two definitions, Stability(self-stability) and Compatibility. Stability means stableness against sludge formation after long term storage, and compatibility means how a fuel oil is stable when mixing with different fuel oils.

Stability shall be considered by fuel oil supplier, it will be referred to future revision of ISO8217, expected to issue in 2022. On the other hand, compliant fuel oils have wide variation of properties according to production area, oil company, refinery plant, and bunkering in utmost case. It is practically impossible to secure compatibility for all compliant fuel oils, and fuel oil suppliers have declared "Do not mix different compliant fuel oils". Generally, mixing of fuel oils mainly composed of aromatics and paraffin based fuel oils may form asphaltene sludge. Sludge dispersant is sometimes used to avoid this problem. Consultation with additive agent supplier is recommended. Deposited sludge might clog strainer and make transfer from tank(s) difficult, and fuel pump plunger/barrel and fuel injection valve might be stuck. Therefore, mixing of different fuel oils should be avoided. Even so, mixing is inevitable, select fuel oils having similar fuel oil properties, specific gravity and PP. Before mixing, spot test(ASTM D4740) must be performed to secure compatibility.

Before changing fuel oil from conventional high sulfur residual fuel oil to compliant fuel oil, it is necessary to clean the deposits in relevant tanks, pipes, and equipment. Deposits might contain sludge and cat fines, and sufficient pre-treatment is required for the fuel oils used for flushing before supplying to engine.

(2) Engine modification for compliant fuel oil

Important points when using compliant fuel oils are mentioned as above section (1), but engine modification is not required.

However, it is recommended to store reasonable number of spare parts, mainly fuel injection system components (plunger/barrel, fuel injection valves etc.) to cope with unexpected cases.

As mentioned, properties of compliant fuel oils have not been fixed and they will have wide variation. In near future, durable engine components, piston rings and fuel injection system, might be requested against compliant fuel oils. These components will be introduced accordingly after ready to supply.