Fuel handling

in Emission Controlled Areas

Introduction

The game-changing legislation that took effect 1st January 2015 reduced the allowed sulphur content for fuel burned in marine engines from 1.00% to 0.10% in Emission Control Areas (ECAs). Understandably, many ship owners and operators have questions about the huge impact this will have on their vessel's fuel handling.

Vessels can comply with the legislation either by installing a scrubber and continuing with HFO, or by using low-sulphur (LS) fuel when operating in ECAs. For those that choose the latter, it will have a major effect on the vessel's fuel handling. Among other things, it will necessitate both the conversion of fuel tanks and the addition of fuel cooling equipment to secure the viscosity of the engine's fuel supply.

In this paper, we explore the operational implications of the ECA fuel change. The first part deals with overall issues such as equipment preparation and fuel storage, while the second part deals with the specific challenges of common LS fuels and emerging alternatives.

Part 1 Fuel issues

This section deals with key issues raised by the change in fuels.

The underlying factors

For the last 50 years, vessels have been designed for HFO operation. Today all engines, both main and auxiliary, can run on HFO. This means that all systems – tanks, separators, pumps, filters, boosters and engines – are made to handle high-density, high-viscosity oil that requires a great deal of heating energy.

HFO with 1.00% sulphur is essentially "normal" HFO with a lower sulphur value, which means it is handled in the same way as other HFO. While the vessel is technically handling two grades of fuel, its operation is the same in practice: the fuel must be heated the whole way from storage tank to engine inlet.

By demanding fuel with 0.10% sulphur, MARPOL Annex VI is causing a paradigm shift in the marine industry. To meet the legislation, vessels must change to other fuels such as gas oil (DMA, DMZ and DMB) or any of the "hybrid" ECA oils on the market. Yet the fuel buyers are not the only ones affected.

Fuel production is also changing, including the way that gas oil is manufactured at refineries. One result of this is the greater amount of wax found in marine diesel oils and marine gas oils. When ordering DMA, DMZ or DMB, the fuel received today will be different from the oil received in the past, which leads to new considerations.

These factors affect all vessels in ECA operation. However, the issues are different for vessels in 100% ECA operation than for vessels that travel in and out of ECAs.

Issues for vessels in 100% ECA operation

For vessels without a scrubber that spend most of their time in ECA operation, there is no alternative but a fuel with a maximum 0.10% sulphur level. The tanks must therefore be prepared for this kind of fuel, i.e. stripped and cleaned.

Simply emptying the tanks and filling them with the new fuel is not a good solution. The new fuel's sulphur content is already so close to 0.10% that even small amounts of fuel with higher sulphur values will result in non-compliance.

Accumulated pollution in the tank is also an issue, especially if a long time has passed since the last tank cleaning. If the pollution is considerable, it may contaminate the new fuel to a level where even the separator will have problems removing it. Lighter fuels will have a washing effect on the tanks, causing pollution to come loose over time and contaminate the fuel for a lengthy period to come.

The only viable solution is thus to empty the tanks and to clean them to a point where the new fuel will not be contaminated. Keep in mind that pipes and other equipment like filters and strainers also contain high-sulphur fuel, which means it may take time until the high-sulphur fuel has completely left the system.

Remember as well that MGO/MDO, unlike HFO, is prone to bacterial growth and it is imperative that water does not enter the storage tanks.

Finally, when changing to lighter fuels, it is possible that the pumps in the system will begin to leak due to sealing wear that has been plugged by the higher-density HFO. When the HFO is washed away, larger gaps in the seal will allow the lower-density fuel to escape. This can be avoided by changing to magnetically coupled pumps that are absolutely leakage-free.

Issues for vessels travelling in and out of ECAs

Before the new ECA legislation, MGO/MDO was mostly used for auxiliary engines and boilers when at berth in ECAs. This meant only a limited amount was needed. Now, when LSMGO/MDO is required for the main engine as well, vessels travelling in and out of ECAs will have to calculate their consumption and be sure to have a sufficient amount on board. The extended storage poses significant challenges.

Above all, it is absolutely paramount that MGO/MDO is never mixed with HFO. There are several reasons for this, but the most important is the fuel sulphur level. Since LS fuel is already very close to the 0.10% limit, even a little high-sulphur fuel mixed in will make it non-compliant.

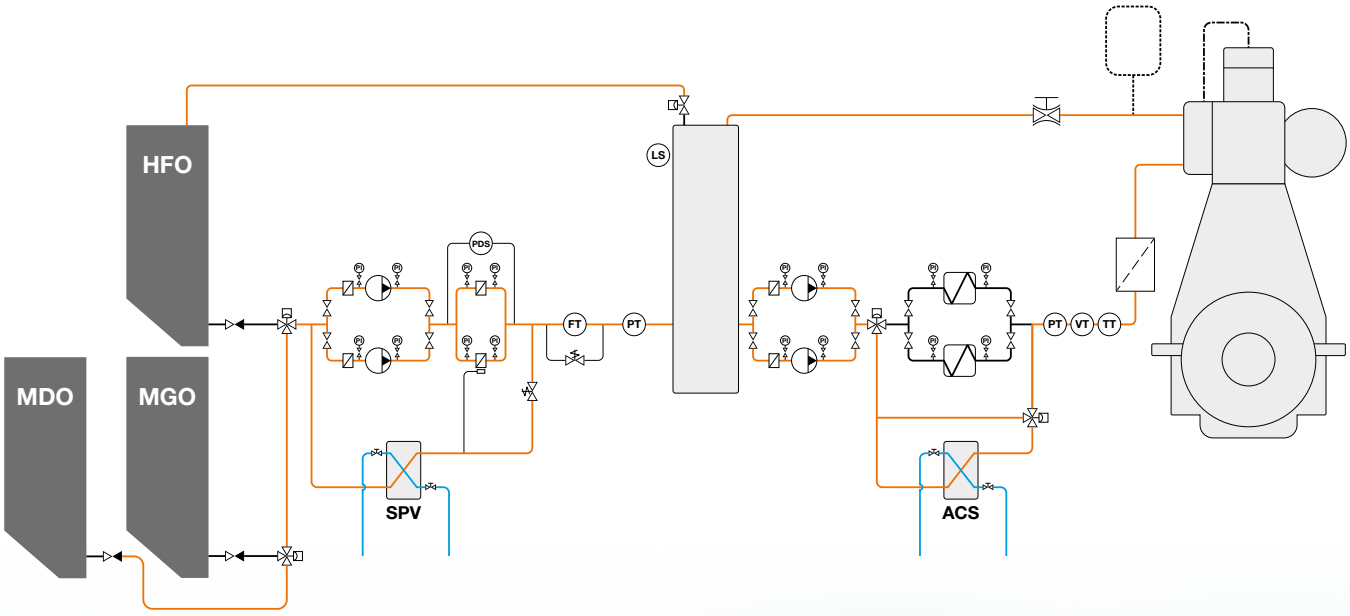
The supplier is responsible for seeing that the fuel sulphur level complies with MARPOL Annex VI when delivered. However, if the sample taken during bunkering shows the correct value and the sample taken at the engine inlet shows an elevated sulphur level, it is the vessel's responsibility – and the vessel will be fined.

Yet another reason to avoid mixing is fuel stability. The mixing of HFO and MGO/MDO is a known issue that can lead to unstable oil. In addition, there are indications that MGO/MDO and new alternative ECA oils can become unstable when mixed. Alfa Laval's recommendation is to keep the fuel types absolutely segregated, and to have dedicated tanks for the LS fuel used on board.

Due to the larger amount of MGO/MDO needed for ECA operation, some HFO storage tanks will need to be converted into MGO/MDO storage tanks. In other words, some bottom tanks and wing tanks previously used for HFO will now be used to store gas oil. During the conversion, it is important that inspections are made to secure adequate storage for the new fuel, and that there is no water ingress and that heating is available.

If the chosen fuel is a NEF (New ECA Fuel), many of the same considerations with regard to preparation must be made in the tanks in order to handle these oils too. It is even more important that NEFs are not mixed with any other fuels, not only HFO; this can, and will, create cases of instability in the oil. Even mixing a NEF with another NEF can cause stability issues.

This is something that should be considered when looking at what kind of fuel to use in ECA operation. Having three different fuels onboard may be a recipe for disaster, or at least hours of extra work cleaning the fuel cleaning equipment, including piping and filter, when stability issues arise.



The Alfa Laval Automated Fuel Changeover System (ACS) safeguards the changeover from HFO to gas oil and vice versa. It secures the cooling of the gas oil needed to meet the engine manufacturer's specified viscosity. Everything is done safely and reliably at the push of a button, ensuring peace of mind.

For more information, please contact your local Alfa Laval representative or go to www.alfalaval.com/acs

Part 2 Fuel challenges

This section deals with specific fuel handling aspects and provides Alfa Laval's fuel handling recommendations. It covers aspects common to LS fuels, as well as aspects specific to certain grades and new LS fuel alternatives. When considering alternatives for meeting the 0.10% sulphur limit in ECAs, it is important to differentiate between alternatives from established suppliers and alternatives from independent fuel suppliers.

Fuel heating

Believing that heating is not necessary with gas oil, some operators considered blocking off the tank heating in order to prevent water from leaking heater coils from entering the tanks and to save money through reduced heating costs. However, this is a misunderstanding that can prove expensive in the end. Heating is still needed for gas oil due to the increasing amount of wax it contains. Moreover, some of the NEFs on the market must be handled in the same way as HFO, as will be discussed later.

Handling recommendations:

- Keep the MGO/MDO in the storage tanks at 30°C, especially during winter conditions, to prevent wax formation where the fuel meets outside temperatures.
- If a separator is used to clean the MGO/MDO, a preheater should be used to raise the temperature to 40–45°C. This will ensure that the wax is not removed in the separator.
- For NEF, the separation temperature is determined by the viscosity according to the table on page 6.
- If an NEF is used, be sure to store it at a correct temperature for that fuel, which is usually 10°C above its pour point.

Water intrusion

One of the issues in storing MGO/MDO on board is the risk of bacterial growth in the oil, a problem that cannot occur with HFO/NEF. The only way to avoid bacterial growth for certain is to remove the oxygen-rich water from the oil, as bacteria are dependent on oxygen and water to grow.

The conversion of bottom and wing tanks for LS fuels creates a water removal issue, because these tanks offer no possibility of drainage. Alfa Laval recommends installing a small separator such as the MIB 303 purifier, which will remove the water from the tanks and prevent bacterial growth. In addition, the separator will clean the oil and keep it free of other contamination.

Handling recommendations:

- Keep the tanks as full as possible when storing fuel for longer periods, because there will always be some condensation in the tanks. The less area there is for water to gather, the less water will enter the oil.
- After conversion and cleaning, check the tanks for leaks from the heating coils. Also check for water intrusion from other tanks, e.g. ballast tanks and cargo tanks, or from outside via cracks in the hull.
- If there is no possibility of drainage, a small separator should ideally be installed to remove the water.

Some NEFs are on the verge being unstable due to the production method used in the refinery. This means if the NEFs are mixed with water or other oils, normal ECA fuels or NEFs, they will most likely produce a lot of sludge due to instability. It is therefore paramount that NEFs are tested before being mixed with any other oils or, at the very least, a spot sample is taken to see if the two oils are compatible.

Separation temperature

The correct separation temperature is determined by the viscosity of the oil. However, the maximum separation temperature today is 98°C. The lower the viscosity of the oil when treated in the separator, the higher the separation efficiency.

Some NEFs require special attention when it comes to separation temperature. We have noticed that, during the first year of operation, some of the newer fuels have temperature issues. Separating these oils using the recommended temperatures used prior to the introduction of NEFs starts a reaction in the oil, accelerating the agglomeration process in a fuel that is on the verge of being unstable and creating sludge issues that will clog filters and separators.

This is unfortunate, of course, since lower separation temperatures dramatically reduce the separation efficiency.

It is difficult to inspect the oil or to test it to see if it is a temperature-sensitive oil; however, we know that some of the heavily blended and heavily cracked NEFs can have this issue. Also, oils produced from shale oil have a tendency to be temperature sensitive.

As mentioned, the result is clogged filters and separators that are filled with sludge and have to be opened and cleaned several times a day. This sludge tends to have the same consistency as sludge fallout when you have unstable oil after mixing two unstable oils.

So what can you do? If you process fuel and you are sure it has not been mixed with other oils and fallout occurs, you may try to reduce the separation temperature to 50–60°C depending on the viscosity of the oil and see if the issue disappears.

The drawback, as mentioned, is reduced separation efficiency. It is therefore important to test the oil to know the contamination of the oil. If there are values indicating a high degree of contamination of catalytic fines, it may be a good idea to reduce the flow in order to increase the separation efficiency again. This means that it might be necessary to start another separator and divide the flow between these two separators in order to cope with the contamination.

The general recommendation regarding separation temperature is described in the table below, and are according to the oil viscosity:

Viscosity @ 50°C	Storage temperature	Separation temperature
Up to 20cSt	30°C	40°C
20 to 30cSt	30°C	50°C
30 to 40cSt	10°C above PP	60°C
40 to 50cSt	10°C above PP	70°C
50 to 80cSt	10°C above PP	80°C
80 to 100cSt	10°C above PP	90°C
100 to 700cSt	10°C above PP	98°C

Specific considerations for DMA, DMZ and DMB

DMA and DMZ are essentially the same fuel with different viscosities according to ISO 8217. DMA has a viscosity of 2cSt @ 40°C, while DMZ has a viscosity of 3cSt @ 40°C. The advantage of these fuels is that they are well-known products that are generally available everywhere.

The sulphur level in these fuels according to ISO 8217:2010 is a maximum of 1.50%, so the buyer must specify the 0.10% needed for ECA operation. When travelling to ports in winter conditions, it is also important to specify winter-grade fuel when ordering.

Because DMA and DMZ are clear and bright, it is not easy to add other products that might contaminate them. What can be added, as is already being seen, are biofuels. These should not be in the fuel according to ISO 8217, but they are almost impossible to avoid due to the way that gas oils are handled.

The issue with biofuels is that they are hydrophilic, which means they retain water on a molecular level. Since this can promote bacterial

growth, it is another argument for installing a small separator to remove water from the storage tanks.

DMB is yet another gas oil with almost the same characteristics as DMA and DMZ. However, the density, water content and total sediment allowed for DMB by ISO 8217 are slightly higher.

The drawback with DMB is that the fuel is not necessarily clear and bright. It may contain more contamination and should always be cleaned with a separator before use. Like DMA and DMZ, it may contain biofuels and a sulphur content of 0.10% must be specified when ordering.

Handling recommendations:

- For the greatest safety, run all fuel through a separator to ensure the removal of all contaminants – including water.
- If the fuel is not clear and bright, it should absolutely be cleaned in a separator before consumption. Some fuels are dyed black, and there is most likely a reason for it. These fuels may contain even more contamination, e.g. cat fines.
- The separator must be independent from the usual HFO separation system, due to the higher sulphur content of the HFO.
- Due to wax content, a heater should ideally be used to heat the oil to 40–45°C.

Alternative fuels (NEFs)

What must be remembered is that marine fuel is only 2–4% of the total fuel market. It is a side business for the major suppliers. When they introduce marine fuels, it is only because the market is there and the fuels cost nothing extra to produce. The fuels will be available only in certain areas of the world, and only when it is convenient for the supplier.

It is important to remember that changes in the ECA legislation only concern the sulphur content of the oil. All other parameters are operational issues. This means that sulphur content is the only parameter the suppliers are blending for, and the results may vary considerably depending on the chosen cutter stock. Certain types of chemical waste can theoretically serve as good cutter stock, for example, but the result will have a devastating effect on onboard equipment.

In other words, these fuels must be approached with caution. Some independent bunker traders have been known to use blending stocks that are not traditional, but which are convenient and cheap. This can lead to oils that are dangerous to handle and use aboard ships, even if ISO 8217 states that the oil should be free of chemicals that are harmful to crews and equipment.

If there is an increased demand in the market for alternative LS fuels, it may cause some of these brokers to use cutter stock that they would otherwise not use– either deliberately or by accident.

Handling recommendations:

- The fuel should not be mixed with other fuels. Mixing could create instability that would render the fuel useless.
- In many cases, the fuel should be treated in the same way as HFO with regard to heating and separation needs.
- The fuel cannot be separated in the same system as normal HFO, due the normal HFO's higher sulphur content.
- The separation temperature must be set according to the viscosity of the oil. Example: Fuel with a viscosity of 45 cSt @ 50°C, which means a IF 40 type oil in the Alfa Laval capacity table, which means a separation temperature of 70°C should be sufficient.
- If the separator used is of the purifier type, the gravity disc will need to be adjusted according to the oil's density.

To learn more about these issues and to gain a more in-depth understanding of fuel management in general – both inside and outside ECAs – we recommend our Fuel Management Course. This course is conducted around the world by Alfa Laval together with VPS (Veritas Petroleum Services).

For more information regarding the course and to register, visit www.alfalaval.com/fmc or www.v-p-s.com

How to contact Alfa Laval
Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com

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