AALBORG INDUSTRIES

Aalborg Solutions

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Changing from HFO to MDO or MGO

MARPOL Annex VI "Regulations for the Prevention of Air Pollution from Ships" stipulate that Heavy Fuel Oil (HFO) combustion is not permitted during port stay and in specific areas at sea. The switch-over to lighter types like Marine Diesel Oil (MDO) or Marine Gas Oil (MGO) requires monitoring and some modifications to the burner and fuel systems, as outlined by Aalborg Industries in this brief.

1.0 Legislation and compliance

Since May 2005, specific environmentally friendly MARPOL regulations have been in force that stipulate that emissions from main and auxiliary machinery are kept within specific limits. They require, for instance, reduction of sulphur oxide combinations (SO_x), carbon dioxide (CO_2) and nitrogen oxide combinations (NO_x).

The subsequent EU Marine Fuel Sulphur Directive defines Sulphur Emissions Control Areas (SECAs) slightly different from those agreed by the International Maritime Organization (IMO) under MARPOL Annex VI.

The mentioned legislation has substantial impact on existing or future installations of Aalborg Industries' boilers, burners and fuel systems.

This brief covers the cautions and considerations, which should be addressed in connection with switch-overs between the traditional HFO or specified fuels and the lighter grades of fuel such as MDO and MGO.

1.1 Oil selection

The regulations limit the traditional use of Heavy Fuel Oil (HFO) for all operating conditions to the extent that combustion of HFO is no longer permissible during port stay and in specific areas at sea.
It has become necessary to switch to lighter, "better" fuel oil types like low sulphur fuels. Low sulphur fuels are unfortunately not always readily available in all ports, which can again lead to use of yet other fuel types like MDO or MGO that can achieve the stipulated emission results and comply with legislation.

1.2 Auxiliary boilers and burners

Most burner systems have so far been designed to burn HFO as the main fuel, but MDO can usually substitute HFO, and most plants will have no problems with temporary change-over to MDO operation.

1.3 Burner and fuel systems

In general, all auxiliary boiler plants are equipped with a burner and an associated fuel system. This often means that the fuel system has been designed for a particular type of burner installation. The components in the fuel systems are generally quite common and will therefore in the following be dealt with in general terms whereas the various burner types react differently upon fuel changes/switch-overs, and will consequently be dealt with separately.

2.0 Fuel properties

If special fuel such as low-sulphur fuel oil is not available in a port, the obvious choice of fuel would be a good quality Marine Diesel Oil (MDO) or Marine Gas Oil (MGO).

These two fuels differ in their properties, however, and should be handled differently as described in the following.

2.1 Heat value
The heat value of lighter fuel oils is typically a little higher than the heat value of HFO.

The additional heat input to the boiler is, however, considered to have an insignificant influence on the boiler itself. In some cases, it may nevertheless be necessary to re-adjust the air/fuel ratio if the pre-set air amount is beyond the limit and grey smoke is generated.

2.2 Viscosity
Lighter oils commonly have lower viscosity and need not be pre-heated.
When operating on fuel oil types of low viscosity, it must be ascertained that the fuel pumps are indeed able to operate with the low viscosity (see 2.5 Lubricating properties). It should also be considered that the viscosity mentioned in the specification is indicated with a reference temperature and that the actual operation temperature might be higher causing the viscosity to drop further.
Heat tracing should be shut off as should oil preheaters that have not been bypassed.

2.3 Density
Typically the density of lighter fuels is lower than of HFO (and MDO), which may have the result that the amount of (lighter) fuel to the burner will differ from the amount original pre-set and thus for instance cause ignition problems or increased smoke emission.

This can happen because most marine installations have the oil amount pre-adjusted based on a calculation of the main fuel, and on a manual volume calculation/adjustment that takes its density into account.

2.4 Flash point
The flash point for some lighter fuels is occasionally lower than the requirements from the classification societies, which should be considered when storing in the traditional fuel tanks onboard.

2.5 Lubricating properties
Lighter fuel oils traditionally also have lower lubricating properties. The hydrodynamic lubrication can, by using the well-known Sommerfeld number, be described as a function of the viscosity,
So = f (v) x k, for a certain pump.

This means that when the viscosity is reduced, the lubricating properties are reduced, which is an important aspect to consider too, with relation to fuel pumps (see 3.2 Fuel pumps).

3.0 Fuel system
Most of the components in the fuel system will not be affected by operation on a lighter fuel oil, but some considerations have to be made.

3.1 Fuel tank
Consider the new fuel's flash point (see 2.4 Flash point)

3.2 Fuel pumps
It must be ascertained that the fuel pump can actually operate with the new fuel under the given operating conditions.

As most fuel pumps are either screw pumps or gear pumps, it is important to check if the pumps are able to operate with the lower viscosity of the new fuel (see 2.2 Viscosity and 2.5 Lubricating properties), as there is a risk of increased wear and tear as well as breakdown if the pump is unsuited for the viscosity.

Fuel pumps running continuously during periods when the boiler/burner is in standby position may heat up, causing the temperature of the fuel to increase and thereby the viscosity to decrease. In this case, the control of the pumps should be considered, too.
In case the pump control system is not preset to do it already, it may be preferable to adjust the control system in such a way that the pumps are always shut off when not required.

3.3 Fuel preheaters

Light fuels rarely need to be preheated, and if heating is unnecessary, the fuel preheaters should be bypassed during operation on light fuel to avoid the risk of the oil being overheated.

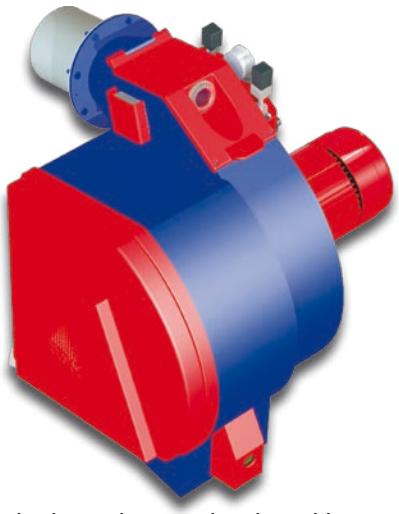
3.4 Fuel pipe tracing

If the fuel does not need preheating, the fuel pipes do not need to be heated, and consequently the tracing of the fuel pipes should be shut off.

If preheating is necessary, check if the tracing is sufficient. Be careful that the tracing does not heat the fuel more than necessary.

3.5 Change-over between fuels

When changing over/switching between fuels, make sure that fuel in the return/recirculation pipes is returned to the correct fuel tank.



The latest burner developed by Aalborg Industries: The KBP™ pressurized burner for our MISSION™ TCi boilers.

Make sure that the new fuel is not preheated in an unintended way.

4.0 Burners

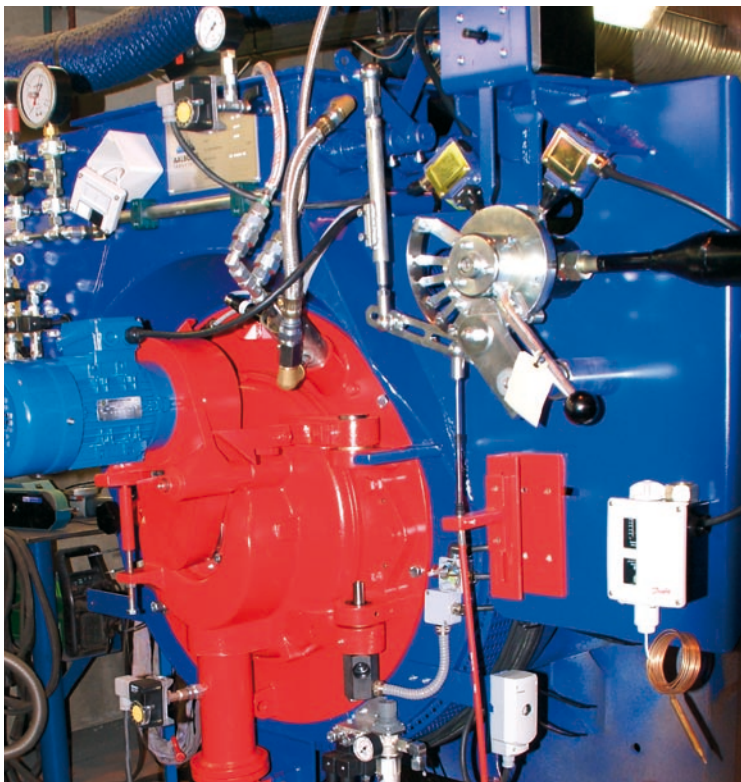
The fuel change-over affects the three common burner types normally supplied for marine boiler installations in various ways.
We recommend a post-purge of the furnace whenever MGO has been used.
It should be observed that the lower viscosity for fuel pumps in systems supplied by Aalborg Industries is normally 4.5 cSt. This means that if a fuel with a lower viscosity is used, the fuel pumps must be changed or modified.

4.1 Pressure jet burner

Pressure jet burners are typically used on smaller boiler types and run on MDO, MGO and HFO.
Installations delivered by Aalborg Industries will typically be able to operate on both MGO/MDO and HFO.
A lower viscosity may also cause an increase in the fuel input through the nozzle, and the risk of increasing smoke emission arises.

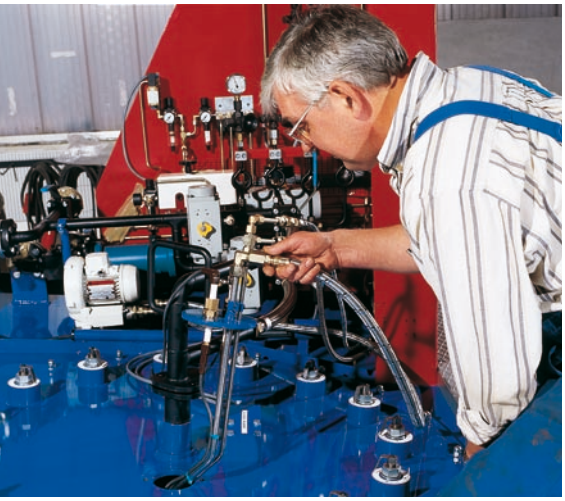
4.2 Rotary cup burner

Rotary burners are used on all boiler types and run on MDO, MGO and HFO.
Installations delivered by Aalborg Industries will typically be able to operate on both MGO/MGO and HFO.
For smaller burners there should be no problem with operation on a lighter fuel; however, the fuel amount (pressure) should be checked/adjusted in order to obtain a reasonably smoke-free combustion.
For larger burners, there is a risk of coke deposit creation in the burner cup, if the installation is not fitted with a suitable heat shield. This happens because the heat radiation into the rotary cup generates a too high temperature of the fuel in the rotary cup causing the fuel to start coking. We therefore recommend having the rotary cup installation checked and if necessary modified.
Due to easier evaporation of lighter fuels, we recommend adjusting the control system so the main burner does not accidentally ignite in case of a missing ignition source/flame, just as it must be avoided that fuel is vaporised unnecessarily.



Oil-fired rotary cup burner type KB™

4.3 Steam atomizing burner
Steam atomizing burners are typically used on medium and larger boiler types and run on MDO, MGO and HFO.
Installations made by Aalborg Industries will generally be able to operate on both MGO/MDO and HFO.
As the viscosity of the fuel burned in the steam atomizing burner is commonly in the range 15–30 cSt, the lower viscosity of a lighter fuel may cause over-firing if the pressure alone controls the oil amount to the burner.



KBSD™ steam atomizing burner for MISSION™ OL boilers.

For continuous operation with lighter fuels, we recommend using either compressed air as the atomizing medium, or changing the lance to a type that does not heat the fuel in the same way as the traditional lance.

Due to easier evaporation of lighter fuels, we recommend adjusting the control system so that the main burner does not accidentally ignite in case of a missing ignition flame/source, just as unnecessarily vaporized fuel should be avoided.

5.0 Modifications to the existing boiler/burner system
When having to operate a boiler/burner system on a lighter fuel than originally intended for the plant, the complete boiler/burner installation should be examined by authorized personnel, as this is not just a matter of complying with legislation but equally so a serious safety matter.

5.1 Steam atomized burner lance
There are two options for the atomization (compressed air and steam) and burner lance design, and Aalborg Industries would recommend changing the existing lance to a modified type where internal volume has been reduced to an absolute minimum and specially designed to operate with MDO/MGO and with steam as atomizing medium. The lance is constructed so the steam piping is insulated from the fuel piping in the burner lance thus avoiding preheating.

5.2 Post purge sequence
The control system needs to be modified to allow for post-purge sequence.

5.3 Flame supervision
On burner plants, usually only one flame scanner is installed (main flame supervision) from the outset. We would recommend having two flame scanners for the main flame supervision and in addition one separate flame scanner to detect the operation of the ignition burner.

5.4 Fuel oil pumps
The usual fuel oil pump installation is designed for a minimum oil viscosity of approx. 4.5 cSt at 50°C. It is therefore recommended to install one additional fuel oil pump to match the chosen fuel viscosity.

5.5 Authorized staff & OEM parts
Modifications to the boiler/burner system should be executed by skilled and authorized combustion experts only. Aalborg Industries offers an inspections and a variety of upgrading options, if required. Modification parts should come from the original equipment manufacturer or an authorized supplier in order to maintain a high degree of operation availability, reliability and safety.
Upon completion of modifications, a test and test report should be carried out by authorized staff.

Aalborg Solutions is published by Aalborg Industries Global After Sales organization and deals with operation of steam and heating equipment. Ideas and suggestions for topics are most welcome.
Aalborg Industries A/S · Gasvaerksvej 24 · P.O. Box 844 · 9100 Aalborg · Denmark
Phone: +45 9930 4000 · Telefax: +45 9810 2233 · E-mail: gafs@aalborg-industries.com
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