Solution overview

Avoiding steam balance risks in 2020 and beyond

How to adapt Alfa Laval Aalborg steam plants for compliant fuels

September 2019

Contents

More about how the 2020 sulphur cap will impact boiler systems can be found at **www.alfalaval.com/boiler2020**

1. Introduction

In 2004, the MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships were agreed upon and adopted. Regulation 14 of the annex established a stepwise reduction of permissible SOx emissions. As of 1 January 2020, the global sulphur cap will be 0.5%, while the previously adopted limit of 0.1% in Emission Control Areas (ECAs) will remain in force.

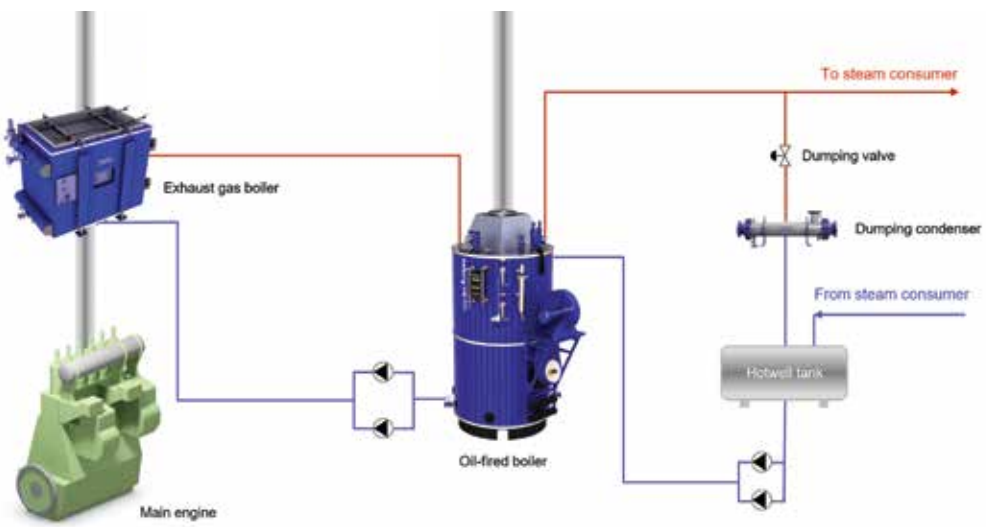
Complying with Regulation 14 will have a tremendous impact on the maritime industry. Vessels will need to reduce their SOx emissions, and there are multiple strategies owners and managers can choose to achieve the necessary reduction. Some of these strategies impact the so-called steam balance of a vessel's steam plant.

This document aims to provide information about how the use of various compliant fuel oils impacts the steam balance. It also offers recommendations on how to best manage excess or insufficient steam production. In addition, the document contains an overview of Alfa Laval Aalborg solutions for optimizing a vessel's steam plant operation.

2. Steam plant overview

The steam plant of a vessel comprises the following systems:

- The **steam consumers**, which are ship systems that require steam for thermal purposes.
- The **steam producers**, which are devices that produce the steam required by the steam consumers. The most common configuration is one **exhaust gas boiler** for waste heat recovery on the main engine exhaust line and one **oil-fired boiler**.
- The **hotwell tank**, which is the water reservoir. It is also used to preheat the water that is delivered to the **oil-fired boiler**.
- The **dump condenser**, which recovers and condenses any excess steam production.



3. The original steam balance calculation

During a vessel's design phase, a steam balance calculation is performed. The aim is to avoid excess or insufficient steam production.

The calculation is usually done by the construction yard or by an independent design company. The first step in the calculation is to list the vessel's steam consumers and quantify the total steam demand. The next step is to specify what capacity the steam producers need to cover the total steam demand. Based on this specification, the boiler manufacturers design the steam producers to ensure the right heating surface areas, burner capacities, etc.

When making the steam balance calculation, the vessel's operation must be taken into account. The steam demand is, for example, affected by the climatic conditions the vessel operates in. If the weather is cold, heat losses from the fuel tanks increase. Likewise, the steam production in the exhaust gas boiler depends on the main engine's load. If the vessel is slow steaming, the steam production will be reduced.

4. Why changing to compliant fuels impacts the steam balance

In the standard steam plant design, the fuel tanks consume a lot of steam. The reason is that the fuel traditionally used requires heating to achieve a viscosity low enough for the engines. In 2018, the global average viscosity of HSFO (high-sulphur fuel oil, which has a maximum sulphur content of 3.5%) was estimated to be around 320 centistokes (cSt).

Heating needs for VLSFO and ULSFO

Due to the 2020 sulphur cap, many vessels will switch to VLSFO (very-low-sulphur fuel oil, which has a maximum sulphur content of 0.5%), and/or ULSFO (ultra-low-sulphur fuel oil, which has a maximum sulphur content of 0.1%). These fuels are expected to have inconsistent specifications across different bunkering ports. The global average viscosity for VLSFO is expected to decrease to around 130 cSt in 2020. In some cases, however, VLSFO has been seen to have a viscosity as low as 10 cSt. ULSFO has similar viscosity ranges.

Such wide variations in viscosity will lead to differing heating requirements. Nonetheless, VLSFO and ULSFO often have a significantly lower viscosity than HSFO. This means that the heating demand for storage, separation and conditioning of these fuels is often lower than for HSFO.

However, some of these fuels are also expected to be more paraffinic, which will impact the fuel's cold flow properties (such as its cloud point, cold filter plugging point and pour point). If the fuel's cold flow properties have high temperature values, the demand for heating increases drastically.

Three potential scenarios

All of this means that steam plants that are not designed to operate solely on MGO, VLSFO or ULSFO might experience challenges. There are three potential scenarios:

- Excess steam production
- Insufficient steam production
- Alternating periods of excess and insufficient steam production

Therefore, Alfa Laval recommends an analysis of the new steam demand when introducing MGO, VLSFO or ULSFO.

5. How to manage excess steam production

The amount of steam produced by the exhaust gas boiler used for waste heat recovery (WHR) is a function of the main engine load. Systems designed for HSFO usually produce the right amount of steam for the consumers when the main engine runs at 75–85% of maximum continuous rating (MCR).

With reduced steam demand due to compliant fuel operation, the excess of steam produced in the exhaust gas boiler will need to be condensed through the dump line. However, continuous dumping of large amounts of steam may stress the dump condenser to the point of breakdown. If the dump condenser stops working, the exhaust gas boiler will still produce steam as long as the main engine is running. This will lead to increased steam pressure that will eventually cause a shutdown of the main engine.

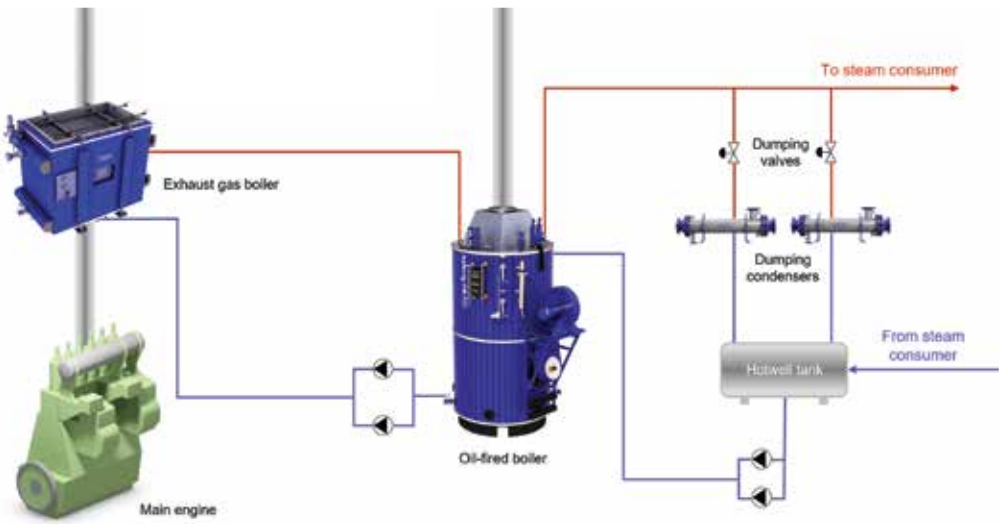
Alfa Laval Aalborg solutions

An Alfa Laval Aalborg specialist can assist with steam plant upgrades based on two predefined solutions:

- **Derating the exhaust gas boiler capacity**
  Derating the exhaust gas boiler capacity is done by modifying the heating surface to minimize steam production. However, this solution is limited to certain exhaust gas boiler designs and will be assessed as an option on a case-by-case basis.
- **Increasing the steam dumping capacity**
  The steam dumping capacity can be increased by installing an additional dump line. Having two dump lines will also ensure flexibility and safe operation of the steam plant. Therefore, Alfa Laval's most common recommendation for increasing the steam dumping capacity is to install an additional dump line, as shown in illustration below.

Other solutions – based on two condensers using a common dump valve or on a single dump condenser – can also be considered.

Whichever solution is chosen, Alfa Laval can provide support by managing the complete project, from dump condenser design to system commissioning.

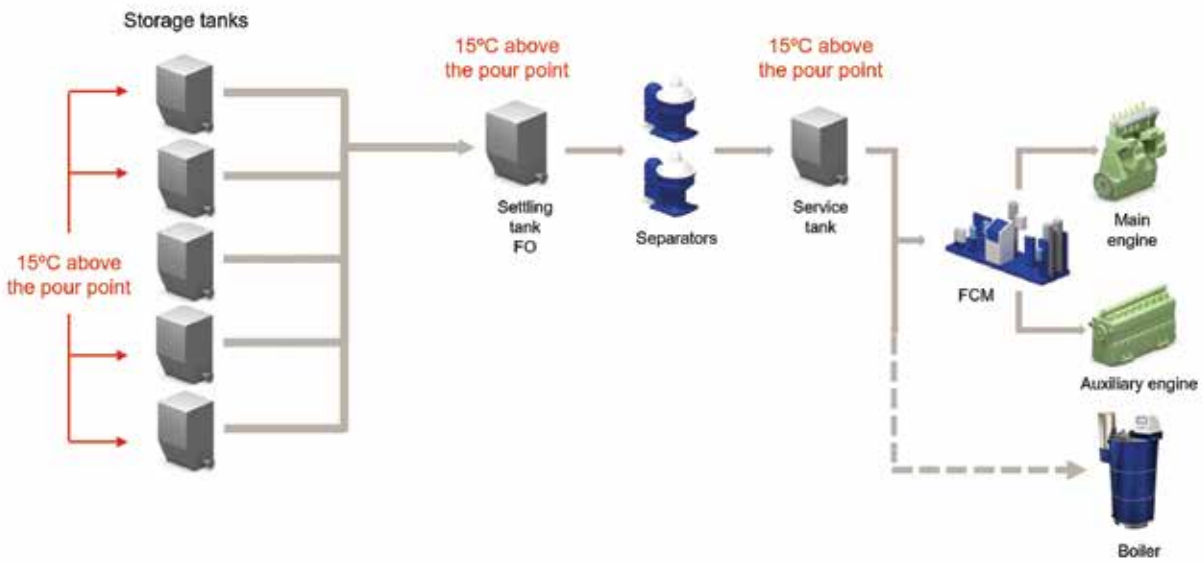


6. How to manage insufficient steam production

As mentioned previously, VLSFO and ULSFO sometimes exhibit high temperature values for their cold flow properties. There have been cases with pour point values between 25°C and 30°C.

If the temperature of these fuels decreases below the pour point, parafinnic wax will precipitate. This process is not reversible due to the low thermal conductivity of wax, which means that once wax has been created, the fuel will be very difficult to return to a liquid state through heating. Therefore, Alfa Laval's recommendation is to keep fuel temperature at least 15°C above the pour point at all times and in all fuel tanks, as shown in illustration below.

This means that if the fuel the vessel operates on has a pour point value of 30°C, there is a requirement to maintain a temperature of 45°C in all tanks where the fuel is stored. Maintaining this temperature in all storage tanks may stress the steam plant to its design limits. External factors, such as cold weather, and operational decisions, such as slow steaming, can also put pressure on the steam balance by increasing the steam demand and/or decreasing the steam supply. In addition, there is always a potential for malfunction of the existing steam equipment.



If these factors make the steam demand higher than the steam supply, there can be serious consequences both during port stay and sailing. Insufficient heating can lead to:

- Bunker losses, due to paraffinic wax precipitation
- Plugging of the fuel lines of the main engine and the auxiliary engines, which jeopardizes the safe operation of the vessel

Another possible problem to be aware of is that the vessel might not have sufficient tank heating equipment.

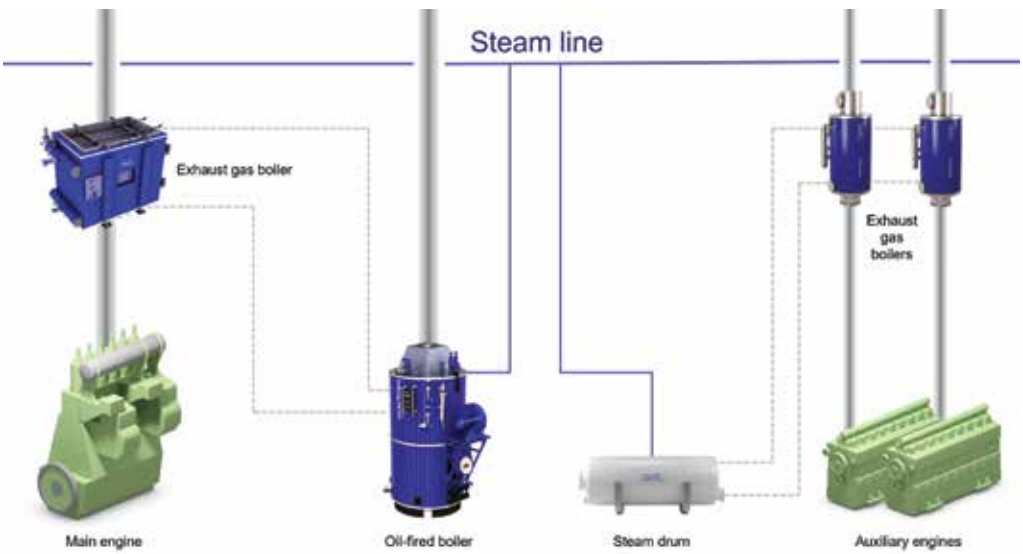
Alfa Laval Aalborg solutions

Alfa Laval has developed a number of retrofit solutions that can increase the production capacity of the steam plant and/or ensure redundancy of the steam prroducers:

- Waste heat recovery after the auxiliary engines
- Additional steam space
- Electrical heaters

An example of an upgrade solution is shown in this illustration, where an additional exhaust gas boiler has been installed after the auxiliary engine and a separate steam drum has been added:

Alfa Laval can assist with new steam demand estimations and find the optimal solution for any vessel.



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Our equipment, systems and services are dedicated to helping customers to optimize the performance of their processes. Time and time again. We help our customers to heat, cool, separate and transport products such as oil, water, chemicals, beverages, foodstuff, starch and pharmaceuticals.

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