Solution overview

Avoiding heat balance risks in 2020 and beyond

How to adapt Alfa Laval Aalborg thermal fluid systems for compliant fuels

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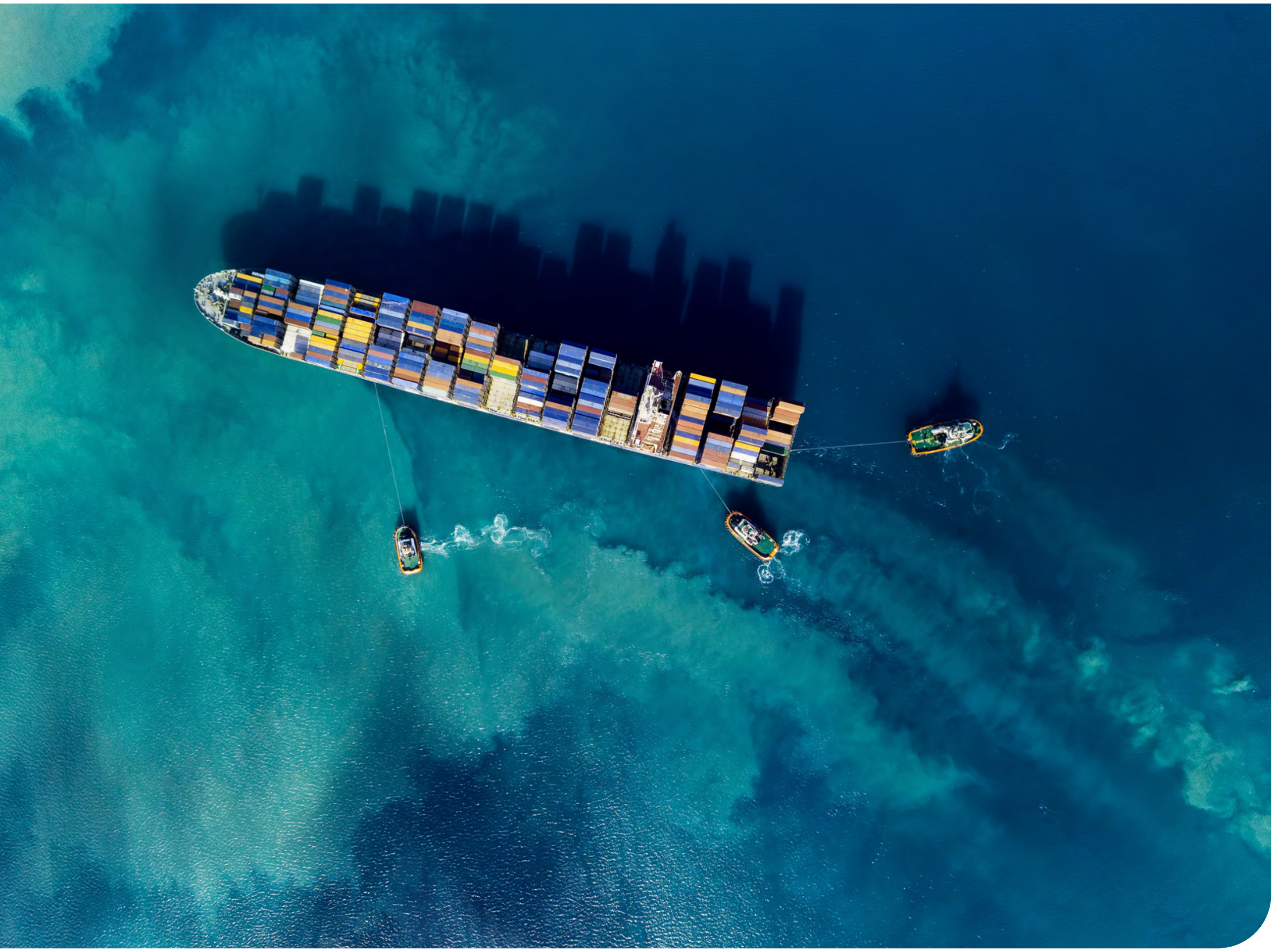

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1. Introduction

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.

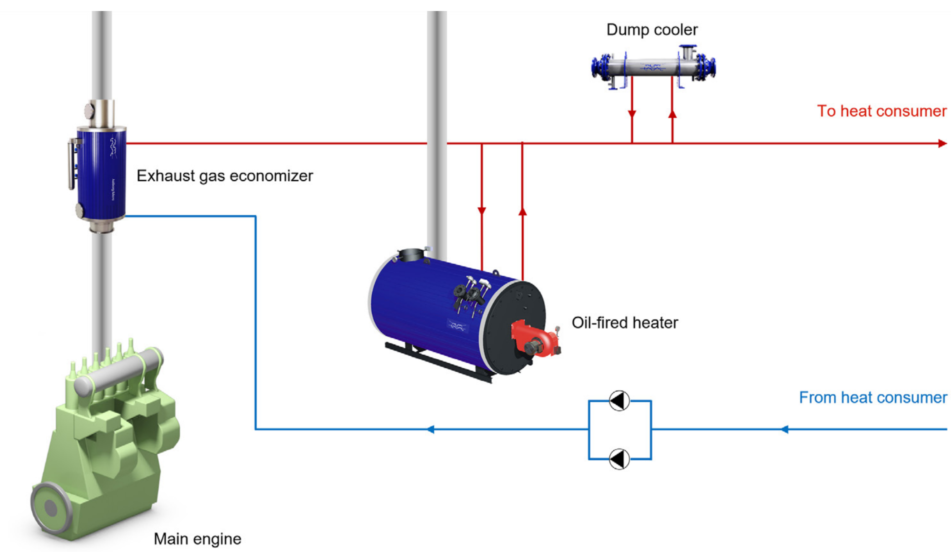
Complying with Regulation 14 will have a tremendous impact on the maritime industry. Vessels will need to reduce their SOx emissions, and there are multiple strategies owners and managers can choose to achieve the necessary reduction. Some of these strategies impact the so-called heat balance of a vessel's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

This document aims to provide information about how the use of various compliant fuel oils impacts the heat balance. It also offers recommendations on how to best manage excess thermal fluid heating. In addition, the document contains an overview of Alfa Laval Aalborg solutions for optimizing a vessel's thermal fluid system.

2. Thermal fluid system overview

The thermal fluid system of a vessel comprises the following systems:

- The **heat consumers**, which are ship systems that require heating.
- The **heaters**, which are devices that produce the heat energy required by the heat consumers. The most common configuration is one exhaust gas economizer for waste heat recovery on each main engine exhaust gas line, in combination with an oil-fired or gas-fired heater.
- The **dump cooler** (if any), which recovers and dumps any surplus of heat produced.



3. The original heat balance calculation

During a vessel's design phase, a heat balance calculation is performed. The aim is to avoid excessive or insufficient heat 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 heat consumers and quantify the total heat demand. The next step is to specify what capacity the heaters need to cover the total heat demand. Based on this specification, the heater manufacturers design the heaters to ensure the right heating surface areas, burner capacities, etc.

When making the heat balance calculation, the vessel's operation must be taken into account. The heat 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 heat production in the exhaust gas economizer depends on the main engine's load. If the vessel is slow steaming, the heat production will be reduced.

4. Why changing to compliant fuels impacts the heat balance

In the standard thermal fluid system design, the fuel tanks consume a lot of thermal energy. 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 thermal fluid systems that are not designed to operate solely on MGO, VLSFO or ULSFO might experience challenges. There are three potential scenarios:

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

5. How to manage excess heat production

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

The temperature of the thermal fluid sent to the heat consumers is automatically controlled by means of exhaust gas bypass valves and/or a dump cooler, which is cooled by a freshwater (FW) cooling circuit or by seawater. With reduced thermal demand due to compliant fuel operation, the excess of heat recovered by the exhaust gas economizer will need to be reduced by these means.

In thermal fluid systems without a dump cooler but with internal exhaust gas bypass valves on the exhaust gas economizers, the heat transfer from exhaust gas to the thermal fluid will never be zero. Even in full bypass mode, heat will be transferred via radiation. In situations where the consumers' heat needs are strongly reduced, this may lead to a surplus of heat production and possible overheating of the thermal fluid.

If a dump cooler is used, it may not be large enough to dump all recovered heat at maximum engine load, as the dump cooler is typically designed for the exhaust gas economizer capacity at normal engine load. Furthermore, the temperature of the low-temperature cooling system may rise if the latter is used as the cooling medium. In a warm-climate area, the cooling system would certainly be stressed to its design limits.

Alfa Laval Aalborg solutions

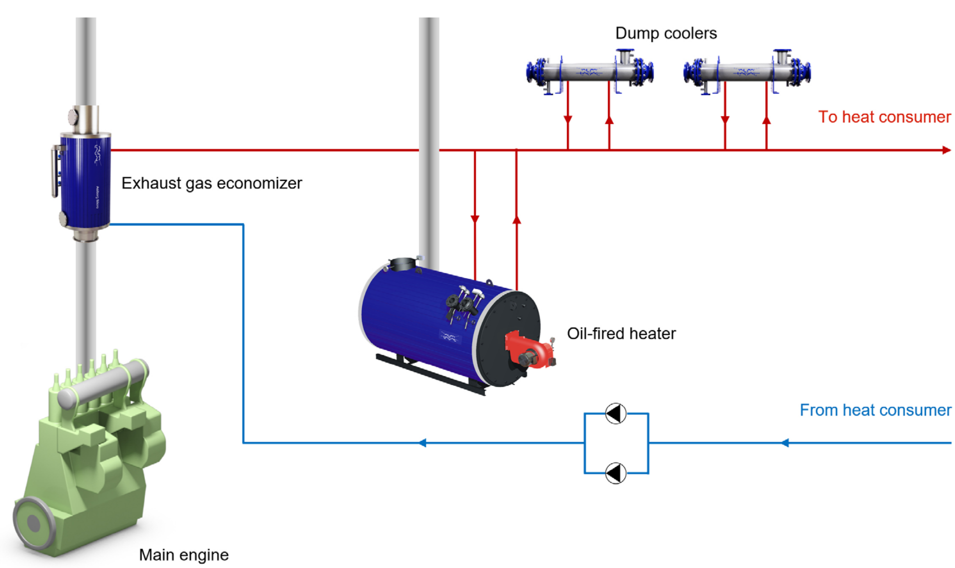
An Alfa Laval Aalborg specialist can assist with thermal fluid system upgrades based on two predefined solutions:

- **Installing a dump cooler or increasing the existing dump cooling capacity**
  If no dump cooler is present, a new unit can be installed. If there is an existing dump cooler with insufficient capacity, either it can be replaced with a larger unit or an additional cooler can be installed. Having two coolers will provide redundancy, which ensures flexibility and safe system operation. Therefore, Alfa Laval's most common recommendation for increasing dump cooling capacity is to install a larger single cooler or an additional cooler, as shown in the illustration below.

- **Decommissioning the exhaust gas economizer**
  The exhaust gas economizer can be decommissioned by removing all of its internals, leaving the shell in place as part of the exhaust ducting.

Dry running of the exhaust gas economizer cannot be seen as a viable solution. Dry running is considered an emergency procedure, rather than a condition for operational use. Not only can long-term operation in dry condition cause irreversible damage to the economizer, it also increases the danger of soot fires.

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

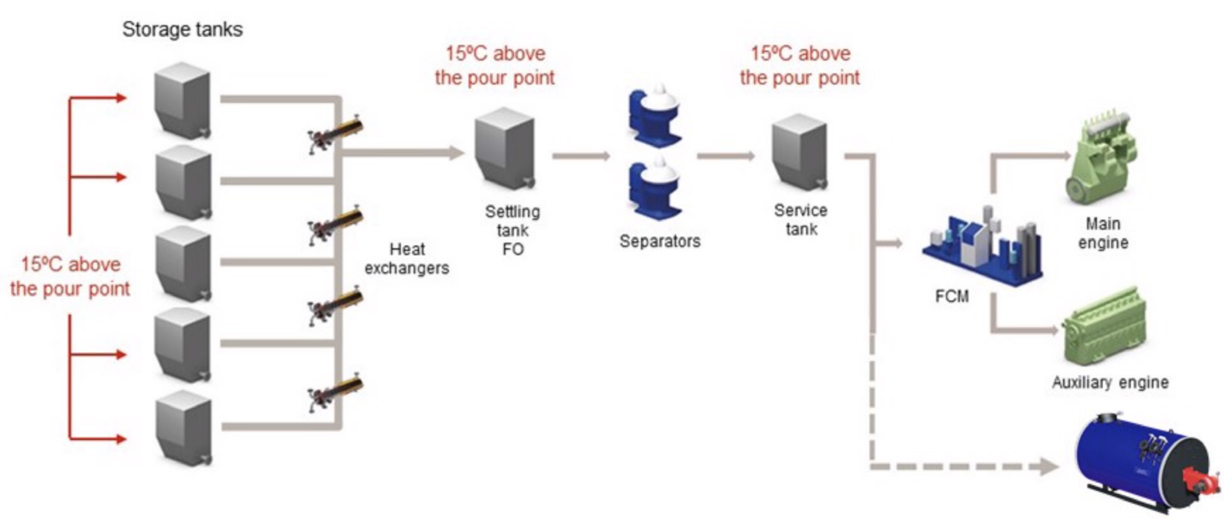


6. How to manage insufficient heat production

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, paraffinic 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 the 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 thermal fluid system to its design limits. External factors, such as cold weather, and operational decisions, such as slow steaming, can also put pressure on the heat balance by increasing the heat demand and/or decreasing the waste heat recovery capacity. In addition, there is always a potential for malfunction of the existing equipment.



If these factors make the heat demand higher than the 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 thermal fluid system and/or ensure redundancy of the heat producers:

- Waste heat recovery after the auxiliary engines
- Additional electrical heater(s)
- Additional fired heater(s)

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

About Alfa Laval

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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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