

Title: System for extracting heated heavy fuel oil from an elongated storage tank**Description****5 Field of invention**

The invention relates to the fuel system of a large vessel running on heavy fuel oil. More specifically it relates to a system for extracting heated heavy fuel oil from an elongated storage tank with low height.

Background

10 Most of the larger ships run on heavy fuel oil. This is a readily available fuel, but the viscosity is high, and it needs to be heated to enable flow of heavy fuel oil from storage tanks to consumer tanks. In prior art it has been customary to heat the entire storage tank of heavy fuel oil, thus wasting energy.

15 EP2630402 B1 describes a storage tank for heavy fuel oil or other high viscous fluids which is equipped with a convection shield with heating elements inside enabling pumping from the tank without having to heat the complete tank according to patent.

20 However, many storage tanks are positioned near the bottom of the ship and are often shaped as elongated rectangular volumes with low height. If a system according to EP2630402 B1 is installed in such a storage tank in order to save energy on fuel heating two problems arise. One is that the entire tank is not heated when the bulk heating valve is open, because the convection pattern does not reach the far ends from the convection shield due to high viscosity during cold conditions. The second problem is that during cold conditions flow into the convection shield according to EP2630402 B1 becomes insufficient especially when the fuel level is 25 low. The problem experienced during such conditions is that not enough fuel is able to enter the convection shield and consequently the fuel suction line will not function properly.

30 The object of the invention is to solve the mentioned problems and supply a reliable flow of fuel also during cold conditions.

Summary of invention

The present invention is set forth and characterized in the independent claims while the dependent claims describes other characteristics of the invention.

In one aspect the invention describes a system for extraction of heated heavy fuel oil from an elongated heavy fuel oil storage tank. The system comprises a convection shield with closed top and side and a substantially open bottom, wherein the convection shield is mounted with a clearance between the bottom of the storage tank and the lower edge of the convection shield to allow for entry of heavy fuel oil into the convection shield through the open bottom,

The system further comprises a heating element arranged inside the convection shield for heating the heavy fuel oil inside the convection shield and a fuel suction line arranged inside the convection shield for extracting heated heavy fuel oil from the heavy fuel oil storage tank. The system further comprises an elongated inflow convection shield, which in turn comprises a closed upper part comprising a top and sides, a lower part, with openings for throughflow, positioned at the same height or lower as the lower edge of the convection shield to allow entry of heavy fuel oil into the inflow convection shield through the lower part. The inflow convection shield is connected to the lower edge of the convection shield, sharing a common interior allowing unhindered flow of heated heavy fuel oil from the inflow convection shield to the convection shield. An inflow heating element is positioned along the length of and inside the inflow convection shield for heating the heavy fuel oil inside the inflow convection shield, and the inflow convection shield extends along the bottom of the storage tank in its longitudinal direction.

In one embodiment the inflow heating element is a heating pipe running inside the inflow convection shield in a loop out from the convection shield (2) to the end piece and back again.

In another embodiment the inflow convection shield has the shape of an elongated rectangular volume with a top, two sides and an end piece at the outer end of the inflow convection shield and a bottom with a plurality of openings.

In yet another embodiment the inflow convection shield extends along more than 10 % of the length or width of the storage tank, preferably more than 30 % of the length of the storage tank.

In yet another embodiment the convection shield has a bulk heating valve mounted at the top of the convection shield.

In yet another embodiment the fuel suction line is positioned inside the convection shield near the top.

In yet another embodiment the system is provided with a second stage heater downstream of the convection shield, wherein the second stage heater comprises a second stage convection shield with a closed top and sides and a mainly closed bottom, a second stage heating element positioned inside the second stage

convection shield, a second stage channel leading partially heated heavy fuel oil from the top of the second stage convection shield to the bottom of the second stage heater and a fuel suction line positioned inside the inflow convection shield.

5 In yet another embodiment a fuel suction line is positioned inside the second stage convection shield near the top.

In yet another embodiment the second stage convection shield has a bulk heating valve mounted at the top of the convection shield.

In yet another embodiment the second stage convection shield has drain holes in the bottom of the second stage convection shield.

10 In a second aspect of the invention it is described an ocean-going vessel comprising a system according to the first aspect of the invention.

Brief description of drawings

15 The following drawings are appended to facilitate the understanding of the invention. The drawings show embodiments of the invention, which will now be described by way of example only.

Fig. 1 shows a convection shield having an inflow convection shield mounted.

Fig. 2 shows a heavy fuel oil fuel tank with convection shield having a inflow convection shield mounted.

20 Fig. 3 shows a cross section of an embodiment of an inflow convection shield mounted.

Fig. 4 shows the embodiment from fig. 2 with a second stage heater mounted and a typical flow pattern of heavy fuel oil through an active system.

25 Fig. 5 shows a flow pattern in a storage tank using an embodiment of the invention with an open bulk heater valve.

Detailed description

30 The invention describes a system for extraction of heated heavy fuel oil from an elongated heavy fuel oil storage tank 1, typically used for fuel. It is particularly useful in heavy fuel oil tanks with low height. Mostly, the extraction of heavy fuel oil is a slow process for example supplying an engine or consumer tank with fuel, but on some occasions a need for immediate emptying of the storage tank may arise.

The system, as seen in fig. 1 and 2, comprises a convection shield 2 having a closed top 8 and closed sides 9 and a mainly open bottom side. Typically, the convection

shield 2 is box shaped, or alternatively has the shape of an upside-down bucket or a hollow cylinder with a circular top. A heating element 3 is positioned inside the convection shield 2 and a convection flow 6 emerges when the heating element is heating the heavy fuel oil. An exemplary flow pattern is seen in figure 2. The heated heavy fuel is extracted from inside of the convection shield 2 by means of a fuel suction line 4. The intake of the fuel suction line 4 is positioned in the upper end of the convection shield near the top where the temperature of the heavy fuel oil is high. The convection shield 2 is mounted near the bottom of the storage tank 1, but with a clearance between the bottom of the storage tank 1 and the lower edge of the convection shield to allow for entry of heavy fuel oil into the convection shield 2 through the open bottom. The clearance between the lower edge of the convection shield and the bottom of the storage tank is between 5 and 70 cm, more preferably between 10 and 15 cm.

In order to mitigate the problems mentioned earlier related to storage tanks with low height, the invention describes an elongated inflow convection shield 10 with a closed upper part 11 comprising a top 12 and sides 13 and an end piece 14 at the outer end of the inflow convection shield 10. The inflow convection shield further comprises a lower part 16 with openings 17 and is mounted at the same height, or lower, as the lower edge of the convection shield to allow entry of heavy fuel oil into the convection shield through the openings in the lower part bottom. In one embodiment the inflow convection shield 10 has the shape of an elongated rectangular volume with an open bottom. The inflow convection shield is connected to the lower edge of the convection shield. Preferably an opening matching the cross-section of the inflow convection shield is cut into the lower side of the convection shield where the inflow convection shield is fastened, to allow unhindered flow of partially heated heavy fuel oil from the inflow convection shield 10 into the convection shield 2 for further heating. The convection shield and inflow convection shield are sharing a common interior allowing unhindered flow of heated heavy fuel oil from the inflow convection shield to the convection shield.

An inflow heating element 15 is positioned along the length of and inside the inflow convection shield 10. Preferably the inflow heating element is a heat pipe running in a loop out from the convection shield 2 to the end piece 14 and back again. The heat pipe has a heating medium like steam or thermal fluid.

The inflow convection shield extends along the bottom of the storage tank mainly at the same height as the lower edge of the convection shield. The effect of this is that heavy fuel oil is allowed to flow into the heated sections along a much longer distance. Preferably the inflow convection shield extends over more than 10% of the length of the storage tank 1, more preferably more than 30 %. Preferably the convection shield is positioned in the aft/stern side of the storage tank. This is advantageous because the ship is normally trimmed towards a lower stern and the

convection shield will then be positioned at the lowest point in the storage tank. In other words, the convection shield is preferably positioned at the lowest point in the storage tank.

5 In one embodiment a bulk heating valve 5, having an open and closed position, is mounted on the top 8 of the convection shield 2. In the open position heated heavy fuel oil will escape upwards from the convection shield and unheated oil will be drawn in from inflow convection shield 10 and from the bottom side of the convection shield 2 and a convection flow 7 will emerge in the bulk of the storage tank as indicated in fig. 5. In the closed position of the bulk heating valve 5 only the heavy fuel oil within the convection shield 2 will be heated. The size of the valve is between 2 and 30 % of the area of the top 8, more preferably between 2 and 10 %. In other words, the invention will function as an ordinary convection shield when the bulk heating valve is in the closed position and as a bulk heater when the bulk heating valve 5 is in the open position. The size of the bulk heating valve will determine the rate of heat released from the convection shield into the bulk of the storage tank. In a storage tank with low height large parts of the heavy fuel oil will remain in the tank when the level has reached the height of the bulk heating valve 5, at which point the mentioned flow pattern will stop.

20 In one embodiment of the invention a second stage heater 21 is connected downstream of the convection shield. The purpose of the second stage heater is to provide a more stable temperature because the low height of the convection shield, and consequently also the low height of the heating element 3, results in larger variations in the temperature of the heavy fuel oil entering the fuel suction line 4, which may result in the suction line clogging up. The second stage heater 21 comprises a second stage convection shield 19 with a closed top 9 and sides 8, a mainly closed bottom 24 and a second stage heating element 20. The bottom 24 of the secondary convection shield must be mainly closed in order to create a suction of heated heavy oil from the convection shield 2 to the secondary convection shield 19 because of the secondary fuel suction pipe 23 extracting heavy fuel oil from the secondary convection shield. In one embodiment the bottom 24 has drain holes. A second stage channel 22 leads partly heated heavy fuel oil from the top of the convection shield to the bottom of the second stage heater 21. A second stage fuel suction line 23 is positioned inside the second stage convection shield 19.

35 **Inventory**

1. Heavy fuel oil storage tank
2. Convection shield
3. Heating element
4. Fuel suction line

5. Bulk heating valve
6. Convection flow inside convection shield
7. Convection flow in the whole heavy fuel oil storage tank.
8. Top (of convection shield)
- 5 9. Side (of convection shield)
10. Inflow convection shield
11. Upper part of inflow convection shield
12. Top (of inflow convection shield)
13. Sides (of inflow convection shield)
- 10 14. End piece (of inflow convection shield)
15. Inflow heating element
16. Lower part
17. Openings
18. Convection chamber
- 15 19. Second stage convection shield
20. Second stage heating element
21. Second stage heater
22. Second stage channel
23. Second stage fuel suction line
- 20 24. Bottom of the second stage convection shield

CLAIMS

1. System for extraction of heated heavy fuel oil from an elongated heavy fuel oil storage tank (1) comprising:
 - 5 a convection shield (2) with closed top (8) and sides (9) and a substantially open bottom, wherein the convection shield (2) is mounted with a clearance between the bottom of the storage tank (1) and the lower edge of the convection shield to allow for entry of heavy fuel oil into the convection shield through the open bottom,
 - 10 a heating element (3) arranged inside the convection shield (2) for heating the heavy fuel oil inside the convection shield,
 - a fuel suction line (4) arranged inside the convection shield for extracting heated heavy fuel oil from the heavy fuel oil storage tank,
 - characterized by** an elongated inflow convection shield (10) comprising:
 - 15 a closed upper part (11) comprising a top (12) and sides (13),
 - a lower part (16), with openings (17) for throughflow, positioned at the same height, or lower, as the lower edge of the convection shield (2) to allow entry of heavy fuel oil into the inflow convection shield through the lower part (16),
 - 20 wherein the inflow convection shield (10) is connected to the lower edge of the convection shield (2), sharing a common interior allowing flow of heated heavy fuel oil from the inflow convection shield to the convection shield, and
 - wherein an inflow heating element (15) is positioned along the length
 - 25 of and inside the inflow convection shield (10) for heating the heavy fuel oil inside the inflow convection shield, and
 - wherein the inflow convection shield extends along the bottom of the storage tank in its longitudinal direction.
- 30 2. System according to claim 1 wherein the inflow heating element (15) is a heating pipe running inside the inflow convection shield (10) in a loop out from the convection shield (2) along the length of the inflow convection shield (10) and back again.
- 35 3. System according to claim 1 or 2, wherein the inflow convection shield (10) has the shape of an elongated rectangular volume with a top (12), two sides (13) and an end piece (14) at the outer end of the inflow convection shield (10) and a bottom with a plurality of openings (17).

4. System according to one of the previous claims, wherein the inflow convection shield (10) extends along more than 10 % of the length or width of the storage tank, preferably more than 30 % of the length of the storage tank.
5. System according to one of the previous claims, wherein the convection shield
5 has a bulk heating valve mounted at the top of the convection shield (2).
6. System according to one of the previous claims, wherein the fuel suction line (4) is positioned inside the convection shield near the top.
7. System according to one of the previous claims, wherein the system is provided with a second stage heater (21) downstream of the convection shield
10 (2) comprising:
 - a second stage convection shield (19) with closed top and sides and a mainly closed bottom,
 - a second stage heating element (20) positioned inside the second stage convection shield,
 - 15 a second stage channel (22) leading partially heated heavy fuel oil from the top of the convection shield to the bottom of the second stage heater (21), and
 - a second stage fuel suction line (23) positioned inside the second stage convection shield (19).
- 20 8. System according to claim 7 wherein a fuel suction line (23) is positioned inside the second stage convection shield (19) near the top.
9. System according to claim 7 or 8, wherein the second stage convection shield (19) has a bulk heating valve (5) mounted at the top of the second stage convection shield (19).
- 25 10. System according to one of the previous claims 7-9, wherein the bottom (24) of the second stage convection shield (19) has drain holes.
11. Ocean going vessel comprising a system according to one of the previous claims.