

FLUID DELIVERY APPARATUS AND METHOD FOR MARINE BUNKERING MEASUREMENT

Field of Invention

5 Embodiments of the invention relate fluid delivery apparatus and method for marine bunkering measurement, particularly, to improving accuracy of marine bunkering measurement by elevating fuel oil flow using plate fixture.

Background

10 In marine bunkering, positive displacement pump is commonly used for tank stripping to remove sludge and water from bunker tanks, and results in two-phase flow (i.e. gas and fuel oil).

 To optimize measurement accuracy, a marine bunker measurement system may incorporate two level switches at both downstream and upstream sides of high-
15 capacity sensor tubes of mass flow meter. Typically, when fuel oil is present in the pipeline, the level switches will send a signal to start or activate totalizers; when there is no fuel oil in the pipeline, the level switches will send a signal to stop or deactivate totalizers. As such, false registering due to unbalanced partially filled sensor tubes is suppressed.

20 In marine bunker measurement systems installed on Very Large Crude Carriers (VLCC) or on main deck of high vessels, fuel oil is likely to flow at a level below the sensing probes of level switches as shown in Figure 1A. This phenomenon may be due to an elevation difference between fuel supplying bunker barge and the receiving vessel, low fuel flow rate, vessel's high trim, etc.
25 Consequently, functionality of level switches becomes an issue. In a particular occurrence as shown in Figure 1A, mass flow rate is represented in Figure 1B. Data collected shows stable Live Zero (see Figure 1C), Pressure (see Figure 1D), Drive Gain % (see Figure 1E), Density (see Figure 1F), , which all point to a presence of fuel oil flowing through the mass flow meter. The fuel oil flow was, however, not

registered as the sensing probes of the level switches were not in contact with the fuel oil.

Accordingly, an improved fluid delivery apparatus for marine bunkering, which addresses the above and other issues is highly desirable.

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Summary

A fluid delivery apparatus for marine bunker measurement is provided. According to one embodiment, the fluid delivery apparatus comprises:

a pipe spool;

10 a switch having a probe which is positioned within an interior of the pipe spool; and

a plate disposed under the probe and joined to the pipe spool, the plate having a first surface to provide an elevated channel configured to elevate fuel oil to come into contact with the probe, wherein the plate is provided with a
15 drainage opening at an edge which adjoins the pipe spool.

In one embodiment, the drainage opening is located at a lowest intersection of the plate and an internal wall of the pipe spool.

20 In one embodiment, the plate includes an annular sector profile wherein an inner annular surface of the plate provides the elevated channel, and a groove on an outer annular surface of the plate provides the drainage opening.

In one embodiment, the plate is joined to the pipe spool by welding.

25 In one embodiment, the switch is one of a vibrating fork level switch, a float type level switch and a thermal flow switch.

In one embodiment, the elevated channel includes a cross-sectional shape selected from one of semi-circle, rectangle, triangle, diamond, and ellipse.

In one embodiment, the elevated channel includes a substantially level
30 surface.

A marine bunker measurement system is further provided. According to one embodiment, a marine bunker measurement system comprises:

a mass flow meter; and

5 the fluid delivery apparatus according to claims 1 to 7 or described in the present disclosure, which is arranged in fluid communication with a downstream side of the mass flow meter.

According to one embodiment, a bunkering method comprises:

10 at a marine bunker measurement system according to claim 8 or described in the present disclosure,

while supplying fuel oil, accumulating the fuel oil at an upstream side of the plate, and delivering the fuel oil through the elevated channel and the drainage opening to a downstream side of the plate; and

15 after ceasing supply of the fuel oil, draining a remaining of the fuel oil, which falls short of the elevated channel, through the drainage opening to the downstream side of the plate.

According to one embodiment of the invention, in the above-described
20 method, the step of delivering the fuel oil through the elevated channel includes activating the switch in response to a presence of contact of the fuel oil with the probe, and wherein draining a remaining of the fuel oil, which falls short of the elevated channel, through the drainage opening to the downstream side of the plate, includes deactivating the switch in response to an absence of contact of the fuel oil
25 with the probe.

According to one embodiment of the invention, a method for installing a fluid delivery apparatus in a bunker measurement system is provided and comprises:

30 at a marine bunker measurement system, cutting and removing a segment of a pipeline which is located at a downstream side of a mass flow meter; and

joining the fluid delivery apparatus according to any of claims 1 to 7 to the pipeline in substitution of the segment.

According to one embodiment of the invention, in the above-described method, the step of joining the fluid delivery apparatus includes welding the pipe spool to the pipeline.

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According to one embodiment of the invention, a method for installing a fluid delivery apparatus in a bunker measurement system is provided and comprises:

cutting and removing a segment of a pipeline of a marine bunker measurement system, which is located at a downstream side of a mass flow meter;

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modifying the segment which includes a switch having a probe which is positioned within an interior of the segment, by disposing a plate under the probe and joining the plate to the segment, the plate having a first surface to provide an elevated channel configured to elevate fuel oil to come into contact with the probe, wherein the plate is provided with a drainage opening at an edge which adjoins the segment; and

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joining the modified segment to the pipeline.

According to one embodiment of the invention, in the above-described method, the drainage opening is located at a lowest intersection of the plate and an internal wall of the segment.

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According to one embodiment of the invention, in the above-described method, the step of joining the modified segment to the pipeline includes welding the modified segment to the pipeline.

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Brief Description of Drawings

The invention will be described in detail with reference to the accompanying drawings, in which:

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Figure 1A shows a marine bunker measurement system having fuel oil flow at a level below the sensing probes of level switches;

Figure 1B is a chart detailing mass flow rate during an occurrence illustrated by Figure 1A;

Figure 1C is a chart detailing live zero during an occurrence illustrated by Figure 1A;

5 Figure 1D is a chart detailing external pressure during an occurrence illustrated by Figure 1A;

Figure 1E is a chart detailing drive gain during an occurrence illustrated by Figure 1A;

10 Figure 1F is a chart detailing density during an occurrence illustrated by Figure 1A;

Figure 2A shows a perspective view of a fluid delivery apparatus according to one embodiment;

Figure 2B shows a cutaway view of the fluid delivery apparatus of Figure 2A;

15 Figure 2C shows a cross-sectional view of the fluid delivery apparatus of Figure 2A;

Figure 2D shows a plate prior to being incorporated with the fluid delivery apparatus of Figures 2A to 2C;

Figures 3A to 3E show cutaway views of fluid delivery apparatus according to various embodiments of the invention; and

20 Figure 4 shows a marine bunker measurement system retrofitted with a fluid delivery apparatus according to one embodiment.

Detailed Description

25 In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. It is

understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the invention. In the drawings, like reference numerals refer to same or similar functionalities or features throughout the several views.

5 Reference is made to Figures 2A to 2D which show various views of a fluid delivery apparatus 200 for marine bunkering measurement according to one embodiment of the invention. The fluid delivery apparatus 200 at least includes a pipe spool 210, a switch 220 having a probe 222, and a plate 230 having a drainage opening 234.

10 The pipe spool 210 is provided as a pre-cut or prefabricated pipe. The pipe spool 210 preferably has dimensions that would provide a complementary fit with a target pipeline of a marine bunkering measurement system. The pipe spool 210 may be provided with flanges 212 at both ends of the pipe spool 210 to facilitate connection with other pipe spools or pipelines.

15 The pipe spool 210 is provided with a switch 220 having a probe 222 which is positioned within an interior of the pipe spool 210. The probe 222 is configured to activate the switch 220 upon contact with fuel oil or liquid, and deactivate the switch 220 in the absence of contact with fuel oil or liquid. The switch 220 may be provided as a vibrating fork level switch, a float type level switch, a thermal flow switch or any
20 other suitable switches having contact-type probes. Upon installing the pipe spool 210 at a marine bunkering measurement system, the switch 220 would also be configured to be electrically or communicably coupled to a totalizer and/or other devices of the marine bunkering measurement system.

 The plate 230 is disposed under the probe 222 and joined to the pipe spool
25 210, such as by welding. The plate 230 has a first surface to provide an elevated channel 232 configured to elevate fuel oil towards the probe 222 and/or come into contact with the probe 222. The plate 230 has a drainage opening 234 at an edge which adjoins the pipe. In the embodiment shown in Figure 2D, the plate 230 has an annular sector cross-sectional profile wherein an inner annular surface provides the
30 elevated channel 232, and an outer annular surface is joined to the pipe spool 210. At the outer annular surface, the plate 230 is provided with a suitably-dimensioned

groove to provide the drainage opening 234. The radius of the drainage opening 234 may be suitably dimensioned to maintain a gap of about 10 mm between sensing point of probe 222 and the plate 230. The radius of the drainage opening 234 may be about 8% of the radius of the pipe spool 210 or 5 mm, whichever is higher. The thickness of the plate 230 may be about 25 mm.

In Figures 2A to 2D, the elevated channel 232 and the drainage opening 234 have semi-circular cross-sectional profiles. It is to be appreciated that the elevated channel 232 and the drainage opening 234 may take on other profiles in certain other embodiments. Figure 3A shows both elevated channel 232 and drainage opening 234 having rectangular cross-sectional profiles; Figure 3B shows both elevated channel 232 and drainage opening 234 having triangular cross-sectional profiles; Figure 3C shows both elevated channel 232 and drainage opening 234 having elliptical cross-sectional profiles; Figure 3D shows both elevated channel 232 and drainage opening 234 having diamond-shaped cross-sectional profiles; Figure 3E shows both elevated channel 232 and drainage opening 234 having a substantially level surface.

In the embodiment shown in Figures 2A to 2D, the drainage opening 234 is located at the lowest intersection of the plate 230 and the internal wall of the pipe spool 210. This is to ensure that remaining fuel oil can be self-draining after supply of fuel oil is ceased. However, it is to be appreciated that in certain other embodiments, the drainage opening 234 may be located at a slight offset from the lowest intersection of the plate 230 and the internal wall of the pipe spool 210.

According to one embodiment of the invention, a marine bunker measurement system 400 (see Figure 4) includes a mass flow meter 410 (also known as Coriolis meter), and a fluid delivery apparatus 200 according to any of above-described embodiments, which is arranged in fluid communication with a downstream side of the mass flow meter 410. The downstream side of the mass flow meter 410 is to be arranged in fluid communication with a bunker-receiving vessel through a pipeline

420. The upstream side of the mass flow meter 410 is to be connected in fluid communication with a bunker-supplying vessel through a pipeline 430, and is provided with a switch 120.

According to one embodiment of the invention, a method for marine bunkering measurement is provided. While supplying fuel oil to a bunker-receiving vessel through a marine bunker measurement system, fuel oil is delivered from a bunker-supplying vessel to the bunker-receiving vessel through pipelines and marine bunker measurement system 400. While fuel oil is supplied through the marine bunker measurement system 400, a very small proportion of the fuel oil is delivered through the drainage opening 234 due to the size of the drainage opening 234; the fuel oil is rapidly accumulated or built up at an upstream side of the plate 230 of the fluid delivery apparatus 200 due to continuous supply of fuel oil. After the accumulated fuel oil level exceeds the height of the plate 230, the fuel oil is mostly delivered through the elevated channel 232 to a downstream side of the plate 230. Delivering fuel oil through the elevated channel 232 elevates the fuel oil to come into contact with the probe 222. In response to a presence of contact of fuel oil with the probe 222, the switch 220 is activated to commence measurement at a totalizer which is electrically coupled to the probe 222.

After ceasing supply of the fuel oil to the bunker-receiving vessel, fuel oil flowing in the marine bunker measurement system 400 decreases abruptly. The decreased fuel oil flow eventually results in falling short of the elevated channel 232 and a remaining of the fuel oil is self-drained through the drainage opening 234 to pipeline 420 at the downstream side of the plate 230. In response to an absence of contact of the remaining fuel oil with the probe 222, the switch 220 is deactivated and, accordingly, measurement at totalizer ceases.

According to one embodiment of the invention, methods of retrofitting an existing marine bunker measurement system are provided for installing the fluid delivery apparatus 200 therein. In one embodiment, at a marine bunker measurement system 400, a segment of a pipeline 420, which is located at a downstream side of a mass flow meter, is cut and removed. A fluid delivery

apparatus 200 for marine bunkering measurement is joined, such as by welding, to the pipeline 420 in substitution of the removed segment. In another embodiment, at a marine bunker measurement system 400, a segment of a pipeline 420, which is located at a downstream side of a mass flow meter 410, is cut and removed. The removed segment, which includes a switch 220 having a probe 222 which is positioned within an interior of the segment, is modified. Modification includes disposing a plate 230 under the probe 222 and joining the plate 230 to the segment, wherein the plate 230 has a profile as described in the present disclosure. The modified segment 200 (which is equivalent to the fluid delivery apparatus described in the present disclosure) is joined to the pipeline, such as by welding. Figure 4 shows a marine bunker measurement system 400 retrofitted with a fluid delivery apparatus according to one embodiment.

Embodiments of the invention are advantageous at least as described in the following:

- By installing a plate under the probe in the pipe spool, fuel oil flow is elevated to come into contact with the probe and thereby activates the switch to commence measurement at a totalizer. This addresses the problem of non-contact with probe during bunkering operation due to lowered flow level of fuel oil, and thereby eliminates inaccuracy due to under-measurement.
- As the plate has a drainage opening adapted to drain fuel oil after ceasing bunkering operation, remaining fuel oil can be self-drained without contact with the probe and thereby deactivates the switch to cease measurement at a totalizer.
- As the plate is installed at the downstream side of the mass flow meter, the plate will increase back pressure of fuel oil flow, which will result in better performance of the mass flow meter.

It is to be understood that the embodiments and features described above should be considered exemplary and not restrictive. Many other embodiments will be

apparent to those skilled in the art from consideration of the specification and practice of the invention. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the disclosed embodiments of the invention.

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Claims

1. A fluid delivery apparatus for marine bunker measurement, the apparatus comprising:

a pipe spool;

5 a switch having a probe which is positioned within an interior of the pipe spool;
and

a plate disposed under the probe and joined to the pipe spool, the plate having a first surface to provide an elevated channel configured to elevate fuel oil to come into contact with the probe, wherein the plate is provided with a drainage
10 opening at an edge which adjoins the pipe spool.

2. The apparatus according to claim 1, wherein the drainage opening is located at a lowest intersection of the plate and an internal wall of the pipe spool.

15 3. The apparatus according to any of claims 1 to 2, wherein the plate includes an annular sector profile wherein an inner annular surface of the plate provides the elevated channel, and a groove on an outer annular surface of the plate provides the drainage opening.

20 4. The apparatus according to any of claims 1 to 3, wherein the plate is joined to the pipe spool by welding.

5. The apparatus according to any of claims 1 to 4, wherein the switch is one of a vibrating fork level switch, a float type level switch and a thermal flow switch.

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6. The apparatus according to any of claims 1 to 2, wherein the elevated channel includes a cross-sectional shape selected from one of semi-circle, rectangle, triangle, diamond, and ellipse.

30 7. The apparatus according to any of claims 1 to 2, wherein the elevated channel includes a substantially level surface.

8. A marine bunker measurement system comprising:

a mass flow meter; and

the fluid delivery apparatus according to any of claims 1 to 7, which is
5 arranged in fluid communication with a downstream side of the mass flow meter.

9. A method comprising:

at a marine bunker measurement system according to claim 8,

while supplying fuel oil, accumulating the fuel oil at an upstream side of the
10 plate, and delivering the fuel oil through the elevated channel and the drainage
opening to a downstream side of the plate; and

after ceasing supply of the fuel oil, draining a remaining of the fuel oil, which
falls short of the elevated channel, through the drainage opening to the downstream
side of the plate.

15 10. The method of claim 9, wherein delivering the fuel oil through the elevated
channel includes activating the switch in response to a presence of contact of the
fuel oil with the probe, and

wherein draining a remaining of the fuel oil, which falls short of the elevated channel,
20 through the drainage opening to the downstream side of the plate, includes
deactivating the switch in response to an absence of contact of the fuel oil with the
probe.

11. A method comprising:

25 at a marine bunker measurement system, cutting and removing a segment of
a pipeline which is located at a downstream side of a mass flow meter; and

joining the fluid delivery apparatus according to any of claims 1 to 7 to the
pipeline in substitution of the segment.

30 12. The method of claim 11, wherein joining the fluid delivery apparatus includes
welding the pipe spool to the pipeline.

13. A method comprising:

cutting and removing a segment of a pipeline of a marine bunker measurement system, which is located at a downstream side of a mass flow meter;

modifying the segment which includes a switch having a probe which is positioned within an interior of the segment, by disposing a plate under the probe and joining the plate to the segment, the plate having a first surface to provide an elevated channel configured to elevate fuel oil to come into contact with the probe, wherein the plate is provided with a drainage opening at an edge which adjoins the segment; and

joining the modified segment to the pipeline.

14. The method of claim 13, wherein the drainage opening is located at a lowest intersection of the plate and an internal wall of the segment.

15. The method of any of claims 13 to 14, wherein joining the modified segment to the pipeline includes welding the modified segment to the pipeline.