

METHOD AND SYSTEM FOR CLEANING A STORAGE TANK USING A PLURALITY OF DEVICES

Field of Invention

- 5 The present disclosure relates to a method and a system for cleaning a storage tank using a plurality of devices.

Background Art

10 The following discussion of the background to the disclosure is intended to facilitate an understanding of the present disclosure. It may be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge in any jurisdiction as at the priority date of the application.

15 Storage tanks may be used in a variety of industries to store various substance, for example oil, bitumen, etc.

The storage tanks typically need to be cleaned and maintained on a regular basis or when triggered by certain events. When it is time for an inspection of the storage tank, it may be required to clean the storage tank for the inspector to inspect the storage tank. When the storage tank has a mechanical failure, it may also be
20 required to clean the storage tank to make the storage tank vapour free before repairing the storage tank.

If there is a plan to store a new product which is different from the product contained in the storage tank, a storage tank cleaning may also be necessary. For example, if the product is switched from an unrefined product such as
25 bitumen/asphalt to a refined product such as diesel, the entire storage tank is required to be thoroughly cleaned to remove any impurities or undesirable particles such as residue, sludge, waste, pollutants, contaminants etc. from the bottom as well as the side wall of the storage tank which the new product would contact directly, to avoid any contamination of the new product.

Conventionally, manual labour is required in the storage tank cleaning. In general, such storage tank may be dozens of metres in diameter and in height. It is necessary to erect structures or scaffolds for workers to clean the high portions of the side wall. After cleaning the high portions of the side wall, the workers have to
5 dismantle the scaffolds. In this regard, it takes long time and is costly to clean the storage tank. In addition, since the workers have to climb the scaffolds to clean the high portions of the side wall, there are risks of the collapse of the scaffolds and safety hazards associated with the workers falling off from the scaffolds.

In light of the above, there exists a need to minimize manual labour involved in the
10 storage tank cleaning. There exists a further need to provide a solution that meets the mentioned needs or alleviates the challenges at least in part.

Summary of the Invention

Throughout the specification, unless the context requires otherwise, the word
15 “comprise” or variations such as “comprises” or “comprising”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including”, will be understood
20 to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The present disclosure seeks to provide a method for cleaning a storage tank with the minimal usage of manual labour. The technical solution may be provided in the form of a method for cleaning a storage tank using a plurality of devices, for
25 example a first device and a second device. The device may include, but not be limited to one or more of the following:-a robot, a machine, an equipment and a vehicle.

The first device is operable to clean a bottom of the storage tank and the second device is operable to clean an inner side wall of the storage tank. The first device is
30 further operable to clean the bottom once again to remove an impurity which has

been caused by the operation of the second device. The first device and the second device can be operated by a remote controller by a user. Therefore, the present disclosure is able to save the costs and time and eliminate risks that are associated with the conventional cleaning methods of using the manual labour and structures or scaffolds.

In accordance with an aspect of the present disclosure, there is a method for cleaning a storage tank using a plurality of devices comprising: positioning a first device at a first position of the storage tank; controlling the first device to move on a bottom and remove an impurity at the bottom; attaching a second device to a second position of the storage tank; controlling the second device to move on an inner side wall and remove the impurity on the inner side wall; and controlling the first device to remove the impurity which has fallen onto the bottom caused by an operation that the second device removes the impurity on the inner side wall.

In some embodiments, the first position is on a surface approximate an edge of the storage tank.

In some embodiments, the surface includes the bottom or the inner side wall.

In some embodiments, the second position is on the inner side wall.

In some embodiments, the second device comprises at least one magnet to climb the inner side wall by magnetic force.

In some embodiments, the second device comprises a water jet operable to wash the inner side wall to remove the impurity.

In some embodiments, the method further comprises a step of controlling the second device to remove stain caused by a mist from the water jet, after the second device removes the impurity on the inner side wall.

In some embodiments, the second device is operated pneumatically.

In some embodiments, the method further comprises steps of arranging a pump on the second device; and controlling the pump to remove the impurity on the inner side wall along with the second device.

In some embodiments, the pump includes an ultra-high pressure (UHP) pump.

In some embodiments, at least one of a third device and a fourth device is arranged on a top of the storage tank.

5 In some embodiments, the method further comprises a step of sprinkling water inside the storage tank using the at least one of the third device and the fourth device.

In some embodiments, the method further comprises a step of sprinkling a chemical inside the storage tank using the at least one of the third device and the fourth device to reduce viscosity of the impurity.

10 In some embodiments, the at least one of the third device and the fourth device includes a nozzle operable to sprinkle the chemical onto the inner side wall so that the chemical flows down to the bottom of the storage tank.

In some embodiments, the nozzle is operable to turn in a predetermined angle at a predetermined timing.

15 In some embodiments, the method further comprises a step of circulating the storage tank to allow the chemical to agitate and react with the impurity.

In some embodiments, the method further comprises a step of arranging at least one filtration tank outside the storage tank in order to trap at least a part of the impurity which is pumped out during the circulation.

20 In some embodiments, the method further comprises a step of introducing the first device into the storage tank to remove a remaining impurity at the bottom, after the filtration tank traps the at least a part of the impurity.

In some embodiments, the method further comprises a step of introducing the second device into the storage tank to remove the remaining impurity on the inner side wall.

25 In some embodiments, the first device is introduced into the storage tank using a lever through a manhole of a side wall of the storage tank.

In some embodiments, at least one of the plurality of devices is operated by a remote controller.

In accordance with another aspect of the present disclosure, there is a system for cleaning a storage tank using a plurality of devices comprising: a first device, positioned at a first position of the storage tank, arranged to move on a bottom and remove an impurity at the bottom; and a second device, attached to a second position of the storage tank, arranged to move on an inner side wall and remove the impurity on the inner side wall; wherein the first device is arranged to remove the impurity which has fallen onto the bottom caused by an operation that the second device removes the impurity on the inner side wall.

In some embodiments, the first position is on a surface approximate an edge of the storage tank.

In some embodiments, the surface includes the bottom or the inner side wall.

In some embodiments, the second position is on the inner side wall.

In some embodiments, the second device comprises at least one magnet to climb the inner side wall by magnetic force.

In some embodiments, the second device comprises a water jet operable to wash the inner side wall to remove the impurity.

In some embodiments, the second device is arranged to remove stain caused by a mist from the water jet, after the second device removes the impurity on the inner side wall.

In some embodiments, the second device is operated pneumatically.

In some embodiments, a pump is arranged on the second device, wherein the pump is arranged to remove the impurity on the inner side wall along with the second device.

In some embodiments, the pump includes an ultra-high pressure (UHP) pump.

In some embodiments, the method further comprises a step of sprinkling water inside the storage tank using at least one of a third device and a fourth device.

In some embodiments, the at least one of the third device and the fourth device is arranged on a top of the storage tank.

In some embodiments, the method further comprises a step of sprinkling a chemical inside the storage tank using the at least one of the third device and the fourth device to reduce viscosity of the impurity.

5 In some embodiments, the at least one of the third device and the fourth device includes a nozzle operable to sprinkle the chemical onto the inner side wall so that the chemical flows down to the bottom of the storage tank.

In some embodiments, the nozzle is operable to turn in a predetermined angle at a predetermined timing.

10 In some embodiments, the storage tank is circulated to allow the chemical to agitate and react with the impurity.

In some embodiments, at least one filtration tank is arranged outside the storage tank in order to trap at least a part of the impurity which is pumped out during the circulation.

15 In some embodiments, the first device is introduced into the storage tank to remove a remaining impurity at the bottom, after the filtration tank traps the at least a part of the impurity.

In some embodiments, the second device is introduced into the storage tank to remove the remaining impurity on the inner side wall.

20 In some embodiments, the first device is introduced into the storage tank using a lever through a manhole of a side wall of the storage tank.

In some embodiments, at least one of the plurality of devices is operated by a remote controller.

25 Other aspects of the disclosure will become apparent to those of ordinary skilled in the art upon review of the following description of specific embodiments of the disclosure in conjunction with the accompanying drawings.

Brief Description of the Drawings

The present disclosure will now be described, by way of example only, with reference to the accompanying drawings, in which:

5 Figs. 1 to 3 show a method of cleaning a storage tank in accordance with an embodiment of the disclosure.

Figs. 4 and 5 show a method of moving the first device in accordance with an embodiment of the disclosure.

Figs. 6 to 12 show a method of cleaning a storage tank in accordance with another embodiment of the disclosure.

10 Fig. 13 shows an example on how the vacuum truck and the high-powered suction pump with a disposal bin operate.

Figs. 14 to 18 show a method of cleaning a storage tank in accordance with another embodiment of the disclosure.

15 Other arrangements of the disclosure are possible and, consequently, the accompanying drawings are not to be understood as superseding the generality of the preceding description of the disclosure.

Description of Embodiments of the Invention

20 In an industry which manufactures and/or distributes, there is a need to store products, for example materials, unrefined products and/or refined products. One example of such industry is an oil industry. In the oil industry, the products such as bitumen/asphalt, diesel, crude oil or gasoline are stored in the storage tank.

25 The present disclosure contemplates that for various reasons, there is a need to clean the storage tank. For example, if the product to be stored is changed (e.g. from bitumen/asphalt to diesel), the storage tank is required to be thoroughly cleaned to avoid a contamination of the new product.

As discussed earlier, conventionally a manual labour is directly required in the storage tank cleaning. To minimize time and costs for the storage tank cleaning and to eliminate risks associated with the conventional cleaning methods of using

the manual labour and structures or scaffolds, the present disclosure seeks to provide a method for cleaning a storage tank using a plurality of devices. These will be discussed in further details with reference to Figs. 1 to 18 hereinafter.

- 5 Figs. 1 to 3 show a method of cleaning a storage tank 200 in accordance with an embodiment of the disclosure.

The storage tank 200 may include, but not be limited to, an aboveground storage tank and an underground storage tank. In some embodiments, such storage tank 200 may be dozens of metres in diameter and in height.

- 10 The device 100 may include, but not be limited to, a robot, a machine, an equipment and a vehicle. As shown in Figs. 1 to 3, the device 100 may include a first device 110 and a second device 120.

- In the storage tank 200, there is an impurity 300 to be removed. The impurity 300 may include undesirable particles such as residue, sludge, waste, pollutants,
15 contaminants, etc.

- To clean the storage tank 200, the first device 110 can be introduced into the storage tank 200. Once the first device 110 is introduced into the storage tank 200, the first device 110 is positioned at a first position of the storage tank 200. The first position may be on a surface approximate an edge of the storage tank 200. The
20 surface may include the bottom or the inner side wall of the storage tank 200. For example, as shown in Fig. 1, the first device 110 is positioned at the bottom of the storage tank 200. Thereafter, the first device 110 is operable to move on the bottom and remove the impurity 300 at the bottom. For example, the first device 110 is operable to suck the impurity 300 at the bottom.

- 25 Although not shown, in some embodiments, the storage tank 200 further comprises one or more pipes above the bottom of the storage tank 200. For example, some pipes are located about a few inches or a foot above the bottom of the storage tank 200. In some embodiments, the impurity 300 on the pipes can be removed by the first device 110. In some other embodiments, the impurity 300 on the pipes can be
30 removed by a user.

In some embodiments, the first device 110 may comprise at least one camera, for example an explosion proof camera, which can capture the cleaning status and record the same. The user can control the first device 110 to move on the bottom and to suck the impurity 300, from outside the storage tank 200, while he monitors the cleaning status captured by the camera. The user can control the first device 110 using a remote controller. In some embodiments, the user can move physically to the manhole 210 to control or observe the first device 110 if necessary.

In some embodiments, the first device 110 may comprise a water jet to wash the bottom to remove the impurity 300. For example, the first device 110 is capable of water jetting of various ranges of pressure (e.g. up to 20,000 psi). In some other embodiments, the first device 110 is compatible with at least one external device such as a pump and a water jet. The user can control the external device using the remote controller.

As shown in Fig. 2, once the impurity 300 is removed from the bottom by the first device 110, the second device 120 can be introduced into the storage tank 200. Although not shown, it may be appreciated that the second device 120 can be introduced into the storage tank 200 while the first device 110 is removing the impurity 300 on the bottom.

In some embodiments, the second device 120 can be carried by one or few users to be introduced into the storage tank 200. For example, the second device 120 is about 62 kg, and two users can carry the second device 120. The second device 120 is positioned at a second position. For example, the second position is on the inner side wall of the storage tank 200. In another example, the second position is on the bottom. The second device 120 is attached to the inner side wall of the storage tank 200, and is operable to move on the inner side wall and remove the impurity 300 on the inner side wall. The second device 120 comprises at least one magnet, for example at least two magnetic tracks, and is operable to climb the inner side wall by magnetic force. For example, the magnetic force is strong enough to carry one or few users, for example one or two users.

In some embodiments, the second device 120 may comprise at least one camera, for example an explosion proof camera, which can capture the cleaning status and

record the same. The user can control the second device 120 to move on the inner side wall and to suck the impurity 300, from outside the storage tank 200, while he monitors the cleaning status captured by the camera. The user can control the second device 120 using a remote controller.

5 In some embodiments, the user can detect the impurity 300, and move the second device 120 manually on the inner side wall to remove the impurity 300. Although not shown, in some other embodiments, the second device 120 can detect the impurity 300 and automatically move on the inner side wall to remove the impurity 300. In some other embodiments, the second device 120 can move on the inner
10 side wall based on a predetermined route and remove the impurity 300.

In some embodiments, the second device 120 may comprise a water jet to wash the inner side wall to remove the impurity 300. For example, the second device 120 is capable of water jetting of various ranges of pressure (e.g. up to 36,000 psi) depending on the property of the impurity and/or cleaning status. In some
15 embodiments, to prevent the loss of balance of the second device 120, the pressure of the second device 120 can be controlled to increase or decrease gradually.

In some other embodiments, the second device 120 is compatible with external device such as a pump and a water jet. The user can control the external device
20 using the remote controller. For example, the user can arrange the pump on the second device 120 and control the pump to remove the impurity 300 on the inner side wall along with the second device 120. The pump may include, but not be limited to, an ultra-high pressure (UHP) pump 121 (not shown). The UHP pump 121 is operable to remove the impurity 300 on the inner side wall, along with the second
25 device 120. The UHP pump 121 may pump the water to the second device 120 to remove the impurity 300.

The UHP pump 121 is capable of operating in various ranges of pressure (e.g. 10,000 to 40,000 psi) depending on the property of the impurity and/or cleaning status. In some embodiments, if the impurity 300 to be removed is harder and more
30 stubborn, for example solid paint, the UHP pump 121 can be operated in the high pressure to remove the solid paint. As another example, if there is less impurity 300

remained on the inner side wall, the UHP pump 121 can be operated in the low pressure. In some embodiments, the change of the ranges of pressure can be done by exchanging a plunger of the UHP pump 121 with a conversion kit.

5 In some embodiments, to prevent the loss of balance of the second device 120, the pressure of the UHP pump can be controlled to increase or decrease gradually.

While the second device 120 removes the impurity 300 on the inner side wall, a stain may be generated by a mist from the water jet. The second device 120 may be further operable to remove the stain caused by the mist. As such, the second device 120 may be deployed to clean the inner side wall twice.

10 In some embodiments, the second device 120 may be pneumatically operated, and thereby be suitable for operating in confined space environment such as the storage tank 200. The second device 120 may be operated safely as there is no danger of short circuit.

15 Although not shown, in some embodiments, the storage tank 200 may comprise one or more columns and/or one or more internal pipe lines inside the storage tank 200. The user may manually clean the columns and/or pipe lines by means of water jetting.

20 Although not shown, in some embodiments, the storage tank 200 further comprises one or more outlets, for example inside of columns and/or pipe lines. The outlets are also stained with the impurity 300. For example, the outlets can be cleaned by a high pressure (HP) pump (not shown) to flush out the impurity 300. For example, the HP pump may operate up to 20,000 psi. The HP pump can include at least one flushing nozzle to flush out the impurity 300 from the outlets. The nozzle can be connected to a hose and inserted into the columns and/or pipe lines. In some
25 embodiments, where the depth of the outlets is lower than a predefined depth, a lance can be used to flush out the impurity 300. The lance may include a gun used for hydro-jetting. The lance can be connected to the HP pump and/or UHP pump, and used manually by the user.

30 The required water pressure of the HP pump may be dependent on at least one of the depth of the outlets, the property of the impurity 300 or the amount of the impurity 300.

Although not shown, after the impurity 300 is removed from the inner side wall, the second device 120 can be moved out of the storage tank 200. In some embodiments, the users can detach the second device 200 from the inner side wall and move the second device 200 out of the storage tank 200. In some
5 embodiments, the user can control the second device 120 to reduce the magnetic force to easily detach the second device 200 from the inner side wall.

While the second device 120 removes the impurity 300 from the inner side wall, some of the impurity 300 falls onto the bottom of the storage tank 200. In this regard, a final wash can be proceeded. As shown in Fig. 3, the first device 110 is
10 operable to remove the impurity 300 which has fallen onto the bottom. The impurity 300 may further comprise resultant from the mist caused by the water jetting. For example, the first device 110 is operable to suck the impurity 300.

Although not shown, in some embodiments, the first device 110 is further operable to remove the impurity 300 on the low-lying pipes and/or columns of the storage
15 tank 200.

Figs. 4 and 5 show a method of moving the first device 110 in accordance with an embodiment of the disclosure.

As shown in Fig. 4, the storage tank 200 comprises at least one manhole 210. For
20 example, the manhole 210 can be positioned on the side wall of the storage tank 200. Although not shown, the manhole 210 is covered by a lid. It may be appreciated that while the storage tank 200 stores the product, the lid covers the manhole 210.

After the lid is detached from the manhole 210, the first device 110 can be
25 introduced into the storage tank using a lever 211. The lower side of the manhole 210 can be act as a fulcrum for the lever 211. The centre of the lever 211 can be put on the lower side of the manhole 210 such that one side of the lever 211 can be positioned inside the storage tank 200 and the other side of the lever 211 can be positioned in the outside the storage tank 200. The first device 110 is then
30 positioned on the other side of the lever 211. A force is applied to the one side of the lever 211 and thereby the lever 211 is tilted and raises the first device 110. The

tilt of the lever 211 leads the first device 110 to be introduced into the storage tank 200.

In some embodiments, the first device 110 can be removed from the storage tank 200 at a predetermined time, for example at the end of each day. The storage tank 200 can be covered or boxed up to prevent fume or vapour from escaping overnight. In some other embodiments, after the first device 110 removes the remained impurity 300 on the bottom and the final wash is completed, the lever 211 can be used to take the first device 110 away from the storage tank 200. As shown in Fig. 5, the lower side of the manhole 210 can be act as a fulcrum for the lever 211. The centre of the lever 211 can be put on the lower side of the manhole 210 such that one side of the lever 211 can be positioned inside the storage tank 200 and the other side of the lever 211 can be positioned in the outside the storage tank 200. The first device 110 is then positioned on the one side of the lever 211. A force is applied to the other side of the lever 211 and thereby the lever 211 is tilted and raises the first device 110. The tilt of the lever 211 leads the first device 110 to be moved out of the storage tank 200.

Figs. 6 to 12 show a method of cleaning a storage tank 200 in accordance with another embodiment of the disclosure. Fig. 13 shows an example on how the vacuum truck and the high-powered suction pump with a disposal bin operate.

As shown in Figs. 6 to 9, the device 100 may further include at least one of a third device 130 and a fourth device 140. The at least one of the third device 130 and the fourth device 140 may be used with the first device 110 and the second device 120 to clean the storage tank 200. The use of the third device 130 and/or the fourth device 140 can be decided based on the size of the storage tank 200. For example, if the size of the storage tank 200 is greater than a predetermined size, the third device 130 may be used. If the size of the storage tank 200 is less than a predetermined size, the fourth device 140 may be used.

In this manner, the third device 130 and/or the fourth device 140 may be used to clean the storage tank 200. Specifically, one or both of the third device 130 and the fourth device 140 may be used to clean the storage tank 200. It may be

appreciated that any one of the third device 130 and the fourth device 140 or a combination thereof may be used to clean the storage tank 200.

For example, the third device 130 or the fourth device 140 may be arranged on the top of the storage tank 200. As shown in Figs. 6 and 8, the third device 130 or the fourth device 140 may be hung from a roof of the storage tank 200. The third device 130 or the fourth device 140 may be hung from a centre of the roof of the storage tank 200 so that a chemical 131, 141 can be reach the entire inner side wall.

As another example, although not shown, both the third device 130 and the fourth device 140 may be arranged on the top of the storage tank 200. As another example, the third device 130 and the fourth device 140 can be hung from the roof of the storage tank 200.

Although not shown, one or more third devices 130 and/or one or more fourth devices 140 may be used to clean the storage tank 200. Specifically, for example, a plurality of third devices 130 may be used to clean the storage tank 200. In another example, a plurality of fourth devices 140 may be used to clean the storage tank 200. In another example, a single third device 130 may be used with a plurality of fourth devices 140 to clean the storage tank 200. In another example, a plurality of third devices 130 may be used with a single fourth device 140 to clean the storage tank 200. In another example, a plurality of third devices 130 and a plurality of fourth devices 140 may be used to clean the storage tank 200.

In some other embodiments, the third devices 130 and/or the fourth device 140 may be in the form of a vehicle, for example an unmanned vehicle such as a drone which can fly. It may be appreciated that while the third device 130 and/or the fourth device 140 sprinkles the chemical 131, 141, the storage tank 200 may be closed and sealed, and the lid covers the manhole 210.

As shown in Fig. 7, the third device 130 may include a container 132 containing the chemical 131 and a self-rotating nozzle (also referred to as a 'tip') 133 sprinkling the chemical 131 onto the inner side wall so that the chemical 131 flows down to the bottom of the storage tank 200. The nozzle 133 is operable to turn in a prescribed angle at a prescribed timing. In some embodiments, the nozzle 133 can

automatically turn in the prescribed angle at the prescribed timing. In some other embodiments, the user can control the nozzle 133 to turn in a certain angle at a certain timing. The user can control the third device 130 using a remote controller.

As shown in Fig. 9, the fourth device 140 may include a container 142 containing the chemical 141 and at least one nozzle 143, for example four (4) nozzles, sprinkling the chemical 141 onto the inner side wall so that the chemical 141 flows down to the bottom of the storage tank 200.

In some embodiments, in the third device 130 and/or the fourth device 140, the angle between the container 132, 142 and the nozzle 133, 143 is 90°. This arrangement may allow to wash light products in the storage tank 200 and/or to sprinkle chemical 131, 141 without manual labour. In this manner, the third device 130 and/or the fourth device 140 can preliminary wash down the bottom and the inner side wall of the storage tank 200. Therefore, the third device 130 and/or the fourth device 140 may allow the first device 110 and the second device 120 to easily remove the impurity 300.

The chemical 131, 141 may be a material which can react with the impurity 300. The user can choose the chemical 131, 141 suitable for cleaning the storage tank 200 based on the property of the impurity 300. In some embodiments, the chemical 131, 141 is a pale yellow viscous but pourable liquid having a slightly nutty odour. The chemical 131, 141 can be blended from non-ionic surfactants. The chemical 131, 141 may be used as a main ingredient during oil remediation activities, be used in soil remediation, or be used as a base component in surface cleaners and degreasing systems. In some other embodiments, the chemical 131, 141 is a pale yellow formulated liquid having a slightly citrus odour. The chemical 131, 141 can be blended from non-ionic surfactants and solvents. The chemical 131, 141 may be used as a cleaning product for the removal of light tar and greasy deposits or be used as a general cleaning agent.

The impurity 300 can react with the chemical 131, 141. In this regard, the chemical 131, 141 can reduce the viscosity of the impurity 300, and thereby make the impurity 300 to be capable of being pumped. In this manner, the impurity 300 can

be easily removed without manual labour who discards the impurity 300 inside the storage tank 200.

In some embodiments, the chemical 131, 141 can be used together with another chemical. For example, the chemical 131, 141 can be used with bio-diesel in a ratio of 1:4. In this regard, the container 132, 142 can contain the mixture of the chemical 131, 141 and the bio-diesel. In some embodiments, the chemical 131, 141 can suppress the vapour inside the storage tank 200 while the bio-diesel or diesel reacts with the chemical 131, 141.

For example, the mixture of the chemical 131, 141 is performed in a separate container outside the storage tank 200. A separate pump may be used to pump the mixture to provide to the third device 130 and/or the fourth device 140. Thereafter, the third device 130 and/or the fourth device 140 can spray the mixture around the storage tank 200. Few inches, e.g. 2 mm, thick of the mixture is then created on the bottom of the storage tank 200. In another example, the container 132, 142 can contain at least certain amount of the chemical 131, 141 such that the chemical 131, 141 can create the reaction of reducing the viscosity of the impurity 300 at the bottom of the storage tank 200. It may be appreciated that even when there is no agitation, the chemical 131, 141 may have started reacting with the impurity 300 inside the storage tank 200.

In this manner, the third device 130 and/or the fourth device 140 can at least reduce the viscosity of the impurity 300 in the storage tank 200. As the chemical 131, 141 reacts with the impurity 300, the impurity 300 became capable of being pumped, so that the impurity 300 can be easily removed. Therefore, the third device 130 and/or the fourth device 140 may allow the first device 110 and the second device 120 to easily remove the impurity 300.

After the third device 130 and/or the fourth device 140 sprinkles the chemical 131, 141 inside the storage tank 200, a loop is created in and outside the storage tank 200. In an example, the circulation process may take about a fortnight. Although not shown, in some embodiments, during the circulation, more chemical 131, 141 or the mixture of the chemical 131, 141 and the bio-diesel can be introduced into the storage tank 200.

Air is circulated in the storage tank 200 to aid the removal of vapour into the atmosphere. Although not shown, one or more ventilating fans are installed on some manholes to remove the air from inside the storage tank 200. By the operation of the fans, air from the outside would automatically enter the storage tank 200 from the other manholes.

Although not shown, a vacuum truck or a high-powered suction pump can be used to discharge the impurity 300 which is reacted with the chemical 131, 141. Since the reacted impurity 300 is capable of being pumped, the vacuum truck or the high-powered suction pump can pump out such impurity 300 during the circulation.

After the third device 130 and/or the fourth device 140 washes down the storage tank 200, the first device 110 and the second device 120 are introduced into the storage tank 200 to remove the impurity 300, as to be described below with Figs. 10 to 12.

As shown in Fig. 10, the first device 110 can be introduced into the storage tank 200 and be positioned at the first position, for example on the bottom, of the storage tank 200. Thereafter, the first device 110 is operable to move on the bottom and remove the impurity 300 at the bottom. Since the third device 130 and/or the fourth device 140 preliminary washed down the bottom of the storage tank 200, the first device 110 can focus on the removal of the impurity 300 which is harder and more stubborn and thereby was not removed by the third device 130 and/or the fourth device 140. Therefore, the first device 110 is capable of water jetting of certain ranges of pressure which is suitable for removing the harder and more stubborn impurity 300.

As shown in Fig. 11, the second device 120 can be introduced into the storage tank 200 and be attached to the second position, for example on the inner side wall, of the storage tank 200. The second device 120 is operable to move on the inner side wall and remove the impurity 300 on the inner side wall. The second device 120 is operable to climb the inner side wall by magnetic force. Since the third device 130 and/or the fourth device 140 preliminary washed down the inner side wall of the storage tank 200, the second device 120 can focus on the removal of the impurity 300 which is harder and more stubborn and thereby was not removed by the third

device 130 and/or the fourth device 140. Therefore, the UHP pump 121 arranged on the second device 120 is capable of water jetting of certain ranges of pressure which is suitable for removing the harder and more stubborn impurity 300.

5 While the second device 120 removes the impurity 300 from the inner side wall, some of the impurity 300 falls onto the bottom of the storage tank 200. In this regard, a final wash can be proceeded. As shown in Fig. 12, the first device 110 is operable to remove the impurity 300 which has fallen onto the bottom. The impurity 300 may further comprise resultant from the mist caused by the water jetting.

10 Although not shown, in some embodiments, the first device 110 is further operable to remove the impurity 300 on the low-lying pipes and/or columns of the storage tank 200.

As shown in Fig. 13, in some embodiments, before the first device 110 and the second device 120 are introduced into the storage tank 200, a vacuum truck 410 or a high-powered suction pump 420 with a disposal bin 430 can be used to remove
15 the impurity 300 which has been washed down by the third device 130 and/or the fourth device 140.

Since the third device 130 and/or the fourth device 140 preliminary washed down the bottom of the storage tank 200 and the impurity 300 which was washed down has been removed by the vacuum truck 410 or the high-powered suction pump 420,
20 the first device 110 can focus on the removal of the impurity 300 which is harder and more stubborn and thereby was not removed by the third device 130 and/or the fourth device 140.

In addition, since the third device 130 and/or the fourth device 140 preliminary washed down the inner side wall of the storage tank 200 and the impurity 300
25 which was washed down has been removed by the vacuum truck 410 or the high-powered suction pump 420, the second device 120 can focus on the removal of the impurity 300 which is harder and more stubborn and thereby was not removed by the third device 130 and/or the fourth device 140.

Figs. 14 to 18 show a method of cleaning a storage tank 200 in accordance with another embodiment of the disclosure.

As shown in Figs. 14 and 15, the device 100 may further include the third device 130 and/or the fourth device 140. The third device 130 and/or the fourth device 140 may be used with the first device 110 and the second device 120 to clean the storage tank 200. Although not shown in Figs. 14 to 18, the third device 130 and/or the fourth device 140 may be used with the first device 110 and the second device 120.

As shown in Figs. 14 and 15, at least one filtration tank 240 can be arranged outside the storage tank 200 in order to filtrate and trap such impurity 300 which has been pumped out by a first pump 231 during the circulation. In this manner, the impurity 300 which has been pumped by the first pump 231 can be removed from the storage tank 200. In some embodiments, a second pump 232 may provide the chemical 131, 141 back to the third device 130 and/or the fourth device 140.

After such impurity 300 which has been pumped is deemed to have cleared by the filtration tank 240, the remaining impurity 300 inside the storage tank 200 can be removed. Since the remaining impurity 300 may be harder and more stubborn, a powerful pump may be needed to discharge the remaining impurity 300 from the storage tank 200.

At this stage, as shown in Fig. 16, the first device 110 can be introduced into the storage tank 200 to carry out the suction at different locations at the bottom of the storage tank 200. The first device 110 is operable to move on the bottom and remove the remaining impurity 300 at the bottom. Since some impurity 300 has already been removed by the filtration tank 240, the first device 110 can focus on the removal of the impurity 300 which is harder and more stubborn and thereby was not removed by the filtration tank 240. Therefore, the first device 110 is capable of water jetting of certain ranges of pressure which is suitable for removing the harder and more stubborn impurity 300.

Although not shown, in some embodiments, the storage tank 200 further comprises one or more pipes above the bottom of the storage tank 200. For example, some pipes are located about a few inches or a foot above the bottom of the storage tank

200. The pipes can be cleaned by the first device 110. In another example, the pipes can be cleaned by the users, while the second device 120 cleans the inner side wall or after the second device 120 cleans the inner side wall. Bulk of the stains has already been removed by the chemical 131, 141.

5 As shown in Fig. 17, the second device 120 can be introduced into the storage tank 200. In some embodiments, the second device 120 can be introduced into the storage tank 200 after the first device 110 removes the remaining impurity 300 from the bottom. In some other embodiments, the second device 120 can be introduced into the storage tank 200 while the first device 110 is removing the remaining
10 impurity 300 from the bottom.

The second device 120 can be attached to the inner side wall of the storage tank 200. The second device 120 is operable to move on the inner side wall and remove the impurity 300 on the inner side wall. The second device 120 is operable to climb the inner side wall by magnetic force. Since at least the part of the impurity 300 has
15 already been removed by the filtration tank 240, the second device 120 can focus on the removal of the impurity 300 which is harder and more stubborn and thereby was not removed by the filtration tank 240.

In some embodiments, the UHP pump 121 arranged on the second device 120 is capable of water jetting of certain ranges of pressure which is suitable for removing
20 the harder and more stubborn impurity 300. The water jetting may remove the remaining impurity 300, for example as a residual, on the inner side wall.

Although not shown, in some embodiments, the storage tank 200 further comprises one or more outlets, for example inside of columns and/or pipe lines. The outlets are also stained with the impurity 300. For example, the outlets can be cleaned by
25 a high pressure (HP) pump (not shown) to flush out the impurity 300. The HP pump can include at least one flushing nozzle to flush out the impurity 300 from the outlets. The nozzle can be connected to a hose and inserted into the columns and/or pipe lines. In some embodiments, where the depth of the outlets is lower than a predefined depth, a lance can be used to flush out the impurity 300.

30 The required water pressure of the HP pump may be applied according to the depth of the outlets and be dependent on the property and/or amount of the

impurity 300. In some embodiments, the impurity 300 on the outlets can be contact with the chemical 131, 141, and thereby be easily removed. In this regard, the high water pressure may not be required. For example, the required water pressure may be less than 10,000 psi.

5 While the second device 120 removes the impurity 300 from the inner side wall, some of the impurity 300 falls onto the bottom of the storage tank 200. In this regard, a final wash can be proceeded. As shown in Fig. 18, the first device 110 is operable to remove the impurity 300 which has fallen onto the bottom. The impurity 300 may further comprise resultant from the mist caused by the water jetting.

10 Although not shown, in some embodiments, the first device 110 is further operable to remove the impurity 300 on the low-lying pipes and/or columns of the storage tank 200.

To prevent any contamination subsequently, it is required to clean the storage tank 200 properly. As described above with Figs. 14 to 18, the use of the chemical 131,
15 141 can remove bulk of the impurity 300 from the inner side wall of the storage tank 200. The chemical 131, 141 may reduce the viscosity of the impurity 300, and thereby allow the impurity 300 to be pumped out easily without the need to apply manual labour or equipment to remove the impurity 300. Because, the impurity 300 reacted with the chemical 131, 141 continues to remain in a liquid form at least until
20 the cleaning of the storage tank 200 is completed, under normal and room temperature.

In addition, it is required to suppress the vapour in the storage tank 200, since the vapour is caused by the product inside the storage tank 200. Such product (and therefore the vapour) may have low flash points (i.e. temperature which will ignite
25 fire) and the presence of such vapour may trigger fire and/or explosion. It is also required to make the storage tank 200 to be gas-free state to allow man entry subsequently (for inspection, etc.). The chemical 131, 141 can suppress the vapour in the storage tank 200.

It may be appreciated by the person skilled in the art that variations and
30 combinations of features described above, not being alternatives or substitutes,

may be combined to form yet further embodiments falling within the intended scope of the disclosure.

CLAIMS

1. A method for cleaning a storage tank using a plurality of devices comprising steps of:-

- positioning a first device at a first position of the storage tank;
- controlling the first device to move on a bottom of the storage tank to remove an impurity at the bottom of the storage tank by water jetting;
- attaching a second device to a second position of the storage tank;
- controlling the second device to move on an inner side wall of the storage tank to remove the impurity on the inner side wall of the storage tank by water jetting after the first device has removed the impurity at the bottom of the storage tank; and
- controlling the first device to remove the impurity which has fallen onto the bottom of the storage tank caused by removal of the impurity on the inner side wall of the storage tank by the second device.

2. The method according to claim 1, wherein the first position is on a surface approximate an edge of the storage tank.

3. The method according to claim 2, wherein the surface includes the bottom or the inner side wall.

4. The method according to claim 1, wherein the second position is on the inner side wall.

5. The method according to claim 1, wherein the second device comprises at least one magnet to allow the second device to climb the inner side wall by magnetic force.

6. The method according to claim 5, wherein the second device comprises a water jet operable to wash the inner side wall to remove the impurity.

7. The method according to claim 6, wherein the method further comprises a step of controlling the second device to remove stain caused by a mist from the water jet, after the second device removes the impurity on the inner side wall.
8. The method according to claim 6, wherein the second device is operated pneumatically.
9. The method according to claim 5, wherein the method further comprises steps of arranging a pump on the second device; and controlling the pump to pump water for water jetting the impurity on the inner side wall.
10. The method according to claim 9, wherein the pump includes an ultra-high pressure (UHP) pump.
11. The method according to claim 1, wherein at least one of a third device and a fourth device is arranged on a top of the storage tank.
12. The method according to claim 11, wherein the method further comprises a step of sprinkling water inside the storage tank using the at least one of the third device and the fourth device.
13. The method according to claim 11, wherein the method further comprises a step of sprinkling a chemical inside the storage tank using the at least one of the third device and the fourth device to reduce viscosity of the impurity.

14. The method according to claim 13, wherein the at least one of the third device and the fourth device includes a nozzle operable to sprinkle the chemical onto the inner side wall so that the chemical flows down to the bottom of the storage tank.

15. The method according to claim 14, wherein the nozzle is operable to turn in a predetermined angle at a predetermined timing.

16. The method according to claim 13, wherein the method further comprises a step of circulating the chemical at the bottom of the storage tank back to the at least one of the third device and the fourth device.

17. The method according to claim 16, wherein the method further comprises a step of arranging at least one filtration tank outside the storage tank in order to trap at least a part of the impurity which is pumped out together with the chemical during the circulation.

18. The method according to claim 17, wherein the method further comprises a step of introducing the first device into the storage tank to remove a remaining impurity at the bottom, after the filtration tank traps the at least a part of the impurity.

19. The method according to claim 18, wherein the method further comprises a step of introducing the second device into the storage tank to remove the remaining impurity on the inner side wall.

20. The method according to claim 1, wherein the first device is introduced into the storage tank using a lever through a manhole in a side wall of the storage tank.

21. The method according to claim 1, wherein at least one of the plurality of devices is operated by a remote controller.

22. A system for cleaning a storage tank using a plurality of devices comprising:

a first device, positioned at a first position of the storage tank, arranged to move on a bottom of the storage tank to remove an impurity at the bottom of the storage tank by water jetting; and

a second device, attached to a second position of the storage tank, arranged to move on an inner side wall to remove the impurity on the inner side wall of the storage tank by water jetting;

wherein the first device is arranged to remove the impurity which has fallen onto the bottom of the storage tank caused by removal of the impurity on the inner side wall of the storage tank by the second device.