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(54) **SYSTEM AND METHOD FOR LOADING AND UNLOADING TANKS USED IN A PHYSICAL, CHEMICAL AND/OR BIOLOGICAL PROCESS**

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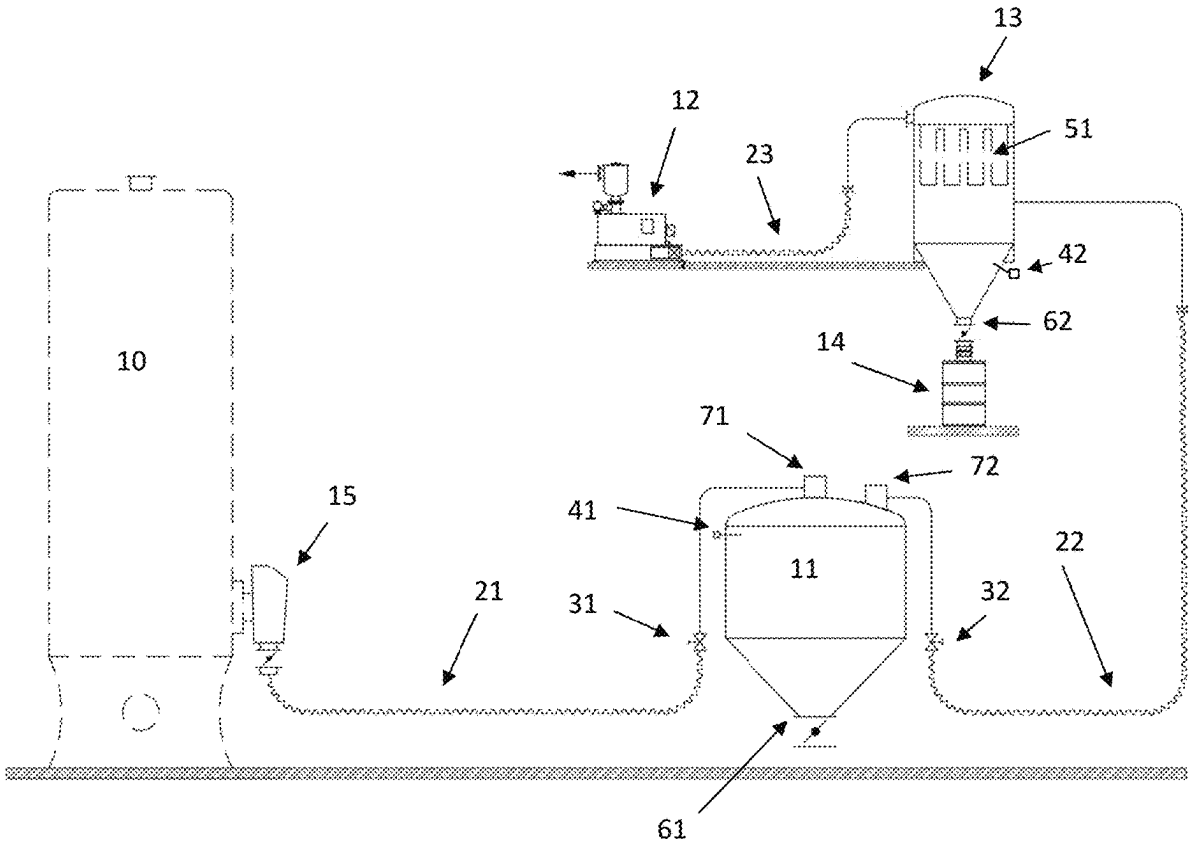
(57) **ABSTRACT**

The present invention relates to a system for loading and unloading agents in the form of particulate solid material, used for carrying out a physical, chemical, and/or biological process in one or more tanks. The system includes: an intermediate tank, a pump, and a pneumatic conveyor. The intermediate tank and the pump are fluidically connected. For unloading a tank containing saturated or degraded solid material particles, an empty or partially empty solid material tank is fluidically connected to the intermediate tank and the tank containing saturated or degraded solid material particles. For loading a tank, a solid material tank containing unsaturated or undegraded solid material particles is fluidically connected to the intermediate tank.



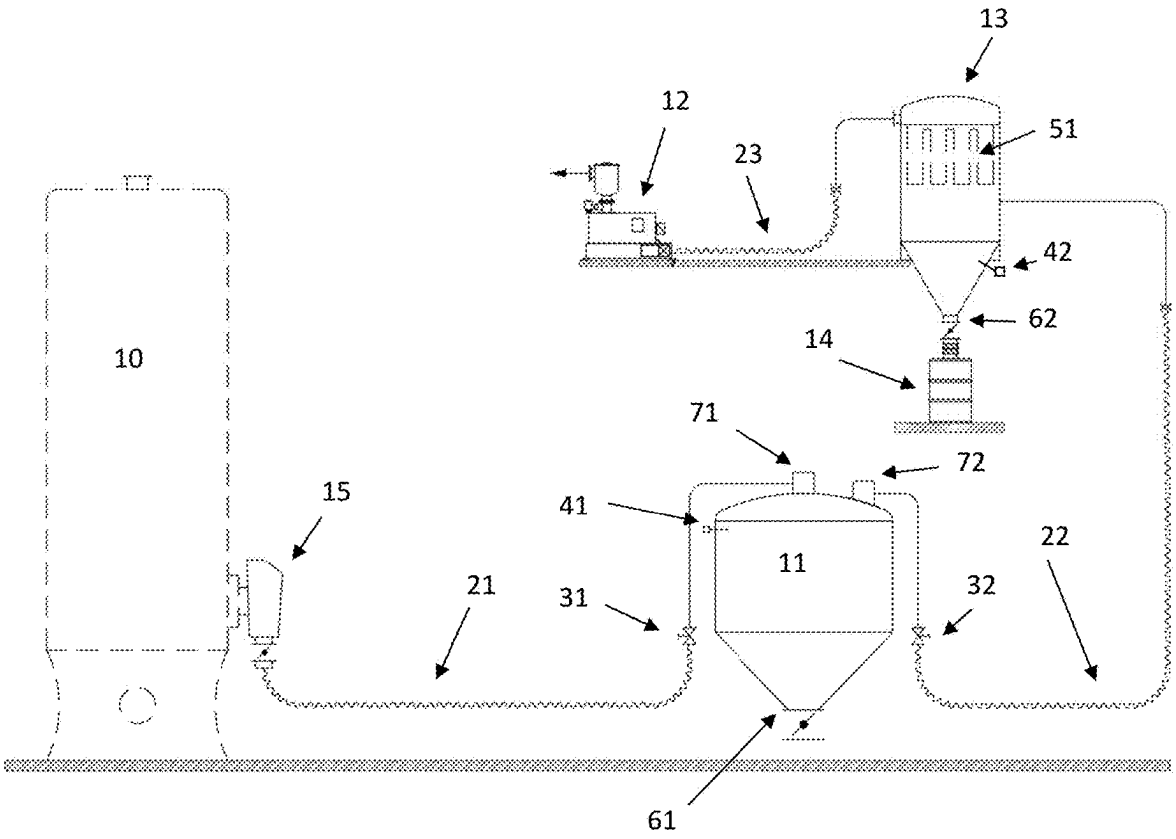


FIGURE 1

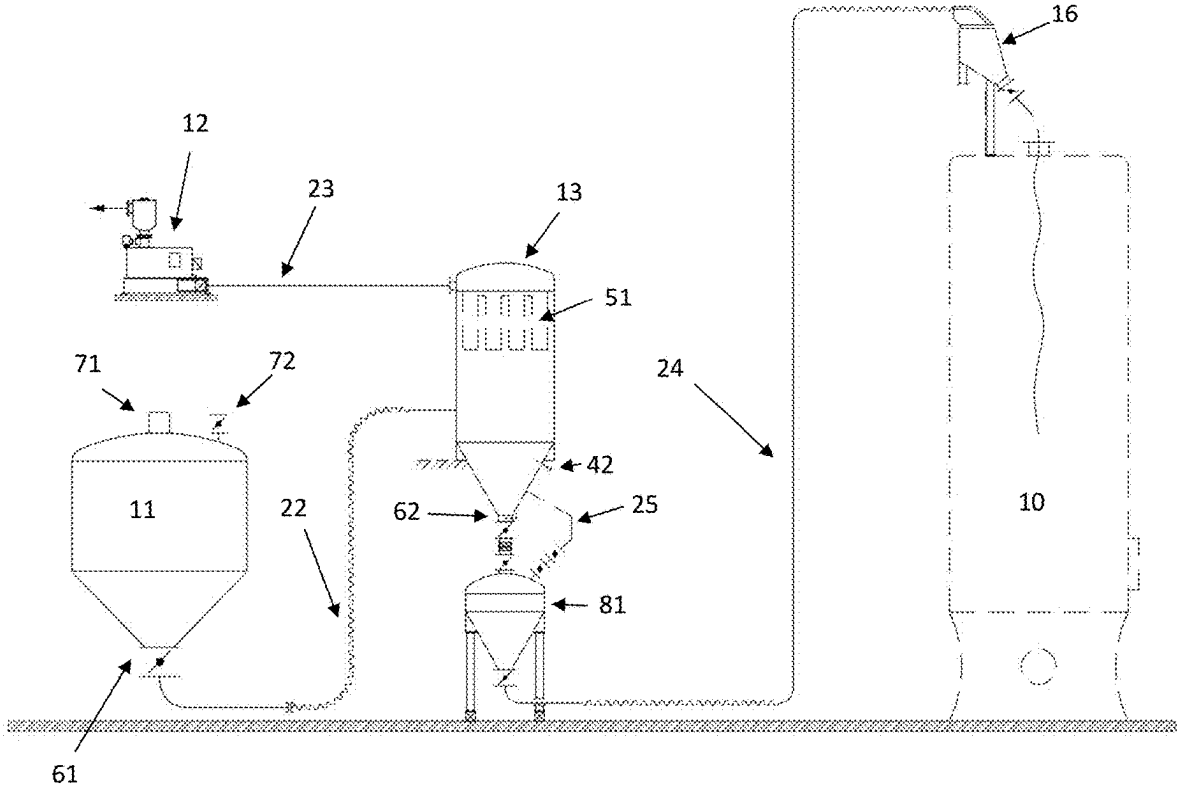


FIGURE 2

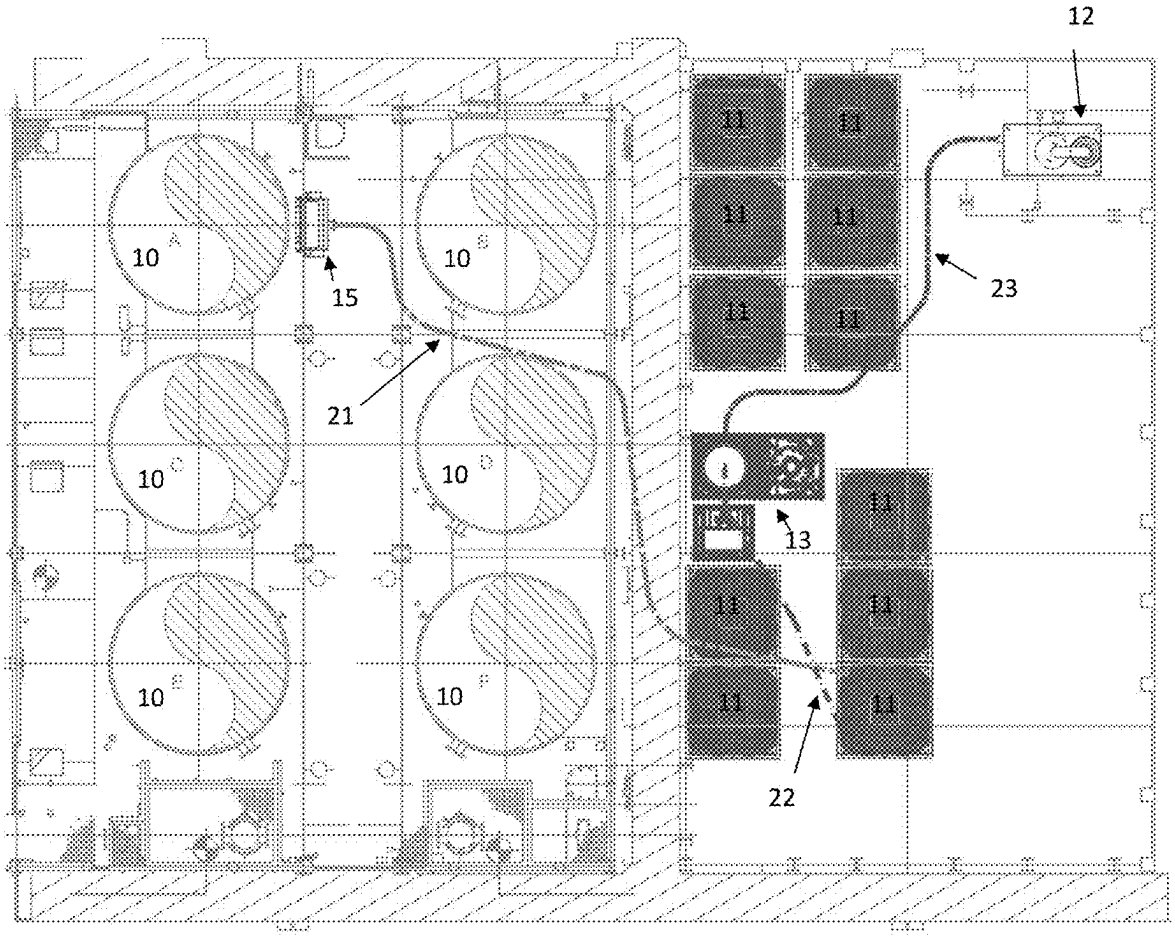


FIGURE 3

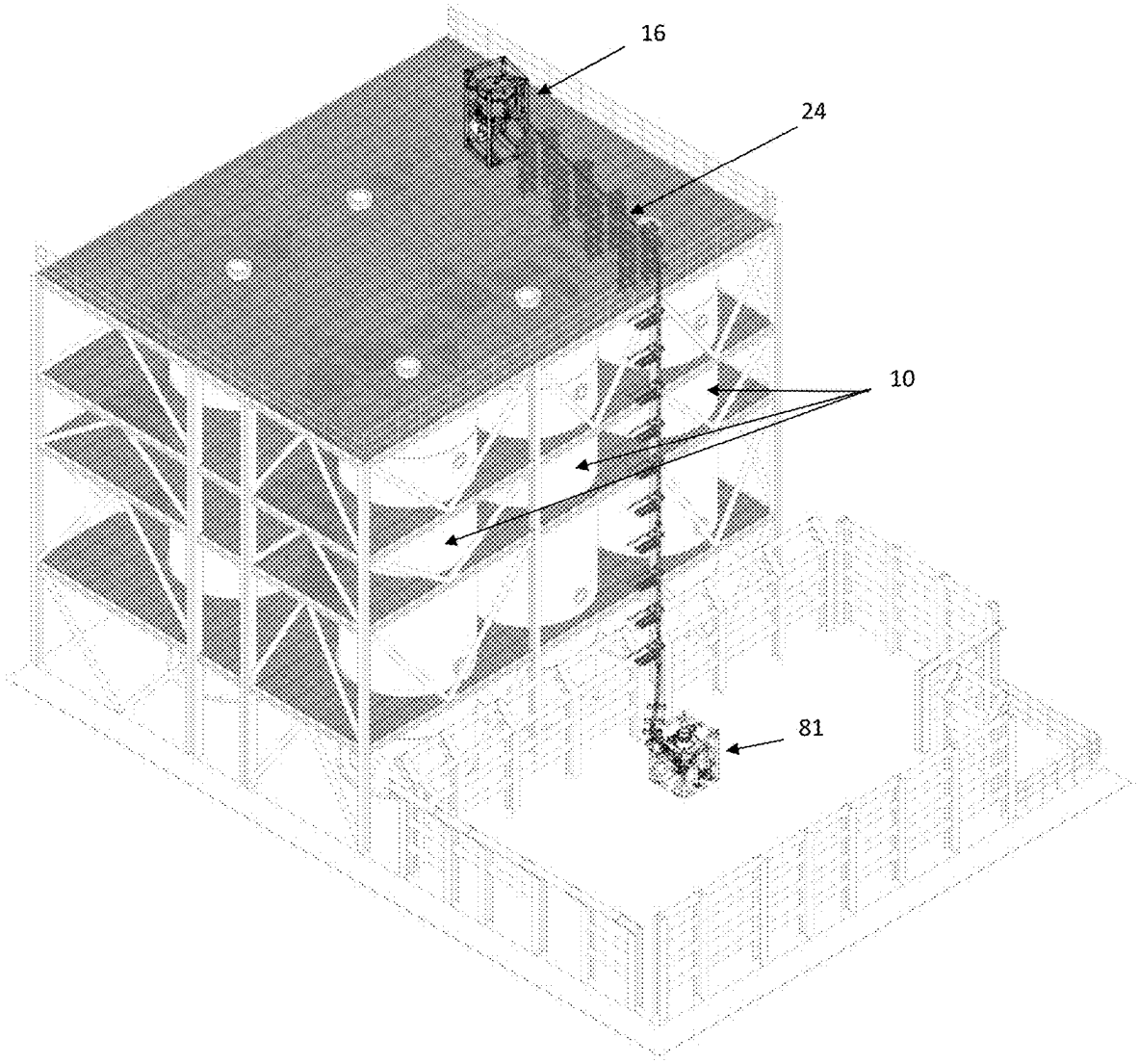


FIGURE 4

SYSTEM AND METHOD FOR LOADING AND UNLOADING TANKS USED IN A PHYSICAL, CHEMICAL AND/OR BIOLOGICAL PROCESS

TECHNICAL FIELD

[0001] The present invention relates to the loading and unloading of tanks. More particularly, the present invention relates to a pneumatic system and method for loading and unloading solid material used to carry out a physical, chemical or biological process in a tank.

BACKGROUND OF THE ART

[0002] Tanks are commonly used for the storage and transport of various products. Tanks, typically made of metal or composite materials, can also be used as containers within which a physical, chemical, or biological process takes place. To carry out and control such processes, agents of different natures can be employed, such as chemical agents, catalysts, and adsorbents. For example, when a chemical or biological reaction must occur, a tank acts as a reactor, and some type of catalyst is used inside it.

[0003] Reactors are important equipment for carrying out and controlling chemical and/or biological reactions on an industrial or laboratory scale. Reactors are designed to provide optimal conditions for chemical substances to react and form desired products. They play a crucial role in various sectors such as the chemical, pharmaceutical, food, and materials industries. There are several types of reactors, each suitable for different types of processes. Some of the most common reactors include batch reactors, continuous reactors, stirred tank reactors, tubular reactors, and fixed-bed reactors. The choice of reactor type depends on the characteristics of the reaction, the required conditions, and the objectives of the process. For example, the use of reactors in the oil industry is well-known, such as reactors used to transform heavy hydrocarbons into light ones using catalysts in so-called catalytic reactors.

[0004] The loading and unloading of catalysts in reactors depend on the type of reactor and the specific process. For fixed-bed reactors, catalysts are typically loaded at the start, during reactor installation. This involves filling the reactor bed with catalyst particles suitable for the desired reaction. In stirred tank reactors, for instance, the catalyst can be added directly to the tank or placed in a suspension system. In contrast, in tubular systems, the catalyst can be placed in a specific section of the tube where the reactants flow. Unloading in fixed-bed reactors usually occurs during scheduled maintenance shutdowns. Spent or saturated catalyst can be removed from the bed and replaced with a new catalyst. In stirred tank reactors, the catalyst can be removed using methods such as filtration or sedimentation, depending on the nature of the catalyst. Cleaning and replacing catalysts in tubular systems can be carried out by stopping the flow and replacing the catalyst in the appropriate section.

[0005] Alternatively, or additionally to functioning as a reactor, a tank may also contain an agent that serves a filtration role. In this case, the agent acts as an adsorbent, trapping the material to be filtered on its surface. Some agents can simultaneously function as both catalyst and adsorbent.

[0006] With use, after a certain number of chemical or biological reactions and/or physical separations of particles have been carried out, the agent begins to lose its efficiency, either due to saturation, chemical degradation, or loss of permeability, requiring its replacement.

[0007] In all cases, the loading of new agents and the unloading of spent agents represent a technical challenge and often require: complex mechanical equipment and operations at the top of the tanks, which can pose risks to people and facilities around; and/or exhaustive manual labor with human intervention inside the tank, which, besides being slow and inefficient, involves working in confined spaces with contaminated and hazardous atmospheres.

SUMMARY OF THE INVENTION

[0008] The present invention relates to a system for loading and unloading agents in the form of particulate solid material used for carrying out a physical, chemical, and/or biological process in one or more tanks. The system comprises: an intermediate tank; a pump; and a pneumatic conveyor. The intermediate tank and the pump are fluidically connected. For unloading a tank containing saturated or degraded solid material particles, an empty or partially empty solid material tank is fluidically connected to the intermediate tank and to the tank containing saturated or degraded solid material particles. The pump is configured to generate negative pressure in the intermediate tank, the empty or partially empty solid material tank, and the tank containing saturated or degraded solid material particles to carry the saturated or degraded solid material particles from inside the tank to the inside of the empty or partially empty solid material tank. For loading a tank, a solid material tank containing unsaturated or undegraded solid material particles is fluidically connected to the intermediate tank. The pump is configured to generate negative pressure in the intermediate tank and in the solid material tank containing unsaturated or undegraded solid material particles to carry the unsaturated or undegraded solid material particles from inside the solid material tank to the inside of the intermediate tank. The pneumatic conveyor is positioned below the intermediate tank, and the intermediate tank is configured to carry the unsaturated or undegraded solid material particles received into the pneumatic conveyor. The pneumatic conveyor is fluidically connected to the tank to carry the unsaturated or undegraded solid material particles received into the tank.

[0009] Optionally, the one or more tanks are reactors.

[0010] Optionally, the solid material is: a catalyst; an adsorbent; or both a catalyst and an adsorbent.

[0011] Optionally, the one or more tanks, the solid material tank, the intermediate tank, and the pump are fluidically connected by means of transport lines, and the one or more tanks and the pneumatic conveyor are fluidically connected by means of a transport line.

[0012] Optionally, the transport lines are: rigid; flexible; or comprise both rigid and flexible parts.

[0013] Optionally, the solid material tank has a conical bottom section and an outlet at the bottom.

[0014] Optionally, the intermediate tank has a conical bottom section and an outlet at the bottom.

[0015] Optionally, the intermediate tank comprises a filtration means inside it to filter the flow of material coming from the solid material tank.

[0016] Optionally, the solid material tank comprises a level sensor or a weight sensor.

[0017] Optionally, the intermediate tank comprises a level sensor or a weight sensor.

[0018] Optionally, the system comprises a connection box to connect the transport line that connects a tank to a solid material tank.

[0019] Optionally, the system comprises a receiving box at one end of the transport line that connects the pneumatic conveyor to a tank to direct unsaturated or undegraded solid material particles into the tank.

[0020] The present invention also relates to the use of the system as described above for the loading and unloading of one or more tanks.

[0021] The present invention is further related to a method for loading and unloading solid material particles used for carrying out a physical, chemical, and/or biological process in one or more tanks through a system as described above. The method comprises the steps of, for unloading a tank containing saturated or degraded solid material particles: generating a negative pressure in the intermediate tank, the empty or partially empty solid material tank, and in the tank containing saturated or degraded solid material particles to move the saturated or degraded solid material particles from inside the tank to the empty or partially empty solid material tank; and, for loading a tank: generating a negative pressure in the intermediate tank and in the solid material tank containing unsaturated or undegraded solid material particles to move the unsaturated or undegraded solid material particles from inside the solid material tank into the intermediate tank; moving the unsaturated or undegraded solid material particles from the intermediate tank into the pneumatic conveyor; and moving the unsaturated or undegraded solid material particles from the pneumatic conveyor into the tank.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** illustrates an embodiment of the system according to the present invention during the unloading of a tank.

[0023] FIG. **2** illustrates an embodiment of the system according to the present invention during the loading of a tank.

[0024] FIG. **3** illustrates an example of an embodiment of the system according to the present invention on an offshore platform.

[0025] FIG. **4** illustrates a perspective view of a part of the example of embodiment shown in FIG. **3**.

DETAILED DESCRIPTION

[0026] The following description refers to transport lines connecting the different components of the system of the present invention. As a person skilled in the art will recognize, the connected components of the system described below must be fluidically connected. However, different configurations for achieving fluidic connections are possible, such as, for example, the use of multiple lines between two components and manifolds.

[0027] Similarly, the description refers to saturated or degraded material particles and unsaturated or undegraded material particles. It should be understood that saturated or degraded material particles include particles that are at least partially saturated or degraded. For the purposes of the present invention, the material particles do not need to be completely saturated or degraded to be considered as saturated or degraded material particles. The present invention deals with unloading particles from a tank that need to be replaced and with the loading new particles.

1—Tank Unloading

[0028] FIG. **1** illustrates an example of a system according to the present invention during the unloading of a tank **10**. The system comprises a solid material tank **11**, an intermediate tank **13** and a pump **12**. A transport line **23** connects the pump **12** to the intermediate tank **13**. A transport line **22** connects the intermediate tank **13** to the solid material tank **11**. A transport line **21** connects the solid material tank **11** to the tank **10**.

[0029] Physical, chemical, and/or biological reactions occurring inside the tank **10** cause the solid material inside the tank to become saturated or degraded over time. At this point, the solid material particles inside the tank **10** need to be removed. The concept of dense-phase vacuum pneumatic conveying, known in the prior art, is employed. The pump **12** is activated to suction through line **23**. At some point, negative pressure is generated in line **23**, in the intermediate tank **13**, in line **22**, in the solid material tank **11**, in line **21**, and finally in tank **10**. The tank **10** can, for example, be opened at its top to allow air to flow into the system, facilitating the movement of the solid material particles through the system. Alternatively, air or any other gas such as N2, argon, or carbon dioxide can be introduced into the tank **10** to enable the flow of the solid material particles. The generated negative pressure will reach a level where the solid material particles inside the tank **10** will begin to move into and through line **21** to the solid material tank **11**. Since line **22** is connected to the top of the solid material tank **11**, the solid material particles will accumulate, due to centrifugal and gravitational forces and due to the reduction in speed below pneumatic drag values, at the bottom of the tank **11**.

[0030] The tank **10** may be a reactor connected to a chemical and/or biological process, and the solid material may be any catalyst capable of performing such a chemical and/or biological process. The tank **10** may also be related to a physical filtration process, and the solid material may be any adsorbent capable of performing such a filtration process. In some cases, the solid material may serve both as a catalyst and an adsorbent.

[0031] As one skilled in the art will recognize, any vacuum pump or compressor equipment known and commercially available can be used as the pump **12**. The size and power of the pump **12** will depend on each project, such as the type of tank used, the tank dimensions, the type and length of the transport lines, and the type of connections employed. It is also possible to install more than one pump **12**, which can alternate or work together to generate a negative pressure in the system of the invention.

[0032] The transport lines **23**, **22** and **21** can be rigid, such as metal pipes, or flexible, such as rubber hoses. The choice of rigid or flexible lines, or a combination of both, will also depend on each project and the site of installation of the system of the present invention.

[0033] The solid material tank **11** is preferably a metallic tank that will accumulate the solid material particles removed from the tank **10**. The solid material tank **11** has an inlet **71** and an outlet **72** at its top. The inlet **71** is connected to transport line **21**, and the outlet **72** is connected to transport line **22**. Preferably, it has a conical bottom section

to facilitate the subsequent unloading of the accumulated solid material particles through a lower outlet **61**.

[0034] In a preferred embodiment of the system of the invention, the intermediate tank **13** may comprise, inside it, a filtration means **51** to filter the material arriving through line **22**. Thus, solid material particles, especially finer or powdered particles, as well as any other particle present in the tank **10**, the solid material tank **11**, or in the transport lines **21**, **22**, that may escape through the solid material tank **11** during suction by the pump **12**, are filtered by the filtration means **51** before exiting the intermediate tank **13** through transport line **23**. This prevents such particles from reaching the pump **12**, which could cause potential damage to the pump **12**, and also prevents such particles from being released into the environment by the pump **12**, which could be harmful to the environment or any living being near the outlet of pump **12**.

[0035] The filtration mean **51** can be any known and commercially available filter, such as one or more fabric or plastic meshes or a set of one or more microporous papers. Alternatively, or additionally, other filtration means (not shown) may also be positioned along the system, such as at the inlet of pump **12**, at the outlet of tank **11** and at transport line **22**.

[0036] As with the solid material tank **11**, residual particles that reach the intermediate tank **13** and are filtered by the filtration means **51** will accumulate by gravity at the bottom of the intermediate tank **13**.

[0037] The intermediate tank **13** is preferably metallic. Also preferably, it has a conical bottom section to facilitate the subsequent discharge of accumulated particles through a lower outlet **62**.

[0038] At some point during the unloading of tank **10**, the solid material tank **11** will fill up. At this point, the pump **12** is turned off, and valves **31**, **32** positioned along lines **21**, **22** are closed, allowing the loaded tank **11** to be disconnected and a new empty tank **11** to be connected. Optionally, the solid material tank **11** and valves **31**, **32** are designed to maintain an inert atmosphere inside the loaded solid material tank **11** after its disconnection from the system.

[0039] With the new solid material tank **11** installed in the system, valves **31**, **32** are reopened, and pump **12** is turned back on, continuing or starting the unloading process of tank **10** or a new tank **10**. Depending on the project, the volume of solid material to be unloaded from tank **10** may correspond to the volume of the solid material tank **11**. As any person skilled in the art will note, although an empty solid material tank **11** has been described for unloading tank **10**, the solid material tank **11** can be partially empty and still capable of receiving saturated solid material particles.

[0040] Since pump **12** can be a large, high-power device with a labor-intensive start/stop process, instead of turning off pump **12** during the disconnection of the loaded tank **11** from the system, a relief valve (not shown), positioned either on pump **12** or transport line **23**, can be opened. This allows the suction created by pump **12** to draw from the environment instead of the system. After a new empty tank **11** is connected to the system and valves **31**, **32** are opened, the relief valve can be closed, restoring suction to the system.

[0041] Valves **31**, **32**, as well as any other valves used throughout the system, can be any known and commercially available valves, such as a ball valve.

[0042] The state of filling of solid material tank **11** can be manually verified. Alternatively, a weight sensor (not shown), such as a scale, can be placed beneath the solid material tank **11** to detect when its fill level reaches a maximum limit. Alternatively, a level sensor **41** can be used inside the solid material tank **11** to determine when the fill level reaches a maximum limit.

[0043] Eventually, the intermediate tank **13**, especially when the filtration means **51** is present, will also fill up. Its maximum fill level can be checked in the same way as with the solid material tank **11**, i.e., manually, or using, for example, a weight sensor or a level sensor **42**.

[0044] The level sensor **41**, **42** can be any known and commercially available one, such as, for example, a hydrostatic level sensor, a capacitive level sensor or an ultrasonic level sensor.

[0045] The system may optionally include a container **14** which may be positioned below the intermediate tank **13** to collect the particles accumulated inside the intermediate tank **13**. For example, when the intermediate tank **13** reaches a maximum fill level, a valve positioned below the lower outlet **62** can be opened, allowing the particles to flow into the container **14**.

[0046] The container **14** can be any container capable of receiving and storing the particles, such as a metallic drum.

[0047] The system may optionally include a connection box **15** attached to the outlet of tank **10**, preferably at its lower section. The connection box **15** may optionally take the form of a discharge funnel. The connection box **15** can be a metallic box primarily serving as an interface between the outlet of tank **10** and the type of connection of transport line **21**, acting as a quick-connect/disconnect mechanism between the system and tank **10**. This is particularly useful for unloading multiple tanks **10**. The connection box **15** may also be equipped with a valve to open or close its outlet, connecting or disconnecting the outlet of tank **10** to the system.

[0048] Thus, the system of the present invention enables the unloading of one or more tanks **10** in a simple and efficient manner, where only the solid material tanks **11** are connected and disconnected from the system. In a "plug-and-play" fashion, an empty solid material tank **11** is connected to the system for unloading one or more tanks **10**. There is no need to move any elements of the system. As a solid material tank **11** fills with solid material particles, it is only necessary to operate the valves and adjust the transport lines to disconnect tank **11** and connect another empty solid material tank **11** to the system.

2—Tank Loading

[0049] Once unloaded, tank **10** is ready to receive new solid material that is not saturated or degraded. Depending on the industry, tank **10** may first undergo a special cleaning and inerting process, which is not within the scope of the present invention. According to the invention, the same system structure used for unloading tank **10** is also used for loading tank **10**.

[0050] FIG. **2** illustrates an example of the system according to the present invention during the loading of tank **10**. The solid material tank **11** is filled with new solid material (not saturated or degraded). Inlet **71** is opened to allow the flow of atmospheric air to promote the movement of the material out of the solid material tank **11**. Outlet **72** is closed, and lower outlet **61** is opened.

[0051] As in the unloading of tank **10**, the pump **12** is activated to generate a negative pressure in transport line **23**,

in the intermediate tank **13**, and in transport line **22**, which is now connected to the lower outlet **61** of the solid material tank **11**. The generated negative pressure will reach a level where the solid material particles inside the solid material tank **11** will start to move into and along transport line **22** until they reach the intermediate tank **13**. Due to gravity, the solid material particles will accumulate at the bottom of the intermediate tank **13**.

[0052] If the filtration mean **51** is present, as it is optionally the case during the unloading of tank **10** already explained with reference to FIG. **1**, the filtration means **51** will filter any solid material particles attempting to exit the intermediate tank **13** toward the pump **12**.

[0053] The main function of the intermediate tank **13**, in tank **10** loading procedure, is to receive the solid material particles from the solid material tank **11** and direct them through the lower outlet **62** into a pneumatic conveyor **81** positioned below the intermediate tank **13**. During the discharge of solid material particles from the intermediate tank **13** into the pneumatic conveyor **81**, the pump **12** is turned off, or the relief valve is opened, as in the unloading of tank **10** explained in relation to FIG. **1**. The lower outlet **62** is opened, and the material inlet of the pneumatic conveyor **81** is also opened.

[0054] The same level sensor **42** described in relation to FIG. **1** can optionally be used to determine when to stop loading the intermediate tank **13** and begin discharging the solid material particles from the intermediate tank **13** into the pneumatic conveyor **81**.

[0055] The principles of pneumatic conveying are widely known in the art. Furthermore, any skilled person in the art can employ a range of commercially available pneumatic conveyors. For example, the HDP4000 pneumatic conveyors manufactured and sold by Dynamic Air Ltda, which utilize the concept of dense-phase pressure pneumatic conveying, can be used.

[0056] Once the pneumatic conveyor **81** is loaded with solid material particles, its material inlet is closed, its lower material outlet is opened, and its transport fluid inlet is opened. This fluid is preferably air but may also be gases such as N2, argon, or carbon dioxide. Then, the air is injected, causing the solid material particles to exit the pneumatic conveyor **81**, travel along transport line **24**, and reach tank **10**.

[0057] In an optional embodiment of the present invention, a second pump is provided to supply air to the pneumatic conveyor **81**. In another preferred embodiment, the pump **12** itself is used to supply air to the pneumatic conveyor **81**. As any skilled person in the art will note, it is sufficient to release the inlet of pump **12** and connect a pneumatic line to the outlet of pump **12** to provide a positive pressure. In an even more preferred embodiment, there is no need to install a pneumatic line between pump **12** and the pneumatic conveyor **81**. Transport line **23** can be connected to the outlet of pump **12**, which will direct air into the intermediate tank **13**. In this case, a pneumatic line **25** is installed between the intermediate tank **13** and the pneumatic conveyor **81**. All the inlets and outlets of the intermediate tank **13** are closed except for the outlet to pneumatic line **25**, allowing air from pump **12** to be injected into the pneumatic conveyor **81**.

[0058] Like transport lines **23**, **22** and **21**, transport line **24** and pneumatic line **25** can be rigid, such as metallic pipes, or flexible, such as rubber hoses. The choice between rigid or flexible lines, or a combination of both, will also depend on each project and the site of installation the system of the present invention.

[0059] In an optional embodiment, transport line **24** is directly connected to tank **10**, preferably at its upper section. In another optional embodiment, transport line **24** is connected to a receiving box **16** that directs the solid material particles into tank **10**. Like the connection box **15**, the receiving box **16** serves as an interface between the tank inlet and the type of connection of transport line **24**, acting as a receiving hopper and a quick-connect/disconnect mechanism between tank **10** and the system, which is particularly useful for loading multiple tanks **10**. The receiving box **16** may also be equipped with a valve to open or close its outlet, connecting or disconnecting the inlet of tank **10** to/from the system.

[0060] The cycle of loading/unloading the intermediate tank **13** and loading/unloading the pneumatic conveyor **81** can be repeated as many times as necessary to transfer the new solid material from the solid material tank **11** to tank **10**. When the solid material tank **11** is empty, its lower outlet **61** can simply be closed to disconnect it from the system and reconnect transport line **22** to the lower outlet **61** of another filled solid material tank **11**.

[0061] Thus, the system of the present invention enables the loading of one or more tanks **10** in a simple and efficient manner, where only the solid material tanks **11** are connected and disconnected from the system. In a "plug-and-play" manner, a solid material tank **11** loaded with new solid material is connected to the system for loading one or more tanks **10**. As the solid material tank **11** empties its solid material particles, it is disconnected and replaced with another filled solid material tank **11**. Additionally, as can be readily noted, the same system used to unload tank **10** is also used to load tank **10**. Thus, in addition to providing simple and efficient loading and unloading of tanks, the system of the present invention is easy to install and can be continuously used for both loading and unloading tanks.

3—Example of Embodiment

[0062] FIG. **3** illustrates a possible embodiment of the systems of FIGS. **1** and **2** in an offshore oil platform or rig. This embodiment is provided as an illustrative and non-limiting example.

[0063] Depending on the location of an oil well, the oil and/or gas produced may reach the surface mixed with a certain amount of H2S. The extraction of at least part of the H2S produced is necessary due to its high toxicity, which can be lethal to living beings in contact with it, and its corrosive nature, which can damage pipelines transporting natural gas from a platform to land. Thus, platforms are commonly equipped with reactors through which natural gas passes for H2S removal. Commonly used catalysts in this process include platinum and rhenium catalysts, nickel catalysts, and iron and cobalt oxides.

[0064] FIG. **3** illustrates part of a platform with six reactors **10** (A-F) containing saturated catalyst particles, eleven solid material tanks **11**, a pump **12**, an intermediate tank **13**, and three transport lines **21**, **22**, **23**. A connection box **15** is used at one end of transport line **21**. Saturated catalyst particles are removed from reactor **10** (A) using the system of the invention and loaded into solid material tanks **11** until reactor **10** is free of saturated catalyst. The connection box **15** is then disconnected from reactor **10** (A) and connected

to another reactor **10** (B-F) for the same unloading process. At some point, the solid material tank **11** will be filled with saturated catalyst. At that point, the other end of transport line **21** is disconnected from the inlet **71** of the full solid material tank **11** and connected to the inlet **71** of another empty solid material tank **11**. Similarly, transport line **22** is disconnected from the outlet **72** of the full solid material tank **11** and connected to the outlet **72** of the other empty solid material tank **11**.

[0065] The process is repeated until all six reactors **10** (A-F) are unloaded. At this point, the eleven solid material tanks **11** will be filled with saturated catalyst particles. A platform crane (not shown) lifts the eleven full solid material tanks **11** onto a support vessel, such as a tugboat, which transports the eleven full solid material tanks **11** to land. On land, the eleven full solid material tanks **11** are unloaded for proper processing and disposal of the saturated catalyst particles.

[0066] Also on land, empty solid material tanks **11** are filled with new unsaturated catalyst particles. The support vessel carries the solid material tanks **11** filled with unsaturated catalyst particles back to the platform, where they are hoisted back onto the platform.

[0067] The same system of the invention used to unload reactors **10** (A-F) is used to load these reactors. To do so, as explained, a pneumatic conveyor **81** is positioned below the intermediate tank **13**. The inlet **71** and outlet **72** of the solid material tank **11** are closed, and the end of pneumatic line **22**, which was previously connected to the outlet **72** of solid material tanks **11**, is now connected to the lower outlet **61** of each solid material tank **11** filled with unsaturated catalyst particles for loading the reactors **10**.

[0068] FIG. **4** shows the same part of the platform, emphasizing only the presence of the pneumatic conveyor **81**, transport line **24**, receiving box **16**, and the six reactors **10** (A-F). Once a reactor **10** is sufficiently loaded with new unsaturated catalyst particles, the receiving box **16** is disconnected from that reactor and connected to another empty reactor **10** to be loaded with unsaturated catalyst particles. With all six reactors **10** (A-F) loaded with unsaturated catalyst particles, the solid material tanks **11** will be empty again. Thus, they will be ready to receive catalyst particles as they become saturated using the same loading and unloading system of the invention, ensuring the entire cycle is repeated.

[0069] Although six reactors are illustrated as an example, the loading and unloading process can be applied to any number of reactors. Similarly, the number of solid material tanks **11** may vary as needed or depending on the available space on the platform.

1. A system for loading and unloading solid material particles used for carrying out a physical, chemical, or biological process in one or more tanks, the system comprising:

an intermediate tank;

a pump; and

a pneumatic conveyor,

wherein the intermediate tank and the pump are fluidically connected,

wherein, for unloading a tank containing saturated or degraded solid material particles:

an empty or partially empty solid material tank is fluidically connected to the intermediate tank and to the tank containing saturated or degraded solid material particles; and

the pump is configured to generate a negative pressure in the intermediate tank, in the empty or partially empty solid material tank, and in the tank containing saturated or degraded solid material particles to move saturated or degraded solid material particles from inside the tank to the empty or partially empty solid material tank;

and wherein, for loading a tank:

a solid material tank containing unsaturated or undegraded solid material particles is fluidically connected to the intermediate tank;

the pump is configured to generate a negative pressure in the intermediate tank and in the solid material tank containing unsaturated or undegraded solid material particles to move unsaturated or undegraded solid material particles from the solid material tank to the intermediate tank;

the pneumatic conveyor is positioned below the intermediate tank, wherein the intermediate tank is configured to move the received unsaturated or undegraded solid material particles to the pneumatic conveyor; and

the pneumatic conveyor is fluidically connected to the tank to move the received unsaturated or undegraded solid material particles into the tank.

2. The system of claim **1**, wherein the one or more tanks are reactors.

3. The system of claim **1**, wherein the solid material is a catalyst, an adsorbent or both a catalyst and adsorbent.

4. The system of claim **1**, wherein the one or more tanks, the solid material tank, the intermediate tank, and the pump are fluidically connected by means of transport lines, and the one or more tanks and the pneumatic conveyor are fluidically connected by means of transport line.

5. The system of claim **4**, wherein the transport lines are rigid, flexible, or comprise both rigid and flexible sections.

6. The system of claim **1**, wherein the solid material tank has a conical lower part and an outlet at the lower part.

7. The system of claim **1**, wherein the intermediate tank has a conical lower part and an outlet at the lower part.

8. The system of claim **1**, wherein the intermediate tank comprises a filtration means inside it to filter the flow of material arriving from the solid material tank.

9. The system of claim **1**, wherein the solid material tank comprises a level sensor or a weight sensor.

10. The system of claim **1**, wherein the intermediate tank comprises a level sensor or a weight sensor.

11. The system of claim **4**, wherein the system comprises a connection box to connect the transport line connecting a tank to a solid material tank.

12. The system of claim **4**, wherein the system comprises a receiving box at one end of the transport line connecting the pneumatic conveyor to a tank to direct the unsaturated or undegraded solid material particles into the tank.

13. A use of the system as defined in claim **1** for the loading and unloading of one or more tanks.

14. A method for loading or unloading solid material particles used for carrying out a physical, chemical, and/or biological process in one or more tanks, through a system as defined in claim **1**, the method comprising the steps of:

for unloading a tank containing saturated or degraded solid material particles:

generating negative pressure in the intermediate tank, in the empty or partially empty solid material tank, and in the tank containing saturated or degraded solid material particles to move saturated or degraded solid material particles from inside the tank to the empty or partially empty solid material tank;

and, for loading a tank:

generating negative pressure in the intermediate tank and in the solid material tank containing unsaturated or undegraded solid material particles to move unsaturated or undegraded solid material particles from the solid material tank to the intermediate tank;

moving the unsaturated or undegraded solid material particles from the intermediate tank to the pneumatic conveyor; and

moving the unsaturated or undegraded solid material particles from the pneumatic conveyor to the tank.

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