

## **SYSTEM AND METHOD FOR SAND DISCHARGE**

### **Field of the Invention**

**[0001]** The present invention generally relates to sand discharge from sand-loaded ships, and more particularly to a system for sand discharge from sand-loaded ships in a continuous and long-distance manner, and further to a method for sand discharge.

### **Background of the Invention**

**[0002]** Many situations such as filling in sea areas in order to gain land require large amounts of mass like sands, where the sands are usually transported by ships or the like carriers and then discharged from the transportation ships to the designated areas.

**[0003]** Current sand discharge modes include direct casting and across-anchor discharge. The direct casting discharges the sands from transportation ships when they are actually located in the designated area. For example, so-called self-unloading dredgers TSHD (“Trailing Suction Hopper Dredgers”) are commonly used. During the transport from the loading site to the discharging site, the mass is located in silo-like compartments in the vessel; the mass may be unloaded by opening the bottom of the vessel, for example by virtue of the hull being formed in two parts structured in a manner allowing them to be moved relative to each other. The across-anchor discharge employs smaller ships to transport the sands from the transportation ships to the designated area. It is apparent that the current sand discharge modes have many problems and disadvantages. For example, the direct casting could cause the ships stranded; the across-anchor discharge makes the limited anchoring space even more crowded. In addition, the water level in the anchorage locale turns shallow by the leakage and spill in the process of anchorage discharge. Furthermore, the ships shuttle between the discharge area and other discharge ships, which will surely bring about the danger because of the high ship density. For all the above, it will surely limit the discharge totality and slow down the stuffing schedule.

### **Summary of the Invention**

**[0004]** Therefore, one objective of the present invention is to provide a sand discharge system and method for continuous and long-distance discharge of sand from a sand-loaded transportation ship.

**[0005]** One aspect of the present invention provides a sand discharge system for continuous discharging sand from a sand-loaded transportation ship. In one embodiment, the sand discharge system comprises one or more sand discharge subsystems; wherein each of the one or more sand discharge subsystems comprises a water-feed module for providing water to dilute the superficial sand layer of sand in the sand-loaded transportation ship; a sand-water extraction module for mixing the water from the water-feed module with the superficial sand layer and extracting the sand-water mixture so as to export the sand-water mixture for transportation; and a sand-water transportation module for pressuring the sand-water mixture exported from the sand-water extraction module and transporting the sand-water mixture into a designated area, wherein the sand-water transportation module is in liquid communication with the sand-water extraction module; and a platform for providing support for the one or more sand discharge subsystems; wherein the one or more sand discharge subsystems are installed on the platform to form the sand discharge system.

**[0006]** In another embodiment, the sand discharge system further comprises a convey module for moving the sand-water extraction module between the platform and the sand-loaded transportation ship; a control module for controlling the operation of the sand discharge system; and a power supply for providing power to the sand discharge system.

**[0007]** In another embodiment of the sand discharge system, the one or more subsystems are disposed on the platform equally spaced.

**[0008]** In another embodiment of the sand discharge system, the water-feed module comprises a water-feed pump for pumping water from a water source to the sand cabin of the sand-loaded transportation ship; a frequency conversion controller for controlling the pumping rate of the water feed pump; and a water pipeline being in liquid communication with the outlet of the water feed pump for transporting water to the sand cabin of the sand-loaded transportation ship. In a further embodiment of the sand discharge system, the water-feed pump is an axially split pump.

**[0009]** In another embodiment of the sand discharge system, the sand-water extraction module comprises one or more sand-water extraction pumps for mixing water

with sand and extracting sand-water mixture; a frequency conversion controller for controlling the exporting rate of the one or more sand-water extraction pumps; and a sand-water connection pipeline being in liquid communication with the outlets of the one or more sand-water extraction pumps for exporting the sand-water mixture to the sand-water transportation module. In a further embodiment of the sand discharge system, the sand-water extraction pump is a high efficiency diving sand and slurry pump.

**[0010]** In another embodiment of the sand discharge system, the sand-water transportation module comprises a pressure pump for increasing the pressure of the sand-water mixture for long distance transportation; a frequency conversion controller for controlling the pressure of the pressure pump; and a long-distance sand-water transportation pipeline being in liquid communication with the pressure pump for transporting the pressured sand-water mixture. In a further embodiment of the sand discharge system, the pressured pump is a high efficient centrifugal slurry pump.

**[0011]** Another aspect of the present invention provides a method for continuous and long-distanced discharge of sand from a sand-loaded transportation ship. In one embodiment, the method comprises providing a water-feed module for providing water to dilute the superficial sand layer of sand in the sand-loaded transportation ship; providing a sand-water extraction module for mixing the water from the water-feed module with the superficial sand layer and extracting the sand-water mixture so as to export the sand-water mixture for transportation; and providing a sand-water transportation module for pressuring the sand-water mixture exported from the sand-water extraction module and transporting the sand-water mixture into a designated area, wherein the sand-water transportation module is in liquid communication with the sand-water extraction module.

**[0012]** The objectives and advantages of the invention will become apparent from the following detailed description of preferred embodiments thereof in connection with the accompanying drawings.

### **Brief Description of the Drawings**

**[0013]** Preferred embodiments according to the present invention will now be described with reference to the Figures, in which like reference numerals denote like elements.

**[0014]** FIG 1 shows a schematic configuration of eight sand discharge subsystems that are equally spaced on a discharge ship in accordance with one embodiment of the present invention.

**[0015]** FIG 2 shows a schematic configuration of one sand discharge subsystem in more details in accordance with one embodiment of the present invention.

**[0016]** FIG 3 shows an isomeric view of an exemplary HS200-150 axially split pump.

**[0017]** FIG 4 shows an isomeric view of an exemplary 150LQ-480 two-phase flow diving slurry pump.

**[0018]** FIG 5 shows an isomeric view of an exemplary 200LH-630 high efficient centrifugal slurry pump.

### **Detailed Description of the Invention**

**[0019]** The present invention may be understood more readily by reference to the following detailed description of certain embodiments of the invention.

**[0020]** Throughout this application, where publications are referenced, the disclosures of these publications are hereby incorporated by reference, in their entireties, into this application in order to more fully describe the state of art to which this invention pertains.

**[0021]** The present invention provides a sand discharge system for discharging sand from a sand-loaded ship in a continuous and long distance manner, where the sand discharge system can be installed in a platform. The platform can be a ship, a barge, a pier or the like. In one embodiment, the platform is a buoyant one such as a discharge ship.

**[0022]** The sand discharge system comprises one or more sand discharge subsystems, where the one or more sand discharge subsystems can be installed in the platform in any suitable configurations, for example, equally-spaced on the platform. As shown in FIG 1, there is provided a schematic configuration of eight sand discharge subsystems that are equally spaced on a discharge ship, where the sand discharge subsystems are in a working configuration with the sand-loaded transportation ship being anchored in parallel with the discharge ship.

**[0023]** Now referring to FIGS 1 and 2, each sand discharge subsystem **100** comprises a water-feed module **10** for providing water to dilute the superficial sand layer, a sand-water extraction module **20** for mixing the water from the water-feed module with the superficial sand layer and extracting the sand-water mixture for transportation, and a sand-water transportation module **30** for pressuring the sand-water mixture from the sand-water extraction module and transporting the sand-water mixture into a designated area. The sand discharge subsystem further comprises a convey module **40** for moving sand-water extraction module between the platform and the sand-loaded transportation ship, a control module **50**, and a power supply **60**. Apparently, the control module and power supply can be centralized for the whole sand discharge system.

**[0024]** In one embodiment, the water-feed module **10** comprises a water-feed pump **11**, a frequency conversion controller **12**, a valve **13** and a water pipeline **14**. The exemplary water-feed pump is HS200-150 axially split pump as shown in FIG 2. The frequency conversion controller controls the output of the water-feed pump; the valve functions as a switch or a safety means; and the water pipeline connects to the outlet of the water-feed pump so as to transport the water onto the superficial sand layer on the sand-loaded transportation ship. The water-feed pump can be installed in any suitable configurations; for example, the water-feed pump is disposed on a buoy so that it has an easy access of water. In addition, the water-feed pump can be located on either side of the discharge ship; preferably it is located on the side away from the transportation ship because this way requires less manipulation of the water-feed module.

**[0025]** In one embodiment, the sand-water extraction module **20** comprises one or more sand-water extraction pumps **21**, a frequency conversion controller **22**, a valve **23** and a sand-water connection pipeline **24**. In one embodiment, the sand-water extraction module comprises four sand-water extraction pumps. The sand-water extraction pump can be a high efficiency diving sand and slurry pump. The exemplary sand-water extraction pump is 150LQ-480 two-phase flow diving slurry pump as shown in FIG 3. The sand-water extraction pump mixes the sand with water and extracts the sand-water mixture to feed into the sand-water connection pipeline for further being pressured for long distance transportation. The ratio of sand over water can be determined empirically by considering the factors such as efficiency and cost. The frequency conversion controller **22** controls the output of the water-feed pump; the valve functions as a switch or a safety means; and

the sand connection pipeline connects the outlet of the sand-water extraction pump to the inlet of the sand-water transportation module. The sand-water extraction pumps are movable by the convey module; during operation, they are moved from the platform (e.g., discharge ship) to the sand-loaded transportation ship; when the discharge is complete, they are moved back and stowed on the platform.

**[0026]** In one embodiment, the sand-water transportation module **30** comprises a pressure pump **31**, a frequency conversion controller **32**, a valve **33** and a long-distance sand-water transportation pipeline **34**. The exemplary pressure pump is 200LH-630 high efficient centrifugal slurry pump as shown in FIG 4. The pressure pump **31** pressures the sand-water mixture from the sand-water extraction pump for long distance transportation. The frequency conversion controller **32** controls the output of the pressure pump; the valve **33** functions as a switch or a safety means; and the sand-water transportation pipeline **34** connects the outlet of the pressure pump so as to transport the pressured sand-water mixture to a designated area.

**[0027]** In one embodiment, the convey module **40** comprises a crane for moving the sand-water extraction pump between the discharge ship and transportation ship back and forth.

**[0028]** In one embodiment, the control module **50** comprises an electronic means such as computer to operate the sand discharge system.

**[0029]** Now the discharge of sand by the sand discharge system of the present invention is briefly described prior to a more detailed description. After the sand discharge system is properly positioned, the water feed pump feeds water into the cabin of the transportation ship to dilute the sand, the sand-water extraction pump mixes the sand with water and extracts the sand-water mixture and then exports into the inlet of the pressure pump, and the pressure pump increases the pressure of the sand-water mixture so as to transport the sand-water mixture to a designated area.

**[0030]** Now a more detailed description of the operation of the sand discharge system of the present invention is provided herein, wherein the numbers of pumps are used for illustration only.

**[0031]** The transportation ship and the discharge ship are surely anchored prior to the operation of the sand discharge system.

**[0032]** Then the sand-water extraction pumps in each subsystem are moved with the cranes from the discharge ship to the sand surface on the cabin of the sand-loaded transportation ship.

**[0033]** Then, the water feed pumps and sand-water extraction pumps start to operate in two phases. The initial phase of discharge when the sand-loaded transportation ship is with the maximum load is commenced first. In order to guarantee the safety and stability of the transportation ship, feed water into one of the cabins on the transportation ship with one HS200 pump to dilute the superficial sand, extract the sand-water mixture with two 150LP pumps and make a concave in the sand. Since the transportation ship is fully loaded before discharge, the water that is initially fed should be controlled within the permitted loaded total. After the sand load in the transportation ship is lessened, start another HS200 pump, feed water into the cabin of the transportation ship, and at the same time start another two 150LQ pumps to extract sand-water mixture. When the loaded total declines to a predetermined point based on ship's safety and stability, other subsystems start following the same working procedure as described herein.

**[0034]** The sand-water mixture is potentially unbalanced in the extraction process because of the different quantity of the sand. In other words, the water fed into the cabin maybe more or less than needed. To avoid it, frequency conversion mode can be employed to adjust the water quantity that is fed and the sand total that is extracted, which can control the mixture in the cabin and balance the water in and out, so as to make sure the ship is steady.

**[0035]** Then, the sand-water mixtures from the sand-water extraction pumps are fed into the inlets of the pressure pumps for long-distance transportation. For example, pool the sand-water mixture extracted by the four 150LQ pumps to one pipeline, and make the pipeline meet the inlet of 200LH pump; make the outlet of the 200LH pump meet the sand transportation pipeline, and transmit the mixture to the designated sea area 1000-2000 meters away.

**[0036]** After the extraction, start the crane and swing the extraction pump from the transportation ship back to the discharge ship.

**[0037]** After the discharge, the transportation ship leaves.

**[0038]** During the operation of the discharge system of the present invention, a few issues need special attention. One is the safety of the discharge ship and the transportation

ship. Fix the discharge ship in the way of fastening the buoy, juxtapose the transportation ship on one side of the discharge ship, and employ a cushion of 2 to 2.5 meters between to prevent scrub and collision.

**[0039]** Another issue is the location of the discharge ship for optimal discharge. Place the discharge ship between the navigation mark and the cofferdam around the to-be-stuffed sea area; make it maximally close to the dam if the water depth permits, so as to shorten the sand ejection pipe staying on the sea surface, which can make the ejection pipe more stable.

**[0040]** Yet another issue is the safety of the pipeline. The transportation pipeline should float in the sea. Composed of macromolecule polyethylene, the pipeline boasts excellent compression resistance (1MPa) and attrition resistance, which ensures it floats on the sea. Fix the pipelines with flanges, and each section of the pipe is 10 meters long with two floating objects on each of them. The plurality of sand-water transportation pipelines on each discharge ship are juxtaposed, and one anchor is set beneath every 50 meters to resist waves and prevent the pipeline from being broken or destroyed. There will be a slight displacement when the tides set in and out. However, this type of pipelines has a good flexibility and permits a bend to some degree, so it can work steadily and will not be easily affected by the waves.

**[0041]** Finally, the issue is about free surface. In the process of discharge, feed water into the cabin of the transportation ship, and make a pit in the sand with wallop. Start the sand extraction pump to extract the sand-water mixture in the pit and the load on the ship will be reduced. Each pump is equipped with a frequency conversion appliance, which can adjust the water in the pit, realizing the balance between the water in and out. When the sand is decreased (for each discharge pump, on water feed pump feeds water, four extraction pumps extract the sand-water mixture), the water level in the pit will not be over the sand around, so a free surface will not appear in the sand out of the pit.

**[0042]** Since the water feed and the sand extraction are performed simultaneously in the process of sand discharge, together with the sand around the pit filled with air, only very little water can filter from the pit out into the sand. As the discharge continues, the water filtering into the sand will accumulate. As the discharge continues, the pit deepens and the water level falls, which makes the water level constantly lower than the sand level,

thus preventing large quantity of water from forming a free surface, thus guaranteeing the ship's stability.

**[0043]** The present invention has many advantages. First, it is environment-friendly. The discharge system is installed airproof without oil leakage and chemical spill, which will not pollute the sea water. The diluted water fed in the process is from the sea, and the sand-water mixture is transported by airproof pipeline to the designated area, which prevents the sand drainage. In addition, the discharge place is designated, which will not cause a concavo-convex sea bottom, thus ships can sail on the sea smoothly. The discharge mouth can be adjusted according to the stuff requirement, ensuring a plain discharge area.

**[0044]** Second, it has high efficiency. The sand is directly transported to a faraway sea area, reducing the interim procedure, which can cut down the cost and raise the working efficiency.

**[0045]** Third, no requirement for the water depth in to-be-stuffed area. This procedure has no requirement for the water depth in to-be-stuffed area, and the sand can be transported to faraway shallow area inaccessible to large ships. In this way, the potential danger of being stranded in direct cast will be avoided, and the interim procedure in anchorage discharge can be saved.

**[0046]** Fourth, it occupies smaller sea area. With the buoy fixing the discharge ship and the transportation ship, ships will not be displaced by wind, flux or tides. Compared to anchored discharge, the occupied sea area is largely reduced.

**[0047]** While the present invention has been described with reference to particular embodiments, it will be understood that the embodiments are illustrative and that the invention scope is not so limited. Alternative embodiments of the present invention will become apparent to those having ordinary skill in the art to which the present invention pertains. Such alternate embodiments are considered to be encompassed within the scope of the present invention. Accordingly, the scope of the present invention is defined by the appended claims and is supported by the foregoing description.

**CLAIMS**

What is claimed is:

1. A sand discharge system for continuous discharging sand from a sand-loaded transportation ship, comprising:

one or more sand discharge subsystems; wherein each of the one or more sand discharge subsystems comprises:

a water-feed module for providing water to dilute the superficial sand layer of sand in the sand-loaded transportation ship;

a sand-water extraction module for mixing the water from the water-feed module with the superficial sand layer and extracting the sand-water mixture so as to export the sand-water mixture for transportation; and

a sand-water transportation module for pressuring the sand-water mixture exported from the sand-water extraction module and transporting the sand-water mixture into a designated area, wherein the sand-water transportation module is in liquid communication with the sand-water extraction module;

a platform for providing support for the one or more sand discharge subsystems; wherein the one or more sand discharge subsystems are installed on the platform to form the sand discharge system; and

a convey module for moving the sand-water extraction module between the platform and the sand-loaded transportation ship;

a control module for controlling the operation of the sand discharge system; and

a power supply for providing power to the sand discharge system.

2. The sand discharge system of claim 1, wherein the platform is a ship, a barge or a pier; and wherein one or more subsystems are disposed on the platform equally spaced.

3. The sand discharge system of claim 1, wherein the water-feed module comprises:

a water-feed pump for pumping water from a water source to the sand cabin of the sand-loaded transportation ship;

a frequency conversion controller for controlling the pumping rate of the water feed pump; and

a water pipeline being in liquid communication with the outlet of the water feed pump for transporting water to the sand cabin of the sand-loaded transportation ship.

4. The sand discharge system of claim 4, wherein the water-feed pump is an axially split pump.

5. The sand discharge system of claim 1, wherein the sand-water extraction module comprises:

one or more sand-water extraction pumps for mixing water with sand and extracting sand-water mixture;

a frequency conversion controller for controlling the exporting rate of the one or more sand-water extraction pumps; and

a sand-water connection pipeline being in liquid communication with the outlets of the one or more sand-water extraction pumps for exporting the sand-water mixture to the sand-water transportation module.

6. The sand discharge system of claim 5, wherein the sand-water extraction pump is a high efficiency diving sand and slurry pump.

7. The sand discharge system of claim 1, wherein the sand-water transportation module comprises:

a pressure pump for increasing the pressure of the sand-water mixture for long distance transportation;

a frequency conversion controller for controlling the pressure of the pressure pump; and

a long-distance sand-water transportation pipeline being in liquid communication with the pressure pump for transporting the pressured sand-water mixture.

8. The sand discharge system of claim 8, wherein the pressure pump is a high efficient centrifugal slurry pump.

9. A method for continuous and long-distanced discharge of sand from a sand-loaded transportation ship, said method comprising:

providing a water-feed module for providing water to dilute the superficial sand layer of sand in the sand-loaded transportation ship;

providing a sand-water extraction module for mixing the water from the water-feed module with the superficial sand layer and extracting the sand-water mixture so as to export the sand-water mixture for transportation;

providing a sand-water transportation module for pressuring the sand-water mixture exported from the sand-water extraction module and transporting the sand-water mixture into a designated area, wherein the sand-water transportation module is in liquid communication with the sand-water extraction module, wherein the water-feed module, the sand-water extraction module and the sand-water transportation module forms a sand discharge subsystem;

providing a platform for supporting the sand discharge subsystem; and

providing a convey module for moving the sand discharge subsystem between the platform and the sand-loaded transportation ship.

10. The method of claim 9, wherein the water-feed module comprises:

a water-feed pump for pumping water from a water source to the sand cabin of the sand-loaded transportation ship;

a frequency conversion controller for controlling the pumping rate of the water feed pump; and

a water pipeline being in liquid communication with the outlet of the water feed pump for transporting water to the sand cabin of the sand-loaded transportation ship.

11. The method of claim 9, wherein the water-feed pump is an axially split pump.

12. The method of claim 9, wherein the sand-water extraction module comprises:

one or more sand-water extraction pumps for mixing water with sand and extracting sand-water mixture;

a frequency conversion controller for controlling the exporting rate of the one or more sand-water extraction pumps; and

a sand-water connection pipeline being in liquid communication with the outlets of the one or more sand-water extraction pumps for exporting the sand-water mixture to the sand-water transportation module.

13. The method of claim 12, wherein the sand-water extraction pump is a high efficiency diving sand and slurry pump.

14. The method of claim 9, wherein the sand-water transportation module comprises:

a pressure pump for increasing the pressure of the sand-water mixture for long distance transportation;

a frequency conversion controller for controlling the pressure of the pressure pump; and

a long-distance sand-water transportation pipeline being in liquid communication with the pressure pump for transporting the pressured sand-water mixture.

15. The method of claim 14, wherein the pressured pump is a high efficient centrifugal slurry pump.