

SPLIT MOORING SYSTEM AND METHODS FOR VESSELS

BACKGROUND OF THE DISCLOSURE

Field of the Disclosure

[0001] Embodiments disclosed herein generally relate to a mooring system. More specifically, embodiments disclosed herein relate to a split mooring system to attach to and hold vessels near other vessels in offshore operations.

Description of Related Art

[0002] In oilfield operations, offshore vessels, such as platform supply vessels (PSV), offshore barges, anchor handling vessels, construction support vessels (CSV), drilling vessels, well intervention vessels, ice breaking vessels, crane vessels, cable laying vessels, seismic vessels, and firefighting vessels, are commonly used for various tasks, including, but not limited to, hydrocarbon exploration, hydrocarbon drilling and production, holding and transporting hydrocarbons, safety platforms, and heavy lift cranes. Before, during, and after operations, additional support and/or the use of additional equipment may be beneficial to the success of an operation in order to stabilize the vessel. Historically, offshore vessels may use mooring systems to maintain a position in a body of water. In conventional mooring systems, an offshore vessel is anchored in position by a mooring line. Conventional mooring systems may include various configurations such as, but not limited to, a catenary mooring system, a taut leg mooring system, a tension leg mooring system, a single point (buoy, tower, or turret) mooring system, or a spread mooring system.

[0003] Additionally, oilfield operations may include a vessel-to-vessel transfer of products while the offshore vessels remain in the body of the water. Using a floating facility for the production of hydrocarbon or other processing plant may accelerate production schedules. However, processing plants may not have the required storage for transportation parcels to be offloaded, thus requiring the use of a storage vessel or Floating Storage Unit ("FSU") to which other carriers can take the cargo in adequate parcel sizes. While traditional methods served their purpose, problems arise with the proximity between the two offshore vessels and how to maintain a safe distance between them. The use of conventional mooring systems requires large distances

between the two offshore vessels. In a non-limiting example, for the transfer of cryogenic materials, such as liquefied natural gas (“LNG”), the length of the transfer hoses may be limited to less than 30 meters, making the conventional mooring systems of two vessels challenging, time consuming, and resource intensive such that it may be un-feasible.

SUMMARY OF THE DISCLOSURE

[0004] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0005] In one aspect, the embodiments disclosed herein relate to a split mooring system. The split mooring system may include at least two vessels in a body of water and a plurality of mooring lines. The plurality of mooring lines may be attached to the at least two vessels and configured to fix and maintain a position of the at least two vessels in the body of water relative to each other. A first vessel of the at least two vessels may be adjacent to a second vessel of the at least two vessels. The plurality of mooring lines may be attached to sides of the first vessel and the second vessel. The sides of the first vessel and the second vessel with mooring lines may face open water of the body of water.

[0006] In another aspect, the embodiments disclosed herein relate to a method. The method may include placing a first vessel of the at least two vessels adjacent to a second vessel of the at least two vessels; attaching mooring lines to sides of the first vessel and the second vessel that face open water of the body of water; fixing a position of the first vessel and the second vessel in the body of water with the mooring lines; and maintaining the fixed position of the first vessel and the second vessel with the mooring lines.

[0007] In yet another aspect, the embodiments disclosed herein relate to a system that may include a production vessel positioned a distance apart from a floating storage unit in a body of water. The system may also include a plurality of mooring lines attached to the production vessel and the floating storage, the plurality of mooring lines may be configured to fix and maintain a position of the production vessel and

the floating storage in the body of water relative to each other. The system may further include a transfer hose attached to a first adjacent side of the production vessel and a second adjacent side of the floating storage, the transfer hose may be configured to transfer cryogenic materials from the production vessel to the floating storage. The first adjacent side and the second adjacent side may face each other. The plurality of mooring lines may be attached to a first opposite side of the production vessel and a second opposite side of the floating storage. The first opposite side may be opposite the first adjacent side and the second opposite side is opposite the second adjacent side.

[0008] Other aspects and advantages of the disclosure will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0009] Figure 1 illustrates a flowchart of a split mooring system for an offshore vessel according to one or more embodiments of the present disclosure.

[0010] Figures 2A-2B show examples of a split mooring system for use with an offshore vessel in accordance with one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

[0011] Specific embodiments of the present disclosure will now be described in detail with reference to the accompanying Figures. Like elements in the various figures may be denoted by like reference numerals for consistency. Further, in the following detailed description of embodiments of the present disclosure, numerous specific details are set forth in order to provide a more thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that the embodiments disclosed herein may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description.

[0012] Furthermore, those having ordinary skill in the art will appreciate that when describing a first element to a second element disposed thereon, it is understood that disposing may be either directly disposing the first element on the second element, or

indirectly disposing the first element on the second element. For example, a first element may be directly disposed on a second element, such as by having the first element and the second element in direct contact with each other, or a first element may be indirectly disposed on a second element, such as by having a third element, and/or additional elements, disposed between the first and second elements. As used herein, the term “attached to” or “coupled” or “coupled to” or “connected” or “connected to” may indicate establishing either a direct or indirect connection, and is not limited to either unless expressly referenced as such. Wherever possible, like or identical reference numerals are used in the figures to identify common or the same elements. The figures are not necessarily to scale and certain features and certain views of the figures may be shown exaggerated in scale for purposes of clarification.

[0013] In one aspect, embodiments disclosed herein generally relate to split mooring systems. In one or more embodiments, the split mooring system may be designed for use with vessels, in particular, offshore vessels or structures. Further, embodiments disclosed herein are described with terms designating an offshore vessel in reference to a floating vessel, but any terms designating offshore structure (i.e., any platform or semi-submersible) should not be deemed to limit the scope of the disclosure. It is to be further understood that the various embodiments described herein may be used in various stages of offshore oil and gas operations, such as rig site preparation, drilling, completion, abandonment etc., and in other environments, such as work-over rigs, fracking installation, well-testing installation, oil and gas production installation, without departing from the scope of the present disclosure. The embodiments are described merely as examples of useful applications, which are not limited to any specific details of the embodiments herein. In other embodiments, the split mooring systems may be designed for use in any marine environment without departing from the scope of the present disclosure.

[0014] Split mooring systems, according to embodiments herein, are systems that include a plurality of mooring lines for mooring at least two vessels near each other in a body of water. In a non-limiting example, a first set of the plurality of mooring lines are attached to a first vessel and a second set of the plurality of mooring lines are attached to a second vessel. In addition, spring lines may be connected between the first vessel and the second vessel to further aid in maintaining the relative positions of

the first and second vessels. Further, fenders may be provided on the bodies of the first and second vessels to prevent collisions between the two vessels. By splitting the plurality of mooring lines between the first and second vessels, the need for a complete mooring system on both vessels is eliminated such that the two vessels may be maintained in close proximity while significantly reducing HSE risks, potentially equipment damage, unwanted downtime, and improve vessel-to-vessel transfer. As described in the prior art such as U.S. Patent No. 8,561,563 and U.S. Patent No. 9,272, 755, which are incorporated in their entirety herein by reference, conventional methods require extensive mooring configurations to moor two vessels side-by-side. Such conventional methods may be both time consuming and may also increase HSE risks. Accordingly, one or more embodiments in the present disclosure may be used to overcome such challenges as well as provide additional advantages over conventional methods of mooring two vessels side-by-side, as will be apparent to one of ordinary skill in the art upon reading this disclosure.

[0015] With reference to Figures 1-2B, this disclosure describes systems and methods of a split mooring system (“SMS”) 100 for mooring vessels side-by-side. In some embodiments, the SMS 100 is used at an offshore site (in a body of water) to maintain a position of two vessel being near each other. The SMS 100 may use a wide variety of mooring lines to stabilize the vessels in a position such that the vessels may be side-by-side to complete a vessel-to-vessel transfer of products (i.e., moving equipment from one vessel to another vessel, transfer of hydrocarbons or cryogenic materials, scheduled repairs, replace equipment, etc.). One skilled in the art will appreciate how the SMS 100 may be able to achieve increased performance, decreased non-productive time (NPT), and improved equipment life and maintenance.

[0016] Referring to Figure 1, in one or more embodiments, a system flow chart of a SMS 100 deployed at an offshore site is shown. The SMS 100 includes a plurality of mooring lines 101 to be coupled to a vessel(s). Further, it is also understood that depending on a size, shape, and configuration of vessels (and its usage), different sizes, numbers and/or types of mooring lines may be used. For example, each mooring line of the plurality of mooring lines 101 may be a rope, wire, cable, chain or a combination thereof. In a non-limiting example, each mooring line of the plurality of mooring lines 101 may be made out of fibrous material, sisal, hemp, linen, cotton,

steel wire, metal chain, polyethylene (e.g., DYNEEMA and SPECTRA), polypropylene, polyester (e.g., PET, LCP, VECTRAN), nylon, aramid (e.g., TWARON, TECHNORA, and KEVLAR), acrylics (e.g., DRALON) or any combination thereof. In some embodiments, the plurality of mooring lines 101 may be split into a first set of mooring lines 102 and a second set of mooring lines 103. The first set of mooring lines 102 may be attached to a first vessel 104 such that a first end of the mooring lines 102 is coupled to the first vessel 104 and a second end of the mooring lines 102 is anchored to maintain a position of the first vessel 104. In addition, the second set of mooring lines 103 may be attached to a second vessel 105 such that a first end of the mooring lines 103 is coupled to the second vessel 105 and a second end of the mooring lines 103 is anchored to maintain a position of the second vessel 104. It is further envisioned that the first and second vessel may be any offshore structure. In a non-limiting example, the first vessel 104 may be a production vessel using a processing plant on a floating facility and the second vessel 105 may be a storage vessel or a floating storage unit (“FSU”).

[0017] Using the SMS 100, the first vessel 104 and the second vessel 105 may use the plurality of mooring lines 101 to be moored in a body of water such that the vessels 104, 105 are proximate each other. By having the vessels 104, 105 proximate each other, vessels 104, 105 may have an adjacent side and an open side. The adjacent side of the first vessel 104 may face the adjacent side of the second vessel 105. The open side of the vessels 104, 105 may be opposite the adjacent side of the vessels 104, 105. The open side of the vessels 104, 105 may be a side that faces open water. In addition, the adjacent side of the vessels 104, 105 may have no mooring lines such that the plurality of mooring lines 101 are only on the open side of the vessels 104, 105. In a non-limiting example, the first vessel 104 and the second vessel 105 are moored a distance of less than 30 meters apart from each other, such as a distance of between 2 and 25 meters apart, or from 5 to 15 meters apart, for example. It is further envisioned that one or more transfer hoses may be interconnected between the first vessel 104 and the second vessel 105 such that a transfer of cryogenic materials (e.g., liquefied natural gas) may occur from the first vessel 104 to the second vessel 105 or vice versa.

[0018] Still referring to Figure 1, in one or more embodiments, one or more spring lines 106 may be connected to the first vessel 104 and the second vessel 105. The spring lines 106 may have a first end attached the first vessel 104 and a second end attached to the second vessel 105 such that the first and second vessels 104, 105 maintain a relative position with each other. The spring lines 106 may be made out of the same materials as the plurality of mooring lines 101. Further, the spring lines 106 may limit a fore-and-aft movement of the first vessel 104 and the second vessel 105 with respect to each other.

[0019] In some embodiments, the first vessel 104 and/or the second vessel 105 may include one or more fenders 107 attached thereon. The fenders 107 may be attached to an outer surface the vessels 104, 105 to prevent collisions between a body of the first vessel 104 and a body of the second vessel 105 and thereby preventing damage to the vessels 104,105. The fenders 107 may be made a rubber material.

[0020] Though not shown in Figure 1, in one or more embodiments, one or more sensors may be included within the SMS 100. In a non-limiting example, the sensors may be a microphone, ultrasonic, ultrasound, sound navigation and ranging (SONAR), radio detection and ranging (RADAR), acoustic, piezoelectric, accelerometers, temperature, pressure, weight, position, or any known sensor in the art to detect changes to the position or conditions of the vessels 104, 105 and the plurality of mooring lines 101. For example, the one or more sensors are located on the vessels 104, 105 and/or any mooring line of the plurality of mooring lines 101 on locations where they can gather data, be able to detect any damage/wear, and to determine a location or movement of said vessels or mooring lines. Further, global position system ("GPS") devices may also be used to monitor the positions of the vessels 104, 105. In addition, one skilled in the art will appreciate how a dynamic positioning system (i.e., boat motors) may be used in conjunction with the SMS 100 to aid in maintaining the positions of the vessels 104, 105 in the body of water. It is further envisioned that the information regarding the positions of the vessels 104, 105 may be accessed and run from an existing control systems (i.e., a computer/control panel at or on one or both of the vessels) and may include a display as well as allowing remote access to the control system.

[0021] Now referring to Figure 2A, a perspective view of the SMS 100 deployed in a body of water 200 is illustrated in accordance with in one or more embodiments. The first vessel 104 and the second vessel 105 are floating within the body of water 200 at a buoyancy. As discussed above, the first vessel 104 and the second vessel 105 may be moored with the plurality of mooring lines 101 to be a distance of less than 30 meters apart from each other. Further illustrated by Figure 2A, the first set of mooring lines 102, used on the first vessel 104, may include mooring lines 101A at a bow 201 of the first vessel 104 and mooring lines 101B at a stern 202 of the first vessel 104 at a side (port or starboard) opposite the second vessel 105. Additionally, the second set of mooring lines 103, used on the second vessel 105, may include mooring lines 101C at a bow 203 of the second vessel 105 and mooring lines 101D at a stern 204 of the second vessel 105 at a side (port or starboard) opposite the first vessel 104. It is further envisioned that the mooring lines 101A-D have one end connected to the vessels 104, 105 and a distal end of the mooring lines 101A-D is anchored. In a non-limiting example, the mooring lines 101A-D may be coupled to an anchor point (e.g., cleat or fairleads) on a hull of the vessels 104, 105. Furthermore, while the mooring lines 101A-D are shown in pairs of mooring lines, one skilled in the art will appreciate how this is only shown for examples purposes only and any number of mooring lines may be used. It is further envisioned that while the mooring lines 101A-D are shown attached to the bow and stern of the vessels 104, 105, the mooring lines 101A-D may be attached to any portion of the vessels 104, 105.

[0022] In one or more embodiments, the spring lines 106 may include a bow spring 106A and a stern spring 106B connecting adjacent sides of the vessels 104, 105. The spring lines 106A, 106B may run diagonally forward or aft from the first vessel 104 to the second vessel 105 at an angle to limit said vessel's relative fore-and-aft movement. In a non-limiting example, if one of the vessels 104, 105 tries to move astern against the stern spring 106B, the stern spring 106B will force the stern 202, 204 of said vessel 104, 105 inward and the bow 201, 203 of said vessel 104, 105 outward (or vice-versa in use of the bow spring 106A) to maintain the position of the vessels 104, 105 relative to each other. It is further envisioned that the spring lines 106A, 106B may be attached to the vessels 104, 105 at the bow 201, 203, at the stern 202, 204, or in the middle of the vessels 104, 105, at midship or spring cleats. In some

embodiments, the spring lines 106A, 106B may be made of the same materials as the plurality of mooring lines 101. Furthermore, the spring lines 106A, 106B may be the same spring lines as those used to dock the vessels 104, 105.

[0023] In Figure 2B, a front view of the SMS 100 deployed in the body of water 200 is illustrated in accordance with one or more embodiments. As the first vessel 104 and the second vessel 105 are floating within the body of water 200 at a buoyancy, a portion of the hull of said vessels' 104, 105 may be underwater. It is further envisioned that the plurality of mooring lines 101 may be affixed to fairleads on the portion of the hull of said vessels' 104, 105 below a surface 200A of the body of water 200. Further illustrated by Figure 2B, each mooring line of the plurality of mooring lines 101 may have three parts. In a non-limiting example, each mooring line may have a top portion 205 connected to the vessels 104, 105, a bottom portion 206 connect to an anchor 208 (e.g., suction pile anchor) in a seabed 200B, and a middle portion 207 connected inter-between the top portion 205 and the bottom portion 206. In some embodiments, top portion 205 is a chain line, the middle portion 207 is a polyester line, and the bottom portion 206 is a chain line. In order to maintain the position of the vessels 104, 105 in the body of water 200, each mooring line of the plurality of mooring lines 101 is in tension. In a non-limiting example, to maintain the position of the vessels 104, 105 in the body of water 200, a tension in a vertical direction T_v and in a horizontal direction T_h at the point where the mooring line (101) is coupled to the vessel (104, 105) is equal and opposite to a tension in tension in a vertical direction T_v and in a horizontal direction T_h at the point where the mooring line (101) is coupled to the anchor (208). One skilled in the art will appreciate how having one end of the mooring lines (101) coupled to the vessels (104, 105) a distal end of the mooring lines (101) coupled to the anchors (208), the SMS 100 may allow for the position of the vessels (104, 105) in the body of water 200 to be maintained for 20 or more years.

[0024] In one or more embodiments, the one or more fenders 107 extend from the hull of the vessels (104, 105). Additionally, the one or more fenders 107 may be removable or permanently fixed to the hull of the vessels (104, 105). Further, the one or more fenders 107 may be floating fenders in the body of water 200. The one or more fenders may be used to absorb energy berthing against the hull of the vessels

(104, 105) such that damage to the hull of the vessels (104, 105) may be prevented. In order to absorb energy, the one or more fenders 107 may be made from rubber, foam elastomer, plastic, or any combination thereof. It is further envisioned that the one or more fenders 107 may be chosen based most suitable for an application that depends on many variables, including dimensions and displacement of the vessels (104, 105), maximum allowable stand-off, berthing structure, tidal variations and other berth-specific conditions. In a non-limiting example, the one or more fenders 107 may be a cylindrical fender, arch fender, cell fender, cone fender, pneumatic fender, submarine hydro-pneumatic fender (“SHPF”), foam elastomer fender, D-type fender, square fender, wing fender, keyhole fender, tugboat fender, solid rubber fender, floating rubber fender, or any combination thereof. Furthermore, one skilled in the art will appreciate how the one or more fenders 107 may be designed to meet standards set in the PIANC “Guidelines for the design of fender systems,” the Japanese Industrial Standards (“JIS”), and the British Standard BS 6349-4: 2014.

[0025] Furthermore, methods of the present disclosure may include use of the split mooring system and other systems, such as in Figures 1-2B. Because the method may apply to any of the embodiments, reference numbers are not referenced to avoid confusion of the numbering between the different embodiments.

[0026] Initially, a first vessel and a second vessel are positioned in a body of water and the vessels are placed adjacent to each other. Then a plurality of mooring lines is used to fix and maintain the relative positions of the vessels in the body of water. In a non-limiting example, mooring lines are attached to the first vessel and the second vessel. For example, the mooring lines may only be attached to a side of the first vessel and the second vessel that faces open water. By attached the mooring lines to only the open water side, a side of the first vessel that faces a side of the second vessel may have no mooring lines. Further, a distal end of the mooring lines is attached to a corresponding anchor that is anchored in a seabed. Once the mooring lines have an end attached the first and second vessels and a distal end attached to corresponding anchors, the relative position of the first and second vessel is fixed and maintained in the body of water. It is further envisioned that the first vessel may be positioned and moored in the body of water first, and then the second vessel is placed adjacent to the first vessel to then be moored in said position. One skilled in the art will appreciate

how the mooring lines are split among the first vessel and the second vessel such that each vessel does not need a complete mooring system.

[0027] Next, a first end of one or more spring lines may be attached to the first vessel and a second end of the one or more spring lines may be attached to the second vessel. The one or more spring lines aid in maintaining a position of the first and second vessels relative to each other. Furthermore, the one or more spring lines may be angled from the first vessel to the second vessel to limit said vessels' fore-and-aft movement relative to each other. It is further envisioned that one or more fenders are provided on a hull on the first vessel and/or the second vessel to aid in preventing collisions between the hulls of the first and second vessels. Further, one skilled in the art will appreciate how, with the first vessel and the second vessel split moored in the body of the water, the first vessel and the second vessel may be spaced and kept at distance of less than 30 meters apart from each other in the body of the water. With the first and second vessel at the distance of less than 30 meters apart from each other, such as a distance of between 2 and 25 meters apart, or from 5 to 15 meters apart, one or more transfer hoses may be connected from the first vessel to the second vessel such that materials, such as cryogenic fluids, may be transferred between the first vessel and the second vessel.

[0028] While the present disclosure has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments may be devised which do not depart from the scope of the disclosure as described herein. Accordingly, the scope of the disclosure should be limited only by the attached claims.

CLAIMS

What is claimed is:

1. A split mooring system, the split mooring system comprising:
 - at least two vessels in a body of water; and
 - a plurality of mooring lines attached to the at least two vessels and configured to fix and maintain a position of the at least two vessels in the body of water relative to each other,wherein a first vessel of the at least two vessels is adjacent to a second vessel of the at least two vessels,
 - wherein the plurality of mooring lines is attached to sides of the first vessel and the second vessel, and
 - wherein the sides of the first vessel and the second vessel with mooring lines face open water of the body of water.
2. The split mooring system of claim 1, wherein the first vessel is a production vessel, and wherein the second vessel is a storage vessel or floating storage unit.
3. The split mooring system of claim 1, further comprising one or more spring lines having a first end attached to the first vessel and a second end attached to the second vessel, wherein the one or more spring line are configured to maintain a relative position of the first and second vessels with each other.
4. The split mooring system of claim 1, further comprising fenders attached to the first vessel and/or the second vessel, wherein the fenders are configured to prevent collisions between a body of the first vessel and a body of the second vessel.
5. The split mooring system of claim 1, wherein each mooring line of the plurality of mooring lines comprise at least one chain line and a polyester line.
6. The split mooring system of claim 5, wherein one end of the mooring line is connected to a corresponding vessel and a distal end of the mooring line is connected to an anchor.
7. The split mooring system of claim 6, wherein the anchor is a suction pile anchor disposed on a seabed of the body of water or a buoy on a surface of the body of water.

8. The split mooring system of claim 1, wherein the first vessel and second vessel are less than 30 meters apart from each other.
9. The split mooring system of claim 8, further comprises a transfer hose attached between the first vessel and the second vessel, wherein the transfer hose is configured to transfer cryogenic materials.
10. A method for split mooring at least two vessels in a body of water, the method comprising:
 - placing a first vessel of the at least two vessels adjacent to a second vessel of the at least two vessels;
 - attaching mooring lines to sides of the first vessel and the second vessel that face open water of the body of water;
 - fixing a position of the first vessel and the second vessel in the body of water with the mooring lines; and
 - maintaining the fixed position of the first vessel and the second vessel with the mooring lines.
11. The method of claim 10, further comprising:
 - attaching a first end of one or more spring lines to the first vessel;
 - attaching a second end of the one or more spring lines to the second vessel; and
 - maintaining a relative position of the first and second vessels relative to each other with the one or more spring lines.
12. The method of claim 10, further comprising:
 - providing fenders on the first vessel and/or the second vessel; and
 - preventing collisions, via the fenders, between a body of the first vessel and a body of the second vessel.
13. The method of claim 10, wherein the fixing of the position of the first vessel and the second vessel comprises attaching a distal end of each mooring line to an anchor.
14. The method of claim 13, further comprising anchoring the anchor in a seabed of the body of water.

15. The method of claim 10, further comprising keeping the first vessel and second vessel at a distance of less than 30 meters apart from each other.
16. The method of claim 15, further comprising transferring cryogenic materials between the first vessel and the second vessel via a transfer hose.
17. A system comprising:
 - a production vessel positioned a distance apart from a floating storage unit in a body of water;
 - a plurality of mooring lines attached to the production vessel and the floating storage, wherein the plurality of mooring lines is configured to fix and maintain a position of the production vessel and the floating storage in the body of water relative to each other; and
 - a transfer hose attached to a first adjacent side of the production vessel and a second adjacent side of the floating storage, wherein the transfer hose is configured to transfer cryogenic materials from the production vessel to the floating storage, wherein the first adjacent side and the second adjacent side face each other, wherein the plurality of mooring lines is attached to a first opposite side of the production vessel and a second opposite side of the floating storage, and wherein the first opposite side is opposite the first adjacent side and the second opposite side is opposite the second adjacent side.
18. The system of claim 17, further comprising one or more spring lines having a first end attached to first adjacent side of the production vessel and a second end attached to the second adjacent side of the floating storage, wherein the one or more spring line are configured to maintain a relative position of the production vessel and the floating storage with each other.
19. The system of claim 17, further comprising fenders attached to first adjacent side of the production vessel and/or the second adjacent side of the floating storage, wherein the fenders are configured to prevent collisions between the production vessel and the floating storage.
20. The system of claim 17, wherein the production vessel and the floating storage are spaced apart a distance between 5 to 25 meters.