

Title:

Cargo Transfer Vessel

Technical field:

5 The invention concerns a method and a system for transferring hydrocarbon fluid from an offshore production facility to a fluid carrying vessel.

Background and prior art:

10 Loading of fluid to tankers in open sea may be a demanding operation, in particular in harsh environment. The operation requires dedicated shuttle tankers equipped with dynamic positioning system, excessive thruster capacity and specialized loading systems. Such shuttle tankers are equipped with loading systems, normally installed in the vessel's bow, enabling the tanker to connect to a floating production facility, a loading tower or loading buoy via a loading hose, and thereby allowing transfer of the cargo to the tanker. The tanker can be moored to the production by a flexible hawser, 15 assisted by vessel's own thrusters or propellers. The tanker can alternatively be positioned by its own thruster system (Dynamic Positioning System) without any mooring hawser.

20 The most advanced system for loading tankers is the proven Submerged Turret Loading, STL, where the tankers is connected to the transfer line of cargo through the vessel's bottom by a rotating buoy moored to sea bed, as e.g. disclosed in WO 95/08469. The STL system allow operation all year round in the most exposed and harsh environment such as the North Sea and North Atlantic regions. Typically for these systems are dedicated ships with additional special designed equipment, resulting in higher investment 25 compared with conventional tankers.

In more benign areas, offshore loading with conventional tankers can be performed using moored floating buoys (Catenary Anchor Leg Moorings, CALM Buoys) moored to the seabed. See e.g. WO 2012/035354. Loading of tankers with CALM buoys are limited by the sea state, current and wind.

30 The main challenge using conventional tankers are their limited maneuvering and station keeping capabilities. Lately the Hiload concept was introduced to the market. See e.g. WO 2005/118389 A1. The Hiload is a self-contained semi submerged construction with propellers and thrusters. The unit is capable of attaching to the tanker's hull, thereby assisting the tanker's

maneuverability. The Hiload requires a dedicated support vessel to assist the Hiload in idle periods and a specialized crew when in operation.

5 A system that addresses the above disadvantages is disclosed in US 5'803'779. A loading buoy in the form of a floating hull is provided with hawser lines, propulsion means and liquid transfer means to ensure safe liquid transfer operations at a predetermined distance from the offshore structure. However, the disclosed system is considered vulnerable to environmental induced movements such as roll, in particular during liquid transfer. In addition, the suitability for use as an effective means of transport is
10 questionable.

There is therefore a need to mitigate the disadvantages with the existing systems and to further reduce the investments in extra equipment.

It is thus an object of the present invention to provide a method and a system that further improves the loading efficiency of conventional tankers, LNG
15 carriers or other ships carrying fluids in open sea.

Summary of the invention:

The present invention is set forth and characterized in the main claims, while the dependent claims describe other characteristics of the invention.

20 More specifically, the invention concerns a cargo transfer vessel for transferring fluid between an offshore production facility and a tanker. The cargo transfer vessel comprise a hull having a first and a second outer longitudinal hull side; a deck, propulsion means for actively maintaining the cargo transfer vessel at a predetermined distance from the offshore production facility and the tanker during fluid transfer operations and fluid transfer
25 means for transferring fluid between the offshore structure and the tanker. The vessel is further characterized in that the hull comprises a main hull member and at least one protruding hull member arranged below the cargo transfer vessels water line at each of the outer longitudinal hull sides for suppressing roll of the vessel, wherein the at least one protruding hull member extends at least partly along the hulls longitudinal length, i.e. from
30 the start of the vessel's bow to the end of the vessel's stern. The protruding hull member preferably extends between 10 % and 90 % of the longitudinal length, more preferably between 20 % and 80 % of the longitudinal length, even more preferably between 30 % and 70 % of the longitudinal length, even

more preferably between 40 % and 60 % of the longitudinal length, for example about 50 %.

In an advantageous embodiment the extension of the at least one protruding hull member includes the hulls longitudinal midpoint.

- 5 In another advantageous embodiment at least one longitudinal section of the at least one protruding hull member extends beyond the lateral boundaries of the cargo transfer vessel's deck, i.e. beyond the outer edge of the deck situated parallel to the water after submersion. In an alternative formulation at least one longitudinal section of the at least one protruding hull member
10 extends beyond a vertical projection of the portion of the vessel situated above the water line.

- In another advantageous embodiment the outermost horizontal projection of one or both end sections of at least one of the at least one protruding hull member defines a resistance reducing arc curving towards the hull's vertical
15 center plane, thus reducing the vessel's propulsion resistance. The ends of the protrusion are defined as the ends situated at the most forward and the most rearward part of the protrusion. Furthermore, an end section may be defined as an entire longitudinal half of a protrusion. However, in a more preferred definition the end section is defined as covering only a part of each
20 longitudinal half, such as 40 % of the longitudinal half measured from the outer longitudinal end. Other examples of end section lengths may be 30 %, 20 %, 10 % or 5 %.

- In another advantageous embodiment the outermost horizontal projection of both end sections of at least one of the at least one protruding hull member
25 defines a resistance reducing arc curving towards the hull's vertical center plane, wherein the length of the resistance reducing arc at one end section is shorter than the length of the resistance reducing arc at the opposite end section. The resistance reducing arc with the shorter length may be situated closest to the bow of the cargo transfer vessel.

- 30 In another advantageous embodiment at least one of the resistance reducing arc(s) terminates at a termination point situated at the surface of the main hull member.

- In another advantageous embodiment the inclination angle of at least part of the at least one protruding hull member, relative to the horizontal plane, is
35 between 0° and 10°. The at least part of the at least one protruding hull

member may for example be the part situated between of the protrusion ends. Furthermore, one or both of the protrusion ends may have an inclination angle exceeding 10° relative to the horizontal plane. The horizontal plane is defined as the plane oriented parallel to the water surface after vessel submersion.

- 5 In another advantageous embodiment the main part of the cargo transfer vessel's bottom is flat.

In another advantageous embodiment the fluid transfer means comprises a loading arrangement, preferably situated at the bow part of the vessel, for receiving fluid from the offshore structure comprising a loading manifold
10 configured to be connected to an end of at least one production facility loading hose, a discharge arrangement, preferably situated at the stern part or midship part of the vessel, for discharging fluid to the tanker, comprising at least one vessel discharge hose and a fluid coupling system situated in the cargo transfer vessel forming a fluid communicating coupling between the
15 loading arrangement and the discharge arrangement.

The invention also concerns a method for transferring hydrocarbon containing fluid from an offshore production facility to a tanker via a cargo transfer vessel. The vessel comprises a floating hull having a first and a second outer longitudinal side, a deck, a loading arrangement for receiving fluid from the
20 offshore structure including a loading manifold, a discharge arrangement for transferring fluid to the tanker including at least one vessel discharge hose, and a fluid coupling system situated in the cargo transfer vessel forming a fluid communicating coupling between the loading arrangement and the discharge arrangement.

- 25 The method comprises the following steps:
- a. transferring an end of the vessel discharge hose from the cargo transfer vessel to the tanker manifold,
 - b. connecting the end of the vessel discharge hose to the tanker manifold, allowing the fluid to flow from the cargo transfer vessel to a fluid tank
30 within the tanker,
 - c. moving the cargo transfer vessel to a position where at least one production facility loading hose may be transferred between the offshore production facility and the cargo transfer vessel, for example by means of a production facility messenger line,
 - 35 d. connecting the at least one production facility loading hose to the loading arrangement and

- e. transferring desired amount of fluid between the offshore production facility and the tanker via the at least one production facility loading hose, the loading arrangement, the fluid coupling system and the discharge arrangement.

5 The floating hull may advantageously display at least one roll suppressing protrusion arranged below the cargo transfer vessels water line. Further, the production facility loading hose may be situated on the offshore production facility, on the cargo transfer vessel or a combination of both.

In an advantageous embodiment the method comprises the additional step of

- 10 - connecting at least one tanker hawser between the cargo transfer vessel and a first end of the tanker prior to step a.

In another advantageous embodiment step a comprises the additional steps of

- transferring the end of the at least one vessel discharge hose to an assisting tug and
- 15 - moving the assisting tug with the end of the vessel discharge hose to a position where the end of the vessel discharge hose may be connected to the tanker manifold.

In another advantageous embodiment step a comprises the additional step of

- picking up and pulling at least one messenger line connected to the end
- 20 of the at least one vessel discharge hose in order to facilitate the hose transfer.

In another advantageous embodiment the method comprises the additional step of

- moving an assisting tug to a second end of the tanker,
- 25 - connecting a tug towing hawser between the assisting tug and the second end of the tanker and
- adding a pulling force on the second end of the tanker by means of the assisting tug, the pulling force being directed away from the offshore production facility.

30 In another advantageous embodiment the method comprises the additional step of

- connecting at least one production facility hawser between the offshore production facility and the cargo transfer vessel after step c.

The hawser may for example be stored on the production facility.

In another advantageous embodiment the method comprises the additional step of

- controlling the position of the cargo transfer vessel by means of dynamic positioning means.

5 In another advantageous embodiment the method comprises the additional step of

- controlling the flow rate between the offshore production facility and the tanker by means of at least one booster pump during step e.

10 In another advantageous embodiment the cargo transfer vessel is in accordance with any one of features mentioned previously.

The invention also concerns a transfer arrangement for transferring hydrocarbon containing fluid from an offshore production facility to a tanker. The transfer arrangement comprises an offshore production facility for producing hydrocarbons, a tanker for receiving and storing hydrocarbons and
15 a transfer vessel in accordance with any of the features mentioned previously. The transfer arrangement may advantageously also comprise an assisting tug suitable for transferring an end of at least one vessel discharge hose from the cargo transfer vessel to the tanker manifold on the tanker and/or suitable for adding a pulling force on the second end of the tanker, the pulling force being
20 directed away from the offshore production facility, and at least one production facility loading hose suitable for connection between the offshore production facility and the cargo transfer vessel.

Normally a conventional tanker is requiring assistance from tugs and transfer vessels. As apparent from the above description and the claims, the invention
25 offers a solution in which the transfer vessels include equipment allowing a tanker to approach and unload a floating production unit or terminal. Preferably the transfer vessel should be equipped with a dynamic positioning system (DP) allowing the transfer vessel to keep the position relative to the floating production terminal while the tanker weathervanes from the stern of
30 the transfer vessel.

In the following description, numerous specific details are introduced to provide a thorough understanding of embodiments of the claimed vessel and method. One skilled in the relevant art, however, will recognize that these
35 embodiments can be practiced without one or more of the specific details, or with other components, systems, etc. In other instances, well-known

structures or operations are not shown, or are not described in detail, to avoid obscuring aspects of the disclosed embodiments.

Brief description of the drawings:

5 Preferred embodiments of the present invention will now be described with reference to the attached drawings, in which:

Figure 1 shows a perspective view of a cargo transfer vessel with a bow part in accordance with a first embodiment of the invention,

Figure 2 shows a perspective view of the bow part of the cargo transfer vessel in figure 1,

10 Figure 3 shows a perspective view of a cargo transfer vessel with a bow part in accordance with a second embodiment of the invention,

Figures 4 and 5 show perspective views from two different angles of the bow part of the cargo transfer vessel in figure 3,

15 Figures 6A and 6B show side views of a cargo transfer vessel in accordance with the invention, viewed perpendicular and parallel to the vessels longitudinal axis, respectively,

Figure 7 shows a top view of a cargo transfer vessel with a reel-based offloading system in accordance with a first embodiment of the invention,

20 Figure 8 shows top views of the stern part of a reel-based offloading system in accordance a first embodiment of the invention, in which figure 8A and figure 8B shows the spooling device of the offloading system in two different spooling positions relative to an offloading hose drum,

25 Figure 9 shows perspective views of the stern part of a cargo transfer vessel with a reel-based offloading system in accordance with the first embodiment of the invention, in which figure 9A and figure 9B shows arrangements with a vessel discharge hose reeled onto, and unreeled from, the offloading hose drum, respectively,

30 Figure 10 shows a side view of the stern part of a cargo transfer vessel with a reel-based offloading system in accordance with the first embodiment of the invention,

Figure 11 shows a top view of the stern part of a cargo transfer vessel in accordance with a second embodiment of the invention,

Figures 12-16 show principle top view sketches of the intermediate steps in a method for the transfer of hydrocarbon fluid from an offshore production facility and the fluid carrying vessel via a dedicated cargo transfer vessel in accordance with the invention and

Figures 17 and 18 show principle sketches in top view and side view, respectively, illustrating the inventive transfer system in a fully assembled transfer mode.

10 Detailed description of the invention

Figures 1 and 2 shows a cargo transfer vessel 8 in accordance with the invention, hereinafter referred to as a CTV, for assisting the offloading and transfer of fluid from an offshore production facility 1 to a fluid carrying vessel 2 (shown in figures 12-18). Examples of offshore production facilities 1 may be a floating production storage and offloading unit (FPSO), a floating storage and offloading unit (FSO) or a floating liquefied natural gas unit (FLNG). Examples of fluid carrying vessels 2 may be a conventional tanker or a LNG carrier. As best illustrated in figure 2 the bow part 8a of the CTV 8 is equipped with a loading arrangement 7 having a loading manifold 7a configured to connect an end of a production facility loading hose 10 (such as a standard dry break loading hose end piece) into fluid communication with an onboard fluid coupling system 16. The loading arrangement 7 also includes a loading crane (not shown) to inter alia facilitate said connection. The loading manifold 7a may have a quick disconnect function. Other equipment of the loading arrangement 7 may be a combined line-handling winch 7c suited for pull-in and connection of loading hoses 10, a back-up connection for direct connect of a back-up loading hose (i.e. a fixed flange with an integrated double valve for safe disconnection without oil-spill), sheaves etc. for pull-in of the back-up loading hose, valves and cargo pipes 109 for safe operation and transfer of oil, service cranes located adjacent of the bow part 8a for equipment handling and service, and anchor winches with chain lockers.

One or more optional second loading arrangements 107 may be positioned at the side(s) of the CTV 8, preferably aft of the CTV's living quarter 108, as illustrated in figures 1 and 2. If the roll motion of the CTV 8 is sufficiently

small (see below), loading of fluid at the side of the CTV 8 represents a robust and safe loading method for a floating loading hose 10. It may also be a catenary type loading hose 10 used as an alternative, or an addition, to the bow loading arrangement 7.

- 5 Figures 3-5 show a CTV 8 which is similar in design and function as the CTV 8 disclosed with reference to figures 1 and 2. However, in contrast to the previously disclosed CTV 8 the loading manifold(s) 107a of the side loading arrangement 107 is/are located solely at the side(s) of the CTV 8, i.e. not at the bow part 8a, thereby providing a less complex and less expensive solution. As for the first embodiment the side loading arrangement 107 may also include a dedicated service crane 107b.

- 15 In the above figures a protrusion 13 is seen extending along part of the CTV's 8 longitudinal length at each side 20a, 20b of the hull 20. The principal purpose of these protrusions 13 is to suppress roll of the CTV 8 due to environmental forces (waves, wind, current, etc). Extensive tests have shown that these protrusions 13 are effectively suppressing rolling motions down to levels considered acceptable in order to perform fluid transfer at wind sea exposure of at least 5 meters significant wave height, even during side loading to the CTV 8.

- 20 These protrusions are better illustrated in figure 6, presenting two side views of the CTV 8;
- perpendicular to the CTV's longitudinal axis (figure 6A) and
 - along the longitudinal axis, as viewed from the bow side (figure 6B).

- 25 The side loading arrangement(s) 107 is/are identical to the side loading arrangements 107 shown in figures 3-5. Figure 6A shows an example where the entire length of the protrusion 13 is situated below the water line 14, and extends from at least near the CTV's bow part 8a (approximately at the bow side end of the living quarter 108) to the CTV's stern part 8b. Moreover, the protrusion 13 curves in direction towards the water line 14 at both the bow end section 13a and the stern end section 13b in order to minimize the propulsion resistance during forward thrust. In particular, figure 6a shows an example where the mid part of the protrusion 13 follows at, or near, the base of the illustrated flat-bottom hull (figure 6B). Further, the stern end section 13b curves fully up to the water line 14, above the vessels main thrusters 12, and the bow end section 13a curves partly up to the water line 14, aft of a bow-part situated DP thruster 12a. The particular bending radii in respect of
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- 35

the mid, non-bending part of the protrusion 13 and in respect of the water line 14, may be set based on computer simulations and/or model experiments. The protrusion 13 shown in figures 6A and 6B is mirrored on both sides of the vessel's 8 outer longitudinal hull sides 20a,20b. The mirroring of the protrusions 13 on both hull sides 20a,20b is most apparent in figure 7 where the entire CTV 8 is shown in top view. Figure 7 also clearly shows the side loading arrangement 107 situated at both sides of the CTV 8 and the reel-based offloading system 6 situated at the stern part 8b.

The discharge arrangement 5 shown in figures 8A and 8B for discharge of fluid from the CTV 8 to the tanker 2 is preferably similar to the standard arrangement used for loading from floating production and storage units 1 to shuttle tankers or conventional tankers. The equipment on board the CTV 8 is in figure 8 shown as a standard Stern Discharge System (SDS) 5 which includes a reel-based offloading system 6 having inter alia a spooling device 6a, an discharge hose drum 6b and a mooring hawser arrangement 6c. The hose drum 6b may be lowered into a recess 20c of the hull 20 to ensure efficient operation and maintenance. Draining of the recess 20c may be made directly to a slop tank (not shown). Access to the lower section of the drum 6b is preferably achieved from a position down in the recess 20c. Further, the mooring hawser arrangement 6c may be placed aft on the main deck 30 and include a plurality of tanker hawsers 4. The spooling device 6a is in figure 8 illustrated as an inclined (see figure 10) loading hose support structure (chute), which longitudinal end situated closest to the drum 6b may be shifted along the drum's axial extension, thereby ensuring even spooling. The spooling device 6a presented in figure 6 achieves the axial shifting of its end by controlled pivoting around the opposite end.

Figure 9A and 9B shows the vessel discharge hose 5a in an at least partly reeled and a fully unreeled state, respectively. In the reeled state, the pivotable spooling device 6a, which is configured to cover the full axial distance of the drum 6b, is in figure 9A seen arranged with its end in an axial mid position relative to the drum 6b. In the unreeled state the spooling device 6a is arranged with its end in a leftmost axial position relative to the drum 6b. The discharge hose 5a may comprise a main section and one or more second sections, in which the main section is a large diameter hose string made up of interconnected hose segments and the second section(s) are made of smaller diameter hose segments which are tailored for connection to a midship

manifold 3 of the tanker 2. The second section(s) and the main section would in this embodiment be connected by transition piece(s).

In addition to tanker hawsers 4, the mooring hawser arrangement 6c may comprise a chafing chain, a thimble and a messenger line. The tanker hawser
5 4 may be a super-line or double braid nylon hawser with soft eyes in both ends.

Figure 10 shows a cross section side view along the stern part 8a of the CTV 8, illustrating offloading system 6 and the main thruster 12. The recess 20c surrounding the lowered hose drum 6b is clearly seen.

10 The arrangement with the lowered hose drum 6b and the spooling device 6a for the discharge hose 5a also enables an efficient disconnection and replacement of a damaged hose section, preferably by use of a dedicated discharge hose crane 110 (see e.g. figure 9).

15 A reel-based offloading system 6 having an alternative spooling device 6a is illustrated in figure 11. In this embodiment the spooling device 6a is fixed relative to the underlying deck 30 and the vessel discharge hose 5a slides onto the support surface during reeling / unreeling, covering an axial distance corresponding to the drum's 6b axial length.

20 The operation of the inventive transfer arrangement may be described in the following steps (not necessarily in sequence), with reference to figures 12-18:

1. (Figure 12) The CTV 8 is transferring one or more tanker hawsers 4 to a mooring connection (e.g. Smith bracket(s)) in the bow part 17 of the tanker 2.
2. (Figure 13) After the tanker hawser(s) 4 is/are connected, the CTV 8
25 moves to a "towing" position. At the same time, or afterwards, one or more pick-up and messenger lines connected to vessel discharge hose(s) 5a is/are transferred to an assisting tug 15. During the transfer the discharge hose(s) 5a is/are at least partly reeled to a discharge hose drum 6b on the CTV 8
3. (Figure 14) The tug 15 pulls the end of the discharge hose 5a to a position
30 close to a tanker manifold 3, and transfer the pick-up and messenger line(s) to the tanker 2. The tanker manifold 3 is normally situated midship of the tanker 2.

4. (Figure 15) After the pick up and messenger line(s) is/are transferred to the tanker 2, the tug 15 moves to the stern 18 of the tanker 2 and connects a tug hawser 19 to the tanker 2. The tug 15 then moves to a position where it may start adding a constant force to the tanker 2. The tug 15 will operate according to instructions given by the operator in charge located in the CTV 8 and/or the tanker 2.
5. (Figure 15) After the tug 15 is connected stern 18 of the tanker 2, the tanker 2 may shut off the main engine and the CTV 8 starts moving towards the offshore production facility 1. The hook-up of the vessel discharge hose 5a to the tanker manifold 3 of the tanker 2 may continue during the move towards the facility 1. Further, the hook-up of the discharge hose 5a may be made by use of a standard crane on the tanker 2. The tanker 2 is lifting up the end(s) of the discharge hose(s) 5a and connects the discharge hose(s) to the tanker manifold 3.
6. (Figures 16 and 17) The CTV 8 and then tanker 2 are moving into a position where the CTV 8 can receive a production facility messenger line 9 from and offloading station on the offshore production facility 1.
7. (Figures 17 and 18) Keeping the CTV 8 positioned by a DP system 12,12a, the production facility loading hose 10 is pulled over from the offloading station 11 and connected to the loading arrangement 7,107 on the CTV 8.
8. (Figures 17 and 18) With all connections made, the offloading and transfer operation may start.
9. When a constant or near constant flow is reached one or more booster pumps may be started to increase the transfer rate. The booster pump(s) is/are preferably equipped with a variable speed motor to allow a good control of the flow rate.
10. After completing the transfer operation the cargo pumps are stopped. The production facility loading hose(s) 10 is/are then flushed with liquid (e.g. water) and/or purged with nitrogen and/or inert gas from the production facility 1 side.
11. When the flushing and/or the purge is completed, the loading hose(s) 10 from the production facility 1 is/are disconnected and the CTV 8 and the tanker 2 moves away from the production facility 1.

12. When reading a “safe” distance from the production facility 1 the disconnection of the vessel discharge hose(s) 5a on the tanker 2 can be made.
13. The discharge hose(s) 5a is/are then reeled back to the discharge hose drum 6b at the CTV 8.
14. The main engine of the tanker 2 is started and the tanker hawser(s) 4 between the tanker 2 and the CTV 8 is/are disconnected from the tanker 2.
15. The tanker 2 starts moving and the tug 15 is disconnected from the tanker stern 18.
- 10 The function of the tug 15 may be partly or fully replaced by dynamic position means 12,12a on the CTV 8 and/or the tanker 2.
- The loading and transfer operation undertaken by use of the CTV 8 has additional safety features, both related to the use of well proven loading arrangement and the introduction of additional safety distances between the
- 15 offshore production facility 1 and the receiving tanker 2.
- The offloading arrangement for transfer of fluid between the offshore production facility 1 and the CTV 8 may be a conventional offshore loading system that has been in operation both in the North Sea and in Brazil for several decades.
- 20 The discharge arrangement for discharge of fluid between the CTV 8 and the tanker 2 may preferably be similar to the standard arrangement used for loading to trading tankers from “Calm Buoys”. This system has been in operation for a long period e.g. at offshore production units in West Africa.
- When combining the offloading arrangement and the discharge arrangement
- 25 the distance between the offshore production facility 1 and the tanker 2 is significantly increased compared to the standard tanker connection. The increased distance between the two units 1,2 is an important safety feature.
- The inventive roll suppressing means in form of protrusions 13 from the vessel’s hull 20 further increase the safety and simplicity of the fluid transfer and in addition contribute to set an optimum heading and position of the CTV
- 30 8 in order to reduce the tensions and motions in the tanker hawser 4. The transfer system may be used for offloading from “spread” moored offshore floating units and from “turret” moored offshore units. The system may also

be considered for offloading from “fixed” unit (unit fixed to the seabed) having an offshore storage facility, e.g. a submerged oil storage tank.

5 In the preceding description, various aspects of the vessel, the method and the transfer arrangement according to the invention have been described with reference to the illustrative embodiment. For purposes of explanation, specific numbers, systems and configurations were set forth in order to provide a thorough understanding of the invention and its workings. However, this description is not intended to be construed in a limiting sense. Various
10 modifications and variations of the illustrative embodiment, as well as other embodiments of the vessel, method or arrangement, which are apparent to persons skilled in the art to which the disclosed subject matter pertains, are deemed to lie within the scope of the present invention.

Reference list:

- 1 Offshore production facility
- 2 Tanker / fluid carrying vessel
- 3 Tanker manifold
- 4 Tanker hawser
- 5 Discharge arrangement / Stern Discharge System (SDS)
- 5a Vessel discharge hose
- 6 Reel-based offloading system
- 6a Spooling device / loading hose support structure
- 6b Discharge hose drum
- 6c Mooring hawser arrangement
- 7 Loading arrangement
- 7a Loading manifold
- 7c Line-handling winch
- 8 Cargo transfer vessel / CTV
- 8a Bow part of transfer vessel
- 8b Stern part of transfer vessel
- 9 Production facility messenger line
- 10 Production facility loading hose
- 11 Offshore production facility offloading station
- 12 Propulsion means / main thruster / stern DP system
- 12a Bow dynamic positioning means / Bow DP thruster / Bow DP system
- 13 Protruding hull member / Roll suppressing protrusion
- 13a First end section of protruding hull member / bow end section

- 13b Second end section of protruding hull member / stern end section
- 14 Water line
- 15 Assisting tug
- 16 Fluid coupling system
- 17 First end of tanker / tanker bow
- 18 Second end of tanker / tanker stern
- 19 Tug hawser / tug towing hawser
- 20 Cargo transfer vessel hull
- 20a First outer longitudinal hull side
- 20b Second outer longitudinal hull side
- 20c Recess in hull
- 21 Cargo transfer vessel messenger line
- 30 Cargo transfer vessel deck
- 107 Second loading arrangement / side loading arrangement
- 107a Loading manifold
- 107b Service crane
- 108 Living quarter
- 109 Cargo pipe
- 110 Discharge hose crane

CLAIMS

1. A transfer vessel (8) for transferring fluid between an offshore production facility (1) and a tanker (2), comprising
- a transfer vessel hull (20,13) having a first (20a) and a second (20b) outer longitudinal hull side;
 - a transfer vessel deck (30);
 - propulsion means (12,12a) for actively maintaining the transfer vessel (8) at a predetermined distance from the offshore production facility (1) and the tanker (2) during fluid transfer operations; and
 - fluid transfer means (5,7) for transferring fluid between the offshore structure (1) and the tanker (2),
- characterized in that** the hull (20) further comprises
- a main hull member (20) and
 - at least one protruding hull member (13) arranged below the transfer vessels (8) water line (14) at each of the outer longitudinal hull sides (20a,20b) for suppressing roll of the vessel (8),
- wherein the at least one protruding hull member (13) extends at least partly along the hulls (20) longitudinal length.
2. The transfer vessel (8) in accordance with claim 1, **characterized in that** the extension of the at least one protruding hull member (13) includes the hulls (20) longitudinal midpoint.
3. The transfer vessel (8) in accordance with claim 1 or 2, **characterized in that** at least one longitudinal section of the at least one protruding hull member (13) extends beyond the lateral boundaries of the transfer vessel's (8) deck (30).
4. The transfer vessel (8) in accordance with any one of the preceding claims, **characterized in that** the outermost horizontal projection of one or both end sections (13a,13b) of at least one of the at least one protruding hull member (13) defines a resistance reducing arc curving towards the hull's (20) vertical center plane .
5. The transfer vessel (8) in accordance with any one of the preceding claims, **characterized in that** the outermost horizontal projection of both end sections (13a,13b) of at least one of the at least one protruding hull member (13) defines a resistance reducing arc curving towards the hull's (20) vertical center plane,

wherein the length of the resistance reducing arc at one end section (13a) is shorter than the length of the resistance reducing arc at the opposite end section (13b).

- 5 6. The transfer vessel (8) in accordance with claim 5, **characterized in that** the resistance reducing arc with the shorter length is situated closest to the bow (8a) of the transfer vessel (8).
- 10 7. The transfer vessel (8) in accordance with any one of claims 4 to 6, **characterized in that** at least one of the resistance reducing arcs terminates at a termination point situated at the surface of the main hull member (20).
8. The transfer vessel (8) in accordance with any one of the preceding claims, **characterized in that** the main part of the transfer vessel's (8) bottom is flat.
- 15 9. The transfer vessel (8) in accordance with any one of the preceding claims, **characterized in that** said fluid transfer means (5,7), comprises
- a loading arrangement (7) for receiving fluid from the offshore production facility (1) comprising a loading manifold (7a) configured to be connected to an end of at least one production facility loading
- 20 hose (10),
- a discharge arrangement (5,6) for discharging fluid to the tanker (2) comprising at least one vessel discharge hose (5a) and
- a fluid coupling system (16) situated in the transfer vessel (8) forming a fluid communicating coupling between the loading
- 25 arrangement (7) and the discharge arrangement (5,6).
- 10.A method for transferring hydrocarbon containing fluid from an offshore production facility (1) to a tanker (2) via a transfer vessel (8) comprising
- a floating hull (20) having a first (20a) and a second (20b) outer
- 30 longitudinal side, wherein the floating hull (20) displays at least one roll suppressing protrusion (13) arranged below the transfer vessels (8) water line (14),
- a deck (30),
- a loading arrangement (7) for receiving fluid from the offshore
- 35 structure (1),

a discharge arrangement (5,6) for transferring fluid to the tanker (2) comprising at least one vessel discharge hose (5a), and

a fluid coupling system (16) situated in the transfer vessel (8) forming a fluid communicating coupling between the loading arrangement (7) and the discharge arrangement (5),
5 wherein the method comprises the following steps:

- a. transferring an end of the vessel discharge hose (5a) from the transfer vessel (8) to a tanker manifold (3),
- 10 b. connecting the end of the vessel discharge hose (5a) to the tanker manifold (3) allowing the fluid to flow from the transfer vessel (8) to a fluid tank within the tanker (2),
- c. moving the transfer vessel (8) to a position where at least one production facility loading hose (10) may be transferred between the offshore production facility (1) and the transfer vessel (8),
- 15 d. connecting the at least one production facility loading hose (10) to the loading arrangement (7) and
- e. transferring desired amount of fluid between the offshore production facility (1) and the tanker (2) via the at least one production facility loading hose (10), the loading arrangement (7), the fluid coupling system (16) and the discharge arrangement (5,5a,6).
- 20

11. The method in accordance with claim 10, **characterized in that** the method comprises the additional step of

connecting at least one tanker hawser (4) between the transfer vessel (8) and a first end (17) of the tanker (2) prior to step a.
25

12. The method in accordance with claim 10 or 11, **characterized in that** step a comprises the additional steps of

transferring the end of the at least one vessel discharge hose (5a) to an assisting tug (15) and

30 moving the assisting tug (15) with the end of the vessel discharge hose (5a) to a position where the end of the vessel discharge hose (5a) may be connected to the tanker manifold (3).

13. The method in accordance with any one of claims 10 to 12, **characterized in that** step a comprises the additional step of

35 picking up and pulling at least one messenger line connected to the end of the at least one vessel discharge hose (5).

14. The method in accordance with any one of claims 10 to 13, **characterized in that** the method comprises the additional step of
moving an assisting tug (15) to a second end (18) of the tanker (2),
connecting a tug towing hawser (19) between the assisting tug (15)
5 and the second end (18) of the tanker (2) and
adding a pulling force on the second end (18) of the tanker (2) by
means of the assisting tug (15), the pulling force being directed away
from the offshore production facility (1).
15. The method in accordance with any one of claims 10 to 14,
10 **characterized in that** the method comprises the additional step of
connecting at least one production facility messenger line (9)
between the offshore production facility (1) and the transfer vessel
(8) after step c.
16. The method in accordance with any one of claims 10 to 15,
15 **characterized in that** the method comprises the additional step of
controlling the position of the transfer vessel (8) by means of
dynamic positioning means (12,12a).
17. The method in accordance with any one of claims 10 to 16,
20 **characterized in that** the method comprises the additional step of
controlling the flow rate between the offshore production facility
(1) and the tanker (2) by means of at least one booster pump during
step e.
18. The method in accordance with any one of claims 10 to 17,
25 **characterized in that** the transfer vessel (8) is in accordance with any
one of claims 1 to 9.
19. A transfer arrangement comprising an offshore production facility (1)
for producing hydrocarbons, at least one production facility loading
hose (10) situated on the offshore production facility (1), a tanker (2)
for receiving and storing hydrocarbons and a transfer vessel (8) in
30 accordance with any one of claims 1 to 9.
20. The transfer arrangement in accordance with claim 19, **characterized in that** the transfer arrangement further comprises an assisting tug (15)
for transferring an end of at least one vessel discharge hose (5a) from
the transfer vessel (8) to the tanker manifold (3) on a tanker (2).