VESSEL AND UNLOADING SYSTEM

Inventors: Rolf Emblem, Oslo (NO); Oystein Bruno, Drammen (NO)

Correspondence Address:
BROWDY AND NEIMARK, PLLC.
624 NINTH STREET, NW
SUITE 300
WASHINGTON, DC 20001-5303 (US)

Assignee: Leif Hoegh & Co. ASA, Oslo (NO)

Appl. No.: 09/859,725

Filed: May 18, 2001

ABSTRACT

A system and method for transferring fluid from a vessel to a shore-based facility, the system including at least one vessel and at least one coupling structure which is established at an unloading location. The vessels travel in continuous shuttle traffic between a loading station and the coupling structure and are organised such that at least one of the vessels is periodically connected to one of the coupling structures so that the fluid is conveyed from each vessel through the coupling structure and directly ashore via a pipeline system for further distribution of the fluid. Vessels are provided with storage tanks for storing natural gas in its liquid state, a vaporizer for regasifying the liquefied natural gas on arrival at the unloading point and equipment for connection to the coupling structure for transferring natural gas from the vessel to a submerged pipeline system.
Fig. 3

Vessel no.

1 Vessel 1
2 Vessel 2
1 Vessel 3
2 Vessel 4

Buoy no.

Loading LNG at Supply Source

Regasifying operation at submerged turret buoy direct to pipeline

Voyage
VEssel And UNLOADING SYSTEM

Background of the invention

0001. The invention relates to a special vessel together with a system and method for unloading fluid from the vessel to a shore-based infrastructure.

0002. In connection with the transport of fluid such as natural gas from offshore wells to the area in which the natural gas has to be unloaded, a system is often employed involving a number of special vessels and a series of fairly complicated operational steps. A known vessel which is commonly employed for this purpose is an LNG carrier, which is equipped with special tanks suitable for storing natural gas in its liquid state. When loading on board the LNG carrier in the field, at least one additional vessel is often employed for receiving fluid directly from the wells and treating the fluid before it is transferred to the LNG carrier. According to common practice, on arrival at the unloading point the LNG carrier will transfer the load to an intermediate storage unit where the liquefied natural gas is converted to a gaseous state before being transferred to the end user.

0003. These systems, requiring the use of several different special vessels and the performance of related complicated operations, are shown to be complex and extremely costly.

0004. The following special vessels and systems are known from the patent literature:

0005. In U.S. Pat. No. 6,089,022 an unloading system is described involving an LNG carrier which is equipped with spherical tanks for storing liquefied natural gas (LNG) and vaporizers for regasifying the liquefied natural gas. On arrival at the unloading point, the carrier is moored in such a manner that the vessel is located at a distance from the mooring structure by mooring lines which extend from the bow area to the mooring structure. The liquefied natural gas is regasified before being transported in a pipeline system which transfers the natural gas from the carrier to a shore-based installation which in the publication represents the end user.

0006. In the arrangement disclosed in U.S. Pat. No. 6,089,022, a single pipeline is employed for unloading the natural gas from the vessel to shore. In FIG. 1 of that patent, this pipeline is illustrated arranged in such a manner that it extends from the bow area, through the mooring structure, from where there is provided yet another pipeline which transfers the natural gas to shore. In the publication there is no indication of any possibility of using a buoy structure or alternative technical solutions, which can be mounted in the vessel’s hull for unloading natural gas or a transfer structure or alternative technical solutions which can be attached to a structure projecting from the vessel’s bow area.

0007. U.S. Pat. No. 5,564,957 discloses a vessel in which a buoy structure is provided for installation in a recess in the bow portion. The buoy structure is intended for use as a combined mooring and transfer structure for transport of a liquid medium to and from the vessel.

0008. In U.S. Pat. No. 6,094,937, a processing plant is described for converting natural gas to a liquid state (LNG) and a shuttle system for transporting LNG from the field. In this shuttle system, two buoys and four carriers may be employed for transporting LNG in order to maintain almost continuous production in the field.

0009. The existing technical solutions disclosed in these known publications demonstrate an inadequacy in relation to the complex requirements, which is eliminated or reduced by the present invention.

Brief summary of the invention

0010. It is an object of the present invention to reduce the number of special vessels which must be included in such a system, and to improve the characteristics of these special vessels in relation to the operations which have to be carried out.

0011. A more specific object of the present invention to provide a system for unloading fluid, and especially natural gas, wherein the carrier vessel has storage tanks as well as a vaporizer on board, and is arranged to receive a coupling structure, which may be a buoy structure which has both a mooring function and a transfer function, or a transfer structure that can be connected to a receiving structure that projects from the vessel’s bow area.

0012. It is a further object of the present invention that the vessel with its special functions should be able to form part of a shuttle system which in a preferred embodiment includes a plurality of vessels and a plurality of the coupling structures concerned. The object of this system is to achieve the continuous supply of natural gas from the unloading point to the infrastructure.

0013. The technical solution according to the present invention makes use of a coupling structure, which may be a submerged buoy structure which has to be brought into abutment in a recess in the vessel’s hull, or a transfer structure which has to be brought into abutment with a portion projecting from the vessel’s bow, for transferring natural gas to shore. In contrast to the technique disclosed in U.S. Pat. No. 6,089,022, the coupling structure offers a substantially simplified solution which provides advantages both with regard to manning and the equipment situation, since mooring and fluid transfer are implemented by means of one and the same structure.

0014. The technique disclosed in U.S. Pat. No. 5,564,957 differs from the invention in that there is no vaporizer provided on board the vessel disclosed in that patent, nor is there any indication in that patent that the medium has to be transferred directly to a shore-based installation.

0015. A basic difference between the present invention and the system disclosed in U.S. Pat. No. 6,094,937 is that the system disclosed in the patent is used in connection with loading, while the system according to the invention has to be used for unloading. This is manifested by the fact that a liquefier is provided on board the carrier in U.S. Pat. No. 6,094,937, while a vaporizer is provided in the LNG tanker according to the invention. In U.S. Pat. No. 6,094,937 there is no suggestion that this loading/transport system will be capable of use in connection with unloading. Nor is there a vessel like that disclosed in U.S. Pat. No. 6,094,937 able to be used for unloading natural gas to a shore-based infrastructure without the need for considerable structural modifications to the vessel.
With the vessel according to the invention, a number of the operations required when using the previously known systems are made superfluous. Specifically, a number of the operations associated with mooring, connection of pipelines, transfer of liquid cargo from one vessel to another will be made superfluous and/or simplified. In addition, when using the system according to the invention the number of crew members needed will be reduced, and thereby also the operating costs, due to the fact that both the number of operations performed becomes less and more functions are concentrated on one vessel.

The design and production of a multi-functional vessel of this kind can be an extremely costly and time-consuming process. It is therefore another object of the present invention to enable the vessel to be built in a cost-effective manner, thus enabling the vessel to be offered at a competitive price.

In preferred embodiments of the invention the vessel is provided in a simple and inexpensive manner using a standard LNG carrier as the basis. The carrier with its storage tanks for liquefied natural gas is equipped with one or more vaporizers preferably in the deck area. According to one preferred embodiment of the invention, the vessel has a downwardly opening receiving recess formed in the hull for receiving the buoy structure. According to a second preferred embodiment of the invention, a receiving device is built in the bow area for receiving the transfer structure. Both embodiments make the vessel suitable for performing several types of operation. This special vessel is described as a “Shuttle and Regas Vessel (SRV)”, and the vessel may of course also be used as an ordinary LNG carrier.

In preferred embodiments, the vessel according to the invention is equipped with spherical tanks for storing liquefied natural gas, but other types of storage tanks may also be suitable, such as, for example, membrane tanks. These different types of storage tanks are well-known from the patent literature and are in practical use. A person skilled in the art will be able to select the type of tank which is most suitable in an individual case.

The principles and equipment to be used in connection with the regasification of the liquefied natural gas also represent known per se technology. Sea water may be utilized as a heat exchange medium in the vaporization process, but also other media such as, for example, propane either alone or together with sea water, and a water-glycol mixture may be suitable vaporization media.

The buoy structure which is to form part of the system may be designed in many ways. From the patent literature, including patents cited above, several examples are known of submerged buoy structures which can be connected to a vessel, thus enabling the vessel to rotate freely around the buoy. However, with regard to the buoy structure’s mode of operation, rapid connection and disconnection of the buoy are a requirement in order that the unloading of fluid can start almost immediately without delays due to time-consuming mooring procedures.

When the buoy structure is not in use, it is in a submerged condition. On arrival at the unloading area, the vessel will pick up an auxiliary buoy, which has a line attached to the buoy structure. The line is used to convey the buoy structure to the surface, whereupon the buoy structure is brought into abutment in the vessel’s recess. Such procedures, and devices for their implementation are already known in the art.

Around its circumference the buoy structure is equipped with mooring lines which extend down to mooring points on the seabed. Risers are provided up to the middle of the buoy structure and a swivel structure is arranged above the buoy structure. By means of this arrangement fluid can be passed through the buoy structure via the riser to the submerged pipelines, while at the same time the vessel rotates around the buoy structure. Arrangements of this type are also already known in the art. The submerged pipelines transport fluid away from the vessel towards the shore-based infrastructure.

The transfer structure is attached to one end of a riser, while the other end of the riser is equipped with a coupling which provides for the connection of the riser to a submerged pipeline system. The transfer structure attaches the riser to the vessel’s projecting bow portion, thus enabling natural gas to be transferred from the vessel to the on-shore infrastructure. Included in the transfer structure is a rapid coupling device which induces a rotating movement (a swivel) and can be attached to the end of the riser or to the vessel, as well as the necessary valves such as an emergency connection valve, a non-return valve, a shut-off valve and a flow meter.

When the transfer structure with the riser are not in use, they are in a submerged condition. On arrival at the unloading area, the vessel will use a dynamic positioning system (DP) to manoeuvre itself into position to pick up an auxiliary buoy floating on the surface. To the auxiliary buoy is attached a line which in turn is connected to the submerged transfer structure. The line is hauled up, thereby pulling the transfer structure to the surface, whereupon the transfer structure is brought into abutment against the bow portion’s projecting portion. Liquefied natural gas will be passed from the storage tanks to the vaporizer where the fluid is regasified and passed through the transfer structure to submerged pipelines which convey the natural gas to a shore-based infrastructure. When the unloading from the vessel is completed, the transfer structure will be released from the projecting bow portion and returned to its submerged state. In the submerged state the transfer structure with the riser will either be located on the seabed or floating at a level some distance below the surface of the sea.

The vessel may employ dynamic positioning to maintain position both at the unloading point, as mentioned in the paragraph above, and during the actual unloading operation. The dynamic positioning is undertaken on the basis of signals received from a transducer which is located on the seabed and/or from signals from DGPS.

The invention provides systems for achieving an efficient unloading of fluid to a shore-based infrastructure.

According to preferred embodiments of the invention, two coupling structures and two or more carrier vessels are included in the system. The number of vessels included in the system depends on the distance to the loading point. One and the same vessel will alternate between different operations such as loading at a loading station, for example in the field, transporting LNG from the loading station to the unloading point and regasifying liquefied natural gas with
subsequent transfer to a receiving system on shore. When the unloading of fluid through the coupling structure takes place almost continuously by having at least one vessel connected to one of the coupling structures at all times, while the other vessels are on the way to or from the loading stations, optimal efficiency is achieved in the utilization of the system.

[0029] On arrival at the unloading point, a coupling structure will be inserted in the receiving recess in the carrier vessel. Liquefied natural gas will be passed from the storage tanks to the vaporizer where the fluid is regasified and passed directly through the coupling structure to submerged pipelines which convey the natural gas to a shore-based infrastructure.

[0030] The shore-based infrastructure may take many forms, as long as the infrastructure is suitable for receiving the regasified fluid which is sent ashore from the carrier and the fluid is further distributed to the end users. For example, the infrastructure may comprise a pipeline network which conveys the natural gas directly to the end user or the infrastructure may comprise a depot which is connected to appropriate transport means for further transport of natural gas to the consumers, etc.

BRIEF DESCRIPTION OF THE DRAWING

[0031] The invention will now be explained in more detail with reference to the figures in which:

[0032] FIG. 1 is a side view of a carrier vessel with the necessary equipment according to a first embodiment of the invention.

[0033] FIG. 2 is a perspective view of one of the vessels shown in FIG. 1 coupled up to one of several buoy structures and of the connection of the pipelines with the infrastructure.

[0034] FIG. 3 is a general view of the organization of the vessels shown in FIG. 1 in order to obtain an efficient unloading of fluid.

[0035] FIG. 4 illustrates two vessels as shown in FIG. 1 connected to two buoy structures simultaneously.

[0036] FIG. 5 is a view similar to that of FIG. 1 of a carrier vessel with the necessary equipment according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0037] The invention will be described first with reference to an embodiment in which the vessel is arranged to be coupled to a buoy system. As will become apparent from the description, the illustrations provided in FIGS. 2 and 4 are applicable, with some modification, to the second embodiment shown in FIG. 5. The illustration provided in FIG. 3 is directly applicable to the embodiment of FIG. 5.

[0038] FIG. 1 is a simplified schematic view of a retrofitted LNG carrier “Shuttle and Regas Vessel” (“RSV”) according to the invention. The vessel 1 is illustrated provided with a plurality of tanks 2 for storing liquefied natural gas. The figure shows how in the vessel’s hull, generally along the keel, there is provided a downwardly opening conical recess 5 which forms a receiving arrangement for the buoy structure 7 (not illustrated in FIG. 1). The vessel 1 is further provided with at least one vaporizer 4. In order to improve the vessel’s maneuverability, the vessel is also equipped with thrusters 6 in the vessel’s bow portion and stern portion, respectively.

[0039] FIG. 2 illustrates an arrangement of buoy structures 7 which are connected to a submerged pipeline system. The submerged pipeline system comprises risers 8 each attached to a respective one of the buoy structures 7, and pipelines 9 each connected to the end of a respective one of the risers 8. The pipelines 9 are connected to an on-shore infrastructure, illustrated here in the figure by an underwater pipeline system 10 and a shore-based pipeline system 12.

[0040] The buoy structures 7 are equipped with mooring lines 11 extending from mooring points on the seabed to attachment points on the circumference of the buoy structure.

[0041] FIG. 2 illustrates two vessels 1, 1' where one of the vessels 1 is connected to one of the buoy structures 7, while the other vessel 1' is en route to or from the loading point. On connection of vessel 1 with the buoy structure 7, the liquefied natural gas is transferred from tanks 2 to the vaporizer 4, where the fluid is regasified before being transferred through the buoy structure 7 and via one of the submerged pipelines 9 and 10 for bringing natural gas ashore to the pipeline system 12.

[0042] FIG. 3 illustrates the principle for the organization of the connection of the various vessels to the buoy structures as well as transport to and from the loading station where LNG is loaded on board the vessel. In this example four vessels are included in the system. As represented by the legends in FIG. 3, trips by the vessels can be synchronized so that unloading of regasified gas can take place almost continuously.

[0043] In FIG. 4 two buoy structures 7 are connected to the vessels 1 and 1' simultaneously. In the situation illustrated in FIG. 4, the vessel 1 is in the process of completing the unloading of natural gas, while the vessel 1' has just received a buoy structure 7 in its recess 5. By means of this arrangement a uniform transition will be achieved in the unloading process from vessel 1 to vessel 1', and a continuous flow of natural gas into the submerged pipeline system will thereby be maintained.

[0044] FIG. 5 is a simplified schematic view of the second embodiment of a retrofitted LNG carrier “Shuttle and Regas Vessel (RSV)” according to the invention. The vessel 1 is illustrated provided with a plurality of tanks 2 for storing liquefied natural gas, one or more vaporizers 4 and thrusters 6, as in the embodiment of FIG. 1. At the vessel’s bow portion there is provided a projecting structure 15 which forms a receiving arrangement for a transfer structure 17 that is connected to a riser 8. Projecting structure 15 and transfer structure 17 can be constructed, coupled and operated according to principles already known in the art. A structure 15 ensures connection between vaporizer or vaporizers 4 and projecting structure 15. As a substitute for traditional mooring lines the vessel is provided with a dynamic positioning system 4.

[0045] Transfer structure 17 is secured by a line 19 to a buoy 21 that floats on the water surface 23. When transfer
structure 17 is not in use, it will be submerged. Line 19 is used to retrieve transfer structure 17 for connection to projecting structure 15.

[0046] It is readily apparent that the a plurality of vessels as shown in FIG. 5 can be connected to a pipeline system in the manner shown in FIGS. 2 and 4 and can be organized to travel in the manner shown in FIG. 3.

[0047] While the description above refers to particular embodiments of the present invention, it will be understood that many modifications may be made without departing from the spirit thereof. The accompanying claims are intended to cover such modifications as would fall within the true scope and spirit of the present invention.

[0048] The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims, rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A system for delivering a fluid to a shore-based facility, said system comprising at least one vessel, at least one coupling structure and a pipeline connected between said coupling structure and the shore-based facility, wherein said vessel is operated to be periodically connected to said coupling structure for transferring the fluid from the vessel through said coupling structure and said pipeline directly to the shore-based facility for further distribution of the fluid.

2. The system according to claim 1, wherein at least two vessels and at least two coupling structures are included in the system and the vessels travel in continuous shuttle traffic between a loading station and the coupling structures and at least one vessel is periodically connected to one of the coupling structures for transferring the fluid from the vessel through the coupling structure.

3. The system according to claim 1, wherein the vessel is a retrofitted LNG tanker.

4. The system according to claim 1, wherein the fluid is natural gas.

5. The system according to claim 1, wherein the vessel is equipped with a vaporizer.

6. A system for unloading a fluid from a vessel, the vessel having a hull provided with a downwardly facing recess, said system comprising a submerged buoy structure and a pipeline system connected to said buoy structure for transferring fluid from storage in the vessel to a shore-based infrastructure, wherein said buoy structure is constructed to be inserted into said recess for connecting said pipeline system to the storage in the vessel.

7. A system for unloading a fluid from a vessel, comprising; a transfer structure; a pipeline system connected to said transfer structure; and a receiving structure that projects from the vessel's bow area for receiving and coupling to said transfer structure for transferring fluid from storage in the vessel to a shore-based infrastructure via said receiving structure and said transfer structure.

8. A system for unloading from a vessel provided with storage tanks for storing natural gas in a liquid state (LNG), wherein the system comprises:

a vaporizer provided on the vessel for vaporizing the liquefied gas into a gaseous state on arrival at an unloading point,

a buoy structure insertable into a bottom area of the vessel's hull for transferring gas in the gaseous state from the vessel, and

a transport system including a submerged pipeline for transferring the natural gas from the buoy structure to a shore-based infrastructure.

9. A system for unloading from a vessel provided with storage tanks for storing natural gas in a liquid state (LNG), wherein the system comprises:

a vaporizer provided on the vessel for vaporizing the liquefied gas into a gaseous state on arrival at an unloading point,

a transfer structure for transferring gas in the gaseous state from the vessel, the transfer structure being connected to a receiving structure projecting from the vessel's bow area, and

a transport system including a submerged pipeline for transferring the natural gas from the buoy structure to a shore-based infrastructure.

10. A vessel having a hull, said vessel comprising:

storage tanks for storing natural gas in its liquid state,

a vaporizer for regasifying the liquefied natural gas on arrival at an unloading point, in combination with one of:

a buoy receiving recess arranged in the bottom area of the vessel's hull for connection to a buoy structure; and

a receiving structure projecting from the vessel's bow area for connection to a transfer structure, for transferring natural gas from the vessel to a submerged pipeline system.

11. A method for transferring a fluid to a shore-based facility, comprising:

providing at least one vessel having fluid storage means containing the fluid and equipment to receive a coupling structure;

navigating the vessel to a location proximate to the shore-based facility;

at the location proximate to the shore-based facility, connecting a coupling structure that is coupled to a pipeline to the equipment and coupling the fluid storage means to the pipeline via the coupling structure; and

transferring the fluid via the coupling structure and the pipeline to the shore-based facility.

12. The method of claim 11 further comprising, before said step of transferring, gasifying the fluid.

13. The method of claim 12, wherein:

the equipment on each vessel includes a downwardly facing recess in the vessel hull communicating with the fluid storage means and the coupling structure is a buoy structure that is connected to the pipeline;

said step of providing at least one vessel comprises providing a plurality of the vessels;
said step of navigating comprises navigating each vessel in succession to the location proximate to the shore-based facility; and

said step of connecting a coupling structure comprises introducing the buoy structure into the recess of each vessel.

14. The method of claim 13, wherein said step of introducing a buoy comprises introducing a different buoy into the recess of each vessel.

15. The method of claim 14, wherein said step of transferring is carried out from each vessel in sequence.

16. The method of claim 12, wherein:

the equipment on each vessel includes a receiving structure projecting from the vessel and coupled to the fluid storage means and the coupling structure is a transfer structure that is coupled to the pipeline;

said step of providing at least one vessel comprises providing a plurality of the vessels;

said step of navigating comprises navigating each vessel in succession to the location proximate to the shore-based facility; and

said step of connecting a coupling structure comprises connecting the transfer structure to the receiving structure.

17. The method of claim 16, wherein said step of connecting a transfer structure comprises connecting a different transfer structure to the receiving structure of each vessel.

18. The method of claim 17, wherein said step of transferring is carried out from each vessel in sequence.

* * * * *