Title: FACILITIES FOR OFFSHORE LIQUEFIED NATURAL GAS FLOATING STORAGE WITH JETTY REGASIFICATION UNIT

Abstract: Facilities for offshore liquefied natural gas (LNG) floating storage with jetty regasification unit, the facilities including: a jetty unit of a steel structure or an iron concrete structure installed in offshore; a storage unit moored at the jetty unit providing a space for storing LNG; a regasification unit as a module which regasifies the LNG supplied from the storage unit, installed on a top portion of the jetty unit and is separable from the jetty unit; a utility unit comprising a power source and a sea water pump to supply power and sea water to the regasification unit; and a piping unit comprising unloading pipe for connecting the regasification unit and the storage unit and supplying pipe for carrying natural gas gasified by the regasification unit.


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Description

Title of Invention: FACILITIES FOR OFFSHORE LIQUEFIED NATURAL GAS FLOATING STORAGE WITH JETTY REGASIFICATION UNIT

Technical Field

The present invention relates to facilities for offshore liquefied natural gas (LNG) floating storage with jetty regasification unit, and more particularly, to offshore facilities that have floating storage and regasification unit installed on jetty unit. Compared to conventional regasification facility which is installed on LNG carriers or onshore LNG terminal, this concept have been found to reduce installation, operating costs and construction time, and moreover increases stability of regasification performance of LNG.

Background Art

The regasification facilities are used for regasification of LNG, i.e., to turn LNG back into natural gas. There facilities can be identified into two different types, onshore and offshore. In onshore facilities, LNG storage and regasification units are installed onshore, whereas offshore facilities include a floating LNG storage unit, usually an LNG carrier or a gravity based structure (GBS), and a regasification unit installed on the floating structure, a shuttle regasification vessel (SRV) or a LNG regasification vessel (RV).

The SRV or the LNG RV is special purposed vessels that can navigate with regasification facilities. The procedure starts by loading LNG from where it is produced and transports to an unloading location where then it is moored by submerged turret loading (STL) in offshore. These vessels have been widely used in the US, etc. for supplying natural gas and have been constructed by several Korean shipbuilding companies.

In light of growing of LNG demand, many attempts have been considered to construct new FSRU, but only several second-handed LNG carriers had been converted to FRSU due to economical reason and time constrains to deliver in Latin America and Asia, etc.

Construction of onshore facilities, however, faces more severe constrains. A large site has to be secured near facilities where LNG carriers are moored, and large scale construction incurs high cost, complex civil appeals of neighboring residents, and immobility of the facility once the construction is over. Thus, in many cases, offshore facilities are considered as a better solution for the fast tract of supplying natural gas.

Nevertheless, when newbuilding or conversion of FSRU is considered, the con-
struction period expands to several years along with high capital costs. Also, when a second-handed LNG carrier conversion is considered, one has to account for the age of the vessel and cargo containment type, since it determines the conversion cost and period. With respect to the cargo containment type, LNG carriers with membrane cargo containment system have to go through a partial reinforcement on its membrane structure to support the regasification facilities on the upper deck; storage of LNG and operation of regasification facilities are restricted due to the risk of sloshing damage from frequent partial loading of LNG.

Meanwhile, FSRU or SRV is moored to a jetty structure to withstand offshore weather and conditions. LNG is supplied to FSRU from LNC carrier (LNGC) through a loading arm installed on a jetty where both FSRU and LNGC are moored side by side. Once regasified by FSRU or SRV, high pressured natural gas (usually between 40 and 90 atm) is supplied to onshore through high pressure gas arm. During this process, because floating facilities like FSRU or LNG RV are influenced by tidal currents and wind, directional and rotational motions are accompanied. Thus, the loading arm and the high pressure gas arm have a large number of components which can absorb impact from the motions. If the FSRU or the LNG carrier is disconnected from the jetty beyond an operational range, the pipe line will automatically disconnect from the jetty for the safety. Although general LNG carriers are designed to operate under several pressures while loading and unloading of LNG, FSRU and LNG RV are constantly exposed to high pressure natural gas leak which can cause a fire or an explosion.

Disclosure of Invention

Technical Problem

The present invention, facilities for offshore LNG floating storage with jetty regasification unit, is designed for reduction of a construction time and cost, and enhances the stability for operation when compared to a newly constructed or converted FSRU and LNG RV.

Solution to Problem

According to an aspect of the present invention, there is provided a facilities for offshore liquefied natural gas (LNG) floating storage with jetty regasification unit, the facilities comprising: a jetty unit of a steel structure or an iron concrete structure installed in offshore; a storage unit moored at the jetty unit providing a space for storing LNG; a regasification unit as a module which regasifies the LNG supplied from the storage unit, installed on a top portion of the jetty unit and is separable from the jetty unit; a utility unit comprising a power source and a sea water pump to supply power and sea water to the regasification unit; and a piping unit comprising unloading pipe for connecting the regasification unit and the storage unit and supplying pipe for
carrying natural gas gasified by the regasification unit.

[10] The utility unit may be implemented as a module to be separable from the jetty unit.

[11] The regasification unit may be used an open rack vaporizer (ORV) using sea water for heat exchanger.

[12] The sea water pump of the utility unit and a ballast water pump disposed in the storage unit may be simultaneously used to supply sea water to the regasification unit.

[13] A power facility, a steam generator, and a ballast water pump disposed in the storage unit may be used to supply power, steam, and sea water, respectively, which are necessary for the regasification unit.

[14] The storage unit may be fixed to the jetty unit, loads LNG from a movable LNG carrier or a floating storage unit (FSU), and carries the LNG to the regasification unit.

[15] The storage unit may be separable from the jetty unit and movable to load LNG.

[16] The storage unit may be the LNG carrier or an FSU.

**Advantageous Effects of Invention**

[17] The present invention of offshore LNG floating storage with jetty regasification unit can provide a solution that can dramatically reduce the possibilities of high pressured natural gas leak into the atmosphere when compared to regasification on a floating structure.

**Brief Description of Drawings**

[18] FIG. 1 is a schematic diagram of a liquefied natural gas (LNG) regasification unit according to an embodiment of the present invention.

**Best Mode for Carrying out the Invention**

[19] Hereinafter, the detailed mode for carrying out the present invention will be described with reference to exemplary embodiments of the invention.

[20] FIG. 1 is a schematic diagram of a liquefied natural gas (LNG) regasification unit according to an embodiment of the present invention.

[21] The LNG regasification unit, according to the present invention, is used to regasify LNG in offshore and supply the regasified LNG, to gas users onshore. And this invention includes the jetty unit 10, a storage unit 20, a regasification unit 30, a piping unit 40, and a utility unit 50.

[22] The jetty unit 10 is a fixed structure installed in sea bed with its legs, made of steel or iron concrete. The term 'jetty' has various meanings, for example, a structure like a breakwater which distinguishes an inland and the sea, or a facility which is for anchoring vessels. To anchor large ships, such as container vessel, oil tankers, or LNG carriers, a site with certain depth of water, higher than a predetermined depth, is required.

[23] And the jetty can be used for berthing in the way of stretching steeled structure from
onshore to offshore or constructing a container terminal after dredging. In the present invention, the jetty unit 10 is a semi-permanent structure that is installed to maintain a constant altitude above the sea level to withstand the changes of the wave by tidal current. As the shape of jetty unit 10 is not limited, it can be changed according to the locations and conditions thereof as long as the storage unit 20 can be anchored at. A structure for anchoring the storage unit 20, such as a mooring dolphin or a fender, may be installed around the jetty unit 10, and is not shown in FIG. 1 for illustrative convenience (all the constituents are quite simply illustrated in FIG. 1).

The storage unit 20 provides a space for storing LNG once moored at the jetty unit 10. The storage unit 20 can be converted from a second-handed LNG carrier or an existing LNG floating storage unit (FSU). Meanwhile, the storage unit 20 may be fixedly moored at the jetty unit 10 and separated from the jetty unit 10 on occasional demands. Conventional operation involves supplying the LNG to the regasification unit 30 after receiving LNG from another LNG carrier. On an occasional demand, the storage unit 20 may move to a location where LNG is produced or another FSU by itself, then receives LNG therefrom and supply the LNG to the regasification unit 30 again after being moored at the jetty unit 10. In the latter case, for continuously regasification of LNG, another LNG carrier may supply LNG to the regasification unit 30, at the opposite side of the jetty unit 10.

Fixed or movable type of the storage unit 20 is determined according to circumstances or economical efficiency. For example, when a converted LNG carrier is used for the storage unit 20, storage type can be decided depending on the situation, as its mobility is already obtained.

Meanwhile, when a second-handed LNG vessel is used for the storage unit 20, the conversion process may require the vessel to operation both LNG loading pipe 21 and LNG unloading pipe 42 simultaneously, as general LNG carrier is designed not to proceed loading and unloading at the same time. Furthermore, if the storage unit 20 is expected to move, an appropriate facility for separating the unloading pipe 42 from the storage unit 20 is required as well.

The storage unit 20 includes a utility facility 22, such as a power facility, a steam generator, a ballast water pump P2, etc. which general LNG carriers and FSU are already equipped, thus no additional facility is needed when the second-handed LNG carrier or the FSU is converted.

The regasification unit 30 is a module for regasifying LNG which is supplied from the storage unit 20. The regasification unit 30 is also separable from the jetty unit 10. Installment of the regasification unit 30 on the jetty unit 10, which is fixed on the sea bed, allows LNG to be regasified in offshore without the problems which commonly occurs in operation of conventional FSRU of LNG RV, a danger of leakage of natural
gas due to an automatic piping separation in the operation or abrupt disconnection of a high pressure gas arm on the jetty unit 10 under the various offshore conditions. Since regasification work is performed on the hull 11 of the jetty unit 10, LNG can be transferred through the pipe between the storage unit 20 and the regasification unit 30. The stability of the hull 11 allows more safe transfer of LNG, regardless of the storage unit 20 movement due to the waves and tidal current.

[29] A heat exchanger of the regasification unit 30 in the present invention is an open rack vaporizer (ORV) that utilizes sea water as a heat source. By contacting the heat exchanger, sea water absorbs the heat and vaporizes LNG into gas. ORV is strongly recommended due to its low investment and operating cost. However, if sea water is not uniformly coated on the vaporizer, the heat exchanger freezes and deteriorates its structure. That is why the ORV cannot be installed on FSRU of LNG RV. For the present invention, fixed structure of the jetty unit 10 guarantees safe operation of the ORV, which is a relatively inexpensive heat exchange system.

[30] A sea water pump PI in the utility unit 50 and the ballast water pump P2 of the utility facility 22 in the storage unit 20 are used to supply sea water to the ORV. Although the sea water pump PI and the ballast water pump P2 are designed to operate simultaneous as depicted in FIG1, it is not necessary to use both of them. The sea water pump PI acts as a main pump and the ballast water pump P2 as an auxiliary pump. Or, only the sea water pump PI may be operated if the storage unit 20 is disconnected. How to supply the sea water to the ORV are subject to circumstances.

[31] The piping unit 40, connecting the regasification unit 30 and the storage unit 20, includes unloading pipe 41 for supplying LNG from the storage unit 20 to the regasification unit 30 and supply pipe 42 for supplying gasified LNG from the regasification unit 30 to the end users in onshore. If required part of the piping unit 40 may be installed below a sea level.

[32] The utility unit 50 (module) includes a power source, the sea water pump PI, and the steam generator for supplying power, sea water, and steam, respectively, to the regasification unit 30. Similar with the regasification unit 30, it is installed on the jetty unit 10, but also separable. The utility unit 50 and the regasification unit 30 are connected by a power cable 51, sea water pipe 52, and steam pipe 53. They are respectively connected to the utility facilities in the storage unit 20 to be used simultaneously or complementarily in the present invention. Unlike shown in FIG.1, only the utility unit 50 may operate independently.

[33] The piping unit 40, the power cable 51, the sea water pipe 52, and the steam pipe 53 are quite simply illustrated in FIG.1 for illustrative convenience, but the actual design is considerably complicated. Nevertheless, for the purpose of illustration, such simple diagram will be understood by those who have knowledge of this technology.
Now, functions and effects of regasification element will be described below with explanation of LNG regasification process.

LNG stored in the storage unit 20 is supplied to the regasification unit 30 through the unloading pipe 41. Once regasified through the unit 30, regasified LNG is carried to the end users' pipe line onshore through the supplying pipe 42.

The storage unit 20 can be fixed to the jetty unit 10 to load LNG from an LNG carrier (supplied through the loading pipe 21) or can be moved by itself to receive LNG from a neighboring FSU or a location where LNG is produced. If the storage unit 20 moves to different site, designated replacement should substitute for the previous storage unit 20, in order to supply LNG continuously.

Power, sea water, and steam are supplied to the regasification unit 30 through the utility unit 50.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood that various changes in form and details may be possible in the technical range of this invention as defined by the following claims.
Claims

[Claim 1] Facilities for offshore liquefied natural gas (LNG) floating storage with jetty regasification unit, the facilities comprising:

- a jetty unit of a steel structure or an iron concrete structure installed in offshore;
- a storage unit moored at the jetty unit providing a space for storing LNG;
- a regasification unit as a module which regasifies the LNG supplied from the storage unit, installed on a top portion of the jetty unit and is separable from the jetty unit;
- a utility unit comprising a power source and a sea water pump to supply power and sea water to the regasification unit; and
- a piping unit comprising unloading pipe for connecting the regasification unit and the storage unit and supplying pipe for carrying natural gas gasified by the regasification unit.

[Claim 2] The facilities of claim 1, wherein the utility unit is implemented as a module to be separable from the jetty unit.

[Claim 3] The facilities of claim 1, wherein the regasification unit uses an open rack vaporizer (ORV) using sea water for heat exchanger.

[Claim 4] The facilities of claim 3, wherein the sea water pump of the utility unit and a ballast water pump disposed in the storage unit are simultaneously used to supply sea water to the regasification unit.

[Claim 5] The facilities of claim 1, wherein a power facility, a steam generator, and a ballast water pump disposed in the storage unit are used to supply power, steam, and sea water, respectively, which are necessary for the regasification unit.

[Claim 6] The facilities of claim 1, wherein the storage unit is fixed to the jetty unit, loads LNG from a movable LNG carrier or a floating storage unit (FSU), and carries the LNG to the regasification unit.

[Claim 7] The facilities of claim 1, wherein the storage unit is separable from the jetty unit and movable to load LNG.

[Claim 8] The facilities of claim 1, wherein the storage unit is the LNG carrier or an FSU.