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(54) **FRONTIER FIELD DEVELOPMENT SYSTEM FOR LARGE RISER COUNT AND HIGH PRESSURES FOR HARSH ENVIRONMENTS**

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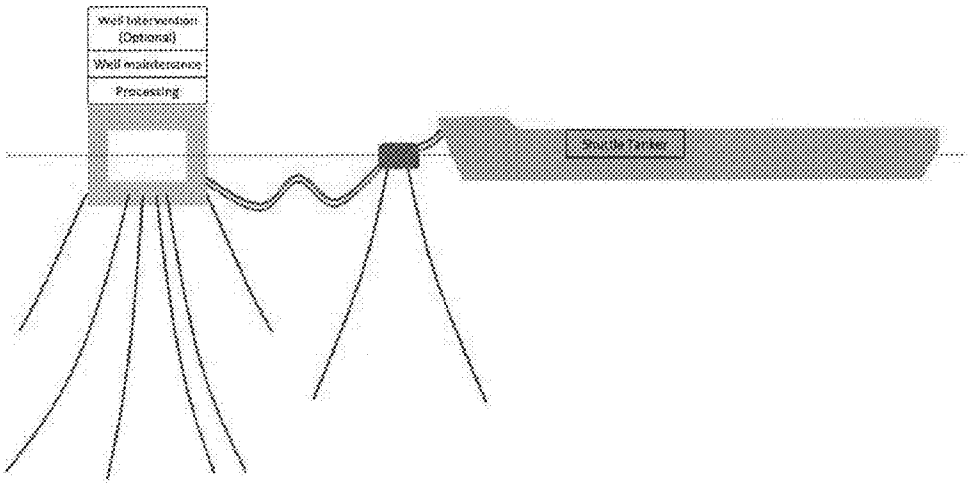
(52) **U.S. Cl.**

CPC ***B63B 35/44*** (2013.01); ***B63B 21/50*** (2013.01); ***B63B 22/021*** (2013.01)

(57) **ABSTRACT**

A system comprising a semisubmersible, at least two offloading terminals and shuttle tankers in optional combination with an FSO may be deployed in deep water harsh environments where riser performance (either SCR or LWSCR) is a key performance parameter. The semisubmersible is used to support the risers because of its favorable motion characteristics under harsh conditions. The semisubmersible supports the entire process train and provides well maintenance, which may include water and/or gas injection. The semisubmersible may provide work-over capabilities for well intervention. The produced hydrocarbons are exported through flexible pipes to at least two off-loading buoys. A FSO or shuttle tanker receives the produced hydrocarbons. Two or more off-loading buoys may be employed to allow for uninterrupted production when a shuttle-tanker-only embodiment is utilized.



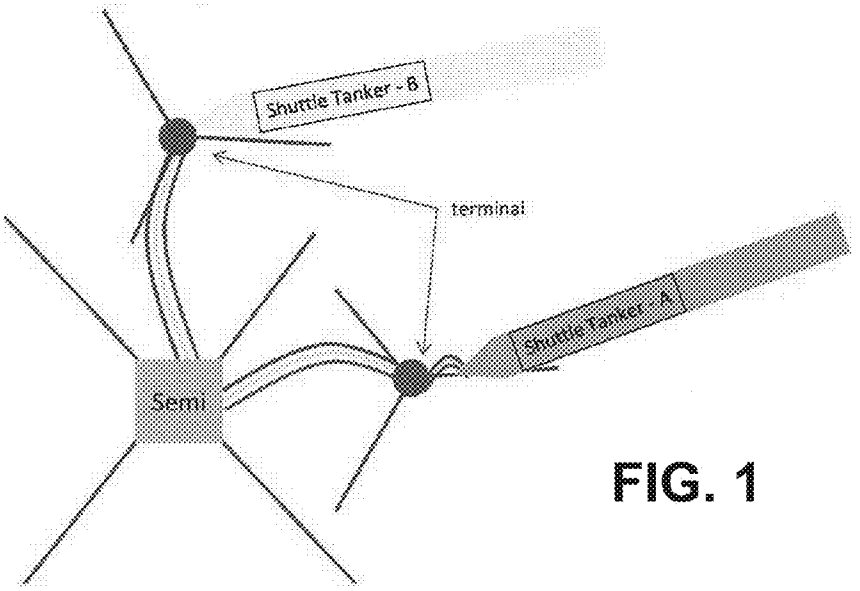

Shuttle Tanker - B
terminal
Shuttle Tanker - A
Semi

FIG. 1

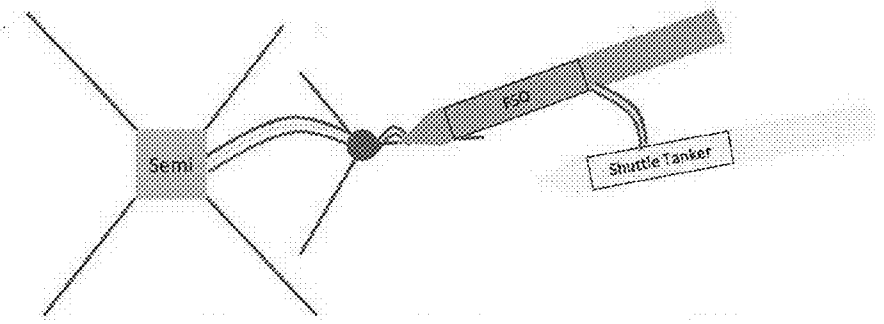

Semi
Shuttle Tanker

FIG. 2

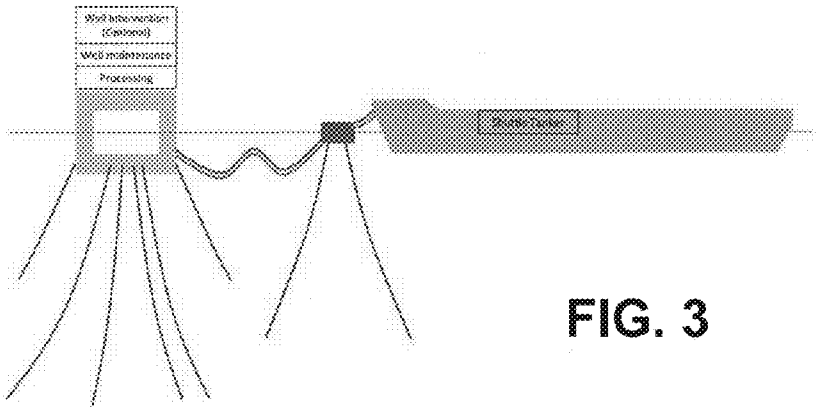

Well Intervention
(Optional)
Well maintenance
Processing

FIG. 3

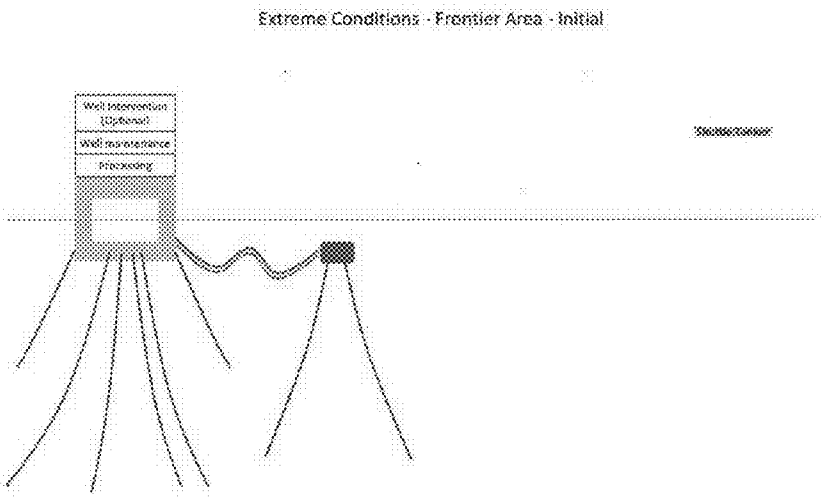

Extreme Conditions - Frontier Area - Initial
Well Intervention
(Optional)
Well maintenance
Processing

FIG. 4

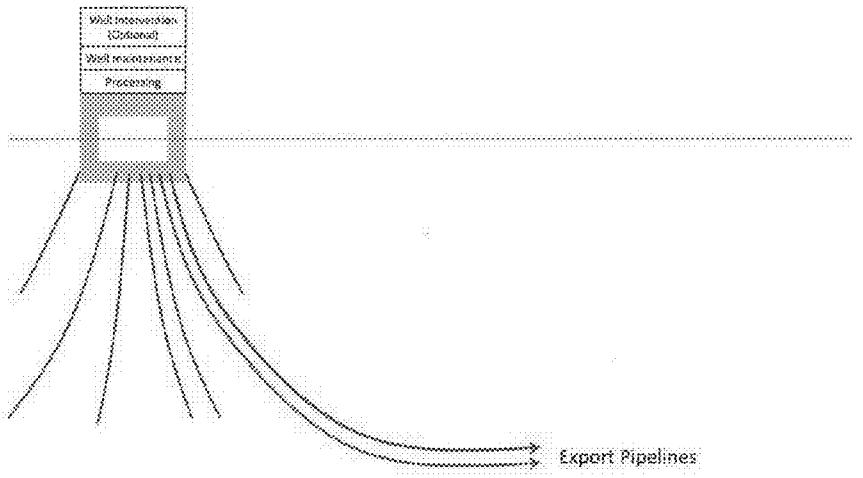

Well Intervention (Optional)
Well Maintenance
Processing
Export Pipelines

FIG. 5

FRONTIER FIELD DEVELOPMENT SYSTEM FOR LARGE RISER COUNT AND HIGH PRESSURES FOR HARSH ENVIRONMENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/901,758 filed on Nov. 8, 2013.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] The present invention generally relates to the offshore production of oil and gas. More particularly, it relates to surface vessels used to receive, process and store hydrocarbons from subsea wells.

[0005] 2. Description of the Related Art

[0006] Including information disclosed under 37 CFR 1.97 and 1.98.

[0007] The invention relates to a field development methodology for offshore oil and gas fields in harsh environments (e.g. hurricane/cyclonic) for a frontier location where the existing pipeline infrastructure is insufficient during the entire field life or during the early phases thereof.

[0008] An "FPSO" is a Floating Production Storage and Offloading system—a floating facility installed above or close to an offshore oil and/or gas field to receive, process, store and export hydrocarbons.

[0009] It consists of a floater, which is either a newly built or converted tanker, permanently moored on site. The cargo capacity of the vessel is used as buffer storage for the oil produced. The process facilities (topsides) and accommodation are installed on the floater. The mooring configuration may be of the spread mooring type or a single point mooring system, generally a turret.

[0010] The high pressure mixture of produced fluids is delivered to the process facilities mounted on the deck of the tanker, where the oil, gas and water are separated. The water is discharged overboard after treatment to eliminate hydrocarbons. The stabilized crude oil is stored in the cargo tanks and subsequently transferred into shuttle tankers either via a buoy or by laying side by side or in tandem to the FPSO. The gas is used for enhancing the liquid production through gas lift, and for energy production onboard the vessel. The remainder is compressed and transported by pipeline to shore or re-injected into the reservoir.

[0011] An "FSO" is a similar vessel but without the process facilities.

BRIEF SUMMARY OF THE INVENTION

[0012] The invention comprises a semisubmersible, at least two offloading terminals and shuttle tankers in optional combination with an FSO. A system according to the invention may be deployed in deep water harsh environments where riser performance (either SCR or LWSCR) is a key performance parameter. The semisubmersible is used to support the risers because of its favorable motion characteristics under harsh conditions. The semisubmersible supports the entire process train and provides well maintenance, which may include water and/or gas injection. The semisubmersible may provide work-over capabilities for well intervention. The produced hydrocarbons are exported through flexible pipes to at least two off-loading buoys. A FSO or shuttle tanker receives the produced hydrocarbons. Two or more off-loading buoys may be employed to allow for uninterrupted production when a shuttle-tanker-only solution is utilized.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0013] FIG. **1** is a schematic plan view of an offshore field development according to an embodiment of the invention.

[0014] FIG. **2** is a top plan schematic view of another embodiment of the present invention that uses an FSO and a shuttle tanker.

[0015] FIG. **3** is a side schematic view of a field development in operating conditions according to the present invention.

[0016] FIG. **4** is a side schematic view of the field development shown in FIG. **3** in extreme metocean conditions.

[0017] FIG. **5** is a side schematic view of the field development shown in FIG. **3** in a mature stage.

DETAILED DESCRIPTION OF THE INVENTION

[0018] The invention comprises a semisubmersible, at least two offloading terminals and shuttle tankers in possible combination with an FSO. A system according to the invention may be deployed in deep water harsh environments where riser performance (either SCR or LWSCR) is a key performance parameter. The semisubmersible supports the risers because of its favorable motion characteristics under harsh conditions. The semisubmersible supports the entire process train and provides well maintenance, which may include water and/or gas injection. The semisubmersible could provide work-over capabilities for well intervention. The produced hydrocarbons are exported through flexible pipes to at least two off-loading buoys. A FSO or shuttle tanker receives the produced hydrocarbons (FIG. **3** or FIG. **2**). At least two off-loading buoys are necessary to allow for uninterrupted production (FIG. **1**) when a shuttle-tanker—only solution is utilized (i.e. no FSO), see FIG. **2**.

[0019] The pipeline infrastructure may reach the location where this semisubmersible is located. The pipeline infrastructure can be an oil line, a gas line or both. The gas can then be exported via the gas pipeline while the oil could be the existing offloading terminals. The offloading terminals can be removed if an oil pipeline is present. Use of a system according to the invention allows for a delay on the decision to build the pipeline infrastructure; a pipeline infrastructure to a frontier area is an expensive preposition.

[0020] The shuttle tanker/FSO disconnects from the offloading terminal when the environment becomes too intense. The offloading terminal is connected to the semisubmersible via a bundle of lines which include power and data. This allows for controlled ballast operations on the offloading terminal to submerge it to reduce the environmental forces.

[0021] The invention is intended for use in harsh environments. The methodology is highly applicable to locations where the harsh environments are rare but intense (a benign methodology might work except for those rare occasions). Such locations include the many of the hurricane/cyclonic areas of the world.

[0022] The system is similar to the Rapid Deployment Offloading System (RDOS) which was developed for Shell, BP

and Chevron, 2007-2009, project 46028. The RDOS is intended to provide temporary offloading capacity in case of a non-functional pipeline. The design life is specified as typically ten deployments of 6 months each. A system according to the invention may have a single deployment ranging from several years to field design life.

[0023] Competing systems include the FPSO or semisubmersible by itself, a disconnect able buoy similar to White Rose or Stones or the MoorSpar, or RDOS. The advantages of the proposed methodology include:

[0024] Support for a large number of risers under harsh conditions, including high pressure, sour service, high H_2S content;

[0025] A fluid transfer system between the semisubmersible and shuttle tanker that is "low pressure", and comprises of only a few lines. Therefore simplifying the design and allowing for more motion;

[0026] A disconnect able buoy which supports only a few lines and may not have any rotational parts;

[0027] A swivel requiring only a few flow paths and an electronic data path;

[0028] The entire system comprises of field proven hardware;

[0029] Ability to start producing a field before pipeline infrastructure; and,

[0030] Limited additional hardware required before pipe line infrastructure is present.

[0031] The possible disadvantages of this system include:

[0032] Requirement for one semisubmersible and two offloading terminals in relatively close proximity, with associated mooring line infrastructure; and,

[0033] Operation of three vessels in relatively close proximity to one another.

[0034] Systems or methodologies that perform similar functions include the FPSO, the semisubmersible, the disconnect able FPSO, the MoorSpar, riser tower and RDOS. Each system has advantages and disadvantages. Most of these systems cannot meet at least one of the following requirements: many risers, high pressure, sour service, high H_2S content, large quantities and/or high pressure water injection, harsh environment, storage & offloading.

[0035] The independent innovative aspects of the invention include:

[0036] Support deep water risers in harsh environment without initial pipeline infrastructure;

[0037] Support deep water risers that will have to withstand high H_2S levels and/or high temperatures and/or sour service, without initial pipeline infrastructure;

[0038] Use of one or more shuttle tankers to directly store the all or some of the hydrocarbons that are being produced/processed by the semisubmersible; and,

[0039] Use of one or more FSOs to directly store all or some of the hydrocarbons that are being produced/processed by the semisubmersible.

[0040] Although particular embodiments of the present invention have been shown and described, they are not intended to limit what this patent covers. One skilled in the art will understand that various changes and modifications may be made without departing from the scope of the present invention as literally and equivalently covered by the following claims.

What is claimed is:

1. A system for offshore oilfield development comprising:

a semi-submersible having hydrocarbon processing equipment thereon;

a plurality of subsea risers in fluid communication with the hydrocarbon processing equipment and wellheads on the seafloor;

a submersible mooring buoy having means for fluid connection to a shuttle tanker moored to the mooring buoy; and

at least one fluid conduit connecting the mooring buoy to the hydrocarbon processing equipment on the semi-submersible.

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