SHEARABLE RISER SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from and the benefit of U.S. Provisional Application Serial No. 62/464,031, entitled "*Shearable Riser System and Method*," filed February 27, 2017, which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] The invention relates generally to riser structures used in marine oil and gas applications.

BRIEF DESCRIPTION

[0003] The development of technologies for exploration for and access to minerals in subterranean environments has made tremendous strides over past decades. While wells may be drilled and worked for many different reasons, of particular interest are those used to access petroleum, natural gas, and other fuels. Such wells may be located both on land and at sea. Particular challenges are posed by both environments, and in many cases the sea-based wells are more demanding in terms of design and implementation. Subsea wells tend to be much more costly, both due to the depths of water beneath which the well lies, as well as for the environmental hazards associated with drilling, completion, and extraction in sensitive areas.

[0004] In subsea applications, a drilling or other well servicing installation (such as a platform or vessel) is positioned generally over a region of the sea floor, and an tubular structure extends from the installation to the sea floor. Surface equipment is positioned at the location of the well to facilitate entry of the tubular into the well, and to enable safety responses in case of need. As the well is drilled, a drill bit is rotated to penetrate into the earth, and ultimately to one or more horizons of interest, typically those at which

minerals are found or anticipated. The tubular structure not only allows for rotation of the bit, but for injection of mud and other substances, extraction of cuttings, testing and documenting well conditions, and so forth.

[0005] During the various stages of drilling, intervention, completion and production, riser structures are commonly used that extend between the vessel or platform and equipment at the seabed. Such risers may be designed to bend and flex. In extreme conditions, however, the risers may transmit forces to the equipment on the sea floor that can cause severe damage to the equipment. Such extreme conditions or events may include, for example, the loss of control of the vessel or platform, extreme weather conditions, extreme wave events, and so forth. There has been little or no significant innovation in the art to address such events.

[0006] There is a need, therefore, for improvements in the field that may allow risers that can avoid damage to subsea equipment in case of an extreme event.

SUMMARY OF INVENTION

[0006a] According to a first aspect of the present invention, there is provided a method, including: assembling a riser to extend between a vessel and a subsea well location, the riser comprising a first riser section made of a first material and a second riser section made of a second material different from the first material, the second riser section comprising a passive fracture section that fractures passively under design conditions that will not cause fracture of the first riser section, the second riser section being installed above a lower marine riser package; utilizing the assembled riser during normal operating conditions; and permitting passive fracture of the passive fracture section under design conditions that exceed design loading; wherein the passive fracture section comprises a single wall tubular structure having a wall in which cracking initiates that is promoted during the passive facture, and wherein the passive fracture section comprises a titanium alloy or an aluminum alloy, and the first riser section comprises a steel alloy.

[0006b] According to a second aspect of the present invention, there is provided a marine riser including: first riser section extending made of a first material and extending partially between a vessel and a subsea well location; a second riser section made of a second material different from

the first material and coupled to the first riser section and extending partially between the vessel and the subsea well location, the second riser section being installed above a lower marine riser package, the second riser section comprising a passive fracture section that fractures passively under design conditions that will not cause fracture of the first riser section; wherein the passive fracture section comprises a single wall tubular structure having a wall in which cracking initiates that is promoted during the passive facture, and wherein the passive fracture section is characterized by a yield strength to tensile strength ratio of at least approximately 0.9, a modulus of elasticity of at most approximately 17 Mpsi, and a fracture toughness of at most approximately 45 $KSIin^{-2}$.

[0006c] According to a third aspect of the present invention, there is provided a marine riser including: a riser section made of a material different from other riser sections of the marine riser, and extending partially between a vessel and a subsea well location, the riser section comprising a passive fracture section installed above a lower marine riser package that fractures passively under conditions exceeding design loading, wherein the passive fracture section comprises a single wall tubular structure having a wall in which cracking initiates that is promoted during the passive facture; and wherein the passive fracture section comprises a titanium alloy or an aluminum alloy.

DRAWINGS

[0007] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0008] FIG. 1 is a diagrammatical representation of an exemplary installation for drilling, completing, or servicing a subsea well in accordance with the present techniques;

[0009] FIG. 2 is a diagrammatical representation of a sections of a tubular riser extending from a platform or vessel to the location of a well, and into the well to a horizon of interest;

[0010] FIG. 3 is a diagrammatical representation of permitted fracture of the riser in case of an extreme event; and

or any other operations performed, as well as well conditions, such as pressures, production, depths, rates of advance, and so forth.

[0014] In accordance with the present disclosure, at least two different tubular stocks are provided and used by the operation, and these may be stored on a deck or other storage location. In FIG. 1 a first of these is designated tubular 1 storage 32, and the second is designated tubular 2 storage. As will be appreciated by those skilled in the art, such tubular products may comprise lengths of pipe with connectors at each end to allow for extended strings to be assembled, typically by screwing one into the other. The two different tubular stocks are used here to allow the operation to balance the technical qualities of each against their costs. That is, one material may be selected for its relative strength but lower cost (e.g., steel), while the other is selected based upon its superior ability to be sheared in case of need, although it may be more costly than the first material. In presently contemplated embodiments, this second tubular stock may comprise titanium alloys, aluminum alloys, but possibly also certain composite materials. As discussed below, the operation judiciously selected which material to use based upon the likelihood that it may be necessary to shear or allow fracture of the overall string. In the illustrated embodiment, the string comprises a riser through which other tubulars, tools, fluids and so forth may pass between a vessel, platform, rig, ship, or other structure at or near the sea surface and equipment at the seabed.

[0015] In the illustration of FIG. 1, a first or lower tubular section 36 has been assembled and deployed in the well, and is connected to a tubular riser section 38 above that forms the riser. A further riser section 40 has been assembled and connected above the lower riser section and extends to the platform. In practice, the upper riser section may be made of the first tubular material while the lower riser section is made of the second tubular material. The riser sections may comprise any suitable length of tubular products, and these will depend upon a number of factors, but typically the location of the horizon of interest (e.g., its depth or for wells having off-vertical sections, the distance to the location of interest), the depth of the water, and the anticipated location of potentially

CLAIMS:

1. A method, comprising:

assembling a riser to extend between a vessel and a subsea well location, the riser comprising a first riser section made of a first material and a second riser section made of a second material different from the first material, the second riser section comprising a passive fracture section that fractures passively under design conditions that will not cause fracture of the first riser section, the second riser section being installed above a lower marine riser package;

utilizing the assembled riser during normal operating conditions; and

permitting passive fracture of the passive fracture section under design conditions that exceed design loading;

wherein the passive fracture section comprises a single wall tubular structure having a wall in which cracking initiates that is promoted during the passive facture, and

wherein the passive fracture section comprises a titanium alloy or an aluminum alloy, and the first riser section comprises a steel alloy.

2. The method of claim 1, wherein the second riser section is most costly per unit length than the first riser section.

3. The method of claim 1, wherein the passive fracture section is connected adjacent to seabed well equipment.

4. The method of claim 1, wherein the passive fracture section is characterized by a yield strength to tensile strength ratio of at least approximately 0.9, a modulus of elasticity of at most approximately 17 Mpsi, and a fracture toughness of at most approximately 45 $KSIin^{-2}$.

5. A marine riser comprising:

first riser section extending made of a first material and extending partially between a vessel and a subsea well location;

a second riser section made of a second material different from the first material and coupled to the first riser section and extending partially between the vessel and the subsea well location, the second riser section being installed above a lower marine riser package, the second riser section comprising a passive fracture section that fractures passively under design conditions that will not cause fracture of the first riser section;

wherein the passive fracture section comprises a single wall tubular structure having a wall in which cracking initiates that is promoted during the passive facture, and

wherein the passive fracture section is characterized by a yield strength to tensile strength ratio of at least approximately 0.9, a modulus of elasticity of at most approximately 17 Mpsi, and a fracture toughness of at most approximately 45 $KSIin^{-2}$.

6. The marine riser of claim 5, wherein the passive fracture section comprises a titanium alloy.

7. The marine riser claim 6, wherein the first riser section comprises a steel alloy.

8. The marine riser of claim 5 wherein the passive fracture section comprises an aluminum alloy.

9. The marine riser of claim 5, wherein the second riser section is most costly per unit length than the first riser section.

10. A marine riser comprising:

a riser section made of a material different from other riser sections of the marine riser, and extending partially between a vessel and a subsea well location, the riser section comprising a passive fracture section installed above a lower marine riser package that fractures passively under conditions exceeding design loading,

wherein the passive fracture section comprises a single wall tubular structure having a wall in which cracking initiates that is promoted during the passive facture; and

wherein the passive fracture section comprises a titanium alloy or an aluminum alloy.

11. The marine riser of claim 10, comprising a further riser section extending partially between the vessel and the subsea well location and coupled to the riser section having the passive fracture section, wherein the further riser section will not fracture under the design loading.

12. The marine riser of claim 11, wherein the further riser section comprises a steel alloy.

13. The marine riser of claim 11, wherein the riser section having the passive fracture section is more costly per unit length than the further riser section.

14. The marine riser of claim 10, wherein the passive fracture section is characterized by a yield strength to tensile strength ratio of at least approximately 0.9, a modulus of elasticity of at most approximately 17 Mpsi, and a fracture toughness of at most approximately 45 $KSIin^{-2}$.