

MARINE PIPELAYING SYSTEM FOR LAYING AN OFFSHORE PIPELINE

Description

[0001] The present invention relates to a marine pipelaying system for installing an offshore pipeline that includes one or more accessories.

[0002] In most offshore pipelines to be laid on the seabed there is a need to install accessories (modules) on the ends of the pipeline and/or at one or multiple intermediate locations along the pipeline. These modules are usually quite large and heavy and are commonly designed to be welded to the pipeline. Examples of such accessories are: initiation fittings, pipeline end terminations (PLET), branches, inline SLED assemblies, inline manifolds, pipe valves, tee assemblies with their supporting structures and mud-mats.

[0003] Such pipeline accessories should often be welded inline with the pipeline. Often the accessory has pipeline connection parts at opposed ends thereof to connect the pipeline to those pipeline connection parts. It is however also known to have a pipeline accessory which is to be mounted, mostly by welding or using bolts, externally on the pipeline.

[0004] Various prior art solutions are known to mount an accessory at the end of a pipeline or at an intermediate location in or on a pipeline.

[0005] For example in WO 03/067019 a system for introducing an inline accessory into a pipeline is described. The pipelaying installation comprises a pipeline spool, a tensioner and a clamp, usually referred to as "hang-off" clamp. The clamp is adapted to support the weight of the launched pipeline which is suspended from said clamp. Furthermore, this known system comprises a launch

ramp, here having variable inclination, with a pipeline feeding position and an accessory connection position, arranged next to one another. The area in between the tensioner and the clamp can be used to install accessories into the pipeline. The clamp is capable of translating horizontally - while the launched pipeline is suspended therefrom - from the pipeline feeding position to the accessory connection position. Means are provided for lowering the pipeline and accessory connected thereto past the clamp.

[0006] Another prior art solution is disclosed in Wo 03/087652. According to the described method of pipelaying an elongated pipeline is spooled upon a reel and then launched through a guide tower to the seabed. An end portion of the pipeline is clamped, above which clamp the pipeline is separated into a first section held by the clamp and a second section above the clamp supported on the vessel. The clamp and the clamped pipeline are moved laterally so that the first and second pipeline sections are offset. A manifold is connected to the moved first pipe section, after which the clamp and the first pipe section and the connected manifold are moved back laterally to be able to connect the second pipeline section to the manifold.

[0007] The known techniques for inserting an accessory into or at the end of a pipeline while laying an offshore pipeline are unsatisfactory.

[0008] The object of this invention is to provide an improved technique and associated system for laying an offshore pipeline and fitting one or more pipeline accessories into or onto a pipeline, e.g. at the end and/or at intermediate locations of the pipeline.

[0009] The present invention provides a system according to claim 1.

[0010] Further embodiments of the inventive system are described in the subclaims and the description of the drawings.

[0011] The present invention further relates to a method wherein the inventive system is used.

[0012] The invention further relates to an accessory handling device, an accessory handling frame, and an accessory loader device as described herein, as well as the use thereof in a method for laying offshore pipelines.

[0013] The invention further relates to a pipelaying vessel provided with a system and/or an accessory handling device, and/or an accessory handling frame and/or an accessory loader device as described herein.

[0014] In the drawings:

Fig. 1 schematically shows a part of a reel-lay pipelaying vessel provided with an exemplary embodiment of the system according to the invention, Fig. 2 shows a plan view of a part of the vessel of figure 1, wherein the launch device is in inclined position,

Fig. 3 shows in a side view a part of the launch structure of the vessel of figures 1,2, an accessory handling frame supported by the accessory handling device, as well as the accessory loader device of the invention,

Fig. 4 shows in a rear view the launch structure, the accessory handling device, and the accessory handling frame of figure 3,

Fig. 5 in a view similar to figure 3 a part of the launch structure, the accessory loader device, and an accessory handling frame held by said loader device, Figs. 6a-h illustrate the loading of an accessory onto the accessory handling device according to the invention, and

Figs. 7a-g illustrate the integration of an accessory into a pipeline according to the invention.

[0015] In the figures a "Reel-Lay" pipelaying vessel 1 is shown for laying an offshore pipeline. As is common in reel-laying the pipeline 2 to be laid is manufactured in a continuous length on board of the pipelaying vessel or at a shore facility and then spooled onto a large spool 3. This spool 3 is often a vertical spool, but it is also known to arrange the spool 3 horizontally. In the latter version the pipelaying technique is also known as "carousel-lay". The pipeline can be a rigid pipeline or a flexible pipeline as is known in the art.

[0016] During the pipelaying process the pipeline 2 is unwound from the spool 3.

[0017] The vessel 1 is provided with a pipeline launch device 10 for launching the pipeline 2 from the vessel 1 in the direction of the seabed. This launch device 10 here is arranged at the stern of the vessel 1. It could also be arranged at another location, e.g. at a moonpool of the vessel.

[0018] The launch device 10 here comprises a launch structure 11 mounted on a travelling base 12. The base 12 is slidably supported (e.g. by a skid arrangement) on support rails 13 on a deck 5 of the vessel.

[0019] The rails 13 here extend essentially parallel to the stern of the vessel, so that the launch device 10 can assume several positions along said stern.

[0020] The structure 11 is pivotable about a pivot axis 14 with respect to the base 12. One or more support struts 15 are provided, here telescopic support struts, to maintain a desired inclination of the launch structure 11.

[0021] At the upper end the structure 11 is provided with a pipeline guide 16, here a rotatable guide wheel, for the pipeline 2 coming from the spool 3.

[0022] The launch structure 11 here further is provided with a pipeline straightener 17 and at least one pipeline tensioner 18. The pipeline tensioner 18 commonly includes multiple tracks with friction pads which engage on the pipeline 2.

[0023] Below the tensioner 18 the launch structure 11 here is provided with a displaceable workstation 20, which at least provides a shielded working area, e.g. a room, at a pipeline connecting position of the system when said workstation 20 is in an operating position thereof.

[0024] The workstation 20 is displaceable to a remote position to allow for the placement of an accessory 40 at said pipeline connecting position as will be explained below.

[0025] Below said pipeline connecting position the launch structure 11 is provided with a pipeline clamping device 30, which clamping device is adapted to clamp and support the weight of the previously launched pipeline. Such a clamp is commonly referred to as a "hang-off clamp".

[0026] The clamp 30 here is arranged movable, so as to allow for the passage of an accessory 40 integrated into the pipeline 2 as will explained further on.

[0027] Here the clamp 30 is held by a parallelogram linkage, including parallel support bars 31, 32, which are at one end pivotable connected to the clamp 30 and at the other end to the launch structure, the pivot axes lying essentially horizontal. One or more (hydraulic) actuators 33 are provided for moving and positioning the clamp 30. As such the clamping device 30 is mounted for movement between an active position near the firing line of the pipeline and a remote position.

[0028] As has been mentioned before, it is often desired to fit an "accessory" at the end of the pipeline or at an intermediate position in or onto the pipeline 2.

[0029] Such accessories are commonly large and heavy items, such as a PLET (PipeLine End Terminal).

[0030] In the figures an accessory 40 has been depicted schematically as a block for the purpose of simplicity only. It will be clear that an accessory can have a different shape.

[0031] The system also includes an accessory handling device, which is adapted to receive and support an accessory 40 and allow displacement of the accessory 40 between an receiving position, wherein the accessory 40 is received by the handling device and the pipeline connecting position (here below the tensioner 18), wherein the accessory 40 can be connected to the pipeline.

[0032] Not shown in the figures are accessory connecting means for connecting the accessory 40 to the pipeline, e.g. welding means.

[0033] As can be seen in figure 3 two horizontal rails 51, 52 are mounted on the launch structure 11 above another.

[0034] The workstation 20 is slidable supported by these rails 51, 52, so that the workstation 20 can be moved from the central position to the side in order to make room for an accessory 40.

[0035] As can be seen in figure 4 the accessory handling device includes a first subframe 55, which is mounted on said rails 51, 52 and is slideable along said rails 51, 52. The accessory handling device also includes a second subframe 60, which is supported by said first subframe 55 so as to be orientable in one or more degrees of freedom with respect to said first subframe 55.

[0036] In the embodiment shown here the second subframe 60 is movable parallel to the first subframe 55, e.g. up and down with respect to said first subframe 55. This is done here by an hydraulic actuator 57, which is provided for parallel, e.g. up and down motion, of the second subframe 60 with respect to the first subframe 55.

[0037] Between the first and second subframes 55, 60 also a first set of hydraulic positioning actuators 61, 62 and a second set of hydraulic positioning actuators 63, 64 are provided. The first and second sets are spaced apart from one another and each include at least two

spaced apart actuators, so as to allow accurate orientation of the second subframe with respect to the first subframe, both with regard to the distance between the subframes and the angular orientation of the second subframe with respect to the first subframe.

[0038] Preferably each of the actuators 61-64 is controllable such that the second subframe 60 is orientable so as to include an angle with the first subframe 55, e.g. about one or in this case two degrees of angular freedom.

[0039] The second subframe 60 here has hook members 65, 66 adapted to hang the accessory 40 thereon. It will be appreciated that other fastening means could be provided (e.g. on the second subframe) to (temporarily) fasten the accessory (or the associated accessory handling frame as will be explained further on) to the second subframe.

[0040] The actuators 57, 61-64, allow for an accurate positioning of the accessory fastened to the second subframe 60 with respect to the pipeline 2, which facilitates the connection process, e.g. the welding process.

[0041] In this example the accessory 40 is provided with an accessory handling frame 70, which here is detachable from the accessory 40.

[0042] In a preferred embodiment it is envisaged that a standard accessory handling frame 70 (e.g. of uniform principal dimensions) is employed for handling accessories on board of a pipelaying vessel, such that different accessories can be handled in a uniform manner.

[0043] In this example the accessory handling frame 70 has a (elongated) pallet 71, provided with support extensions 72 on opposed sides thereof, which support extensions 72 can engage with the hook members 65, 66 of the second subframe 60.

[0044] The accessory 40 can be placed on the pallet 71 and fixed thereto, e.g. by temporary welds or other detachable fixation means.

[0045] The frame 70 has one or more lift hook engagement members 73, here at the top end of a triangular arranged bars 74 at each longitudinal side of the pallet 71.

[0046] In figure 4 it can be seen that the detachable accessory handling frame 70 also has one or more hook members 76, 77, essentially identical to said one or more hook members 65, 66 on said second subframe 60, such that once a first accessory has been integrated into said pipeline, the associated detachable accessory handling frame can remain on said second subframe, and a new accessory, having an essentially similar detachable accessory handling frame can be hung on said detachable accessory handling frame of said first accessory.

[0047] As will be clear the accessory handling device is adapted for horizontal translation along the rails 51, 52 (e.g. by actuators not shown in the drawings) and in this manner an accessory supported by said handling device can be moved from an accessory receiving position to the pipeline connecting position.

[0048] In figure 3 the reference numeral 40' denotes a position wherein the accessory is held before it is picked up by the handling device. It will be clear that in order to do so the launch structure 11 has to be slid sideways in this embodiment. In another embodiment the rails 51, 52 are extendible to the side, so that the handling device can reach said position in the extended position of the rails 51, 52. In yet another embodiment the accessory is presented within the range of the rails 51, 52.

[0049] For moving an accessory 40 into the receiving position the system further includes an accessory loader device 90, of which an exemplary embodiment will now be explained in detail.

[0050] The accessory loader device 90 is mounted on a deck of the vessel 1, preferably adjacent to the pipe launch device 10, here basically at one end of the rail 13 closest to the stern of the vessel.

[0051] In order to supply an accessory 40 to the loader device 90 the vessel 1 here is provided with an accessory transportation rail structure 100, here with parallel rails 100 extending across at least a part of a deck of said vessel, e.g. along a side of the deck. It is envisaged that the accessory handling frame 70 is adapted to engage on said transportation rail structure 100, e.g. with rollers or a skidding arrangement.

[0052] The loader device 90 here comprises a base 91 mounted on the vessel and a pivotable loader arm 92. The loader arm 92 is pivotable about a horizontal pivot axis 93 with respect to the base 91.

[0053] The loader device 90 further comprises a first linkage member 94, pivotable about an associated horizontal pivot axis 95 with respect to the base 91, and a second linkage member 96, extending between said first linkage member 94 and the loader arm 92 and pivotable connected thereto.

[0054] Also an hydraulic actuator 97 is mounted between the base 91 and said first linkage member 94, so that operation of the hydraulic actuator 97 cause the loader arm 92 to pivot.

[0055] The loader arm 92 has, here at its free end, one or more lift hooks 98 engageable with the members 73 of the accessory handling frame 70.

[0056] The loader arm 92 can hook onto a frame 70 as the frame 70 is on the transportation rails 100 next to the loader device 90. Then the loader arm 92 can be pivoted, so that the frame 70 is lifted up.

[0057] The frame 70 will then come to bear against a tilt stop 99 on the loader arm 92. This causes the frame 70 to follow the tilting motion of the arm 92, and thus the frame 70 will be tilted from an essentially horizontal feed position into the more or less vertical receiving position.

[0058] The tilt stop (and or the co-operating part of the frame 70) could include a damper to dampen the contact between both.

[0059] Although the figures 6a-h basically speak for themselves it will now be explained how an accessory 40 mounted in an associated handling frame 70 will be picked up by the loader 90 and brought into the pipeline connecting position, where the accessory 40 can be welded or the like onto the end of a pipeline or at an intermediate position on or into the pipeline.

[0060] In figures 6a and 6b it is shown that the frame 70 and accessory 40 are picked up by the loader 90 (which is not shown in figure 6a). The frame 70 and the accessory 40 mounted thereon have been transported over the rails 100 towards the loader 90.

[0061] Then the arm 92 is tilted and along with said arm 92 the frame 70 and accessory 40. As such the assembly of the frame 70 and accessory 40 is brought into the position shown in figures 6c,d. (the loader 90 is not shown in figure 6c).

[0062] The launch structure 11 is then translated sideways, such that the accessory handling device (including subframes 55, 60) comes into position opposite the assembly of frame 70 and accessory 40 still held by the loader 90. This movement of the launch device 11 is shown in figure 6 e. Then the frame 70 is hung on the handling device as explained before (fig. 6f).

[0063] By operating the actuator 57 the frame 70 is lifted from the loader 90 as is shown in figure 6g.

[0064] In the meantime the workstation 20 has been slid sideways to make room for the frame and accessory 40. Now the frame 70 and the accessory can be moved to the pipeline connecting position shown in figure 6h.

[0065] As mentioned before an accessory is often mounted at an intermediate position into a pipeline. Referring to figures 7a-g it will now be explained how this can be done on the vessel 1 provided with the accessory handling system.

[0066] In figure 7a the previously launched pipeline 2 is clamped by the clamping device 30. Then the pipeline 2 is cut off above the clamping device 30.

[0067] Then the upper part of the pipeline 2 is spooled back onto the spool 3, at least such that a gap is provided in which the accessory can be mounted. The tensioner 18 is used to provide backtension when spooling back the pipeline 2 onto the spool 3. Also the workstation 20 is here slid sideways to make room for the accessory. In this manner the situation of figure 7b is obtained.

[0068] In the manner explained referring to figure 6 the accessory 40 and the associated frame 70 are picked up by the loader and transferred to the accessory handling device and then moved into the pipeline connecting position, basically above the pipeline end held by the clamping device 30. This situation is shown in figures 7c,d.

[0069] Then the accessory 40 is welded onto this pipeline end held by the clamping device 30. The pipeline end above the accessory 40 is lowered until it can be welded to the accessory as well. This is shown in figure 7 e.

[0070] After welding the accessory is detached from the frame 70. The pipeline weight is taken over from the clamping device 30 by the tensioner 18. Now the clamping device 30 opens and release the pipeline. The clamping device 30 is then moved to its remote position, which is such that the accessory can pass. This is shown in figure 7f.

[0071] In the meantime also the accessory handling device and the frame 70 still held thereby are moved sideways, to allow the repositioning of the workstation 20. If desired the clamping device can be moved into its operable position. This is shown in figure 7g.

[0072] It is noted that the present invention is not limited to the "reel-lay" pipelaying technique. For instance the accessory handling as described herein can also be advantageously used for the J-lay technique or the S-lay technique, for the purpose of installing an accessory into or onto a pipeline.

Claims

1. Marine pipelaying system to be mounted on a vessel (1) for installing an offshore pipeline that includes one or more accessories (40), the system comprising:
 - a pipeline launch device (10) for launching the pipeline (2) from the vessel (1) in the direction of the seabed,
 - a pipeline clamping device (30) adapted to clamp and support the weight of the previously launched pipeline,
 - an accessory handling device (55, 51, 52, 60)

characterized in that the accessory handling device is adapted to receive and support an accessory and allow displacement thereof between an receiving position, wherein the accessory is received by the handling device and a pipeline connecting position, wherein the accessory can be connected to the pipeline, and **in that** the system further includes an accessory loader device (90) for moving an accessory into said receiving position, which accessory loader device is adapted to tilt said accessory from an essentially horizontal feed position into said receiving position.
2. System according to claim 1, wherein said pipeline connecting position is above the clamping device.
3. System according to claim 1 or 2, wherein the system further includes accessory connecting means for connecting the accessory to the pipeline, e.g. welding means.

4. System according to one or more of claims 1-3, wherein said accessory handling device is adapted for horizontal translation of said accessory.
5. System according to any of claims 1-4, wherein said accessory handling device has a rail structure, e.g. a horizontal rail structure, e.g. multiple horizontal rails mounted above one another.
6. System according to claim 5, wherein said rail structure is mounted on said pipe launch device.
7. System according to claim 1, wherein said accessory loader device comprises a base mounted on said vessel and a pivotable loader arm, said loader arm being pivotable about a horizontal pivot axis with respect to said base.
8. System according to claim 7, wherein said loading device includes an hydraulic actuator for actuating said loader arm.
9. System according to claim 7 or 8, wherein said loading device comprises a first linkage member, pivotable about an associated horizontal pivot axis with respect to said base, an actuator mounted between said base and said first linkage member, and a second linkage member, extending between said first linkage member and said loader arm and pivotable connected thereto.
10. System according to one or more of claims 1-9, wherein said accessory loader device has one or more lift hooks engageable with said accessory.

11. System according to claims 1 and 7, wherein said loader arm has a tilt stop, arranged and construed to be contacted by said accessory upon tilting of said loader arm.
12. System according to claim 11, wherein said tilt stop includes a damper.
13. System according to one or more of claims 1-12, wherein said accessory loader device is mounted on said vessel, adjacent to said pipe launch device.
14. System according to one or more of claims 1-13, wherein said vessel is provided with a accessory transportation rail structure extending across at least a part of a deck of said vessel, e.g. along a side of the deck, for transportation of accessories to said accessory loading device.
15. System according to one or more of the preceding claims, wherein said accessory handling device includes an handling frame associated with said accessory.
16. System according to claims 10 and 15, wherein said handling frame has one or more lift hook engagement member, each for engagement with a lift hook of said accessory loader device, e.g. two lift hook engagement members on opposed sides of the handling frame.
17. System according to claims 14 and 15, wherein said accessory handling frame is adapted to be skidded over said transportation rail structure.

- 18.** System according to claim 6, wherein said accessory handling device includes a first subframe, which is mounted on said rails structure and is slideable along said rail structure, and a second subframe, which is supported by said first subframe so as to be orientable in one or more degrees of freedom with respect to said first subframe, and wherein one or more actuators are provided between said first and said second subframe to allow accurate orientation of said second subframe.
- 19.** System according to claim 18, where said second subframe is movable parallel to the first subframe, e.g. up and down with respect to said first subframe, and wherein at least one actuator is provided for parallel, e.g. up and down motion, of the second frame.
- 20.** System according to claim 18 or 19, wherein said second subframe is orientatable so as to include an angle with the first subframe, e.g. about one or possible two degrees of angular freedom.
- 21.** System according to claim 20, wherein between the first and second subframes at least three actuators are provided in a spatial arranged, e.g. a triangular or square arrangement, allowing orientation of the second subframe with respect to the first subframe.
- 22.** System according to claim 20 or 21, wherein between the first and second subframes a first set of positioning actuators and a second set of positioning actuators are provided, said first and second set being spaced apart from one another and each including at least two spaced apart actuators, so as to allow orientation of the second subframe with respect to the first subframe.

- 23.** System according to any of claims 18-22, wherein the second subframe has one or more hook members adapted to hang the accessory thereon, e.g. by the accessory loading device.
- 24.** System according to claims 15 and 23, wherein the accessory handling frame is detachable from the accessory.
- 25.** System according to claim 24, wherein said detachable accessory handling frame has one or more hook members essentially identical to said one or more hook members on said second subframe, such that once a first accessory has been integrated into said pipeline, the associated detachable accessory handling frame can remain on said second subframe, and a new accessory, having an essentially similar detachable accessory handling frame can be hung on said detachable accessory handling frame of said first accessory.
- 26.** System according to one or more of the preceding claims, wherein said pipelaying system is adapted for reel laying, and wherein said system includes a storage reel for pipeline.
- 27.** System according to one or more of the preceding claims, wherein said launch device includes a launch structure having variable inclination.
- 28.** System according to claim 27, wherein one or more support struts, e.g. telescopic support struts, are associated with said launch structure to maintain its desired inclination.

29. System according to claim 27 or 28, wherein said launch structure is slideable over a support rail, which support the lower end of said launch structure.
30. System according to one or more of the preceding claims, wherein the launch device includes a displaceable workstation, at least providing a shielded working area, e.g. a room, at said pipeline connecting position when said workstation is in an operating position thereof, which workstation is displaceable to a remote position to allow for the placement of an accessory at said pipeline connecting position.
31. System according to claim 30, wherein said workstation is adapted for horizontal translation, e.g. along a rail structure, e.g. a horizontal rail structure, e.g. multiple horizontal rails mounted above one another, e.g. a rail structure associated with said accessory handling device.
32. System according to one or more of the preceding claims, wherein the clamp is arranged movable, so as to allow for the passage of the accessory integrated into the pipeline, e.g. the clamp being supported by the launch structure in a mobile manner.
33. System according to claim 32, wherein the clamping device is mounted for translation in horizontal direction between an active position near the firing line of the pipeline and a remote position.
34. System according to claim 32, wherein the clamping device is supported by a parallelogram structure, so as to be mobile essentially parallel to the firing line.

- 35.** System according to claim 26, wherein the launch structure includes at least one pipeline tensioner arranged above the pipeline connection position.
- 36.** Method for installing an offshore pipeline that includes one or more accessories, wherein use is made of a system according to one or more of the preceding claims.