

Seawater intake riser

Field of the invention

The present invention relates to a seawater intake riser. Also, the invention relates to
5 a method for manufacturing such a seawater intake riser. Furthermore, the invention relates to a method for deploying such a seawater intake riser.

Background

From the prior art seawater intake risers are known that are equipped with a ballast.
10 Typically such a seawater intake riser features a single solid ballast acting as inlet or a ballast fully composed by hanging chains.

The solid ballast system has a difficult and relatively expensive implementation, as the deployment needs an installation vessel with a high capacity crane. Also, installation windows are more restrictive depending on the geographical location and climate zone.

15 Furthermore, the lift of the solid ballast connected to the riser pipe could be particularly instable, especially if the sea conditions are not optimal. The movements of the riser pipe could perturb the stability of the lift and increase tensions in the rigging.

Moreover, the solid ballast would be lifted in a horizontal configuration, meaning that very long wire slings will be required. This would require a very significant height under the
20 crane hook and would increase the risks of uncontrolled movements during deployment.

As for the ballast composed by hanging chains only, it's an easier solution to deploy a seawater intake riser, as it only requires Anchor Handling Tug Supply (AHTS) vessels, and installation windows are less restrictive when compared to solid ballast. However, for the application of long risers, it may lead to compression in the riser pipe part of the system,
25 which is not permitted.

It is an object of the present invention to overcome or mitigate one or more of the disadvantages from the prior art.

Summary of the invention

30 The object is achieved by a seawater intake riser configured for intake of water from a body of water comprising:
a riser pipe, a riser head configured for connection to a water tank (in a hull) of a vessel and
a riser inlet configured for the intake of water; the riser head arranged at a proximal end of the riser pipe and the riser inlet arranged at a distal end of the riser pipe; the riser inlet

comprising a grid element with openings configured to allow water to flow into the interior of the riser pipe while blocking objects floating in the flowing water to enter; the grid element comprising a connector configured to attach a ballast to the grid element, wherein the ballast is a distributed ballast of a plurality of ballast elements arranged in a string; the string at one end thereof connected to the connector and the plurality of ballast elements in the string spaced apart from each other along the length of the string by intermediate line segments.

In addition, the invention relates to a method for deploying a seawater intake riser as described above, on a moored hydrocarbon production vessel floating on a body of water, the moored vessel comprising a water tank; the method comprising:

- providing on the body of water a first service vessel and a second service vessel;
- providing in the body of water a floating seawater intake riser portion consisting of the riser pipe including the riser head and the riser inlet and a pickup line, in which a free end of the riser head is attached to the first service vessel, and the pickup line is attached to a free end of the riser inlet;
- providing on a deck of the second service vessel the distributed ballast;
- from the second service vessel taking up the pickup line from the body of water;
- connecting the line of the distributed ballast to the connector of the grid element of the riser inlet;
- lowering the riser inlet by controllably overboarding from the second service vessel the plurality of ballast elements, one ballast element at a time, such that the distal end of the riser pipe and the riser inlet are suspended on the string of the ballast elements overboarded; the overboarding comprising that each ballast element is transferred from the deck to the body of water following the order of the ballast elements in the string.

Advantageously, the invention provides a seawater intake riser that is easier to install due to the use of a distributed ballast. The distributed ballast elements have predetermined smaller dimensions than a prior art single solid ballast allowing them to be handled individually during the deployment, which reduces the need for specialty installation equipment such as a heavy duty crane.

Also, the arrangement of the distributed ballast elements in a string allows to have a ballast with relative increased slenderness, which reduces axial added mass and drag. Accordingly, the stability of the seawater intake riser is improved.

Brief description of drawings

The invention will be explained in more detail below with reference to drawings in which embodiments thereof are shown. The drawings are intended exclusively for illustrative purposes and not as a restriction of the inventive concept. The scope of the invention is only limited by the definitions presented in the appended claims.

5 The drawings are schematic in nature and therefore not necessarily drawn to scale. Identical or similar elements are indicated by the same reference sign.

Figure 1 schematically shows a seawater intake riser according to an embodiment of the invention;

Figure 2 schematically shows a ballast of a seawater intake riser according to an
10 embodiment;

Figures 3A - 3H schematically show steps of a deployment procedure for a seawater intake riser according to an embodiment.

Detailed description of embodiments

15 Figure 1 schematically shows a vessel 200 equipped with a seawater intake riser 100 according to an embodiment of the invention.

On a body of water 202 a vessel 200 is floating that is equipped with a seawater intake riser 100. Such a vessel is for example, a hydrocarbon production vessel, such as an floating production storage and offloading, FPSO, floating production unit, FPU, floating
20 storage and offloading, FSO, or floating liquefied natural gas, FLNG, vessel. The hydrocarbon production vessel is moored during operation, either spread moored or turret moored. Alternatively, the hydrocarbon production vessel can be a tension leg platform, TLP, equipped with a seawater intake riser.

When the vessel 200 is in operation, processing equipment 204 on the vessel
25 produces hydro-carbon fluids from sources as undersea gas or oil fields. During this operation the processing equipment on the vessel 200 uses seawater for auxiliary purposes such as cooling.

For this purpose, seawater is taken in from the body of water by a water intake system comprising a seawater intake riser 100.

30 The seawater intake riser 100 has a length L with an inlet 102 at a depth that substantially matches the required temperature of the water taken in. Typically, the temperature of seawater is lower at larger depths than at the surface. For example, in tropical waters, a temperature of about 7°C is found at a depth of about 700m below sea level.

The seawater intake riser 100 according to the invention comprises a riser head 104, a riser pipe 106, a riser inlet 102 and a ballast 108.

The riser pipe 106 is connected at a proximal end 106a to the riser head 104, and at a distal end 106b to the riser inlet 102.

5 According to an embodiment, the riser pipe 106 is manufactured from a polymer, for example high density polyethylene, HDPE. A riser pipe in one piece up to for example 700 m can be manufactured by extrusion of the polymer material.

The riser head 104 is configured to couple to a water tank or caisson 206 in the vessel 200 to create a connection between the riser pipe 106 and the water tank 206. The
10 riser inlet 102 is arranged on the riser pipe 106 as an inlet for water from the body of water in which the riser pipe is immersed.

In an embodiment, the riser inlet 102 comprises a grid element with openings configured to allow water to flow into the interior of the riser pipe while blocking objects floating in the flowing water to enter. Further the riser inlet 102 comprises a connector
15 configured to attach to the ballast 108.

The ballast is provided to obtain a relatively stable vertical arrangement of the seawater intake riser 100, by reducing drag of the riser due to a (tidal) stream in the body of water.

Fig 2 schematically shows the riser inlet 102 and ballast 108 of a seawater intake
20 riser according to an embodiment.

The riser inlet 102 comprises the grid element 110 which has a substantially cylindrical shape with preferably openings 112 arranged in the radial direction. The size of the individual openings 112 is such that objects or marine life can be prevented to enter the riser pipe volume. At the bottom end of the riser inlet 102 a connector 114 is provided to
25 which the ballast 108 can be connected.

According to the invention, the ballast 108 is configured as a distributed ballast comprising a plurality of ballast elements 120 (i.e., two or more) that are moveable relative to each other. The ballast elements are arranged in a string in which the ballast elements are interconnected by an intermediate line segment 122 between successive ballast elements.
30 In use the ballast string is extending vertically under the grid element 110 and connector 114 with the ballast elements 120 positioned one above the other.

The intermediate line segments 122 provide that adjacent ballast elements 120 are spaced apart and moveable relative to each other. The line segments 122 can be manufactured from one or more of synthetic or polyester rope, steel rope and steel chain.

The ballast elements 120 have an elongated cylindrical shape like for example a torpedo with coupling elements 124 at each end that are configured to connect to a intermediate line segment 122.

5 In an embodiment, one or more ballast elements has a cylindrical shape, in particular a slim cylindrical shape i.e., with relatively small diameter compared to a length of the cylinder.

In an embodiment, the coupling elements 124 have a substantially conical shape or rounded shape which usefully reduces the drag from the water stream on the ballast elements 120.

10 The ballast elements 120 are preferably designed to a size and weight that the connected ballast elements 120 can be manipulated and positioned relative to each other on a deck of an installation/AHTS service vessel (not shown) and that they can withstand the loading/impact of passing over a stern roller of the service vessel during installation.

15 The distributed ballast 108 is attached by a first line segment 123 to the connector on the riser inlet and to a proximal end of a first ballast element 120 in the string. In a preferred embodiment the first line segment 123 consists of a synthetic or polyester rope.

Figures 3A - 3H schematically show steps of a deployment procedure for a seawater intake riser according to an embodiment.

20 As a first step, a seawater intake riser component 100-1 is formed from the riser head 104, riser pipe 106 and riser inlet 102. Also, a distributed ballast component 100-2 comprising the string of ballast elements 120 interconnected by intermediate line segments 122 is formed.

Fig 3A shows schematically a first step of the procedure.

25 The seawater intake riser component 100-1 is prepared to float on the body of water by keeping air in the riser volume 130 by means of a sealing system (no shown) that closes off the internal volume of the seawater intake riser component 100-1. A first service vessel 31 is provided to connect to the riser head 106 by a towing cable 32. A second service vessel 33 such as an AHTS vessel is provided which carries on its loading deck the distributed ballast component 100-2. The second service vessel 33 is connected to the riser inlet by a floating auxiliary line 35 which has been taken up by the second vessel 33 from the water.

Fig 3B shows schematically a next step of the deployment.

35 Next, the first ballast element 120 of the distributed ballast 108 is attached to the connector 114 of the riser inlet 102 by means of the first line segment and overboarded. The floating auxiliary line 35 is removed or disconnected from the riser inlet.

As shown in fig 3B the sealing system is still present, which ensures the seawater intake riser component 100-1 remains floating while the first ballast element is hanging below the seawater intake riser component.

Alternatively, as shown in fig 3C, in this step when overboarding a first ballast element, the sealing system has been opened or removed. The opening of the sealing system causes the internal volume of the seawater intake riser to fill with water which in combination with the weight of the grid element will pull the riser's end that is provided with the riser inlet down.

Thus the opening the sealing system, will allow water will enter the seawater intake riser and the end with the riser inlet to sink, while the other end of the seawater intake riser component remains connected to the second service vessel and relatively close to the water surface.

Fig 3D shows schematically a following step of the deployment. The distributed ballast 108 consisting of the string of ballast elements 120 is overboarded from the loading deck of the second service vessel 33 by controllably releasing the ballast elements one after another into the seawater.

Fig 3E shows schematically a next step. Before releasing a last one of the plurality of ballast elements 120 into the sea, an second auxiliary line 36 is attached to it. The second auxiliary line 36 is taut in this condition, while holding the end of the distributed ballast 120;122. Accordingly, the distributed ballast will be on a relatively curved line.

The second auxiliary line 36 is then slackened to lower the distributed ballast 108 until the floating seawater intake riser 100 is floating in a vertical position in which the riser head 104 is at or near the water surface and the riser inlet 102 is at a depth substantially corresponding with the length L of the riser pipe 106. The riser head 104 is still attached to the first service vessel 31 and manoeuvred close to the position of the hydrocarbon production vessel 200.

Fig 3F- 3G show schematically a subsequent step of the procedure.

When the first service vessel 31 is positioned near the hydrocarbon production vessel 200, the seawater intake riser 100 including the distributed ballast 108 is handed over to a crane or a winch 208 on the hydrocarbon production vessel. An ROV 38 connects a line 40 from the hydrocarbon production vessel to the riser head 104. After the load of the seawater intake riser has been transferred from the first service vessel 31 to the hydrocarbon production vessel 200, the connecting line 35 between the first service vessel and the seawater intake riser is removed.

Finally, as shown in Fig 3H, the seawater intake riser is pulled in by the crane or the winch 208 and secured. The riser head 104 is connected to an inlet 210 of the water tank 206 of the vessel 200.

5 The invention has been described with reference to preferred embodiments. Obvious modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims.

Claims

1. A seawater intake riser configured for intake of water from a body of water comprising:
a riser pipe, a riser head configured for connection to a water tank (in a hull) of a
5 vessel and a riser inlet configured for the intake of water;
the riser head arranged at a proximal end of the riser pipe and the riser inlet arranged at a distal end of the riser pipe;
the riser inlet comprising a grid element with openings configured to allow water to flow into the interior of the riser pipe while blocking objects floating in the flowing
10 water to enter;
the grid element comprising a connector configured to attach a ballast to the grid element,
wherein the ballast is a distributed ballast of a plurality of ballast elements arranged in a string; the string at one end thereof connected to the connector and the plurality of
15 ballast elements in the string spaced apart from each other along the length of the string by intermediate line segments.
2. The seawater intake riser according to claim 1, wherein the string comprises a plurality of intermediate line segments, in which each ballast element is coupled
20 between two line segments and a first line segment is connected at one end to the connector and at the other end thereof to a first of the ballast elements.
3. The seawater intake riser according to claim 2, wherein the line segments consist of one or more of synthetic rope such as polyester rope, steel rope or steel chain.
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4. The seawater intake riser according to any one of claim 2 - 3, wherein the first line segment consists of at least a synthetic rope portion.
5. The seawater intake riser according to any one of the preceding claims, wherein the
30 ballast element has an elongated shape with a coupling element at each end for coupling with a respective line segment.
6. The seawater intake riser according to claim 5, wherein the ballast element has a cylindrical shape, in particular a slim cylindrical shape.

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7. The seawater intake riser according to claim 5 or 6, wherein the coupling elements on the ballast element are cone-shaped.
8. The seawater intake riser according to any one of claims 1 - 7, wherein the grid element has a substantially cylindrical shape with the openings arranged in the circumferential surface thereof.
9. A hydrocarbon production vessel floating on a body of water, the vessel being provided with at least one seawater intake riser according to any one of claims 1 - 8.
10. A method for deploying a seawater intake riser in accordance with any one of claims 1 - 8 on a moored hydrocarbon production vessel floating on a body of water, the moored vessel comprising a water tank;
the method comprising:
- providing on the body of water a first service vessel and a second service vessel;
 - providing in the body of water a floating seawater intake riser portion consisting of the riser pipe including the riser head and the riser inlet and a pickup line, in which a free end of the riser head is attached to the first service vessel, and the pickup line is attached to a free end of the riser inlet;
 - providing on a deck of the second service vessel the distributed ballast;
 - from the second service vessel taking up the pickup line from the body of water;
 - connecting the line of the distributed ballast to the connector of the grid element of the riser inlet;
 - lowering the riser inlet by controllably overboarding from the second service vessel the plurality of ballast elements, one ballast element at a time, such that the distal end of the riser pipe and the riser inlet are suspended on the string of the ballast elements overboarded; the overboarding comprising that each ballast element is transferred from the deck to the body of water following the order of the ballast elements in the string.
11. The method according to claim 10, further comprising:
attaching a slackening line to a last ballast element of the string before overboarding, and slacken the slackening line until the string of distributed ballast is suspended on the connector of the grid element.

12. The method according to claim 11, further comprising:
the first service vessel towing the seawater intake riser towards the moored vessel,
and positioning and connecting the free end of the riser head to the water tank.
- 5 13. The method according to claim 12, wherein the step of positioning and connecting the
free end of the riser head comprises:
handing over the free end of the riser head to an auxiliary pull-in device on the
moored vessel by means of a pull-in line, subsequently pulling-in the free end and
coupling the free end to an entry of the water tank .
- 10 14. The method according to any one of preceding claims 10 – 13, wherein the seawater
intake riser is provided with a sealing system, the method comprising:
providing that the sealing system closes off the floating seawater intake riser portion
and an internal volume of the floating seawater intake riser portion is substantially
15 filled with gas such as air, while the floating riser portion is connected to the first
service vessel and to the second service vessel by means of the pickup line;
and subsequently
either, after overboarding a first ballast element of the plurality of ballast elements,
causing opening of the sealing system to allow water to enter the internal volume
20 or, before or during overboarding a first ballast element of the plurality of ballast
elements, causing opening of the sealing system to allow water to enter the internal
volume.
15. A method for manufacturing a seawater intake riser, comprising
25 providing a riser pipe, a riser head configured for connection to a water tank of a
vessel and a riser inlet configured for the intake of water;
the riser head attached to a proximal end of the riser pipe and, and the riser inlet
attached to a distal end of the riser pipe;
the riser inlet comprising a grid element with openings configured to allow water to
30 flow into the interior of the riser pipe while blocking objects floating in the flowing
water to enter;
providing the grid element with a connector configured to attach a ballast to the grid
element;
creating a distributed ballast of a plurality of ballast elements arranged in a string, the
35 string at one end thereof configured to connect to the connector and the plurality of

ballast elements in the string spaced apart from each other along the length of the string by intermediate line segments.