

(2)

SUCTION ANCHOR AND METHOD OF INSTALLING
A SUCTION ANCHOR

The invention relates to an improved method of installing a suction anchor in the bottom of a body of water.

It is often desirable to install a suction anchor in the water bottom in order to use it for the anchoring of various structures, such as for example floating drilling platforms, floating production platforms, floating tension leg platforms, various types of ships and single buoy mooring systems for loading and unloading tankers, or, for example, for the staying by means of guy cables of various structures, such as for example a free-standing marine conductor.

From European Patent Application No. 79200678.5, it is known to install a suction anchor in the water bottom by reducing the pressure in the interior of the suction anchor by pumping water therefrom. A problem which sometimes occurs during the installation by means of this method is that the plug of bottom material which enters the interior of the suction anchor, may disturb the pumping process since the reduced pressure may cause expansion of the plug of bottom material and/or accumulation of bottom material in the interior of the anchor.

It is an objective of the invention to provide an improved method of installing a suction anchor in the bottom of a body of water.

Therefore the method according to the invention comprises lowering the anchor to the bottom, reducing the pressure in the interior of the anchor by removing water therefrom, in order to create a positive pressure difference between the exterior and interior of the anchor thereby causing the anchor to penetrate into the bottom and a plug of bottom material to

enter into the said interior, removing at least the upper part of the said plug from the said interior by introducing water into the said interior, so as to create a mixture of bottom particles and water, and removing the mixture from the said interior.

5 A preferred embodiment of the method according to the invention comprises removing at least the upper part of the said plug from the said interior by introducing water into the upper part of the said interior and removing the mixture from
10 the upper part of the said interior.

A suction anchor adapted to be installed in the bottom of a body of water by means of the above improved method comprises according to the invention an inlet for introducing water into the interior of the anchor and an outlet for
15 removing water/or a mixture of bottom particles and water from the said interior, the anchor further comprising pumping means being connected to the outlet for removing water/or a mixture of bottom particles and water from the outlet and for reducing the pressure in the interior of the anchor so as to create
20 during installation a positive pressure difference between the exterior and interior of the anchor in order to cause the anchor to penetrate into the bottom.

In an attractive embodiment of the anchor according to the invention, the inlet is in communication with at least one
25 jetting tube arranged in the upper part of the said interior.

The invention will now be explained with reference to the drawings relating to some possible embodiments of the invention, wherein

Figure 1 shows a vertical cross sectional view of a first
30 possible embodiment of the suction anchor according to the invention, at the moment that it has penetrated about halfway into the water bottom.

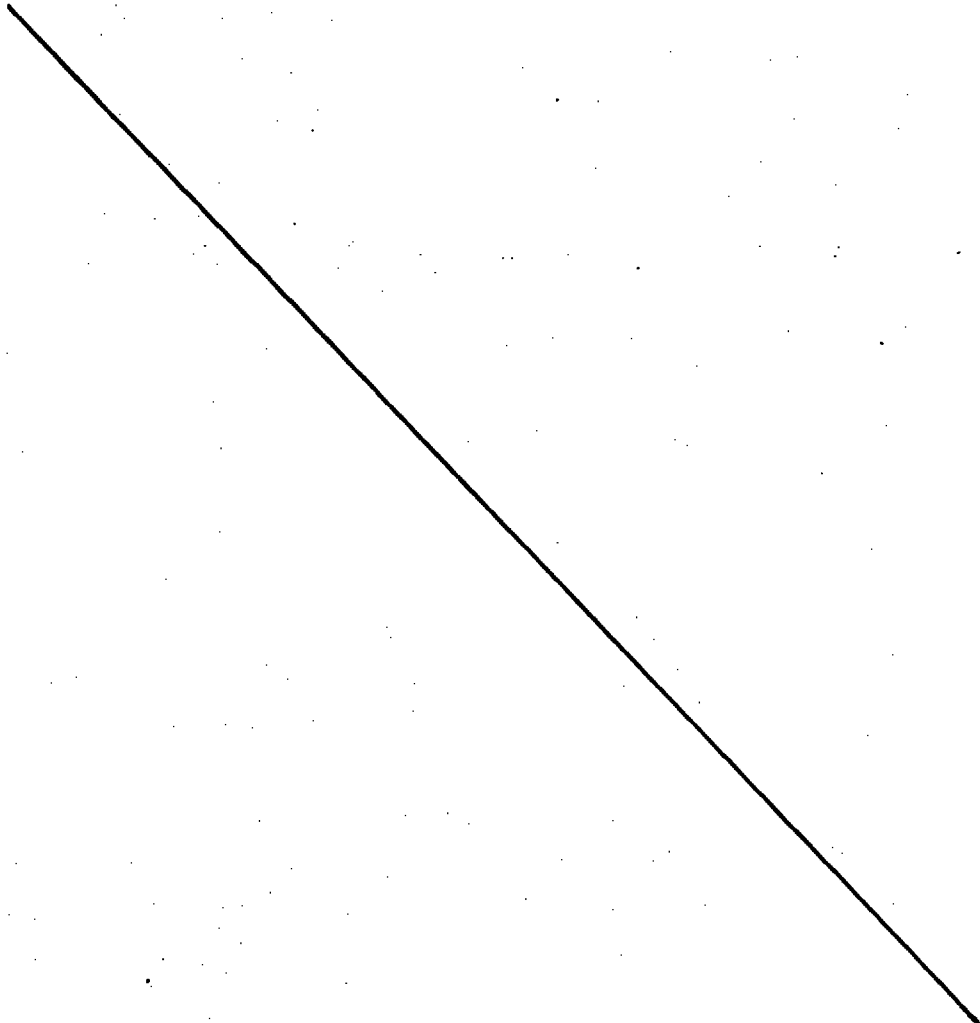
14

2a

Figure 2 shows a vertical cross sectional view of the suction anchor of figure 1, at the moment that the plug of bottom material has reached the upper part of the interior of the anchor and the flushing away of bottom particles from the upper part of the plug has just started.

Figure 3 shows a vertical cross sectional view of the suction anchor of figure 1, when bottom particles are being flushed away from the upper part of the plug of bottom material.

Figure 4 shows a vertical cross sectional view of the suction anchor of figure 1, in the position wherein it has



penetrated entirely into the waterbottom.

Figure 5 shows a vertical cross sectional view of a second possible embodiment of the suction anchor according to the invention.

5 The embodiment of the suction anchor for carrying out the method according to the invention as shown in figures 1 to 4 is generally indicated by the reference numeral 1. A tubular element 2, for example made of steel is closed at its upper end by means of a cap 3. The lower end of the tubular element 2
10 is open and is provided with a cutting edge 4 which enables the suction anchor 1 to penetrate into the bottom 5 of a body of water 6.

 The cap 3 is provided with an outlet 7 and an inlet 8. Pumping means 15 are connected to the outlet 7 by means of a
15 releasable coupling 18, which may be a conventional remotely controlled releasable coupling. The pumping means 15 comprise a pump 16, adapted to pump a mixture of bottom particles and water, which pump 16 is driven by a remotely controlled motor 17.

20 Pumping means 20 are connected to the inlet 8 by means of a releasable coupling 24. The pumping means 20 comprise a pump 22, which is driven by a remotely controlled motor 21, and a remotely controlled valve 23, which valve is arranged in the suction passage of the pump 22.

25 The pumping means 15 and the pumping unit 20 are secured to a frame 10. The frame 10 is provided with a remotely controlled releasable hook 11, which cooperates with an eye 9 secured to the suction anchor 1.

30 The frame 10 is connected to a hoisting cable 12, which is suspended from a vessel (not shown) floating at the surface of the body of water 6.

 A string of umbilical cables (not shown) is suspended from the vessel adjacent to the hoisting cable 12 for operating the motors 17 and 21, the couplings 18 and 24, the hook 11 and the
35 valve 23.

The suction anchor 1 is installed in the bottom of the body of water in the following manner.

The suction anchor 1 is lowered from the floating vessel (not shown) by paying out the hoisting cable 12. During the lowering of the anchor, the pumping means 15 and the pumping means 20 are not in action and air present in the interior 13 of the anchor 1 is allowed to escape either through the pumping means 15, 20 or through special air release valves (not shown) on the anchor 1. When the cutting edge 4 contacts the bottom 5, the hoisting cable 12 is slackened somewhat so as to allow the cutting edge 4 to penetrate into the bottom 5 over a small distance under the weight of the suction anchor 1, in order to form a seal around the base of the tubular element 2.

Then, with the valve 23 in the closed position, the driving motor 17 is started, which causes the pump 16 to evacuate water from the interior 13 of the anchor 1, so that the pressure within the anchor 1 is reduced. The pump 16 removes the water from the interior 13 through the outlet 7 as indicated by arrow I and passes the water to the exterior of the anchor as indicated by arrow II.

In this manner a positive pressure difference is created between the water 6 outside the anchor 1 and the interior 13 of the anchor 1. This pressure difference causes a gradual penetration of the anchor 1 into the bottom 5, while a plug 14 of bottom material enters the interior 13 gradually.

Figure 1 shows the position wherein the anchor 1 has penetrated about halfway into the bottom 5 and the plug 14 of bottom material has reached the middle part of the anchor 1.

Figure 2 shows the position wherein the anchor 1 has penetrated more than halfway into the bottom 5. In that position the plug of bottom material 14 has almost reached the top wall 3 of the anchor 1 and may cause blockage of the outlet 7 and of the pump 16. The top of the plug 14 tends to reach the top wall 3 at an early stage since the reduced pressure in the interior 13 causes the plug 14 to expand. In order to prevent said

blockage, at this moment the valve 23 is opened and the driving motor 21 is started, which causes the pump 22 to introduce water from the exterior into the inlet 8 as indicated by arrow III. From the inlet 8 the water introduced is distributed through jetting tubes 25 into the upper part of the interior 13 as indicated by arrows IV.

The water introduced through the jetting tubes 25 converts the top part of the plug 14 into a mixture of bottom particles, and water.

The mixture of bottom particles and water is removed from the interior 13 by means of the pump 16 which passes the mixture via passage 7 (indicated by arrow I) and to the exterior of the anchor 1, as indicated by arrow II.

The introduction of water into the interior 13 by pump 22 decreases the pressure difference between the exterior and the interior 13 of the anchor 1. The resulting pressure difference may be sufficient to cause a further penetration of the anchor 1 into the bottom 5. If this pressure difference is not sufficient the penetration of the anchor 1 may be continued after the upper part of the plug 14 has been removed. For this purpose the pump 22 is put out of operation, the valve 23 is closed and the pump 16 is put into operation so that in the interior 13 a pressure is created which is sufficiently low to cause further penetration of the anchor.

Figure 3 shows the position wherein the anchor 1 has penetrated almost entirely into the bottom 5 and bottom particles are being flushed away from the upper part of the plug of bottom material.

Figure 4 shows the situation wherein the anchor 1 has reached the desired penetration depth in the bottom 5. At this moment the driving motors 17 and 21 are switched off so that the pumping process is stopped.

The couplings 18 and 24 and the hook 11 are released so that the pumping means 15, the pumping means 20 and the frame 10 are disconnected from the anchor 1.

Then the frame 10, the pumping means 15 and the pumping means 20 are raised to the water surface by hauling in the hoisting line 12 and taken aboard of the vessel (not shown) at the surface of the water 6.

5 Figure 5 shows another possible embodiment of a suction anchor for carrying out the method according to the invention.

In this embodiment a suction anchor 50 (partly shown) comprises a tubular element 51, which is open at the lower end and which is closed at the upper end by means of a cap 52.

10 The cap 52 is provided with an outlet 53 and with inlets 54. A pipe 55 mounted on the anchor 50 forms a fluid passage which is in communication with the outlet 53. Pumping means 60 are connected to the upper end of the pipe 55 by means of a releasable coupling 56.

15 X The pumping means 60 comprise a pump 61, adapted to pump a mixture of bottom particles and water, which pump 61 is driven by a motor 62 adapted to be remotely controlled from a vessel (not shown) by means of an umbilical cable 66. X

20 The pumping means 60 are secured to a frame 63 which is suspended from the floating vessel by means of hoisting line 65 which passes along the pulley-sheaves 69 and 70. Jetting tubes 71 pass through each inlet 54, each tube 71 being secured to the anchor 50 by means of a flange 72.

25 The suction anchor according fig. 5 is installed as follows. The suction anchor 50 is lowered from the vessel to the water-bottom by paying out the hoisting cable 65. When the suction anchor 50 has reached the waterbottom the cable 65 is slackened somewhat in order to allow the tubular element 51 to penetrate into the waterbottom over a small distance under the weight of
30 the whole anchor 50. Then the motor 62 is started by supplying the necessary energy via the umbilical cable 66, which causes the pump 61 to remove water from the interior 57 of the anchor 50 as indicated by arrow V to the exterior 58 as indicated by arrow VI. In this manner a positive pressure difference is
35 created between the exterior 58 and the interior 57 of the

anchor 50. Said pressure difference causes water to flow from the exterior of the anchor 50 via the jetting tubes 71 as indicated by arrows VII into the interior 57 as indicated by arrows VIII. This introduction of water causes a decreased
5 resulting pressure difference between the exterior 58 and the interior 57 of the anchor 50.

The flow restriction of the jetting tubes 71 is high, and the resulting pressure difference is sufficient to cause the anchor 50 to penetrate into the waterbottom.

10 When the top of the plug of bottom material, which enters into the interior 57 during the penetration process, has reached the upper part of the interior 57, bottom particles are flushed away from the top of the plug by the waterflows VIII. The mixture of bottom particles and water as formed is removed from
15 the interior 57 through the outlet 53 as indicated by arrow V to the exterior 58 as indicated by arrow VI.

When the suction anchor 50 has penetrated into the waterbottom to the desired depth, the driving motor 62 is switched off and the coupling 56 is released. Then the frame 63 together
20 with the pumping means 60 are raised to the water surface by hauling in the hoisting cable 65, and taken aboard of the floating vessel.

A suction anchor, installed in the bottom of a body of water in the manner according to the invention can be used for
25 various purposes. If it is provided with an anchor cable, it can for example be used for the mooring of a ship, for anchoring a floating production- or drilling platform, so as for example a so-called tension leg platform, for anchoring a single buoy mooring system for loading or unloading tankers.

30 The said tubular element can also be used as an envelope for protecting the well head and/or the upper part of an oil- or gaswell in the seabed, or for anchoring a pipeline to the seabed, or for the staying by means of guy cables of various structures, such as for example a freestanding marine conductor.

(20)



8

C L A I M S

1. A method of installing a suction anchor in the bottom of a body of water, comprising lowering the anchor to the bottom, reducing the pressure in the interior of the anchor by removing water therefrom, in order to create a positive
5 pressure difference between the exterior and interior of the anchor thereby causing the anchor to penetrate into the bottom and a plug of bottom material to enter into the said interior, removing at least the upper part of the said plug from the said interior by introducing water into the said interior, so
10 as to create a mixture of bottom particles and water, and removing the mixture from the said interior.
2. The method as claimed in claim 1, comprising removing at least the upper part of the said plug from the said interior by introducing water into the upper part of the said interior
15 and removing the mixture from the upper part of the said interior.
3. The method as claimed in claim 1, wherein the mixture of bottom particles and water is removed from the said interior by pumping means.
- 20 4. A suction anchor adapted to be installed in the bottom of a body of water by means of the method as claimed in any one of the claims 1-3, comprising an inlet for introducing water into the interior of the anchor and an outlet for removing water/or a mixture of bottom particles and water from the
25 interior, the anchor further comprising a pumping means being connected to the outlet for removing water/or a mixture of bottom particles and water from the outlet and for reducing the pressure in the interior of the anchor so as to create during installation a positive pressure difference between the
30 exterior and interior of the anchor in order to cause the anchor to penetrate into the bottom.



(21)

9

5. The suction anchor as claimed in claim 4, wherein the inlet is provided with valve means.
 6. The suction anchor as claimed in any one of the claims 4-5, wherein the anchor is provided with a pumping unit for supplying water to the inlet.
 7. The suction anchor as claimed in claim 6, wherein the said pumping unit is provided with a suction passage which is in communication with the water outside the anchor.
 8. The suction anchor as claimed in any one of the claims 6-7, wherein the pumping means and the pumping unit are mounted on the anchor.
 9. The suction anchor as claimed in claim 8, wherein the pumping means and the pumping unit are connected to the anchor by means of releasable couplings.
 10. The suction anchor as claimed in claim 9, wherein the releasable couplings are remotely controlled.
 11. The suction anchor as claimed in any one of the claims 4-10, wherein the inlet is in communication with at least one jetting tube arranged in the upper part of the said interior.
 12. A method of installing a suction anchor in the bottom of a body of water, substantially as described with particular reference to the accompanying drawings.
 13. A suction anchor suitable to be installed in the bottom of a body of water, substantially as described with particular reference to the accompanying drawings.
-