

DESCRIPTION

TITLE OF THE INVENTION: OFFSHORE FLOATING STRUCTURE

5 TECHNICAL FIELD

[0001]

The present invention relates to an offshore floating structure, which is a ship body part for an FPSO (Floating Production, Storage and Offloading system).

10 BACKGROUND ART

[0002]

The FPSO is a facility which can produce petroleum and gas through a riser pipe from the ocean floor at sea, and store crude oil in a tank for delivery to a tanker. The FPSO
15 is different from a tanker, and is not only provided with a tank for holding crude oil, but also has a production facility on an upper deck. The production facility comprises various kinds of equipment, including a gas separation facility, a dewatering facility, a metering facility, an
20 electric power facility, and so on. These facilities are designed in accordance with characteristics of an oil well, and are mounted on the upper deck after construction of the ship body. Therefore, it often occurs that the detailed specifications of these facilities are not decided when
25 designing the ship body. Thus, if the design of the ship

body is carried out after the requirements for the production facility are decided for each of the projects, the construction of the ship body cannot be completed by the time the production facility is to be mounted. As a result, a problem occurs, in which a construction period of the FPSO as a whole becomes long.

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0003]

10 The production facility is installed on an array of stools on an upper deck, in a state in which the production facility is fixed on a base, and the structure of the stools and the installation location should be decided while considering not only the kind, the arrangement, and the size
15 of the production facility, but also the influence of the deformation of the floating body caused by the wave load on the base. Thus, it takes a long time to complete the design, which causes the construction period of the FPSO to be long, as described above. Further, the load transmitted to the
20 floating body may change depending upon the kind and the arrangement of the production facility and the kind of the stools, and because of this, the upper deck may have to be reinforced. However, when it is necessary to connect multiple stools to each other with a stringer on the upper
25 deck, a problem occurs in the consideration of such a

stringer because it should not interfere with the piping on the upper deck.

[0004]

An object of the present invention is to provide an offshore floating structure that can cope with (or support) various types of production facilities and does not need to be reinforced in accordance with the type of the production facility, by which the construction period of the FPSO can be shortened.

10 MEANS FOR SOLVING THE PROBLEMS

[0005]

The present invention is an offshore floating structure, in which a production facility can be mounted on an upper deck of a floating body in which a tank is formed, the offshore floating structure comprising a plurality of transverse strength members provided on a lower surface of the upper deck and extending in the breadth direction of the floating body, and a plurality of longitudinal strength members provided on the lower surface of the upper deck to extend in the longitudinal direction of the floating body, wherein at least a part of a plurality of points on the upper surface of the upper deck at the horizontal coordinates where the transverse strength members intersect with the longitudinal strength members, define a stool placement area where stools for supporting the production facility can be

mounted.

[0006]

It is preferable that the stool placement area for supporting a single production facility is in a grid pattern.

5 A plurality of the longitudinal strength members may be provided for a single stool placement area. The transverse strength member includes either a transverse girder or a transverse bulkhead, for example. The longitudinal strength member includes either a longitudinal girder or a
10 longitudinal bulkhead, for example. The offshore floating structure may further comprise a reinforcing member provided in the stool placement area to connect two adjacent stools in a horizontal direction. Preferably, the stool placement area is provided with a stool base, and the individual stools can
15 be attached to an upper surface of the stool base.

[0007]

Either one of the transverse girder or the transverse bulkhead may be divided into a stool support structure containing the stool placement area and a body structure such
20 that the structures are separately manufactured. In a transverse section of the floating body it is preferable that both ends of the stool support structure are connected to the body structure and incline to taper downward. The stool support structure may comprise a first support structure
25 adjacent to the body structure and a second support structure

separate from the body structure. The stool support structure is assembled top-down from the upper side to the body structure, for example.

EFFECT OF THE INVENTION

5 [0008]

According to the present invention, an offshore floating structure, which can support various types of production facilities and does not need to be reinforced in accordance with the type of the production facility, can shorten the
10 construction period of the FPSO.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a front view showing a general structure on an upper deck of an FPSO, to which a first embodiment of the
15 present invention is applied.

Fig. 2 is a side view showing individual stools and a base in an enlarged state, which are contained in the structure shown in Fig. 1.

Fig. 3 is a plan view showing a positional relationship
20 between transverse strength members and longitudinal strength members, which are provided on a lower surface of the upper deck, and a stool.

Fig. 4 is a sectional view showing a first arrangement example of the longitudinal strength member (longitudinal
25 girder).

Fig. 5 is a sectional view showing a second arrangement example of the longitudinal strength member (longitudinal girder).

Fig. 6 is a sectional view showing a third arrangement
5 example of the longitudinal strength member (longitudinal girder).

Fig. 7 is a view showing a case, in which the reinforcing member extends in the breadth direction of the floating body in a second embodiment.

10 Fig. 8 is a view showing a case, in which the reinforcing member extends in the longitudinal direction of the floating body in the second embodiment.

Fig. 9 is a perspective view showing the stool and the reinforcing member in an enlarged state in the second
15 embodiment.

Fig. 10 is a perspective view, in which the stool and the reinforcing member of Fig. 9 are disassembled.

Fig. 11 is a view showing a stool of a third embodiment.

Fig. 12 is a sectional view showing a fourth embodiment.

20 Fig. 13 is a sectional view showing a fifth embodiment.

Fig. 14 is a sectional view showing a sixth embodiment.

EMBODIMENT OF THE INVENTION

[0010]

In the following, with reference to an embodiment shown
25 in the drawings, the present invention will be described.

Fig. 1 shows a general structure on an upper deck of an FPSO, to which a first embodiment of the present invention is applied. A tank 11 is formed in a floating body 10, and a plurality of production facilities 20 are mounted on an upper deck 12. The production facilities 20 include a gas separation facility, a dewatering facility, a metering facility, an electric power facility, and so on, which are mounted on stools 30 provided on the upper deck 12, in a state in which the production facilities are fixed on bases 21. The stools 30 are arranged in a grid pattern, as described later.

[0011]

Fig. 2 is a view, in which the base 21 and the stools 30 contained in the structure shown in Fig. 1 are enlarged and viewed from the side. The stools 30 have a mountain-shaped body 31, in which the breadth tapers toward the upper side, and each leg portion 22 projecting from the lower surface of the base 21 is mounted on the upper surface of an individual stool body 31. Each leg portion 22 of the base 21 is integrally fixed to the upper surface of a stool body 31, or is relatively moveably supported in the longitudinal direction (vertical to a paper surface of Fig. 1) of the floating body 10 and/or the breadth direction (right and left direction in Fig. 1). This is provided for restraining an influence of the deformation of the floating body 10 caused

by the wave load and the like, on the base 21.

[0012]

In each stool body 31, a top plate (not shown) is provided on a portion on which the leg portion 22 of the base 21 is mounted. As a specific example of the connection between the top plate and the base 21 in one production facility 20, the base 21 is integrally fixed to the top plates of the stool bodies 31 positioned at a rear end side of the floating body 10, and the base 21 is relatively moveably supported by the top plate of the other bodies 31. The latter top plates are composed of fluoroethylene resin and the like, for example, and the base 21 is slidably mounted on the top plates, so that a deformation of the floating body 10 is absorbed by a relative displacement between the top plates and the base 21. Note that material, such as rubber, having a small shear elastic modulus can be used instead of fluoroethylene resin for the top plate relatively moveably supporting the base 21.

[0013]

Fig. 3 shows a positional relationship between a transverse strength member 40 and a longitudinal strength member 41, which are provided on a lower surface of the upper deck 12, and the stools 30. The transverse strength member 40 is a transverse girder (see Fig. 4) extending in a breadth direction of the floating body 10 or a transverse bulkhead.

The longitudinal strength member 41 is a longitudinal girder (see Fig. 4) extending in a longitudinal direction of the floating body 10 or a longitudinal bulkhead. Note that a plurality (five in the example shown in Fig. 3) of stiffeners 42 are provided between two adjacent longitudinal strength members 41.

[0014]

On an upper surface of the upper deck 12, stool placement areas 43 are defined by a plurality of points, at which the transverse strength member 40 and the longitudinal strength member 41 cross to form a grid pattern. The stool placement areas 43 are portions where two strength members 40 and 41 cross, and thus have a higher strength performance than the other portions, by which the stool placement areas 43 are suitable for mounting the stools 30 supporting the production facility 20. The stool placement areas 43 are at least a part of a plurality of points, where the transverse strength members 40 intersect with the longitudinal strength members 41, but the stool placement areas 43 may include all the cross points. In Fig. 3, two examples of the production facilities 20 are shown, in which the stool placement areas 43 supporting each of the production facilities 20 are arranged in a grid pattern, and individual stools 30 are provided in every position of the stool placement areas 43 that are positioned under each of the production facilities

20.

[0015]

Figs. 4-6 show arrangement examples of the longitudinal strength member (longitudinal girder) 41. The transverse strength member (transverse girder) 40 has a common structure in the three examples, and the height of the transverse girder 40 is higher than that of the longitudinal girder 41. The height of the stiffener 42 extending in parallel to the longitudinal girder 41 is lower than that of the longitudinal girder 41. Fig. 4 shows the first arrangement example, in which the number of longitudinal girders 41 at each of the stool placement areas 43 (see Fig. 3) is one, and the stool placement area 43 is an approximately square area, which has the center at the point where the longitudinal girder 41 and the transverse girder 40 cross, and in which the length of one side is the distance between the two adjacent stiffeners 42. That is, the base portion of the stool 30 extends over an area where two stiffeners 42 adjacent to the longitudinal girder 41 are provided. Note that the base portions of the stool 30 may be expanded beyond the example shown in Fig. 4, so that four stiffeners 42 or more can be included in the stool placement area 43, for example.

[0016]

Fig. 5 shows the second arrangement example, and the number of the longitudinal girders 41 in each of the stool

placement areas 43 is two. One stiffener 42 is provided between the two longitudinal girders 41 of the stool placement area 43, which is formed by the two longitudinal girders 41 and the transverse girder 40. The center of the stool placement area 43 is at the point where the stiffener 42, which is located between the two longitudinal girders 41, and the transverse girder 40 cross, and the stool placement area 43 is an approximately square area, in which the length of one side is the distance between the two longitudinal girders 41. That is, the base portion of the stool 30 extends over an area where the two longitudinal girders 41 adjacent to the stiffener 42 passing through the stool placement area 43 are provided. Note that the base portions of the stool 30 may be expanded beyond the example shown in Fig. 5, so that one stiffener 42 or more can be provided outside the longitudinal girders 41 in the stool placement area 43, for example.

[0017]

Fig. 6 shows the second arrangement example, and the number of the longitudinal girders 41 in each of the stool placement areas 43 is three. Two or three stiffeners 42 are provided between the two adjacent stool placement areas 43. The stool placement area 43 is an approximately square area, the center of which coincides with the center of the three longitudinal girders 41 where the transverse girder 40

crosses, and in which the length of one side is the distance between the two adjacent longitudinal girders 41. That is, the base portion of the stool 30 extends over an area where two longitudinal girders 41 positioned on both sides of the stool placement area 43 are provided. Note that the base portions of the stool 30 may be expanded beyond the example shown in Fig. 6, so that one stiffener 42 or more can be provided outside the longitudinal girders 41 of the stool placement area 43, for example.

10 [0018]

In the first embodiment as described above, on the lower surface of the upper deck 12 of the floating body 10, the longitudinal girders 41 are provided along the direction in which the transverse girders 40 cross, and the stools 30 may be mounted at only part of the points where these girders cross, wherein the production facility 20 can be mounted on the part encompassing the stool placement areas 43. Therefore, even when the production facility's specification such as type, arrangement, and size has not been determined, the production facility 20 can be mounted on the floating body 10 after the floating body 10 is designed and manufactured, and the construction of the floating body 10 can proceed to some extent. Thus, the construction period of the FPSO can be shortened.

25 [0019]

Figs. 7-10 show a second embodiment, in which a reinforcement to the stools 30 provided in the first embodiment can be carried out during the construction of the floating body 10. A reinforcing member 50 connects two adjacent stools 30 in a horizontal direction, and the other constructions are identical to the first embodiment. The direction, in which the reinforcing member 50 is provided, may be a longitudinal direction or a breadth direction of the floating body 10. Fig. 7 shows a case, in which the reinforcing member 50 extends in the breadth direction of the floating body 10, and Fig. 8 shows a case, in which the reinforcing member 50 extends in the longitudinal direction of the floating body 10.

[0020]

Figs. 9 and 10 show the stool 30 and the reinforcing member 50 in an enlarged state. The body 31 of the stool 30 is constructed by placing two trapezoidal connection plates, each having a vertical portion, on both surfaces of a trapezoidal plate, such that the plates adjacent to each other are at right angles, and flanges 33 are adhered to the oblique sides. L-shaped reinforcing plates 34 are fixed to the portions between adjacent plates, so that the body 31 is reinforced. The reinforcing plates 34 are provided at the vertical positions corresponding to the upper and lower ends of the reinforcing members 50. The sectional shape of the

reinforcing members 50 has an H-shape, and an end 51 is inclined to tightly fit to the flange 33. A lower surface of the reinforcing members 50 is separated from the upper deck 12 as shown in Figs. 7 and 8, to form a space for providing
5 piping between the reinforcing members 50 and the upper deck 12.

[0021]

According to the second embodiment, the reinforcement of the stool 30 can be carried out before the floating body 10
10 is completed and the production facility 20 is installed. As explained with reference to Fig. 2, the base 21 of the production facility 20 and the stools 30 are integrally fixed in some areas, and are relatively movably supported in the other areas. Regarding the stool 30, in which the base 21 is
15 fixed, the load it bears is greater than that of the other stool 30, and therefore, the reinforcement may be needed after the specification of the production facility 20 is determined. In the second embodiment, since the reinforcing member 50 can be attached after the completion of the
20 floating body 10, the design and construction of the floating body 10 can proceed before the specification of the production facility 20 is determined, and thus, the construction period of the FPSO can be further shortened. Furthermore, since the reinforcing member 50 has a structure
25 that connects only the upper portions of the stools 30, the

reinforcing member 50 can effectively reinforce the stools 30 without interfering with piping.

[0022]

Fig. 11 shows a third embodiment. In this embodiment, on the upper deck 12, a stool base 44 is provided in the stool placement area 43 at the intersection of the transverse girder 40 and the longitudinal girder 41. The other constructions are the same as those of the first embodiment. The stool base 44 has a table-shaped structure having a flat trapezoidal section, and is fixed to the surface of the upper deck 12 with welding and the like. The upper surface of the stool base 44 is large enough to attach the stool 30.

[0023]

The stool placement area 43 is a high-strength performance position where the transverse girder 40 (or transverse bulkhead) and the longitudinal girder 41 (or longitudinal bulkhead) cross, similar to the first and second embodiments. In the third embodiment, the stool base 44 is provided beforehand in the stool placement area 43, and thus the stool 30 can be installed after the production facility to be mounted is determined. Therefore, the number of the individual stools 30 can be restrained to the minimum necessary amount.

[0024]

Fig. 12 shows a fourth embodiment. In this embodiment,

the transverse girder 40 is divided into a stool support structure 45 containing the stool placement area 43 fixed to the upper deck 12 and a body structure 46, so that the structures 45 and 46 are separately manufactured. The stool support structure 45 has the upper deck 12, the longitudinal girder 41, the stiffener 42, the stool 30, and the transverse girder 40, while the body structure 46 has the upper deck 12, the stiffener 42, the longitudinal bulkhead 47, and the transverse girder 40. A boundary 48, at which the transverse girder 40 is divided into the stool support structure 45 and the body structure 46, is a straight line extending obliquely downward from an end portion on the upper deck 12 side of the longitudinal bulkhead 47, in a transverse section of the floating body 10. That is, both ends of the stool support structure 45 are connected to the body structure 46, and are inclined to taper downward. The stool support structure 45 is as long as possible in the longitudinal direction of the floating body 10, and has around 20m in length, for example.

[0025]

The body structure 46 has a standard structure, which does not depend upon the specification and so on of the production facility 20 mounted thereon, is designed to have strength performance that meets the requirement of the assumed maximum load, and has only one design. Conversely, the stool support structure 45 has an individual structure,

which depends upon the load exerted by the production facility 20 mounted thereon, and a plurality of types are designed in advance with taking into consideration the weight, number, and combination of the production facilities 20
5 mounted thereon. As an example of how the plurality of designs can be prepared with design variations in advance, the number of longitudinal girders 41 included in one stool placement area 43 can vary within a range from one to three or the contour line on the tank side of the transverse girder
10 40 can be changed as shown in the solid line A or the dot-and-dash line B.

[0026]

According to the embodiment, a plurality of types of stool support structures 45 are prepared in advance, and when
15 the production facility 20 is determined, the designer is required only to select the optimal one from a plurality of the stool support structures 45. Thus, the design and manufacture of the floating body 10 can be carried out quickly, to shorten the construction period of the FPSO.

20 [0027]

Fig. 13 shows a fifth embodiment. This embodiment has a construction, in which the stool support structure 45 is divided into three parts, and the construction of the body structure 46 is common to the fourth embodiment. The stool
25 support structure 45 is divided into two first support

structures 45a adjacent to the body structure 46 and a second support structure 45b positioned between the first support structures 45a. That is, the second support structure 45b is separated from the body structure 46. A boundary 49 between
5 the first and second support structures 45a and 45b is a straight line extending in perpendicular to a horizontal line, and the lengths of the support structures 45a and 45b in the breadth direction of the floating body are approximately the same.

10 [0028]

In a single transverse section, three support structures 45a and 45b are provided with a single stool 30, respectively. The constructions of these support structures 45a and 45b close to the upper deck 12 are similar, and each of the stool
15 placement areas 43 is located at a position where the transverse girder 40 and the longitudinal girder 41 cross and the stiffeners 42 are provided on both sides of the longitudinal girder 41. Conversely, the constructions of the transverse girders 40 are different in the support structures
20 45a and 45b. That is, regarding the first support structure 45a, the contour lines on the tank side of the transverse girder 40 are set to various shapes as shown in the solid line A or the dot-and-dash line B, depending upon the specifications of the production facility 20 mounted thereon,
25 while regarding the second support structure 45b, the basic

shape is standardized such that the contour lines of the transverse girder 40 and so on are the same. Further, in the second support structure 45b, the number of items that can vary depending upon the mounted production facility 20 is less than that of the first support structure 45a, and only the thickness of the plate can be changed.

[0029]

In the fifth embodiment as described above, since the stool support structure 45 is divided into the first and second support structures 45a and 45b, a greater variety of stool support structures 45 than the fourth embodiment can be easily obtained by combining these stool support structures.

[0030]

Fig. 14 shows a sixth embodiment. In this embodiment, the stool support structure 45 is assembled top-down from the upper side to the body structure 46. The stool support structure 45 of either the fourth embodiment or the fifth embodiment can be adopted. As described above, the stool support structure 45 is designed with taking into consideration the weight, number, combination and the like of the production facilities 20 mounted thereon, and manufactured separately from the body structure 46. However, the constructions of both ends of the stool support structure 45, which are the boundaries 48 with the body structure 46, are common. For example, when there are two stool support

structures 451 and 452 as shown in the drawing, while the shapes of the contour lines of the tank sides of the transverse girders 40 are different from each other as shown by the solid lines A and B, the constructions of both ends of the stool support structures 451 and 452 are common, and inclined to taper downward. Thus, the stool support structures can be easily assembled with the body structure 46.

EXPLANATION OF REFERENCES

[0031]

10 10 floating body

11 tank

12 upper deck

30 stool

40 transverse strength member (transverse girder)

15 41 longitudinal strength member (longitudinal girder)

43 stool placement area

CLAIMS

[CLAIM 1]

An offshore floating structure, in which a production
5 facility can be mounted on an upper deck of a floating body
in which a tank is formed, the offshore floating structure
comprising:

a plurality of transverse strength members provided on a
lower surface of the upper deck and extending in the breadth
10 direction of the floating body; and

a plurality of longitudinal strength members provided on
the lower surface of the upper deck and extending in the
longitudinal direction of the floating body;

wherein at least a part of a plurality of points on the
15 upper surface of the upper deck at the coordinates where the
transverse strength members intersect with the longitudinal
strength members, define a stool placement area where stools
for supporting the production facility can be mounted.

[CLAIM 2]

20 The offshore floating structure according to claim 1,
wherein the stool placement area for supporting a single
production facility is in a grid pattern.

[CLAIM 3]

The offshore floating structure according to claim 1 or
25 2, wherein a plurality of the longitudinal strength members

is provided for a single stool placement area.

[CLAIM 4]

The offshore floating structure according to any one of claims 1 through 3, wherein the transverse strength member
5 includes either a transverse girder or a transverse bulkhead.

[CLAIM 5]

The offshore floating structure according to any one of claims 1 through 4, wherein the longitudinal strength member includes either a longitudinal girder or a longitudinal
10 bulkhead.

[CLAIM 6]

The offshore floating structure according to any one of claims 1 through 5, further comprising a reinforcing member provided in the stool placement area to connect two adjacent
15 stools in a horizontal direction.

[CLAIM 7]

The offshore floating structure according to any one of claims 1 through 6, wherein the stool placement area is provided with a stool base, the stool being able to attach to
20 an upper surface of the stool base.

[CLAIM 8]

The offshore floating structure according to claim 4, wherein one of the transverse girder or the transverse bulkhead is divided into a stool support structure containing
25 the stool placement area and a body structure such that the

structures are separately manufactured.

[CLAIM 9]

The offshore floating structure according to claim 8,
wherein, in a transverse section of the floating body both
5 ends of the stool support structure are connected to the body
structure and incline to taper downward.

[CLAIM 10]

The offshore floating structure according to claim 9,
wherein the stool support structure comprises a first support
10 structure adjacent to the body structure and a second support
structure separate from the body structure.

[CLAIM 11]

The offshore floating structure according to one of
claims 9 and 10, wherein the stool support structure is
15 assembled top-down from the upper side to the body structure.