

LIQUID-LIQUID SEPARATION APPARATUS

The present invention concerns apparatus for separating immiscible water and lighter liquid, for example hydrocarbon liquids and the like from water. More particularly, though not exclusively, the invention concerns a liquid-liquid separator for use in a body of water for separating and removing crude oil from waste water, and specifically, waste water discharged from an offshore drilling platform.

Waste water disposal caissons are available which remove oil from waste water through the use of an internal spillover weir located above the main water level of the body of water in which such caissons are arranged. These caissons, however, are susceptible to the potentially adverse effect of wave action; namely, that the oil/water interface level in the caissons might momentarily rise above the spillover weir and allow water to enter the oil chamber from which it is desired to pump only oil.

According to the present invention, there is provided apparatus for separating the components of a liquid mixture of water and lighter liquid, comprising:

a vessel situated in a body of water;

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a surge plate extending horizontally across the interior of said vessel dividing the vessel into an upper section and a lower section which defines a first reservoir for the liquid mixture and which communicates with said body of water, said surge plate having an opening therethrough between the upper and lower sections forming a flow passage therebetween, the opening being sized to restrict flow between the upper and lower sections as a result of changes in the water level of the body of water;

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10 a weir plate having an upper edge at an elevation above the expected high mean water level of the body of water, the weir plate extending in an upward direction from said surge plate to divide the upper section into a second reservoir, which communicates with the first reservoir through the opening in the surge plate and in

15 which the lighter liquid components of the liquid mixture collect, and a chamber for the lighter liquid components of the liquid mixture which overflow the upper edge of the weir plate;

20 means for supplying said liquid mixture to said first reservoir; and

means in said chamber for removing said lighter liquid from said chamber.

With such separation apparatus, the upward flow of liquids in the upper section of the vessel (caisson) is restricted such that
5 even under storm conditions, the oil level is increased only slightly during a rise in the water level immediately surrounding the caisson. This oil level falls an equivalently small amount when the water level immediately surrounding the caisson falls. ~~The small~~
The opening,
10 ~~hole~~ in the surge plate restricts upward flow of liquids caused by wave action yet does not restrict downward flow of the inlet liquids and solid particles, such as sand.

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A further advantage of the surge plate concept is that since the oil spillover ^{weir} ~~weir~~ does not have to be elevated much above the expected high mean water level, a smaller oil layer will be formed in the upper section of the caisson reducing thereby the possibility that the lower level of the oil level i.e. the oil-water interface will fall below the water inlet terminus.

The invention will be better understood from the following description, given by way of example, with reference to the accompanying drawings, in which :-

Figure 1 is a vertical, sectional view of one form of liquid-liquid separation apparatus in accordance with the invention; and

Figure 2 is a view taken on lines 2-2 of Figure 1.

Referring to the drawing, an open-ended cylindrical caisson 10 is positioned in a body of water 11 adjacent an offshore platform or other oil and gas drilling or producing facility, not shown. The high mean water level of the body of water 11 is indicated at 12. Caisson 10 is arranged upright in the body of water 11. A horizontal surge plate 13 is permanently fixed in the caisson and divides caisson 10 into upper and lower sections, 14

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and 15, respectively. A weir plate 16 is permanently affixed to surge plate 13 and extends vertically in section 14 to form an oil reservoir 17 and an oil bucket chamber 18. The upper edge of weir plate 16 is at an elevation above the expected high mean water level 12 of the body of water. Lower section 15 forms an oil and water reservoir 19.

Surge plate 13 contains a small hole 20 communicating between reservoirs 17 and 19.

A waste water inlet 21 passes through upper section 14 and surge plate 13 into lower section 15, as shown.

A pump 25 is arranged in bucket chamber 18. It is furnished with a check valve 19 at its lower end which permits flow into but prevents flow from pump 25. This pump may be suitably a conventional double-diaphragm pneumatic type pump. A conduit 26 supplies gas, such as air, to pump 25 to operate the pump and an outlet conduit 27 discharges oil from pump 25.

Another tubing 28 extends through the open upper end of caisson 10 into bucket chamber 18. It is open at its lower end and is connected to a level indicator at the surface to determine the level of the oil in bucket chamber 18. This level is determined by measuring back pressure when a steady flow of gas is put into tubing 28 from a point, not shown, outside of caisson 10.

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The level indicator may be a conventional separate float controller, not tubing 28, which turns on pump 25 when the level in oil bucket 18 rises above a pre-set or pre-selected level. Such level indicator is connected to a suitable control for controlling operation of pump 25. Another level control may be provided by a float arranged in a liquid safety high float vessel 31 which is connected to the interior of caisson 10 by lines 32 and 33 which contain valves 34 and 35, respectively.

Water and oil flow through inlet conduit 21 to lower section 15 in which the oil and water separate. Hydrostatic head determines elevation of the oil/water interface. Water downflows through caisson 10 with the excess water leaving through the open end at the bottom of caisson 10 for disposal in the surrounding body of water 11. Solid particles also fall to the open bottom of caisson 10 and out into the surrounding body of water 11 preferably tumbling over baffles, not shown, while travelling down the caisson. Oil flows through small hole 20 into the upper section reservoir 17. Excess oil overflows ^{weir} ~~water~~ plate 16 and spills into oil bucket chamber 18 where a level controller connected to tubing 28 turns pump 25 on and off to keep the oil level within pre-set limits. The oil is pumped by means of gas supplied through conduit 26 from the caisson through conduit 27 to an appropriate oil storage vessel.

The operation is automatically controlled by line 28 and controls, not shown, connected to it. The upper level safety high floats controls flow of the waste water into inlet 21 by controlling a valve, not shown, on that inlet.

- 5 The caisson can be formed of various shapes other than cylindrical. Also, different type pumps might be used instead of gas-operated pump 25. For example, an electrically operated pump might be used instead.



CLAIMS:

1. Apparatus for separating the components of a liquid mixture of water and lighter liquid, comprising:

a vessel situated in a body of water;

5 a surge plate extending horizontally across the interior of said vessel dividing the vessel into an upper section and a lower section which defines a first reservoir for the liquid mixture and which communicates with said body of water, said surge plate having an opening therethrough between the upper and lower sections forming a flow passage therebetween, the opening being sized to restrict flow 10 between the upper and lower sections as a result of changes in the water level of the body of water;

15 a weir plate having an upper edge at an elevation above the expected high mean water level of the body of water, the weir plate extending in an upward direction from said surge plate to divide the upper section into a second reservoir, which communicates with the first reservoir through the opening in the surge plate and in which the lighter liquid of the liquid mixture collects, 20 and a chamber for the lighter liquid of the liquid mixture which overflows the upper edge of the weir plate;



means for supplying said liquid mixture to said first reservoir; and

means in said chamber for removing said lighter liquid from said chamber.

5 2. Apparatus as claimed in Claim 1, in which the lower section of said vessel is open ended.

3. Apparatus as claimed in Claim 2, wherein said means for removing said lighter liquid from the chamber comprises a pump including means for operating said pump responsive to the level of
10 said lighter liquid in said chamber.

4. Apparatus as claimed in Claim 3, including control means for terminating flow of liquids into said vessel in response to the level of said lighter liquid in said upper section of said vessel.

15 5. Apparatus for separating the components of a liquid mixture of water and lighter liquid, substantially as herein before described with reference to Figures 1 and 2 of the accompanying drawings.

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6. Use of apparatus according to any preceding claim,
wherein said liquid mixture comprises waste water discharged from an
offshore drilling platform.
